Application of integral method in terms of 6-factor multiplicative model

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Abstract. In the article the author presented an alternative approach to determination of integral assessment of impact of factors on generalizing indicator. The author's method of integral factor analysis gives an opportunity to make more comprehensible and less time-consuming conclusion about changes in financial state of a company, as well as to evaluate the degree of impact of factors on analyzed indicator variations in the system of management and its change trends. Factor analysis is focused on revealing the impact of certain factors on the effectiveness indicator. That is why the deterministic modeling of factor systems – is a simple and effective way to formalize the connection of economic indicators that serves as a basis for quantitative evaluation of the role of certain factors in the dynamics of changes in generalizing indicator. Due to the fact that the deterministic factor analysis is focused on revealing the impact of factors that exclude errors, on the value of targeted effectiveness indicator, it is more relevant for practical use under conditions of market relations.

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Introduction

In order to take a correct view of the effectiveness of decisions, made in terms of analysis data, the factory management should be well-founded. Managerial decisions in the modern context of intense competition cannot be made instinctively. They must be based on precise calculation and deep economic analysis[1, 2, 3]. The analysis results data is, therefore, the foundation for managerial decision making. Economic analysis is the function of management that ensures the scientific character of decision making. The basis of analysis is the system of indicators and analysis tables, the choice and compiling of which implies the state and dynamics analysis of economic strength of a company, and the results and effectiveness of its use.

Integral method (the method of differential-integral calculus) allows attaining total factorization of productivity indicator and has general character (an additional growth of productivity indicator breaks down due to equal factor interaction regardless of their location in the model), i.e. this method is applied to change the influence of factors in multiplicative, divisible and mixed models of divisible-additive type.

When using the integral method, the aspects of influence of quantitative and qualitative factors were ignored. The influences of factors were considered equal. That is why there is deviation of calculation results regarding the factors as compared to calculations performed through the chain substitution method and the method of absolute and relative differences.

The traditional integral method for multiplicative models is applicable only to two or three factors that are included into the functional model [4-13], where as the author's method can be applied to any number of factors, included into the functional model.

The main goal of the author's integral method of factor analysis (Filatov's method) – is to detect factors that determine the quantity of industry-based supply, i.e. the total change of volume of production from main factors, its components. The main purpose of factor analysis is to get key parameters (the most informative ones) that show an accurate and objective history of changes of volume of production.

Rationally organized information flow and integrated and processed data serves as a basis for model building consistent with goals of analysis.

The modeling of multiplicative factor systems is accomplished by means of consequent breakdown of factors of initial system into cofactors. The functional connection between the productivity indicator and the factors is studied through deterministic factor models. The multiplicative correspondence is used for formalization of integral method. In this correspondence all factors are multiplied together.

The correct interpretation on productivity evaluation can be done under the analysis of interrelation of indicators between each other. That is why in order to characterize an overall performance of a company and an earning capacity of its various business areas (such as production, administration and maintenance, and financial area), profitability margins should be calculated in economic analysis.

Profitability margins are important elements that show the factorial environment of company profit generation. That is why, they are necessary when carrying out a comparative analysis and evaluating a financial condition of a company.

The signal indicator that shows the financial condition of a company is the financial profitability indicator. The profitability of owned capital, or in other words, financial profitability (R_f) – is the indicator that represents the total net profit / average cost of owned capital ratio. The primary formula for factor analysis appears as follows (Formula 1):

$$R_f = \frac{ZK}{SK} * \frac{SA}{ZK} * \frac{AK}{SA} * \frac{SS}{AK} * \frac{V}{SS} * \frac{P}{V} = F_1 * F_2 * F_3 * F_4 * F_5 * F_6 = \prod_{n=1}^{6} F_n \qquad (1)$$

Where:

R_f – financial profitability;

ZK – average value of borrowed capital;

SK – average value of owned capital;

SA – asset value;

AK – average capital stock, advanced into active assets (funds stored for purchase or other receipt of production goods and labor power);

SS – cost of products sold (goods, work, and services);

V – total net proceeds from sale of products, work and services (in other words, total proceeds that company receives after tax (VAT, excise duties, and similar binding payments);

P – total net profit (after profit tax, distributable profit);

$F_1 = \frac{ZK}{SK}$ – financial lever arm (financial risk coefficient);

$F_2 = \frac{SA}{ZK}$ – total capital / borrowed capital ratio;

$F_3 = \frac{AK}{SA}$ – advanced into active assets capital share of the total capital stock;

$F_4 = \frac{SS}{AK}$ – cost of products / advanced capital ratio;

– totalproceeds/ cost of productsratio;

$F_5 = \frac{V}{SS}$ – total net proceeds / cost of sold goods ratio;

$F_6 = \frac{P}{V}$ – profitability of sales.

Further, based on methods of factor analysis developed by the author, we shall evaluate the degree of impact of 6 factors on a change in financial profitability.

The basic data for integral factor analysis is presented in the Table 1.

Table № 1: The initial data for integral factor analysis

p/p	Indicators	initial factor #	Plan* 0	Fact** I	Deviation*** Δ
1	V – total net proceeds from sale of products, thousand dollars		1000000	1400000	400000
2	SS – cost of products sold, thousand dollars		680000	1030000	350000
3	ZK – average value of borrowed capital, thousand dollars		700000	745000	45000
4	SK – average value of owned capital, thousand dollars		800000	900000	100000
5	SA – asset value or balance currency, thousand dollars (3 + 4)		1500000	1645000	145000
6	AK – advanced capital, thousand dollars		620000	670000	50000
7	P – total net profit, thousand dollars		216000	288000	72000
9	**R_f – financial profitability** 7/4 = (10 * 11 * 12 * 13 * 14 * 15)		0,27	0,32	**+0,05**
10	financial risk coefficient (3/4)	F_1	0,875	0,82777778	-0,047222222
11	total capital / borrowed capital ratio (5/3)	F_2	2,14285714	2,20805369	0,065196548
12	advanced into active assets capital share of the total capital stock (6/5)	F_3	0,41333333	0,40729483	-0,006038501
13	cost of products / advanced capital ratio (2/6)	F_4	1,09677419	1,53731343	0,440539239
14	total net proceeds / cost of sold goods ratio (1/2)	F_5	1,47058824	1,3592233	-0,111364934
15	profitability of sales (7/1)	F_6	0,216	0,20571429	-0,010285714

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

The combined deflection according to productivity indicator (ΔR_f) can be determined from the Formula 2:

$$\Delta R_f = \sum_{n=1}^{6} \Delta R_f(F_n) = \Delta R_f(F_1) + \Delta R_f(F_2) + \Delta R_f(F_3) + \Delta R_f(F_4) + \Delta R_f(F_5) + \Delta R_f(F_6) \qquad (2)$$

Where: the calculation of the influence of factors on change of productivity indicator is presented in Formulas 3.1 – 3.6:

$$\Delta R_f\ (F_1) = (\ (\Delta F_1 / n) * (FO_1)\ ) + Z \qquad (3.1)$$

$$\Delta R_f\ (F_2) = (\ (\Delta F_2 / n) * (FO_2)\ ) + Z \qquad (3.2)$$

$$\Delta R_f\ (F_3) = (\ (\Delta F_3 / n) * (FO_3)\ ) + Z \qquad (3.3)$$

$$\Delta R_f\ (F_4) = (\ (\Delta F_4 / n) * (FO_4)\ ) + Z \qquad (3.4)$$

$$\Delta R_f\ (F_5) = ((\Delta F_5 / n) * (FO_5)) + Z \qquad (3.5)$$

$$\Delta R_f\ (F_6) = ((\Delta F_6 / n) * (FO_6)) + Z \qquad (3.6)$$

Where: additional growth of productivity indicator due to interaction of factors equally between each other (Z) is presented in the Formula 4:

When using the integral method, an additional growth of productivity indicator («irreducible excess» – Z) that appeared as a result of factor interaction, is equally divided between them.

$$Z = \Delta R_f - \sum ((\Delta F_n / n) * (FO_n)) / n \qquad (4)$$

Where: Z – additional growth of productivity indicator due to interaction of factors equally between each other;

FO_n – the main part of the formula of author's integral method;

ΔF_n – certain factor deflection;

n – number of factors participating in analysis.

Where: FO_n – the main part of the formula of author's integral method (Filatov's method) that is calculated from Formulas 5.1 – 5.6:

$$FO_1 = 2 * ((F_{2(0)}*F_{3(I)}*F_{4(0)}*F_{5(I)}*F_{6(0)}) + (F_{2(I)}*F_{3(0)}*F_{4(I)}*F_{5(0)}*F_{6(I)})) \qquad (5.1)$$

$$FO_2 = 2 * ((F_{1(0)}*F_{3(I)}*F_{4(0)}*F_{5(I)}*F_{6(0)}) + (F_{1(I)}*F_{3(0)}*F_{4(I)}*F_{5(0)}*F_{6(I)})) \qquad (5.2)$$

$$FO_3 = 2 * ((F_{1(0)}*F_{2(I)}*F_{4(0)}*F_{5(I)}*F_{6(0)}) + (F_{1(I)}*F_{2(0)}*F_{4(I)}*F_{5(0)}*F_{6(I)})) \qquad (5.3)$$

$$FO_4 = 2 * ((F_{1(0)}*F_{2(I)}*F_{3(0)}*F_{5(I)}*F_{6(0)}) + (F_{1(I)}*F_{2(0)}*F_{3(I)}*F_{5(0)}*F_{6(I)})) \qquad (5.4)$$

$$FO_5 = 2 * ((F_{1(0)}*F_{2(I)}*F_{3(0)}*F_{4(I)}*F_{6(0)}) + (F_{1(I)}*F_{2(0)}*F_{3(I)}*F_{4(0)}*F_{6(I)})) \qquad (5.5)$$

$$FO_6 = 2 * ((F_{1(0)}*F_{2(I)}*F_{3(0)}*F_{4(I)}*F_{5(0)}) + (F_{1(I)}*F_{2(0)}*F_{3(I)}*F_{4(0)}*F_{5(I)})) \qquad (5.6)$$

Table 2: Factor selection for the main part of the formula (FO_n) according to the author's method

With the influence of factor #	The sum of multipliers									
	The 1st multiplier					The 2nd multiplier				
	0	I	0	I	0	I	0	I	0	I
1	2	3	4	5	6	2	3	4	5	6
2	1	3	4	5	6	1	3	4	5	6
3	1	2	4	5	6	1	2	4	5	6
4	1	2	3	5	6	1	2	3	5	6
5	1	2	3	4	6	1	2	3	4	6
6	1	2	3	4	5	1	2	3	4	5

Practical approval of the above-mentioned author's method of integral factor analysis is presented in the Table 3 and 4.

In order to generate of the main part of the formula (FO_n) the principle of factor selection should be used. These factors are presented in the Table 2.

Where: **m –** the number of indicators in the main part of the Formula (Table 2). **m** is calculated from Formula 6:

$$\mathbf{m = n * (2*(n-1))} \qquad (6)$$

In 6 factor model (**n** = 6), **m** will be 60 (m = 6 * (2*5) = 6 * 10).

For example, when: n = 7, m = 84; n = 8, m = 112; n = 9, m = 144; n = 10, m = 180; n = 11, m = 220; n = 12, m = 264 and so on.

Table 3: Constituent parts of the formula according to the author's integral method

# of formula	Constituent parts of the formula		
	ΔF_n / n	Main part of the formula (FO_n)	Z
1	$\Delta R_f (F_1) = (\Delta F_1/6)*$	$2 * ((F_{2(0)}*F_{3(I)}*F_{4(0)}*F_{5(I)}*F_{6(0)}) + (F_{2(I)}*F_{3(0)}*F_{4(I)}*F_{5(0)}*F_{6(I)}))$	Z
2	$\Delta R_f (F_2) = (\Delta F_2/6)*$	$2 * ((F_{1(0)}*F_{3(I)}*F_{4(0)}*F_{5(I)}*F_{6(0)}) + (F_{1(I)}*F_{3(0)}*F_{4(I)}*F_{5(0)}*F_{6(I)}))$	Z
3	$\Delta R_f (F_3) = (\Delta F_3/6)*$	$2 * ((F_{1(0)}*F_{2(I)}*F_{4(0)}*F_{5(I)}*F_{6(0)}) + (F_{1(I)}*F_{2(0)}*F_{4(I)}*F_{5(0)}*F_{6(I)}))$	Z
4	$\Delta R_f (F_4) = (\Delta F_4/6)*$	$2 * ((F_{1(0)}*F_{2(I)}*F_{3(0)}*F_{5(I)}*F_{6(0)}) + (F_{1(I)}*F_{2(0)}*F_{3(I)}*F_{5(0)}*F_{6(I)}))$	Z
5	$\Delta R_f (F_5) = (\Delta F_5/6)*$	$2 * ((F_{1(0)}*F_{2(I)}*F_{3(0)}*F_{4(I)}*F_{6(0)}) + (F_{1(I)}*F_{2(0)}*F_{3(I)}*F_{4(0)}*F_{6(I)}))$	Z
6	$\Delta R_f (F_6) = (\Delta F_6/6)*$	$2 * ((F_{1(0)}*F_{2(I)}*F_{3(0)}*F_{4(I)}*F_{5(0)}) + (F_{1(I)}*F_{2(0)}*F_{3(I)}*F_{4(0)}*F_{5(I)}))$	Z

Table 4: The result according to the author's integral method

# of factor	Constituent parts of the formula			
	ΔF_n / n	Main part of the formula (FO_n)	Z	Conclusive result
1	$\Delta R_f (F_1)$ = -0,007870370	0,986525973	0,004342134	-0,003422191
2	$\Delta R_f (F_2)$ = 0,010866091	0,388636469	0,004342134	0,008565093
3	$\Delta R_f (F_3)$ = -0,001006417	2,069200101	0,004342134	0,002259656
4	$\Delta R_f (F_4)$ = 0,073423207	0,687473802	0,004342134	0,054818665
5	$\Delta R_f (F_5)$ = -0,018560822	0,693355822	0,004342134	-0,008527120
6	$\Delta R_f (F_6)$ = -0,001714286	4,687805272	0,004342134	-0,003694104
Only	$(\Delta F_n / n)*FO_n$		0,026052804	**0,050000000**
	0,023947196			

The factor analysis provides an opportunity to get quantitative evaluation of the influence of factor deflections on the deflection of analyzed indicator. As is seen from the conclusive result of tables 1 and 4, the goal of the author's method has been achieved – the influence of factors has been unraveled without deflection.

Advantages of integral method are the complete decomposition of factors and the absence of necessity to determine the priority of factor functioning.

A big disadvantage of this method is the heavy increase in complexity of calculation, when the number of cofactors-multipliers, which are used in the basic model of factor analysis, increases. This method has a significant computational complexity even when using formulas given above. There is also a fundamental contradiction between the mathematical framework of the method and the nature of economic phenomena.

The study of economic reality is impossible without the analytical approach. The author's deterministic factor analysis is aimed to solve a problem of search of influence values of factor changes on the change in resulting indicator. This determines the applied significance of research results, aimed at qualitative improvement of methodology of this type of analysis.

The provision of effective performance of companies requires economically-sensible operations management that is mainly determined by the ability to analyze it. Through analysis the development trends are studied; the factors of change of performance results are examined profoundly and in a consistent manner; plans and managerial decisions are based on it; and their fulfillment is controlled through it. The production efficiency enhancement potential is also discovered through analysis; the results of company performance are evaluated, and the economic strategy of development is elaborated.[14-19].

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