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ISSN 0543-5846
METABK 54(3) 594-596 (2015)
UDC – UDK 621.771:669.1338.5:519.2=111

REGRESSION ANALYSIS AS AN OBJECTIVE TOOL OF ECONOMIC MANAGEMENT OF ROLLING MILL

Received – Prispjelo: 2014-10-03
Accepted – Prihvaćeno: 2015-01-10
Professional Paper – Strukovni rad

The ability to optimize costs plays a key role in maintaining competitiveness of the company, because without detailed knowledge of costs, companies are not able to make the right decisions that will ensure their long-term growth. The aim of this article is to outline the problematic areas related to company costs and to contribute to a debate on the method used to determine the amount of fixed and variable costs, their monitoring and follow-up control. This article presents a potential use of regression analysis as an objective tool of economic management in metallurgical companies, as these companies have several specific features

Key words: metallurgical companies, rolling mill, costs, regression analysis, competitiveness

INTRODUCTION

Economic theory defines costs of a company as the monetary value of consumption of production factors including public expenditures, which arises as a result of production of corporate revenues. Costs represent an important synthetic indicator of the quality of company operation. There is a variety of approaches in terms of their classification.

For a number of managerial decision-making is important classification of costs according to their response to changes in production volume. From this perspective, the cost is divided into fixed costs and variable costs. The classification of the individual cost items into purely fixed and variable depends on the type of company, but a vast majority of cost in a company represent the so-called combined type, where part of the costs is variable and part is fixed. The individual cost items in companies are often empirically classified as fixed or variable, and they are accounted for in this way, for example, in calculations of corrected plan, in controlling reports, when determining the contribution margin, in the evaluation of investments, during the creation of business plans, etc.

The problem is that this empirical classification of the individual cost items into fixed and variable, is not, in many cases, verified retrospectively, using e.g. a regression analysis or a time series analysis, while the accuracy of the classification of cost items into fixed and variable is very important for various economic considerations and it influences the final assessment of development.

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COSTS OF A COMPANY

The amount of variable costs changes with the volume of production. An important distinguishing feature of variable costs is the fact that they change in relation to the changes in the volume of output or capacity utilization. Fixed costs, or permanent cost, are defined as costs that do not change within a certain range of performed outputs. A typical feature of these costs is that they make themselves felt as a consequence at the moment of application of economic resources that are able to execute certain amount of output in a specific time interval (production capacity). They are therefore capacity costs that are caused by the need to ensure the conditions for an efficient execution of the business process [1, 2].

Microeconomic theories of variable and fixed costs are presented in the article as the basic starting points. However, the management of a concrete company must be in compliance with the accounting legislation, but they are not always consistent. This problem has been studied for a long time, for example, by Balachandran, B. and Magee, R [3, 4].

Regression analysis and correlation analysis

A regression analysis is one of the basic methods that are used in statistical analysis of dependencies of the change of variables in time, or the relations between variables. Regression looks for a mean of dependence of two random values in order to facilitate predictions. It forms a regression line (straight line), which tells us

what character value of a dependent variable most likely corresponds to a specific value of character of an independent variable. The primary and the simplest way how to express the dependence is linear dependence. The application section of this article uses a linear regression model, where the graphical expression of the regression function is represented by a line, i.e., a straight line. Linear dependence is expressed using the function [5]:

$$\hat{y} = a + bx \quad (1)$$

Function (1) is analytical expression that expresses occurrences of y (dependent variable) expected most likely and contingent changes in x (independent variable).

EXPERIMENTAL PART AND RESULTS

Regression analysis as an objective tool of classification of the individual cost items into fixed and variable on metallurgical companies

As already mentioned above, is that this empirical classification of the individual cost items into fixed and variable, usually based on detailed statistics of overhead costs, is not, in many cases, verified retrospectively, using e.g. a regression analysis or a time series analysis, while the accuracy of the classification of cost items into fixed and variable is very important for various economic considerations and it influences the final assessment of development.

As already mentioned above, a vast majority of costs in a company are of the so-called combined type. The relation can be expressed using the equation (2). The value of y is obtained as follows:

$$y = a + bx \quad (2)$$

a fixed part of cost
bx variable part of cost.
a, b parameters of regression line

Empirical division of the individual cost items into fixed and variables on metallurgical companies

The article presents a model example that is based on the planned values of fixed and variable costs of a concrete plant in a metallurgical company in VÁLCOVNA TRUB VÍTKOVICE for the year of 2013*. The planned variable and fixed costs for 2013 are listed in Table 1. Table 1 provides only a summary of the planned costs, which is based on very detailed evidence the extent of which, however, exceeds the scope of this article.

Analysis of cost planning model:

Total costs (TC) = 27 301 *EUR*
Fixed costs (FC) = 21 844 *EUR*
Variable costs (VC) = 5 457 *EUR*

The percentage share of fixed planned costs (p) is obtained as follows:

$$\%p = \frac{fixed\ costs}{total\ costs} * 100 \quad (2)$$

Table 1 **Summary of the planned costs in a metallurgical company – Rolling Mill**

	Total costs	Variable costs	Fixed costs
	EUR	EUR	EUR
Total charge	17 030	16 629	323
Technological fuel	687	681	0
Wages and insurance	1 341	532	824
Depreciations of tangible fixed assets	219	0	229
Repairs and maintenance	1 831	449	1 372
Acquisition overhead expenses	1 740	0	1 752
Technical development	0	0	0
Other operating overhead costs	2 980	2 982	0
Other costs	1 582	681	957
Spoilt goods	-110	- 110	0
Total costs	27 301	21 844	5 457

$$\%p = \frac{5457}{27301} * 100 = 19{,}99 \quad (3)$$

The percentage share of planned fixed costs was set at 19,99 %.

The use of regression analysis to determine the relations between the variables

Table 1 presents the planned costs of a concrete plant in company VÁLCOVNA TRUB VÍTKOVICE for the year of 2013 and the determination of the percentage share of fixed planned costs. Table 2 shows the actually achieved values of cost of the above mentioned concrete plant in a company VÁLCOVNA TRUB VÍTKOVICE for the year of 2013**.

Table 2 **Real development of costs in a metallurgical company – Rolling Mill**

Month	Finished production	Change of state of work in process	Corrected production	Total costs
	tonnes	tonnes	tonnes	EUR
1	3 899	+ 696	4 595	2 525
2	3 996	+ 113	4 109	2 334
3	4 327	- 395	3 932	2 278
4	4 118	- 115	4 003	2 295
5	3 985	+ 327	4 312	2 330
6	3 613	- 65	3 548	2 100
7	2 146	- 268	1 878	1 420
8	3 959	+ 209	4 168	2 378
9	4 265	+ 29	4 294	2 331
10	4 235	+ 318	4 553	2 444
11	3 818	- 262	3 556	2 231
12	3 652	- 207	3 445	2 631

Analysis of real development of costs:

Regression line and correlation coefficient parameter values are:

a = 747,1
b = 0,383
r = 0,9823

* Figures for the year of 1999 are converted to the price level for the year of 2013. Actual dates are sensitive dates (trade secret) and can not be published.

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a, *b* parameters of regression line
r correlation coefficient

The cost function has a form of:

$$TC = 747{,}1 + 0{,}382 * x \quad (4)$$

TC total cost
x volume of output

The average values of *TC* and *x* are obtained as follows:

$$Ø\ TC = 747{,}1 \text{ EUR} \quad (5)$$

$$Ø\ x = 3\ 904{,}363 \text{ t} \quad (6)$$

The percentage share of fixed part of actual costs (*s*) is obtained as follows:

$$\varnothing s = \frac{747{,}1}{2242} * 100 = 33{,}31\ \% \quad (7)$$

The correlation coefficient r = 0,9893 $\Rightarrow$ cost function is of high quality and the functional dependency between variables is very tight.

Factors affecting the success rate of the use of regression analysis

The above presented example clearly shows the difference between empirical division of the individual cost items into fixed and variable and share of fixed costs calculated using the regression analysis. The percentage share of planned fixed costs was set at 19,99 %, but the actual share of fixed costs calculated using the statistical method - regression analysis is 33,31 %. The model example is based on actual values achieved in a metallurgical company and it confirms the practical experience showing that the share of fixed part of costs is generally higher than we expect on the basis of the classification of the cost items.

On the basis of this calculation, however, it is not possible to clearly state that the empirical division of cost items was completely wrong and that the share of fixed costs calculated by the statistical method - regression analysis is objective and accurate. As already mentioned above, the success rate of the use of regression analysis is greatly affected by the number of monitored actions, adjusted for organizational, methodological, price and other changes that complicate the comparability of the collected data. The selection of a suitable analyzed period and the adjustment of the input data, performed to derive the cost functions using the regression analysis method and the evaluation of the share of fixed and variable costs on the total costs, represent one of the most difficult areas of the problem. You have to set such a time period, in which the different (weekly, monthly) fluctuations and cost differences, which are not related to production volume, equal. Such aspects include, for example:

- lump-sum payments of certain elements of wage,
- lump-sum accounting of major cost items, such as inventory differences, accruing, additional accounting of actual cost of maintenance compared to preliminary budget, adjusting entries, etc.
- the effect of produced range - for example in metallurgy, the overall level of costs is significantly influenced by the cost of charge, these costs depend mainly on the quantity and price of charge, while the price of charge differs significantly according to quality (in one month, the production output in tones may be lower, but the costs of charge will be higher, because more expensive range is produced),
- effects related to the rising prices of fuel and energies throughout the year, the increase in the tariffs of Czech Railways throughout the year, etc.
- time shift between the cause of costs and their settlement - such as the relationship between the volume of production and maintenance cista

CONCLUSION

The difficulty of a successful application of the methods of statistical analysis used to calculate the cost function is also given by the necessity to eliminate some other effects that distort the informative capacity of the derived results. The theory of fixed and variable costs is based on defined relations between the costs and the volume of production. [6] The amount of costs, however, may also depend on other factors than the volume of production, such as the seasonal factors, etc.

However, when the regression analysis is used properly; it can become an objective tool of economic management and, with a sufficient number of monitoring actions, provable close correlation and correct interpretation of the results, the outcomes of this method are credible and useful in practice. [7].

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Note: The responsible translator for English language is Petr Jaroš, Goodwill - VOŠ, Czech Republic