The Cost Behavior Analysis Through Regression Models and Its Application in Managerial Decision-Making Process

PETR NOVÁK
Department of Enterprise Economics, Faculty of Management and Economics
Tomas Bata University in Zlín
nám. T. G. Masaryka 5555, 760 01 Zlín, CZECH REPUBLIC
pnovak@fame.utb.cz   http://www.fame.utb.cz

SILVIA BĚLAŠKOVÁ
Department of Mathematics, Faculty of Applied Informatics
Tomas Bata University in Zlín,
nám. T. G. Masaryka 5555, 760 01 Zlín, CZECH REPUBLIC
belaskova@fai.utb.cz   http://www.fai.utb.cz

JIŘÍ STROUHAL
Department of Finance and Accounting
Škoda Auto University
Na Karmeli 1457, 293 01 Mladá Boleslav, CZECH REPUBLIC
ystrouhal@is.savs.cz   http://www.savs.cz

Abstract: - Cost management is one of the most important issues of corporate performance and corporate financial management. This study compares four models that predict cost behavior. The total overhead costs (TOC), overhead costs influenceable (IOC) and overhead costs uninfluenceable (UOC) and for the purpose of examination of asymmetric cost behavior there was analyzed log-ratio transformation UOC model. The results indicate that UOC is significantly affected by the production in kg (Qkg, p=0.0063) and the total production time in min (Tmin, p=0.0021). Total overheads costs are significantly affected by the total production time in min (p=0.0478). From the results of transformed model we believe that asymmetric cost behavior is affected by asymmetric behavior of the production in kg in proportion to the production time.

Key-Words: - overhead costs, cost management, regression analysis, decision-making process, corporate performance, financial management

1 Introduction

The issue of the costing systems, methods and techniques represents a key area of measuring corporate performance. It is appropriate to mention that standard and traditional assessment of cost behavior, gauged merely by volume of production or sales, cannot fulfil current needs of (manufacturing) companies.

Managers are interested in estimating past cost behavior patterns, since this information can expedite more accurate cost predictions concerning planning and decision-making [12]. Key information may also be obtained by examining the dependence of costs and their behavior on various factors, from which can be derived predictive models useful for cost estimates. The ignorance of cost behavior and cost dependence can force errors in judgment, from minor to major in scope. This is why there exists an increased pressure on the research of the variability of overhead costs and their projection into costing systems, resulting in the potential product price.

The main objective of this paper is to explore and analyze the behavior of overhead costs on a case of concrete manufacturing company from the perspective of potential dependence on defined factors. The partial objective is to propose a predictive model that would reflect the observed dependences and thus help managers to make the adequate decisions.

2 Literature Review

In managerial accounting the term cost is applied in numerous ways. For example [8] states the main division of costs and designates them as direct and indirect costs. Direct costs primarily comprise direct materials and labor, representing those easily and accurately identified with a particular cost object. Therefore, indirect costs cannot be determined specifically and exclusively with a given cost object [8, 10].

Issues related to an increasing proportion of overhead costs and any subsequent impact on cost management were defined by [11]. Studies have shown that up to 80% of companies continue to use (or have switched back to) traditional product-costing methods, despite the fact that many accountants within these companies express dissatisfaction with relying on the outputs of such cost accounting systems for decision-making purposes [14]. Knowledge of cost behavior is very important, especially for decision-making. As [5] stated, understanding cost behavior is a fundamental issue in cost accounting. For each decision taken, the management of a company requires estimates of costs and revenues at different levels of activity for alternative courses of action. Meanwhile the behavior of the costs and any subsequent decision depends on the cost driver. [13] goes even further and states that criticism of standard traditional cost models is also evident in other areas of cost management, e.g. in budgeting. Such opinions resulted in new methods being introduced, such as activity-based budgeting and beyond budgeting.

Costs are caused by resources. Cost behavior then reflects resource adjustment in response to activity changes. Some resources, such as indirect skilled labor, are costly to adjust in the short term so are predisposed to generating fixed costs [5, 6, 9]. [5] also ask whether firms that face greater demand uncertainty tend to possess a less rigid cost structure with lower fixed costs and higher variable costs, or a more rigid cost structure with higher fixed and lower variable costs. Their results, which are based on less formal analysis of the issue, are contrary to widely held opinions.

[5] argue that with more uncertain demand, unusually high realizations of demand become more likely. Evidence strongly supports their hypothesis that firms facing higher demand uncertainty have a more rigid short-run cost structure with higher fixed and lower variable costs [6]. Such cost behavior is referred to as rigid or fast-moving [1]. The importance of this issue is also the subject of a study by Japanese authors [12], who utilized regression analysis for the behavior of costs and their explanation of the causes of sticky costs. And as [17] highlights, results indicate that firms with stickier cost behaviour have less accurate analysts' earnings forecasts than firms with less sticky cost behaviour. The issue of sticky cost is engaged in a very detailed for example by [4] in their publications. Another view on the issue of sticky costs outlines for example [15], who incidentally refers to the authors, which exclude the existence of sticky cost. According to him, literature notes that the cost may not be linear and proportional to the level of activity.

[3] highlight that classifying costs is subject to managerial choice, and that selling, general, and administrative costs (hereafter "SG&A") represent merely 30% of total cost. Consequently, these create measurement problems when investigating cost behavior. Anderson et al. presented an empirical study measured cost stickiness using the sticky cost regression model that enables measurement of the SG&A response to contemporaneous changes in sales revenue and discriminates between periods when revenue increase and revenue decreases [2].

Something comparable was also presented by [1] in his study, when he discovered anti-sticky cost behavior for the costs of goods sold (CGS) and selling expenses, while the cost behavior for SG&A and administration costs was found to be symmetrical. The CGS model shows an increased degree of stickiness for companies with high asset intensity, whereas a lesser degree of stickiness was discerned for free cash flow.

Research by [18] revealed that the difference in cost stickiness even larger when managers are more optimistic about the future sales even when sales decline; hence the reason to keep slack resources for future use. When analyzing the level of individual stickiness between SG&A costs and the costs of goods sold (hereafter "COGS"), they found that SG&A costs were stickier than those for COGS. Another survey was performed by [7]. They found out and confirmed, that when applying textbook methods that are based on the traditional model of cost behavior, e.g. flexible budgeting or cost-plus pricing, it is necessary to consider that costs do not necessarily behave mechanistically, but might be sticky. As evidenced by the analysis in this study, cost behavior is sensitive to incentives provided to the manager [7].

[16] presented a paper that investigated whether cost stickiness occurred in small and medium sized companies. Their findings show that cost stickiness only emerges for the total cost of labor and not for SG&A costs, the cost of goods sold and operating costs. Stickiness of operating costs is only detected in a sample of listed companies.

These and other studies clearly demonstrate the need to explore, make comparisons and verify this issue, also as it pertains to manufacturing firms in the Czech Republic.

3 Problem Formulation

In relation to investigating the behavior of overhead costs and their variability in terms of various factors in manufacturing companies the case study of specific manufacturing company was performed. Analyzed company belongs to the industrial classification EU-NACE 22.11. The company produces a large volume of agro tires of different categories, especially for agricultural machinery. Such production has an advantage that all tires are very similar from the manufacturing process view and they differ mainly in the way of the material quantity used and of the length of the vulcanization (so product can be measured not only per pieces, but also per weight). The monthly period of the years 2014-2015 was chosen as the default period for researching of overheads behavior and development. Therefore there were available data for 24 consecutive months. Acquired data can be divided into variable costs, total overhead costs (TOC), influenceable overhead costs (IOC) and uninfluenceable overhead costs (UOC).

The dependence on various factors was examined by divided costs. Five factors were chosen as independent variables among which there was an assumption they can influence the overhead cost occurrence and their movement. These factors were:

a) The number of orders entering the manufacturing process (NoO)
b) The number of batches of vulcanized tires (NoB)
c) Production in pieces of tires (Qpcs)
d) Production in kg (Qkg)
e) Total production time in min (TPT)

3.1 Statistical analysis

Statistical analysis was performed by software (SAS, Windows, version 9.13;SAS, Cary,NC). Hypothesis tests about the effect of given factors on dependent variable were performed at the .05 level of significance. The analytical data consisted of 24 numbered observations, each one representing a calendar month from January 2014 to December 2015. Three dependent variables were total overheads (TOC), influenced overheads (IOC) and uninfluenced overhead costs (UOC) examinations over each month.

Table 1. Basic descriptive statistics data file

Variable	Mean	Std Dev	Minimum	Maximum
TOC (CZK)	9,739,207	1,178,801	8,107,421	12,688,198
UOC (CZK)	6,481,688	647,769	5540035	8,414,488
IOC (CZK)	3,257,519	828,227	1,998,593	5,762,106
NoO (pcs)	3,890	802	2,166	4,889
NoB (pcs)	173	28	132	234
Qpcs (pcs)	26,134	5,886	12,853	33,429
Qkg (kg)	3,029,394	670,835	1,514,087	3,926,410
TPT (min)	3,714,723	808,527	1,805,855	4,669,531

Source: our analysis

These data were analyzed as three separated time series and then was analyzed the effect of independent covariates on the costs. The independent variables were represented by 5 above mentioned factors (NoO, NoB, Qpcs, Qkg, TPT).

For UOC we also analyzed transformed ABJ model where we were inspired by Anderson´s "sticky" cost regression model to investigate asymmetry in cost responses. Data are represented as Mean and Standard deviation (SD) for given covariates (see Table 1). The regression analysis with autoregressive error was used to analyze the effect of covariates and Durbin-Watson examined the autocorrelation tests. In the estimation of parameters there was assumed a first-degree of autocorrelation.

The major research objectives were (1) to create a model of the dependence of overhead costs on the above mentioned factors, (2) to create a model for dependencies time lag of one month period, and (3) to create a prediction model of overhead costs development that could be utilized in the managerial decision making process.

4 Problem Solution

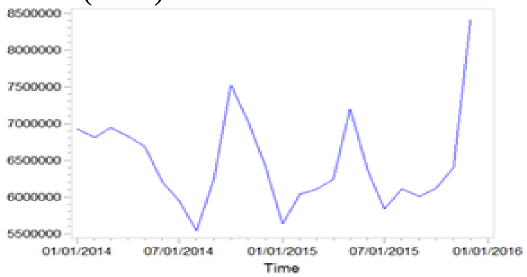
In accordance with the research objectives there were identified several research questions - prerequisites. For their verification it was necessary to design appropriate models. Research assumptions there were as follows: (1) There exists a dependence of the overhead costs behavior on selected predefined factors, (2) The overhead costs behavior is primarily dependent on the factors unrelated to the volume of production, and (3) The overhead costs may vary depending on the changes in the examined factors.

Based on these assumptions there were developed four regression models, including one transformed. Three basic models are based on the relationship (1):

$Y_t = \beta_0 + \beta_1{*}NoO_t + \beta_2{*}NoB_t + \beta_3{*}Qpcs_t + \beta_4{*}Qkg_t + \beta_5{*}TPT_t + \varepsilon_t$ (1)

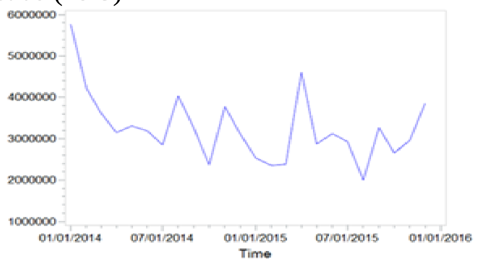
The explanatory variables are represented by continuous variables of NoO in period (Mean=3,890 per month, SD=801), NoB (Mean=173, SD=28), Qpcs (Mean=26,134 per month, SD=5,886), Qkg (Mean=3,029,394 per month, SD=670,835) and TPT (Mean=3,714,723 per month, SD=808,527). Overhead costs act as the dependent variable in the model 1, and these are TOC (Mean=9,739,207 CZK per month, SD=1,178,801 CZK). In model 2 these are UOC (Mean=6,481,688 CZK per month, SD=648,769 CZK). Fluctuation in these costs is expressed in Figure 1. Within model 3 there are expressed IOC (Mean = 3,257,519 CZK per month with SD = 828,227 CZK) and its fluctuations are visible from Figure 2.

Fig. 1 Fluctuation cost trend of uninfluenced overheads (UOC)



Source: our analysis

Fig. 2 Fluctuation cost trend of influenced overheads (IOC)



Source: our analysis

The results show that a statistically significant effect on uninfluenced overheads have only factors Qkg together with TPT (see Table 2).

Table 2. Model #2 with dependent variable UOC, Parameter Estimates. Durbin-Watson=1.368; p=0.0951; R2=0.45.

Parameter Estimates				
Variable	**DF**	**Estimate**	**t Value**	**Approx Pr > |t|**
Intercept	1	5,824,940	6.52	<.0001
NoO	1	-481.8658	-1.30	0.2090
NoB	1	13,403	1.81	0.0875
Qpcs	1	-280.6313	-1.31	0.2069
Qkg	1	7.3884	3.09	**0.0063**
TPT	1	-3.9945	-3.59	**0.0021**

Source: our analysis

Regression coefficients estimates show that uninfluenced overhead costs fluctuate, and they upward (grow about 7.39, p = 0.0063) with increasing manufactured kilograms and downwards (falling, about 3.99, p = 0.0021) with the number of production minutes. Results of the model 2 are described within Table 2. Both factors „Production in kg“ and „Total production time in min” are significant at 0.05 level. This means that Qkg and TPT are potentially important predictors of dependent variable. The final regression function of the development UOC model arising out the Table 2 is as follows:

$$UOC = 5{,}824{,}940 - 481.87{*}NoO + 13{,}403{*}NoB - 280.63{*}Qpcs + 7.39{*}Qkg - 3.99{*}TPT$$

Performed investigation revealed (see Table 3) that a statistically significant effect on TOC factor has the factor of TPT (p = 0.0478) when these overheads Total decrease of 4.69 with increasing production time. This can be explained by better utilization of production capacity with less frequency of birth of the manufacturing intermediate operations inducing growth of overheads.

Out of the detailed results of model 1 it can be seen, that the significance limit is further closer (p = 0.1051) also the Qkg factor which causes growth of overheads of 8.1065 relative to the production rising of 1 kg.

Table 3. Model #1 with dependent variable TOC, Parameter estimates, Durbin-Watson=0.9753; p=0.173; R2=0.34.

Parameter Estimates				
Variable	**DF**	**Estimate**	**t Value**	**Approx Pr > |t|**
Intercept	1	10,602,694	5.97	<.0001
NoO	1	-792.8816	-1.08	0.2946
NoB	1	-3,662	-0.25	0.8065
Qpcs	1	-163.6456	-0.38	0.7052
Qkg	1	8.1065	1.71	0.1051
TPT	1	-4.6912	-2.12	0.0478

Source: our analysis

On contrary to previous assumptions there was not proved the statistically significant effect of the variables on IOC what is visible from Table 4 describing model 3.

Table 4. Model #3 with dependent variable IOC. Parameter estimates, Durbin-Watson=-0.334; p=0.371; R2=0.28.

Parameter Estimates				
Variable	DF	Estimate	t Value	Approx Pr > |t|
Intercept	1	4,777,754	3.67	0.0017
NoO	1	-311.0158	-0.58	0.5706
NoB	1	-17,066	-1.58	0.1314
Qpcs	1	116.9857	0.37	0.7121
Qkg	1	0.7181	0.21	0.8389
TPT	1	-0.6967	-0.43	0.6720

Source: our analysis

From Table 4 there is visible that any of the other factors was proved as statistically significant on the IOC. Only Qkg is approaching the formal significance (p = 0.1314), from whose parameters it can be concluded that the growth in the production batches can lead to a decrease in IOC about 17,066.

As a fourth and final model was considered the model representing the costs change in time shifting about one month. This model can be used for examining costs in time shift by a short period (e.g. months) and thus it is possible to prove cost asymmetric behavior called "sticky costs". To this model adapted according to ABJ we did not include the dummy variable, which represents a decline or increase in this model, but we kept the model clearly transformed and assembled so that there remained only variables that had a statistically significant effect on the dependent variable. The assembled model 4 is following:

$$Log\left(\frac{UOC_{t-1}}{UOC_t}\right) = \beta_0 + \beta_1 * Log\left(\frac{Qkg_{t-1}}{Qkg_t}\right) + \beta_2 * Log\left(\frac{TPT_{t-1}}{TPT_t}\right) + \varepsilon \qquad (2)$$

Based on the transformed model we obtained estimates of regression coefficients, which are shown within table 5 and these influence the development UOC.

Table 5. Model #4 Transformed model, Durbin Watson=0.349; p=0.366; R2=0.23.

Parameter Estimates				
Variable	DF	Estimate	t Value	Approx Pr > |t|
Intercept	1	0.004651	0.24	0.8116
delta TPT	1	-1.1806	-2.22	0.0383
delta Qkg	1	1.1201	2.09	0.0495

Source: our analysis

The results of model 4, as well as of the results of the model 2 clearly shows that the UOC is significantly influenced by the production volume in kg (Qkg; 1.12 times, p = 0.0494) and by the minutes of production (TPT; -1.18 times, p = 0.0383). The model has a statistically significant absolute regression coefficient that is close to zero. This model can then be modified as follows (3)

$$Log\left(\frac{UOC_{t-1}}{UOC_t}\right) = Log(1) + Log\left(\frac{Qkg_{t-1}}{Qkg_t}\right)^{1.12} + Log\left(\frac{TPT_{t-1}}{TPT_t}\right)^{-1.18} + \varepsilon \qquad (3)$$

from which arising after adjustments (relations (4) and (5)) that if we want to stabilize fluctuations in overhead costs, we have to stabilize proportion between kilograms and minutes of production:

$$Log\left(\frac{UOC_{t-1}}{UOC_t}\right) = Log\left(1 * \left(\frac{Qkg_{t-1}}{Qkg_t}\right)^{1.12} * \left(\frac{TPT_t}{TPT_{t-1}}\right)^{1.18}\right) + \varepsilon \qquad (4)$$

$$Log\left(\frac{UOC_{t-1}}{UOC_t}\right) = Log\frac{\frac{Qkg_{t-1}^{1.12}}{TPT_{t-1}^{1.18}}}{\frac{Qkg_t^{1.12}}{TPT_t^{1.18}}} + \varepsilon \qquad (5)$$

4 Conclusion

The above proposed methodology for costs analyzing may bring new information and new insight for management decisions. The classic approach of cost management considers only the dependence on the production volume. These models can be seen as the way into a deeper exploration of overhead costs dependence behavior. We proved that there exists a correlation of overhead costs behavior on some selected factors, which confirmed the first assumption. The most significant difference was demonstrated in the overhead cost group which can be described as uninfluenceable (e.g. Depreciation of machinery; costs related to machinery tools; tools, etc.). There was proven a dependence of production factors on Qkg and duration of production process. From this perspective there was rejected a second assumption about possible dependence of factors irrelevant to the volume of production. This might be explained by very tight linkage of factors in homogeneous production.

From the results of this research was proven that it is impossible to separate the volume of production in kg and total duration of production process.

Based on ABJ regression models there was proposed transformed model respecting the influence of Qkg and TPT. According to this model 4 (within table 5) we proved that changes in overhead costs (UOC) are influence by the volume of these factors in previous period (here months) and was validated the third assumption.

There shall be also mentioned the limitation of presented research. First of all shall be discussed the quality of input data. The major problem might be the relevance of costs within respected period (month, quarter) – sometimes entities updates the proper values in next periods. This may cause some swings in costs and the presented data does not represent the fair view of reality. The higher the improper swing, the lower the relevance of these costs and lower the decision value. Another problem is the seasonality of production. In such case there is necessary to adjust data for these costs despite they are recorded directly within one respective period. Final limitation of this research is the duration of analysed period. Longer the time series, higher the validity of performed regression models.

Finally there might be concluded that these models can show to the managers a brand new insight on overhead costs behaviour. There would be possible to use the simplified cost functions based on the traditional fixed and variable costs approach based on the upgraded paradigms.

Acknowledgement

This paper is one of the research outputs of the project GA 14-21654P/P403 “Variability of Cost Groups and Its Projection in the Costing Systems of Manufacturing Enterprises” registered at the Czech Science Foundation.

References:

[1] J. Abu-Serdaneh, The Asymmetrical Behavior of Cost: Evidence from Jordan, *International Business Research,* Vol. 7, No. 8, 2014.

[2] M. Anderson, R. Banker, & S. Janakiraman, Are selling, general, and administrative costs "sticky"? *Journal of Accounting Research,* Vol. 41, No. 1, pp. 47–63, 2003.

[3] S.W. Anderson, & W.N. Lanen, Understanding cost management: What can we learn from the empirical evidence on sticky costs? *Working paper*, Rice University and University of Michigan, 2009.

[4] R. Balakrishnan, & T. Gruca, Cost stickiness and core competency: A Note, *Contemporary Accounting Research,* No. 25, pp. 993-1006, 2008.

[5] R.D. Banker, & D. Byzalov, Asymmetric Cost Behavior, *Journal of Management Accounting Research*, Vol. 26, No. 2, pp. 43-79, 2014.

[6] R.D. Banker, D. Byzalov, & J.M. Plehn-Dujowich, Demand Uncertainty and Cost Behavior, *The Accounting Review*, Vol. 89, No. 3, pp. 839-865, 2014.

[7] A. Brüggen, & J.O. Zehnder, SG&A cost stickiness and equity-based executive compensation: does empire building matter? *Journal of Management Control*, Vol. 25, No. (3), pp. 169-192, 2014.

[8] C. Drury, *Management and Cost Accounting*, Thomson Learning, 2012.

[9] D.R. Hansen, M.M. Mowen, & L. Guan, *Cost management: accounting & control,* Mason: South-Western, 2009.

[10] D.R. Hansen, & M.M. Mowen, *Cornerstones of Cost Management*, Mason: Cengage Learning, 2015.

[11] S.P. Nimocks, R.L. Rosiello, & O. Wright, Managing overhead costs. *McKinsey Quarterly*, Vol. 41, No. 2, pp. 106-117, 2005.

[12] N. Pichetkun, & P. Panmanee, The Determinants of Sticky Cost Behavior: A Structural Equation Modeling Approach. *available on-line at* http://www.jap.tbs.tu.ac.th/files/Article/Jap23/Full/Jap23NuchPana.pdf (2015-10-21), 2014.

[13] B. Popesko, & V. Šocová, Current Trends in Budgeting and Planning: Czech Survey Initial Results, *International Advances in Economic Research*, No. 22, pp. 99-100, 2016.

[14] P.A. Sharman, The case for management accounting, *Strategic Finance*, Vol. 85, No. 4, pp 42-47, 2003.

[15] A.O.O. Uy, Modeling cost behavior: linear models for cost stickiness. *Academy of Accounting and Financial Studies Journal*, Vol. 15, No. 1, pp. 25-34, 2011.

[16] N.D. Via, & P. Perego, Sticky cost behavior: evidence from small and medium sized companies, *Accounting and Finance*, No. 54, pp. 753-778, 2014.

[17] D. Weiss, Cost Behavior and Analysts' Earnings Forecasts. *The Accounting Review*, Vol. 85, No. 4, pp. 1441-1471, 2010.

[18] K. Yasukata, & T. Kajiwara, Are “sticky costs” the result of deliberate decision of managers? *available at SSRN:* http://ssrn.com/abstract=1444746, 2011.