The Impact of Determinant Factors on Production Cost Variation – An Empirical Study

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Abstract. *It is important to quantify the impact of the determinants on the production cost variation, because this constitutes a decisive principle in establishing pricing policy. On the strength of what has been stated, the objective of this research is to analyze influencing components of the production cost through the descriptive and graphical analysis of panel data and econometric models design. Regarding the impact factors, this study analyzes only the most relevant factors considered based on the descriptive analysis.*

Keywords: cost variation, cost center, panel data, impact factors, analysis

JEL Classification: C33, C58, L11, M11

1. Introduction

The primary purpose of a cost center is to create a distinctly identifiable department, division, or unit of an organization for which the respective managers will be responsible for all associated costs and for ensuring compliance with the company budgets. A cost center supports a company's profitability by improving efficiency, leading to increased product value.

Cost center accounting can help management in the optimal use of resources and improve operational efficiency, through smarter techniques for understanding resources. In this sense, this empirical study help us to estimate the numerical impact of the considered factors, on the variation of total costs in the analyzed cost centers.

The efficiency of the activity of economic entities presupposes the rational exploitation of limited resources. This involves dividing the activity into centers of responsibility, in order to measure performance according to available resources and how they are used. A responsibility center is an organizational entity that involves a delegation of authority regarding means (material, human, financial) and a capacity to negotiate on objectives (Tabără and Briciu, 2012).

In the evolution of Romanian companies, the tendency for managerial activity to be customer- and change-oriented is increasingly. As a result, structuring the activity of companies by responsibility centers has become a priority in satisfying customer requirements and achieving a profitable activity.

In this way, several essential targets can be reached, such as establishing responsibilities for expenses incurred, correct management of expenses at training sites, delimitation of expenses strictly related to the production activity from those necessary for the running of the process, highlighting expenses at the predetermined levels and elaboration of expenses budgets specific to each center.

The main sources of price change are: labor productivity, increase in cost components of the total cost (for example, real wages and energy prices). All other determinants being held constant, the higher the cost of production, the more significant will be the impact on the price of products and services.

When prices are set to match realized production costs only periodically (e.g., once every three or four years) rather than continually, the company derives some financial benefit from reducing its operating costs (Sappington, 2001).

Mamazhonov Akramjon Turgunovich (2021) states that the cost analysis of production is an urgent task these days, being necessary that it should be the main focus of management analysis.

The importance of the empirical study lies in the numerical analysis of the impact of internal factors on the variation of total costs, which have a direct impact on prices. This study can constitute a preliminary stage to the substantiation of decisions to establish price policies at the company level.

Although the concept of cost refers to the effort required in providing the cost object, there are other concepts that must be known from the perspective of management support, especially in terms of control and planning (Buys, 2021).

A fundamental stage in the calculation and cost analysis is represented by the classification of costs that can be done in relation to several criteria: the nature of the expenses that determine the costs, their relationship with the object of calculation, the activities performed, the behavior of the costs, the usefulness in making decisions, the process of production or the period to which it refers.

According to Novák et al. (2018), the traditional approach to cost behavior postulates that the cost of activities changes proportionally to the volume of the activity and the cost considered is fixed or variable, which implies that variable costs are directly modified following adherence to the change in the activity leader.

In order to achieve the proposed goal and facilitate the research process, the following objectives are set: performing the empirical study on the impact of internal factors on the variation of the production cost in the context of cost center accounting; presentation of influencing factors; descriptive analysis of panel data; performing the Ordinary least squares econometric model.

2. Research methodology

The multivalence of the studied phenomenon denotes the obligation of an appropriate methodological approach, combining fundamental and quantitative research through modern and classic research tools.

This paper is fundamental, observational and descriptive, using different methods and techniques: the review of the specialized literature, the method of structuring the research, the documentation, data collection and econometric analysis. We used these methods by consulting specialized papers, various articles and publications, databases, as well as direct documentation that requires knowledge of the practical reality of a company.

3. Data collection

The cost of production consists of all the expenses necessary to obtain products and services. At organization level, knowing and understanding production costs is important for the following reasons: providing the necessary information to identify actions in order to make the organization's activity more efficient and providing information necessary for the management of the organization, representing the basis for substantiating decisions.

In agreement with what has been stated, the objective of the empirical impact study is to identify, quantify and analyze the independent variables: Cpersonal, Cgenerale, Cenergie, Cit, Cmanagement and Ctransport on the on the dependent variable Ctotal. We will not carry out an exhaustive approach to impact factors, we will only refer to the most relevant of them.

Total costs *(Ctotal)* reflect in value form the entire consumption of factors of production or material, financial and human resources, carried out for the manufacture and sale of the production made in a cost center. This economic indicator will constitute the dependent variable from the econometric model presented in the following. Personnel costs *(Cpersonal)* refer to personnel who work for the cost center in question under an employment contract and who have been nominated to work on the project. This component of the total cost is considered as the independent variable.

Another determining factor with significant theoretical impact on the variation of the total cost is general expenses *(Cgenerale),* constituting an independent variable. Energy costs *(Cenergie)* is the value equivalent of electricity, gas and water consumption, recorded by the specified cost center. The costs allocated to the implementation of new software and hardware technologies in order to increase the quality and productivity of work *(Cit),* constitute a factor of progress. The expenses involved in the increase of the quality management *(Cmanagement)* constitute another influencing factor on the total expenses. Transport costs *(Ctransport)* depend directly on the quantities transported.

Cost centers are essential in structuring a company that needs or intends to reduce its expenses. In this way, expenses related to factors with a pronounced numerical impact on total expenses can be reduced or eliminated. Therefore, in the following table we briefly present the influencing factors on the variation of the total cost.

Table 1. Variable description

Variable	Description
Ctotal	Total cost
Cpersonal	Personnel costs
Cgenerale	General costs
Cenergie	Energy costs
Cit	IT costs
Cmanagement	Quality management costs
Ctransport	Transport costs

Source: Own processing

The selected statistical variables (indicators) are relevant from an economic point of view, allowing us to analyze their evolution as well as their interaction during the 5 years and 3 months. The data are organized monthly, in the form of a panel, for the period 2017-2021 and the first 3 months of 2022, in total of 63 months.

4. Descriptive analysis of panel data

Independent variables are expressed as a percentage of total cost. We should observe a wide range of variation as well as significant standard deviations for each variable. There are reasons to expect a significant impact of the independent variables on the dependent variable as well as other significant correlations between the determining factors.

Has to be considered the fact that the empirical study falls within the methodology specific to micro econometrics, which capture correlation over time for a given entity with independence between units. For some panel data there may also be correlation between statistical entities.

The data panel analyzed is a long panel at the lower end (few entities and many time periods). To ensure correct statistical inferences used in the long panel case, it is necessary that $T \to \infty$. The number of cost centers is 10 and T is 63, ensuring that we fit the study into a long panel.

The dependent variable and regressors can vary both with respect to time and with each cost center. It is important to know the type of variation in order to choose the estimator correctly. In particular, the coefficient of the regressor with small internal variance will be imprecisely estimated and not identified if the internal variance is zero.

The organization of the panel data is much clearer if we list some relevant lines from the database. In the following figure is presented in a simplified form, each cost center and the values corresponding to the seven variables. This form of presentation will allow us to a better understanding of the econometric model involved in the study.

Data are available for all cost centers in all 63 months (strong balanced panel) and the time variable (month) increases uniformly by one unit. We can observe that the data is organized in long format; each line corresponds to a distinct cost center-month (CC-Month) pair.

Table 2. Variable descriptive statistics

	CC (1)	Luna (2)	Ctotal (3)	Cpersonal (4)	Cgenerale (5)	Cenergie (6)	Cit (7)	Cmanagement (8)	Ctransport (9)
1.	1	1	863582	15.98	37.32	3.86	18.28	1.81	14.96
2.	1	2	879176	15.45	32.27	3.31	24.55	1.55	16.71
3.	1	3	607191	15.3	33.94	5.57	25.41	2.28	15.85
4.	1	4	227499	15.91	31.32	7.93	21.6	2.92	11.16
5.	1	5	1159238	15.51	30.49	6.3	33.96	1.66	10.71
63.	1	63	655514	18.58	16.69	21.58	30.36	1.94	10.01
64.	2	1	640477	21.76	36.3	4.43	13.4	2.08	13.01
65.	2	2	958163	19.54	34.19	3.89	23.89	1.83	12.23
66.	2	3	1389835	16.84	36.88	6.32	19.82	2.59	13.23
67.	2	4	1320043	18.43	36.15	8.45	15.82	3.11	12.96
68.	2	5	2032957	17.72	30.03	7.48	31.61	1.98	10.68
126.	2	63	1985894	15.2	18	25.36	31	2.18	8.08
568.	10	1	116066	27.69	37.77	3.4	10.98	1.88	9.55
569.	10	2	363797	29.67	29.84	3.66	20.98	1.75	10.61
570.	10	3	493251	26.04	28.42	6.2	22.6	2.54	11.57
571.	10	4	102765	26.2	30.03	8.33	17.94	3.06	11.8
572.	10	5	116340	27.3	22.02	7.23	32.81	1.91	8.08
630.	10	63	2248200	18.92	15.05	25.67	28.64	2.56	6.24

Source: Own processing

The following figure provides information on the relative importance of between-entity variation and intra-entity variation for each variable. The total variance (measured around the mean) can be divided in two components: within and between. Variables involved in the model show within and between variation worthy of consideration and as a result we can use either the between estimator or the within estimator.

Table 3. Total variance of the each variable

Variabile (1)		Mean (2)	Std. Dev. (3)	Min (4)	Max (5)	Observations (6)	
CC	overall	5.5	2.874564	1	10	N =	630
	between		3.02765	1	10	n =	10
	within		0	5.5	5.5	T =	63
Luna	overall	32	18.19869	1	63	N =	630
	between		0	32	32	n =	10
	within		18.19869	1	63	T =	63
Ctotal	overall	1323673	772273.5	91154	5732462	N =	630
	between		432983.4	568348.5	2047564	n =	10
	within		653766.8	-21423.79	5664724	T =	63
Cpersonal	overall	24.32202	6.732336	10.01	43.62	N =	630
	between		5.02945	18.59159	32.99746	n =	10
	within		4.745769	9.433127	44.41408	T =	63
Cgenerale	overall	19.14043	7.634567	10.16	41.78	N =	630
	between		6.769154	12.44524	32.21778	n =	10
	within		4.120892	4.922651	36.339	T =	63
Cenergie	overall	9.532571	4.362664	1.85	28.99	N =	630
	between		.9065732	7.55381	10.7619	n =	10
	within		4.276911	1.579397	28.3194	T =	63
Cit	overall	19.75997	8.688497	9.06	53.79	N =	630
	between		3.772698	15.1881	27.20302	n =	10
	within		7.915787	4.975365	54.30346	T =	63
Cmanagement	overall	2.777587	1.121272	.63	6.88	N =	630
	between		.3222514	2.02381	3.113651	n =	10
	within		1.078722	.9640953	6.83219	T =	63
Ctransport	overall	6.707492	2.9575	3	16.71	N =	630
	between		2.707592	4.179048	11.55905	n =	10
	within		1.462317	1.080667	12.41067	T =	63

Source: Own processing

We can observe that all the variables involved in the models are time varying. Columns 4 and 5 show us the minimum and maximum recorded by each variable. In column 6 we have the number of statistical observations N, the number of cost centers n, and the number of months T related to the 63 months.

5. Results and conclusions

The correlation matrix shows us the level of correlation between the variables involved in the econometric model. We can state that the dependent variable Ctotal correlates sufficiently strongly with the independent variable Cpersonal and more weakly

with the variables Cenergie, Cit and Cmanagement. The level of significance of the correlation, presented below its size, is sufficiently statistically representative for the variables in question to constitute impact factors.

Table 4. Correlation matrix

	Ctotal (1)	Cpersonal (2)	Cgenerale (3)	Cenergie (4)	Cit (5)	Cmanagement (6)	Ctransport (7)
Ctotal	1.0000						
Cpersonal	-0.4525 0.0000	1.0000					
Cgenerale	0.0367 0.3582	-0.4822 0.0000	1.0000				
Cenergie	0.1143 0.0041	-0.0874 0.0283	-0.2817 0.0000	1.0000			
Cit	0.0822 0.0392	-0.3860 0.0000	0.0774 0.0521	0.0301 0.4513	1.0000		
Cmanagement	0.0675 0.0906	0.1897 0.0000	-0.2360 0.0000	0.0991 0.0129	-0.2999 0.0000	1.0000	
Ctransport	0.0071 0.8584	-0.4570 0.0000	0.9316 0.0000	-0.2556 0.0000	0.0845 0.0339	-0.2269 0.0000	1.0000

Source: Own processing

Statistical tests will be the ones that allow us to highlight the significance of the influence of each factor or a group of factors. Less significant, as an impact on the variation of total expenses, appears to be their general and transportation costs. The independent variables are weakly correlated, each with each other, which is not an impediment to applying an Ordinary least-squares (OLS) model.

Ordinary least-squares (OLS) models assume that the analysis is fitting a model of a relationship between one or more explanatory variables and a continuous or at least interval outcome variable that minimizes the sum of square errors, where an error is the difference between the actual and the predicted value of the outcome variable. The most common analytical method that utilizes OLS models is linear regression (with a single or multiple predictor variables) (Zdaniuk , 2014).

Authors consider that OLS is not the only optimization strategy, it is the most popular for this kind of tasks, since the outputs of the regression are unbiased estimators of the real values of alpha and beta (Alto, 2019).

The sign of the correlation can be deduced between each pair of variables, which allows us to intuit the form of interactions, direct or inverse. The complexity of the econometric model to be presented is inspired by the correlation matrix. The behavior of panel data makes a difference in terms of the indicators used to estimate the parameters.

In the following figure, we have an OLS regression model, which shows us how the total cost reacts to changes in the 6 impact factors. The statistical variables included in the model show variation over time. The OLS group model is based on both the between variation and the within variation and it can be written as regression equation with clustering-robust standard errors.

Table 5. The OLS regression model

Ctotal	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
	(1)	(2)	(3)	(4)	(6)	(7)	
Cpersonal	-72595.67	13520.18	-5.37	0.000	-103180.4	-42010.91
Cgenerale	-3095.063	10831.34	-0.29	0.782	-27597.25	21407.12
Cenergie	-2394.819	5145.848	-0.47	0.653	-14035.54	9245.897
Cit	-9879.185	11028.37	-0.90	0.394	-34827.09	15068.72
Cmanagement	66900.01	45910.49	1.46	0.179	-36956.73	170756.7
Ctransport	-58908.91	35309.39	-1.67	0.130	-138784.3	20966.47
_cons	3575938	634114.4	5.64	0.000	2141472	5010405

Std. Err. adjusted for 10 clusters in CC
Number of obs = 630 F(6, 9) = 9.10
Prob > F = 0.0021 R-squared = 0.2795

Source: Own processing

$$Ctotal_i = \beta_0 + \beta_1 Cpersonal_i + \beta_2 Cgenerale_i + \beta_3 Cenergie_i + \beta_4 Cit_i + \\ + \beta_5 Cmanagement_i + \beta_6 Ctansport_i + \varepsilon_i$$

Estimating the impact of the independent variables on the dependent variable, we can obtain consistent estimates of the β parameters, if the ε_i do not correlate with the regressors. As pointed out earlier, it is possible for errors to correlate over time for a given statistical entity. For this reason, we used the option of robustness of standard errors in relation to the classification, on each individual entity.

The regression model represents a linear regression without any fixed and/or random effects being identified. This model assumes that the intercept and slope of the model are constant regardless of group/time period.

We noted $\beta_k, k = \overline{0,6}$ the β_0 intersection of the model with the total cost axis and regression coefficients of the 6 impact factors, and ε_i represents the error.

The econometric model does not capture the reality of panel data well enough. R^2 is 0.2795, which is about 28%, it tells us that this model explains 28% of the variation in total cost due to variation in personnel cost, overhead cost, energy cost, IT cost, quality management cost and with transport.

The rest up to 100% represents the influence of other factors with an impact on the total cost variation, which were not included in the study for various reasons. As a result, the model can still be improved.

From the table presented above, it follows that the only factor with a statistically significant impact is Cpersonal (p<.0000 from column 6).

Considering the research undertaken, we can conclude that the initially established objectives have been met. Regardless of the assumptions made, some corrections are needed to the OLS (Ordinary Least-Squares) estimators regarding efficiency increase.

Different assumptions about the correlation structure of the errors can lead to more efficient estimators than the OLS group estimators, but not fully efficient. The OLS estimator does not fully capture the behavior of the panel data and as a result we have to propose another estimation model. We propose, as future scientific research, to introduce more efficient models, depending on the specifics of the panel data.

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