The European Proceedings of
Social & Behavioural Sciences
EpSBS

Future Academy

ISSN: 2357-1330

https://dx.doi.org/10.15405/epsbs.2018.12.45

RPTSS 2018
International Conference on Research Paradigms Transformation in Social Sciences

DETERMINISTIC FACTOR ANALYSIS OF THREE-FACTOR DUPONT MODEL USING FILATOV METHODS

E.A. Filatov (a)*
*Corresponding author

(a) Leading Researcher Irkutsk Scientific Center of the Siberian Branch of the Russian Academy of Sciences, 134 Lermontov Street, 664033, Irkutsk, Russia, e-mail: johnru3000@rambler.ru, 89646501588

Abstract

The purpose of enterprise economic activity is always a certain result, which depends on numerous and various factors. It follows that influence of factors on the value of the result will be studied in more detail; the forecast of the possibility of achieving it will be more accurate and reliable. Without deep and comprehensive study of factors, there are no reasonable conclusions about results of financial and economic activities of the enterprise.

DuPont model allows determining which factors change profitability or making factor analysis of profitability.

The article presents the author's methods of factor analysis, which allows drawing up a relatively simple conclusion about changes in the financial position of the enterprise, as well as assessing the influence degree of factors on changes in the studied indicator.

This article emphasizes knowledge in the field of economic analysis theory, acquisition of skills of application of methods of modeling factor systems, estimation of influence of quantitative and qualitative factors on indicators characterizing final results of activity of economic entities and their efficiency. The purpose of this article is to generalize and systematize theoretical and methodological foundations of factorial analysis in the form available to specialists in economics and management, which should contribute to formation of their base for development of economic thinking, understanding of the essence of economic processes and phenomena occurring within economic entities, and most importantly – development of skills for their quantitative assessment, economic interpretation and search for reserves.

Keywords: Factor analysis, financial profitability, return on sales, asset turnover, and the equity ratio.

https://dx.doi.org/10.15405/epsbs.2018.12.45
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eISSN: 2357-1330

1. Introduction

As applied science, economic analysis is useful and necessary only when its application increases the efficiency of practical activities of people, when it is possible to anticipate and predict the development of the economic situation at a particular enterprise and to make rational (scientifically based) management decisions.

The basic tool in conducting a comprehensive analysis of the economic activities of enterprises is factor analysis.

The main attention in factor analysis is paid to the study of internal causes that form the specifics of the phenomenon under study, to the identification of generalized factors that stand behind the relevant specific indicators (Mulaik, 1972).

2. Problem Statement

In today's economic conditions, the company is forced to independently determine the prospect of its development. The successful solution of urgent economic problems, of course, depends on the development of the theory of activity analysis, which allows determining the efficiency of economic activity of the enterprise, to identify patterns of changes in the main results of its activities.

Improvement of factor analysis methods is a key task of economic analysis. The more detailed the influence of factors on the value of the indicator, the more accurate the results of analysis and assessment of the quality of the decision. In some situations, without deep and comprehensive study of the direct impact of factors, there are no informed conclusions about the results of the company.

One of the most important tasks of the financial analysis of any economic phenomenon is to identify factors, the level and changes of which have a decisive influence on the formation and change of the level of the phenomenon, considered as effective in relation to these factors (Hakstian, Rogers, & Cattell, 1982).

The task of financial management at the enterprise is to ensure financial stability, which could contribute to the growth of return on equity.

In order to assess the effectiveness of any company, one needs to use any methods of analysis. The methodology of analysis implies a certain sequence of operations, techniques, actions and rules of the most appropriate analytical work (Kim & Mueller, 1978a).

Deterministic factor analysis is a method of studying the influence of factors, the relationship of which with the effective indicator is functional, that is, the effective indicator can be represented as a product of various factors (Kim & Mueller, 1978b).

The profitability of the company and increase of its value for shareholders are reflected by the profitability ratios. Management of profitability of the enterprise becomes a key task for all levels of management: strategic, tactical and operational. Firm «DuPont» was a simple way of managing profitability through the expansion of the coefficient of return on factors reflecting different aspects of activity of the enterprise.

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3. Research Questions

In practical analysis, DuPont method was used by the specialists of the company DuPont in the 1920-ies.

DuPont equation (also DuPont Model or DuPont Formula) is a modified factor analysis that allows determining which factors caused the change in profitability. In the basis of factorial model in the form of tree structure, there is return on equity indicator (ROE) and features characterizing factors of production and financial activity of the enterprise (Kosolapova, 2016). Simply put, the factors that affect ROE are broken down to determine which factors have a greater or lesser impact on return on equity (financial return). The main three factors:

1. return on sales (return on sales is calculated as the ratio of net profit to revenue (net) of all sales);
2. asset turnover (asset turnover ratio or total capital productivity) is calculated as the ratio of revenue from all sales to total assets);
3. the ratio of equity to the total capital (assets) of the organization is characterized by the ratio of equity to the total capital (assets) of the organization (the coefficient of autonomy or the coefficient of financial independence or the coefficient of concentration of equity).

The return on sales ratio characterizes the efficiency of production and commercial activity and shows how much the company has a net profit from the sales ruble. In other words, how much money the company has left after covering the cost of production, interest on loans and taxes. The profitability index of sales characterizes the most important aspect of the company's activity - the sale of basic products - and also allows you to estimate the share of cost in sales (Abdukarimov, 2013).

Profitability of sales is an indicator of the company's pricing policy and its ability to control costs (Chuev, 2013). Differences in competitive strategies and product lines cause a significant variety of return on sales values in different companies. It is often used to evaluate the operational efficiency of companies. Let us note, however, that at equal values of indicators of revenue, operating expenses and profit before income tax from two different firms profitability of sales can vary greatly, due to the influence of the volumes of interest payments by the amount of net profit.

The return on sales ratio is determined by the performance of the reporting period; the likely and planned effect of long-term investments does not reflect (Turmanidze, 2011). For example, when a business organization makes the transition to promising new technologies or products that require large investment, profitability can be reduced temporarily. However, if the strategy was chosen correctly, the incurred costs will be recouped in the future, and in this case the decrease in profitability in the reporting period does not mean low efficiency of the enterprise (Markaryan, 2013).

The asset turnover ratio indicates the efficiency with which an enterprise uses its resources for output and has an economic interpretation showing how many dollars (or other currency) there are from the sale account per one dollar (or other currency unit) of investments in fixed assets.

The asset turnover ratio characterizes the efficiency of the company's use of all available resources regardless of the source of their involvement (Prykina, 2016).

The ratio of autonomy (equity concentration ratio, ownership ratio) characterizes the share of ownership of the owners of the enterprise in the total amount of advanced funds. The higher the value of the coefficient, the more financially stable and independent of external creditors the company (Gorelik,

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2007).

The autonomy ratio is important for investors and lenders, because the higher the ratio, the lower the risk of loss of investment and credit. Company owners, by contrast, prefer a low share of equity capital in order to gain more (this happens when the return on assets is greater than the cost of borrowed capital). But in any case, this figure strongly depends on the industry or rather the ratio in the structure of the organization of non-current and current assets. The larger the organization's share of non-current assets (capital-intensive production) is, the more long-term sources are required for their financing, and therefore the greater should be the share of equity (Kazakova, 2014).

4. Purpose of the Study

The advantage of the DuPont model is the «splitting» of complex indicators into factors that make up them. This allows us to determine the root causes and the relationship of changes in the complex performance indicators of the company. With the help of the factor analysis scheme of key indicators, it is possible to clearly trace the influence of primary factors on the formation of complex indicators, give their comparative characteristics and determine the reasons for their change (Burt, 1950).

Profit margin, net profit margin, asset turnover, equity ratio characterize the three types of activity: operating, investing and financing.

The purpose of the study is to form new methods of factorial deterministic analysis, which are more reliably and reasoned to evaluate its results.

5. Research Methods

The initial data for conducting the author's methods (Filatov & Rudykh, 2014) factor analysis of DuPont model are presented in table 1.

Table 01. The initial data for factor analysis

No.	Indicators	№ factor's	Plan (0) *	Fact (I) **	Deviation (Δ)* * *
1	**V** – Revenue (net) from sales, thousand $		1 500 000	1 923 000	+ 423 000
2	**P** – Net profit, thousand $		200 000	350 000	+ 150 000
3	**A** – Total assets, thousand $		1 680 000	2 125 000	+ 445 000
4	**SK** – Own capital, thousand $		1 000 000	1 250 000	+ 250 000
5	**Rp** – Profitability of sales (2/1)	F_1	0.133333	0.182007	+0.048674
6	**Oa** – Asset turnover (1/3)	F_2	0.892857	0.904941	+0.012084
7	**Ka** – The coefficient of autonomy (3/4)	F_3	1.68	1.70	+0.02
8	**ROE** – Financial profitability (5 * 6 * 7)		0.20	0.28	**+ 0.08**

where: * 0 – past (base) period (year) taken as a basis for comparison; ** I – reporting (current) year; * * * Δ – change for the period is calculated as the difference between the fact and the plan (I – 0).

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In this case, the original formula for factor analysis will be as follows (formula 1):

$$\mathbf{ROE = F_1 * F_2 * F_3} \quad (1)$$

The balance of the variance is as follows (formula 2):

$$\mathbf{\Delta ROE = \Delta ROE\ (F_1) + \Delta ROE\ (F_2) + \Delta ROE\ (F_3)} \quad (2)$$

The algebraic sum of the influence of factors must necessarily be equal to the total gain of the effective indicator. The absence of such equality indicates errors in calculations.

Next, let us consider 10 author's methods of deterministic factor analysis.

Auxiliary data on the author's comparative coefficients for factor analysis are presented in tables 2, 3.

Table 02. Multiple comparative coefficient by one factor

Comparison of factors	Designation of comparative coefficient	Value	Product of coefficients (value)
$F_{1(I)} / F_{1(0)}$	A_1	1.365055	1.00
$F_{1(0)} / F_{1(I)}$	A_2	0.732571	
$F_{2(I)} / F_{2(0)}$	A_3	1.013534	1.00
$F_{2(0)} / F_{2(I)}$	A_4	0.986647	
$F_{3(I)} / F_{3(0)}$	A_5	1.011905	1.00
$F_{3(0)} / F_{3(I)}$	A_6	0.988235	

Table 03. Multiplicative comparative coefficients by two factors

Comparison of factors	Designation of comparative coefficient	Factor factors	Value
$(F_{1(I)} * F_{2(I)}) / (F_{1(0)} * F_{2(0)})$	B_1	A_1*A_3	1.383529
$(F_{2(0)} * F_{3(0)}) / (F_{2(I)} * F_{3(I)})$	B_2	A_4*A_6	0.975039

Author's (alternative) methods of factor analysis are presented in table 4.

Method No.1.1 (formulas 1.1 – 1.3 in table 4) is based on the difference between the effective targets, which is adjusted by comparative coefficients (A_1, B_1).

Method No. 1.2 (formulas 2.1 – 2.3 in table 4) is based on the difference between the effective actual indicators, which is adjusted by comparative coefficients (A_6, B_2).

Method No. 2.1 (formulas 3.1 – 3.3 in table 4) is based on the relation of deviation of the initial factor to the initial planned factor multiplied by the planned effective indicator which is corrected by the comparative coefficient (A_1, B_1).

Method No. 2.2 (formulas 4.1 – 4.3, in table 4) is based on the relation of deviation of the initial factor to the initial actual factor multiplied by the actual effective indicator which is corrected by the comparative coefficient (A_6, B_2).

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Method No. 3.1 (formulas 5.1 – 5.3 in table 4) is based on the difference between the effective actual and planned indicators, which are adjusted by comparative coefficients (A_1, B_1).

Method No. 3.2 (formulas 6.1 – 6.3 in table 4) is based on the difference between the effective actual and planned indicators, which are adjusted by comparative coefficients (A_6, B_2).

Method No. 4.1 (formulas 7.1 – 7.3 in table 4) is based on the ratio of the deviation of the effective factor to the difference between the effective actual and planned factors, which is adjusted by a comparative factor (A_1, B_1).

Method No. 4.2 (formulas 8.1 – 8.3 in table 4) is based on the relation of deviation of the effective factor to the difference between the effective actual and planned factors, which is adjusted by comparative coefficients (A_6, B_2).

Method No. 5.1 (formulas 9.1 – 9.3 in table 4) is based on the ratio of the deviation of the effective factor to the difference between the actual effective factors, which is adjusted by comparative coefficients (A_1, B_1).

Method No. 5.2 (formulas 10.1 – 10.3 in table 4) is based on the ratio of the deviation of the effective factor to the difference between the planned effective factors, which is adjusted by comparative coefficients (A_6, B_2).

Table 04. Methods of alternative factor analysis using comparative coefficients

No. of formulae	Formulas / calculations	
	Main part of formula	**Adjustment factors**
1.1	Δ ROE (F_1) = ROE_0*(A_1) – ROE_0	–
1.2	Δ ROE (F_2) = (ROE_0*(A_3) – ROE_0)*	A_1
1.3	Δ ROE (F_3) = (ROE_0*(A_5) – ROE_0)*	(A_1*A_3) or B_1
2.1	Δ ROE (F_1) = (ROE_I – ROE_I * (A_2))*	(A_6*A_4) or B_2
2.2	Δ ROE (F_2) = (ROE_I – ROE_I * (A_4))*	A_6
2.3	Δ ROE (F_3) = ROE_I – ROE_I * (A_6)	–
3.1	Δ ROE (F_1) = (ΔF_1/ $F_{1(0)}$) * ROE_0	–
3.2	Δ ROE (F_2) = (ΔF_2/ $F_{2(0)}$) * ROE_0)*	A_1
3.3	Δ ROE (F_3) = ((ΔF_3/ $F_{3(0)}$) * ROE_0)*	(A_1*A_3) or B_1
4.1	Δ ROE (F_1) = ((ΔF_1/ $F_{1(I)}$) * ROE_I)*	(A_6*A_4) or B_2
4.2	Δ ROE (F_2) = ((ΔF_2/ $F_{2(I)}$) * ROE_I)*	A_6
4.3	Δ ROE (F_3) = ((ΔF_3/ $F_{3(I)}$) * ROE_I	–
5.1	Δ ROE (F_1) = (ROE_I*A_4*A_6) – ROE_0	–
5.2	Δ ROE (F_2) = ((ROE_I*A_2*A_6) – ROE_0)*	A_1
5.3	Δ ROE (F_3) = ((ROE_I*A_2*A_4) – ROE_0)*	(A_1*A_3) or B_1
6.1	Δ ROE (F_1) = (ROE_I – (ROE_0*A_3*A_5))*	(A_6*A_4) or B_2
6.2	Δ ROE (F_2) = (ROE_I – (ROE_0*A_1*A_5))*	A_6
6.3	Δ ROE (F_3) = ROE_I – (ROE_0*A_1*A_3)	–
7.1	Δ ROE (F_1) = Δ ROE – (ROE_I – (ROE_0*A_1)	–
7.2	Δ ROE (F_2) = Δ ROE – (ROE_I – (ROE_0*A_3))*	A_1
7.3	Δ ROE (F_3) = Δ ROE – (ROE_I – (ROE_0*A_5))*	(A_1*A_3) or B_1
8.1	Δ ROE (F_1) = Δ ROE – ((ROE_I *A_2) – ROE_0)*	(A_6*A_4) or B_2
8.2	Δ ROE (F_2) = Δ ROE – ((ROE_I *A_4) – ROE_0)*	A_6
8.3	Δ ROE (F_3) = Δ ROE – ((ROE_I *A_6) – ROE_0)	–

https://dx.doi.org/10.15405/epsbs.2018.12.45
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eISSN: 2357-1330

9.1	Δ ROE (F_1) = Δ ROE – (ROE $_1$ – (ROE $_1$*A_4*A_6))	–
9.2	Δ ROE (F_2) = Δ ROE – (ROE $_1$ – (ROE $_1$*A_2*A_6))	A_1
9.3	Δ ROE (F_3) = Δ ROE – (ROE $_1$ – (ROE $_1$*A_2*A_4))*	(A_1*A_3) or B_1
10.1	Δ ROE (F_1) = Δ ROE – (ROE $_0$*A_5*A_3) – ROE $_0$)*	(A_6*A_4) or B_2
10.2	Δ ROE (F_2) = Δ ROE – ((ROE $_0$*A_5*A_1) – ROE$_0$)*	A_6
10.3	Δ ROE (F_3) = Δ ROE – ((ROE $_0$*A_3*A_1) – ROE $_0$)	–

6. Findings

The result for methods 1.1, 2.1, 3.1, 4.1, 5.1 is presented in table 5; the result for methods 1.2, 2.2, 3.2, 4.2, 5.2 is presented in table 6.

As can be seen from the final result of tables 1, 5, 6, the purpose of the author's methods is achieved - the determination of the influence of factors is revealed without deviations.

Table 05. Result for methods 1.1, 2.1, 3.1, 4.1, 5.1

No.	main part of formula	adjustment factors		result
1	Δ ROE (F_1) = + 0.073011	–		+ 0.073011
2	Δ ROE (F_2) = + 0.002707	1.365055	A_1	+ 0.003695
3	Δ ROE (F_3) = + 0.002381	1.383529	A_1*A_3	+ 0.003294
	+ **0.078099**			**+ 0.080000**

Table 06. Result for methods 1.2, 2.2, 3.2, 4.2, 5.2

No.	the main part of the formula	adjustment factors		result
1	Δ ROE (F_1) = + 0.074880	0.975039	A_6*A_4	+ 0.073011
2	Δ ROE (F_2) = + 0.003739	0.988235	A_6	+ 0.003695
3	Δ ROE (F_3) = + 0.003294	–		+ 0.003294
	+ **0.081913**			**+ 0.080000**

Thus, in the original example, the change in financial profitability had a positive impact:

- increase in the profitability of sales by 0.049, which caused an increase in financial profitability by 7.3%;
- increase in asset turnover by 0.012, which caused an increase in financial profitability by 0.37%;
- an increase in the coefficient of autonomy (financial independence) by 0.02, which caused an increase in financial profitability by 0.33%.

The combined effect of the three factors resulted in an 8% increase in financial profitability.

Thus, the author's methods converted a 3-factor models, compared to the most common traditional methods, reduce the complexity for a few iterations due to the introduction of copyright comparative ratios.

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Perhaps the most difficult way in practical analysis based on the author's methods was to produce comparative ratios. The aim of investigations was based on comparative ratios to form new methods of deterministic factor analysis that more accurately and reasonably evaluated the results.

7. Conclusion

Return on equity (financial return) depends on three factors: the level of return on sales, the rate of turnover of assets and the structure of the capital of the organization (the coefficient of autonomy or the coefficient of concentration of equity). Thus the directions of increase of return on equity are directly specified.

Factor analysis is aimed at identifying the impact of individual factors on the effective indicator, so deterministic modeling of factor systems is a simple and effective means of formalizing the relationship of economic indicators, which serves as a basis for quantifying the role of individual factors in the dynamics of the change of the overall indicator (Bartholomew, 1984). Due to the fact that factor deterministic factor analysis is aimed at identifying the influence of factors on the value of the performance indicator of interest excluding error, it is most relevant for practical application in market conditions (Joreskog & Sorbom, 1979).

The purpose of this article was to generalize and systematize the theoretical and methodological foundations of factorial analysis in the form that is available for specialists in the field of Economics and management. This should contribute to the formation of their base for the development of economic thinking, understanding of the essence of economic processes and phenomena occurring within the framework of economic entities, and most importantly – the development of skills for their quantitative assessment, economic interpretation and search for reserves.

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