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QUANTITY EVALUATION OF BUSINESS ACTIVITY FINANCIAL COMPONENT

In the article the quantitative evaluation of the business activity financial component by means of multivariate statistical analysis was performed. The evaluation of business activity financial component was carried out according to the data of 24 Ukrainian gas industry enterprises activity in 2016. Seven factors-symptoms describing this component comprehensively have been selected for analysis. Multivariate statistical analysis is proposed to be undertaken in several stages. First, the cluster analysis allows to split the totality of the objects in homogeneous groups. Then, the combined algorithm of taxonomic analysis ranks the selected groups of enterprises in each cluster separately and identifies the best and the worst objects. And finally, the discriminant analysis is applied in order to formulate a universal function that will specify the business activity financial component.

Keywords: business activity, latent characteristic, financial component, multivariate statistical analysis

Problem statement. The proper functioning of the country financial system is impossible without the successful conduct of enterprises economic activity. One of the features that determines the level of this success is the business activity. It can assess the efficiency of using the enterprise's own funds and be implemented in various aspects, such as production, financial and investment¹. The most important aspect to be considered among others is the finance aspect. It enables to release the enterprise's financial resources and invest them in innovative development, improve production processes, increase the motivation of employees. All this ensures the financial stability of the enterprise and, consequently, its good reputation at the market.

Business activity is a latent characteristic, because there is no single quantitative indicator that could measure its level. Nowadays there is a lot of different coefficients, which describe the business activity and on the basis of which experts try to evaluate it. However, only reliable and independent quantitative evaluation of business activity shows the efficiency of enterprises' operations after using all available financial resources. In the economic literature a single evaluation principle that can allow to measure the level of business activity financial component has not been defined yet.

Analysis of recent research and publications. The issue of business activity evaluation is considered by domestic and foreign scientists. Problems of using different approaches of business activity forming are highlighted in the works of scientists Y. Brighem², A. Sheremet³, G. Savitskaya⁴, O. Yefimov⁵, M. Bilyk⁶, N. Kashenko, O. Horoshanskaya⁷, V. Kovalev⁸.

The object of the article. The purpose of this article is to make a quantitative evaluation of the business activity financial component by means of multivariate statistical analysis.

¹ Білик, М.Д. (2007). *Фінансовий аналіз: навчальний посібник*. Київ: КНЕУ.

² Бриггем, Ю.А. (1999). *Финансовый менеджмент: учебное пособие*. Москва: Финансы и статистика.

³ Шеремет, А.Д. (2009). *Финансовый анализ*. Москва: Экономика.

⁴ Савицька, Г.В. (2004). *Економічний аналіз діяльності підприємства: навчальний посібник*. Київ: Знання.

⁵ Ефимова, О.В. (2004). *Анализ финансовой отчетности: учебное пособие*. Москва: Омега-Л.

⁶ Білик, М.Д. (2007). *Фінансовий аналіз: навчальний посібник*. Київ: КНЕУ.

⁷ Кащенко, Н.Б. (2016). *Ділова активність підприємства: сутність та методика аналізу: монографія*. Москва: Видавництво Іванченка І.С.

⁸ Ковалев, В.В. (2007). *Финансовый менеджмент: теория и практика*. Москва: Проспект.

Presentation of basic material of the research. Problems of quantitative evaluation of latent characteristics are successfully solved by means of methods of multivariate statistical analysis. These methods are the most effective quantitative instrument for socio-economic research, which are described by a large number of characteristics. These methods include cluster analysis, taxonomy, factor analysis, correlation analysis, regression analysis.¹ Quantitative evaluation of the level of business activity financial component is proposed to be performed by means of methods of multivariate statistical analysis according to 2016 data of 24 gas industry enterprises of each region. The following factor-indicators were selected for its determination: X_1 – profitability of sales; X_2 – profitability of assets; X_3 – receivables turnover; X_4 – payables turnover; X_5 – cash turnover; X_6 – inventories turnover; X_7 – index of assets growth. These factors were chosen after detailed study of the correlation of each factor with the level of business activity financial component. Data on gas industry enterprises from the official website of the Stock market infrastructure development agency of Ukraine² were used for this analysis. Then it were processed using the Excel editor and the STATISTICA application package on a personal computer.

To begin, it is necessary to make sure that the selected factors do not correlate with each other through correlation-regression analysis. The Pearson correlation coefficient is the most often used for measuring the tightness of the pair linear dependence between the indicators³.

After the matrix of the Pearson correlation coefficients of the selected indicators was calculated, it was found that the indicators of profitability of sale (X_1) and assets (X_2) have a close correlation between each other, as well as indicators of receivables (X_3) and payables (X_4) turnovers. With a close factors correlation, the qualitative content of the analysis will be lost, so it will be difficult to provide an interpretation of the one or another factor's effect on the final result. Since there is a real dependence between the profitability of sales and assets and the factor of profitability of sales is more important for the latent sign of business activity, it was decided to exclude the indicator of profitability of assets from the analysis. However, in terms of a priori analysis, the correlation between the indicators of receivable and payables turnovers should not exist, and these factors play one of the most important roles, so their exclusion will result in an incorrect interpretation of business activity. Therefore, the author decided to introduce in the analysis such factor as a duration of the operating cycle (X_8), which includes the duration of the inventories turnover (inversely proportional to X_6) and the duration of the receivables turnover (inversely proportional to X_3) instead of the coefficients of their turnovers. The the results of correlation analysis of the selected indicators (after the indicators X_2 , X_3 , X_6 exclusion and the indicator X_8 inclusion) are given in Table 1. It proves that there is no close correlation between them, and each factor characterizes the resulting latent indicator in a different way.

The selected factors have different units of measurement, so it is necessary to standardize the space of variables through centering and normalization within a multivariate analysis. The variation range of standardized values should be within from -3 to 3 by the normal variables allocation.⁴ After the data was standardized, it was found that object number 11 shows an abnormally high value of the factor X_8 (its size is 3.31534), and object number 20 shows an abnormally high value of the factor X_4 (its size is 3.30314). The analysis cannot be reliable with such distribution, since the values of factors X_4 and X_8 are shifted by the reason of abnormal observations. Therefore, there was made a decision to exclude objects 11 and 20 from the analysis. The adjusted matrix of standardized data was presented in Table 2.

¹ Янковой, А.Г. (2001). *Многомерный анализ в системе STATISTICA*. Одесса: Оптимум, 1.

² SMIDA (2018) *Офіційний сайт Агентства з розвитку інфраструктури фондового ринку України* <<https://smida.gov.ua/>> (2018, червень, 09).

³ Янковой, А.Г. (2014). *Математико-статистические методы и модели в управлении предприятием: учебное пособие*. Одесса: ОНЭУ.

⁴ Янковий, О.Г. (2015). *Латентні ознаки в економіці: монографія*. Одеса: Атлант.

Table 1

**Matrix of Pearson correlation coefficients of factors-symptoms
of business activity financial component**

	X ₁	X ₄	X ₅	X ₇	X ₈
X ₁	1				
X ₃	0,365283	1			
X ₅	0,019192	-0,08533	1		
X ₇	0,345698	0,115249	0,47618	1	
X ₈	-0,0809	-0,72884	0,209065	-0,02827	1

Source: calculated by author

The analysis was started from the clustering of a selected set of cases. The task of cluster analysis is to divide the totality of investigated enterprises with close weights of factors-symptoms, which reflect the business activity financial component of gas industry enterprises on quantitatively homogeneous groups.

Table 2

**Matrix of standardized data of business activity financial component
of the selected enterprises**

	X ₁	X ₄	X ₅	X ₇	X ₈
1	0,81225	-0,55976	1,29507	-0,40745	1,39248
2	0,15173	-0,44214	1,55482	0,70014	0,60660
3	1,18539	-1,26791	-1,12275	-1,69053	0,36246
4	-0,25566	-1,34011	0,42792	-0,26514	1,96092
5	-0,04481	0,68768	-0,23162	-0,01713	-0,52790
6	-0,27906	0,14184	0,01733	0,11564	-0,43968
7	-0,27030	-0,08154	-0,53201	-0,25679	-0,72478
8	0,22663	-0,15879	-0,83074	0,21464	0,28038
9	0,99987	3,01165	-1,19807	-1,11835	-1,56114
10	0,22856	0,32516	-0,76097	-0,20917	-0,20693
12	-0,17408	-0,23260	-0,09026	0,26949	0,84445
13	-1,06284	0,22164	-0,79706	-0,21759	-0,74295
14	-2,55636	-1,10683	-1,21263	-1,38442	-0,56952
15	0,72428	0,43675	-0,90580	0,14621	-0,42321
16	0,07987	-0,47073	-0,45794	0,57164	1,27984
17	0,18162	1,24739	1,16467	-0,61797	-1,18958
18	-2,55085	-1,41650	1,73986	-0,99829	1,17507
19	0,39500	-0,00244	1,15000	2,10253	0,14080
21	0,11751	0,10145	-0,16190	0,28172	0,64057
22	1,32047	1,37223	1,77057	2,73964	-2,01428
23	0,93957	-0,03093	-0,21715	-0,31543	0,32217
24	-0,16878	-0,43549	-0,60135	0,35662	-0,60577

Source: calculated by author

The cluster analysis was started by using hierarchical algorithms. A hierarchical joining (agglomeration) of cases in clusters based on the criteria that minimize the distances between them in area of business activity factors is presented in Fig. 1. As a metric of the distance between objects it was used the Euclidean distance and as the unification measure it was used the Ward's method to built vertical icicle plot.

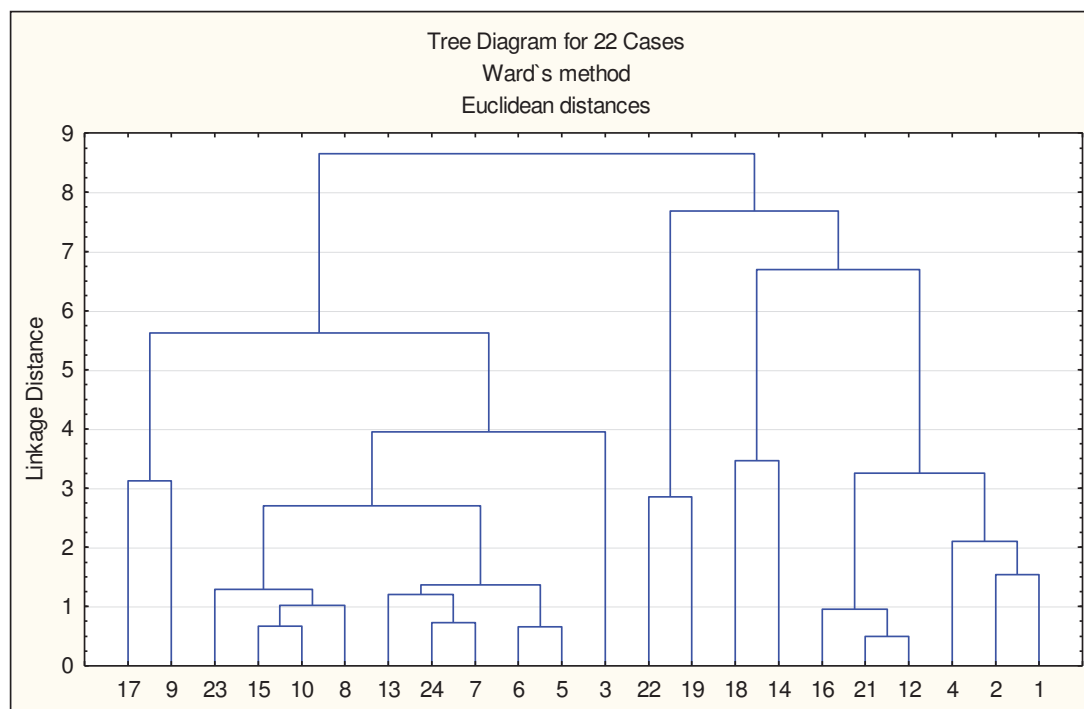


Fig. 1. Vertical icicle plot of clustering process of selected enterprises

Source: built by author

Dendrogram analysis showed that the totality is divided into 5 clusters. The structure of the first includes objects No. 17 and No. 9, the second – No. 23, No. 15, No. 10, No. 8, No. 13, No. 24, No. 7, No. 6, No. 5, No. 3 respectively, the part of the third – No. 22 and No. 19 respectively, the fourth – No. 18 and No. 14 respectively and the fifth – No. 16, No. 21, No. 12, No. 4, No. 2, No. 1 respectively.

Next, it is necessary to verify if the allocation of the primary statistical cases totality is correct. The iterative method of the standart type, which name is the k-means clustering, is used. The result of the totality allocation by this method is presented in Table. 3

After the result was obtained, we could see that the k-means clustering confirmed the results of the hierarchical joining. This means that the objects of one group have proximity and the objects of different groups have the significant difference in the space of factors-symptoms of the business activity financial component.

Identification of the obtained clusters on the basis of the two-way joining method, which is shown in Fig. 2, makes it possible to divide the formed groups of enterprises into: a group of absolute outsiders (cluster 4); the group of the worst among middle class, which consists of 6 objects (cluster 5); middle class cluster with 10 objects (cluster 2); cluster of the worst among the leaders (cluster 1); and the last group (cluster 3) are absolute leaders. Such conclusion can be made on the basis of the analysis of stimulants indicators – profitability of sales, payables turnover, cash turnover; index of assets growth and of the de-stimulator indicator – the duration of the operating cycle.

Table 3

Results of enterprises clusterization by the k-means clustering

Members of Cluster Number 1 and Distances from Respective Cluster Center		Members of Cluster Number 21 and Distances from Respective Cluster Center		Members of Cluster Number 3 and Distances from Respective Cluster Center		Members of Cluster Number 4 and Distances from Respective Cluster Center		Members of Cluster Number 5 and Distances from Respective Cluster Center	
	Distance		Distance		Distance		Distance		Distance
9	0,698324	3	1,056297	19	0,639594	14	0,774784	1	0,57724
17	0,698324	5	0,390402	22	0,639594	18	0,774784	2	0,599327
		6	0,3759					4	0,596437
		7	0,280927					12	0,317861
		8	0,330399					16	0,437399
		10	0,175518					21	0,432956
		13	0,597646						
		15	0,391546						
		23	0,4775						
		24	0,369958						

Source: calculated by author



Fig. 2. Graphical representation of the results of the double association

Source: Built by author

Further, it was decided to make a taxonomic analysis within each cluster of the business activity financial component. Taxonomic analysis is based on the calculation of distances (similarities) of all points (cases) to the standard (anti-standard) in the space of factors-symptoms, which are the external demonstration of the hidden characteristic of objects. This method is implemented in two main taxonomic analysis algorithms – classical and modified. It should be noted that the classical algorithm sometimes has mistakes in determining the similarity with objects-outsiders (on the investigated hidden characteristic of objects), and just the opposite the modified algorithm suffers from inaccuracy in identifying the object-leaders. Therefore, recently it is proposed to use a mixed (combined) algorithm to make ratings. It is based on ratings, which are ranked according to the classical and modified algorithms. After that, an aggregate rating is constructed by using the lowercase sum method. Further, after calculating the combined ratings (r_i) for each object is assigned a final rank (R_i). The results of a taxonomic analysis mixed algorithm are presented in Table. 4

Table 4

Aggregate rating by the Fisher's formula

Explored objects	Rating score		Weights		r_i	Rank by a mixed algorithm
	R_{ei}	R_{ai}	K_{ei}	K_{ai}		
The cluster of absolute leaders						
22	1	1	0,66667	0,33333	1	1
19	2	2	0,33333	0,666666667	2	2
The cluster of the worst among the leaders						
9	1	1	0,66667	0,33333	1	1
17	2	2	0,33333	0,66667	2	2
The middle class cluster						
3	10	10	0,01818	0,18182	2	10
5	1	1	0,18182	0,01818	0,2	1
6	2	2	0,16364	0,03636	0,4	2
7	6	6	0,09091	0,10909	1,2	6
8	8	9	0,05455	0,16364	1,91	9
10	5	7	0,10909	0,12727	1,44	7
13	9	8	0,03636	0,14545	1,49	8
15	3	3	0,14545	0,05455	0,6	3
23	4	4	0,12727	0,07273	0,8	4
24	7	5	0,07273	0,09091	0,96	5
The cluster of the worst among the middle class						
1	3	2	0,19048	0,09524	0,76	2
2	1	1	0,28571	0,04762	0,33	1
4	6	6	0,04762	0,28571	2	6
12	4	4	0,14286	0,19048	1,33	4
16	5	5	0,09524	0,23810	1,67	5
21	2	3	0,23810	0,14286	0,90	3
Cluster of absolute outsiders						
14	2	2	0,33333	0,66667	2	1
18	1	1	0,66667	0,33333	1	2

Source: calculated by author

According to the results of taxonomic analysis, it can be concluded that the absolute leader among the selected enterprises is the enterprise number 22 (PJSC "Cherkassygaz"), and the absolute outsider is the enterprise number 18 (PJSC "Odesagas").

After such results were received, it was proposed to make a discriminant analysis in order to get a single adequate discriminatory function; to determine the rank of latent characteristic for the investigated economic objects based on the constructed regression equation; to evaluate the latent characteristic for the objects, which are not the part of the totality cases.¹

In order to construct a universal discriminant function for the selected enterprises, there should be made a regression analysis of the enterprises classification. Let's it would be taken the \hat{Y} as a dependent variable, which varies from 1 to 22. In this case, 1 would be assigned to the worst object among outsiders, and 22 – the best among leaders. Consequently, the affiliation of a new object to a particular cluster will be represented as follows: if the result of the calculated discriminant function is within 1 and 2, the new object will be an outsider, within 3 and 8 – the worst among the middle class, within 9 and 18 – the middle class, within 19 and 20 – the worst among the leaders, within 21 and 22 – the absolute leader respectively.

First, all five factors-symptoms of the business activity financial component of the gas industry enterprises mentioned above were applied in order to build a universal discriminant function. The results of the regression analysis are presented in Table. 5

Table 5

**Results of multivariate correlation-regression analysis
of business activity financial component**

<i>Regression statistics</i>						
Multiple R	0,90369					
R-squared	0,81666					
Normalized R-squared	0,75937					
Standard error	3,18538					
Cases	22					
Analysis of variance						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Signif. F</i>	
Regression	5	723,15349	144,63070	14,25402	2,067E-05	
Remainder	16	162,34651	10,14666			
Total	21	885,50000				
	<i>Odds</i>	<i>Standard error</i>	<i>t-statistics</i>	<i>P-Value</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Y-intercept.	30,20139	11,96790	2,52353	0,02258	4,83056	55,57221
Var. X ₁	48,01984	17,85121	2,69000	0,01610	10,17696	85,86271
Var. X ₄	1,30789	1,79861	0,72717	0,47763	-2,50500	5,12078
Var. X ₅	0,01428	0,01591	0,89748	0,38277	-0,01945	0,04801
Var. X ₇	1,90980	2,23353	0,85506	0,40514	-2,82508	6,64469
Var. X ₈	-0,21102	0,06078	-3,47168	0,00315	-0,33988	-0,08217

Source: calculated by author

¹ Янковий, О.Г. (2015). *Латентні ознаки в економіці: монографія*. Одеса: Атлант.

Before the constructed model is being used, it is necessary to check the degree of its reliability. Imagine the significance level α of the constructed model is 0.05. The calculated significance of F is much less than the given significance level α ($0.000002067 < 0,05$), so the constructed model should be generally considered reliable with the 95% probability.

The coefficients of the constructed model showed an unequal discriminative ability of the factors because of low value of t- statistics and high P-values each of them, when it was tested the reliability of the model odds. The data in Table 5 showed that the role of variables X_4 , X_5 and X_7 in recognizing the business activity financial component of the investigated objects is not very high. Therefore, it was decided to make step-by-step regression analysis in order to remove non-essential factors from the model. Its final results are presented in Table. 6

Table 6

**Results of stepwise multivariate correlation-regression analysis
of business activity financial component**

<i>Regression statistics</i>						
Multiple R	0,87861					
R-squared	0,77195					
Normalized R-squared	0,74794					
Standard error	3,26012					
Cases	22					
Analysis of variance						
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Signif. F</i>	
Regression	2	683,56067	341,78034	32,15731	7,967E-07	
Remainder	19	201,93933	10,62839			
Total	21	885,50000				
	<i>Odds</i>	<i>Standard error</i>	<i>t-statistics</i>	<i>P-Value</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Y-intercept	41,33178	4,81450	8,58485	0,00000	31,25491	51,40864
Var. X_1	60,01722	14,60473	4,10944	0,00060	29,44916	90,58528
Var. X_8	-0,23944	0,03921	-6,10696	0,00001	-0,32151	-0,15738

Source: calculated by author

As a result, a universal discriminant function contains the following most influential on the business activity financial component variables: profitability of sales and duration of the operating cycle. Their statistical reliability is confirmed by indicators of t-criterion and P-significance and is within acceptable limits.

The universal equation of the discriminant function looks like this:

$$\hat{Y} = 41.33178 + 60.01722 * X_1 - 0.23944 * X_8 \quad (1)$$

Let's check is the constructed model suitable for practical use? The value of the multiplication correlation coefficient $R = 0.87861$ indicates a close connection between the remaining variables and the variable \hat{Y} . The determination coefficient $R^2 = 0,77195$ shows that 77% of the business activity financial component changing is determined by the factors-indicators that are remained in the model. The significance F is 7,967E-07, so we can affirm that the model is reliable with a 95% probability.

Checking the signs of regression coefficients showed that they have the same economic meanings as the direction of correlation between stimulant factors-indicators (X_1), de-stimulator indicator (X_8) and a variable \hat{Y} , which characterizes the rank of their business activity financial component. Therefore, the growth of profitability of sales and the reduction of the duration of the operating cycle sets the rank of the business activity financial component of the object to the highest value. All this proves that the regression model does not need to be adjusted and can be used in practice.

Let's consider the discriminant function of the business activity financial component for an enterprise that was not part of the investigated totality, named PJSC "Umngaz". To do this, the values of the variables $X_1 = 0.0208$, $X_8 = 133.205$ will be substituted into the universal discriminant model (1). The result is:

$$\hat{Y} = 41.33178 + 60.01722 * 0.0208 - 0.23944 * 133.205 = 10.685.$$

The rank of business activity financial component of PJSC "Umngaz" is included in the interval from 9 to 18, which allows to assign this enterprise to the middle class cluster.

It is necessary to analyze in depth the influence of each factor-symptom on the resultant indicator \hat{Y} and to identify the reserves of its growth based on compare objects-leaders with objects-outsiders for the practical using of the universal discriminant model.

The average absolute effect of each factor on the resultant indicator \hat{Y} can be evaluated with regression coefficients help. To evaluate the relative effect of factors, it is necessary to calculate the coefficients of flexibility according to the following formula:

$$\hat{A}_j = a_j \frac{\bar{X}_j}{\bar{Y}}, \quad (2)$$

where a_j – regression coefficient of the j factor;

\bar{X}_j – the mean value of the j factor;

\bar{Y} – the mean value of the resultant indicator.

To determine the average effect with its oscillation degree of the factor X_j on the resultant indicator \hat{Y} , it is necessary to use the β -coefficient. It shows the average amount of standard deviations of the resultant variable \hat{Y} that changes by the one standard deviation of the factor X_j and are calculated by the formula:

$$\beta_j = a_j \frac{\sigma_j}{\sigma_Y}, \quad (3)$$

where σ_j – standard deviation of the j factor;

σ_Y – standard deviation of the variable \hat{Y} .

After these indicators was studied, it can be concluded:

1. With the growth of profitability of sales by 1 unit the rank of the business activity financial component increases by 60, and with the increase in the duration of the operating cycle on 1 day, the rank of business activity financial component decreases by 0.24 units.

2. If the profitability of sales increases by 1%, the business activity financial component increases by 0.05%. If the duration of the operating cycle increases by 1%, the business activity financial component decreases by 2.54%.

3. The calculated β -coefficients for a two-factor constructed model show if the profitability of sales increases by 1 standard deviation, the business activity financial component increases by 0.457 of its standard deviation; and if the duration of the operating cycle increases by the same value, it decreases by 0.002 of its standard deviation respectively.

In order to improve the business activity financial component of outsiders, it is expediently to identify the reserve, which increases its rank. To do this, it is needed to find subtractions between the average values of the leaders and outsiders, and then multiply these subtractions with the corresponding regression coefficients of the constructed model. The calculation is presented in Table 7

As the result, if the average level of profitability of sales increases by 0.16 (16%) and the duration of the operating cycle is reduced by 27 days, the outsiders will be able to realize the growth reserve of the business activity financial component by 9.7 points and 6.4 points respectively. That is, the total reserve will be 16.1 points.

Table 7

**Comparative analysis of the business activity financial component
of leaders and outsiders that is based on the model (1)**

Variables	Average values of variables by groups		Subtractions between average values (c. 2 – c. 3)	Regression coefficients	Effect (reserve) (c. 4*c. 5)
	leaders	outsiders			
X_1	0,02574	-0,13618	0,16193	60,01722	9,71833
X_8	100,79987	127,64365	-26,84377	-0,23944	6,42758
\hat{Y}	20,50000	1,50000	19,00000	-	16,1459

Source: calculated by the author

Conclusion. The proposed method of quantitative evaluation of the business activity financial component is based on the construction of an universal discriminant function, which determines the place of the enterprise on the market among competitors in the industry. A multivariate statistical analysis has shown that the biggest impact on the level of the resulting indicator is made by the factors of profitability of sales and duration of the operating cycle. Specifically, if the absolute value of the factor X_1 increases and the growth rate of the the factor X_8 reduces, the business activity financial component will be improved.

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