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ECONOMETRIC ANALYSIS OF CHANGES IN WORKING CAPITAL OF UKRAINIAN ENTERPRISES

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Анотація

Стаття присвячення питанням економетричного аналізу оборотного капіталу підприємств України. Встановлено тенденцію змін оборотного капіталу під впливом факторів кількості найманих працівників, фінансового результату діяльності та матеріальних витрат. Проведено розрахунок характеристик кореляційного зв'язку між факторами та оцінку їх еластичності. За даними статистики (при 5% рівні значимості факторів) обґрунтовано найбільший зворотній вплив фактору кількості працівників на фактор оборотного капіталу.

Abstract

An article on econometric analysis of working capital of Ukrainian enterprises. The trend of changes in working capital under the influence of factors of the number of employees, financial performance and material costs is determined. The characteristics of the correlation between the factors and the assessment of their elasticity are calculated. According to statistics (at 5% level of significance of factors) the greatest reverse influence of the factor of the number of employees on the factor of working capital is substantiated.

Ключові слова: оборотний капітал, матеріальні витрати, факторний вплив, економетричний аналіз, кореляція, еластичність,

Keywords: working capital, material costs, factor influence, econometric analysis, correlation, elasticity

Working capital plays an indispensable role in the process of agricultural production as one of the most important factors that significantly affects the formation of production prime cost. The working capital of enterprises is represented by such assets that are intended for intermediate material consumption or sale during the operating cycle or for 12 months from the balance sheet date, as well as cash and cash equivalents. In this case, the operating cycle is understood as the period of time from the moment of acquisition of stocks for economic activity to the time of receipt of funds from the sale of products produced with their participation. According to its economic content, the category of working capital can be defined as a set of floating capital and working capital [1].

The working capital is the monetary expression of objects of labor that are at the stage of production stocks and work-in-process inventory, which participate in only one cycle of production and fully transfer their value to the product created. The working capital from an economic point of view is an advanced value at the stage of production. In their functional role, they differ significantly in the production process. According to this feature, the following groups are distinguished: production stocks, work in progress inventory and animals for breeding and fattening. In the assets side of the balance sheet of enterprises, the working capital is reflected in section II "Current assets", subsection "Stock". This subsection also includes finished products, although in terms of its economic content, this type of working capital should be considered as a circulation constituent.

Production stocks are objects of labor that have not yet entered the stage of industrial consumption, and in agricultural enterprises, they are of agricultural and industrial origin. The production stocks of agricultural origin include fodder, seeds and planting material, litter, agricultural raw materials for industrial processing, adult poultry, rabbits.

Production stocks of industrial origin are represented in agricultural enterprises by mineral fertilizers, pesticides, petroleum products and solid fuels, spare parts, low-value and rapidly wearing items used for not more than one year, building materials for current repairs, etc. If agricultural enterprises have processing industrial productions, then the production stocks of this type may include containers, basic and auxiliary materials, packaging materials, semi-finished products, etc.

The ratio between the production stocks of industrial and agricultural origin in agricultural enterprises is different and depends on the degree of development of processing industries and other types of industrial activity, the intensity of production and its specialization.

All other things being equal, the main share of production stocks is represented by stocks of agricultural origin and reaches 60% or more. The size of inventories should ensure the continuity of production and depends on the volume of production, standards and the nature of industrial consumption of material and supplies.

Animals for breeding and fattening are current assets represented by the value of adult animals for fattening, young animals for breeding, culled from the main herd of adult animals for sale, as well as the value of poultry, animals and rabbits. By their economic nature, these means of production are not stocks in the truest sense of the word, but are at the stage of production. Therefore, it would be more appropriate to consider them as a constituent of work-in- progress inventory.

The work-in-process inventory is a part of the working capital that has already been consumed but the finished product has not yet been received. As you can see, this working capital is at the stage of production, its size depends on the scale of production and production area of the enterprise, the level of its specialization in the main industry.

In agricultural enterprises, the work-in-progress inventory is divided into the following types: in crop production, animal husbandry, in processing production and in auxiliary production. The crop production in progress is represented by the costs of after-harvesting residues peeling off and fall-plowed field raising, the cost of fertilizers applied in the fall and the cost of their delivery and application to the soil for next year's harvest, costs for seeds and winter crops, snow retention and etc. In animal husbandry, this type of working capital is represented by the costs of the incubation of eggs in progress, the cost of transitional stocks of honey in hives; in processing industries – the value and costs of processing production raw materials that are in the production process at all stages of the production cycle; in subsidiary production – unfinished repair of the equipment, unfinished firing of bricks, etc.

The second important component of working capital is floating assets. They are not directly involved in the production process, but only operate it, while being the result of this production. Circulation funds include finished manufactures, goods, promissory notes received, receivables according to settlements and other current receivables, current financial investments, cash and cash equivalents in national and foreign currency, other current assets.

Finished products are those products that are intended for sale to procurement and processing enterprises, for sale at exchange houses, cooperative shops, rural markets, for sale and distribution against wages to employees of agricultural enterprises, for catering and more. If the product does not meet the requirements for its sale, it is reflected in the work in progress.

The element of working capital "goods" reflects the value of goods purchased by the company for resale, and the element "bills received" shows the debt of buyers, various customers for shipped products (work performed or services provided), which is secured with bills.

Accounts receivable for goods, works, services are funds that must be received by the company from other market participants for the products sold to them, services provided and work performed as payment for promissory notes received, etc.

Accounts receivable by calculations include debts to the budget, advances, accrued income and internal payments. In particular, it reflects the debt of financial tax authorities, various overpayments of taxes; the amount of advances provided to other enterprises for subsequent payments; amounts of dividends, interest, royalties, etc. accrued to the enterprise, which are subject to receipt; arrears of internal settlements.

Current financial investments are a relatively new component of working capital for agricultural enterprises. These are investments that are made for a period not exceeding one year and can be freely sold at any time. These include short-term commercial market securities, treasury bills, negotiable certificates of deposit, other market securities purchased for resale within one year.

An important component of working capital is cash and cash equivalents. They are represented by cash on hand, current and other bank accounts (these funds can be freely used for current transactions), as well as cash equivalents. They are short-term financial investments that are highly liquid, freely convertible into certain amounts of cash and which involve little risk of change in value.

A complex combination of causes leads to different results. Acting upon the consequence in the same direction, they increase each other's influence. If part of the causes has the opposite direction in relation to the object of action, then their combined effect on the consequence either weaken or even bring to naught. There may even be a situation where a well-defined, real cause has no obvious consequence. This means that along with this cause, there is another, absorbing action of the first one. Therefore, it is necessary to investigate the influence of different causes, i.e. to investigate the dependence of one phenomenon on a number of other phenomena that cause the first one. Not all causes and factors, to some extent, influence the phenomenon under study and can be investigated. Therefore, they are limited only to the essential reasons. The economic phenomenon is determined by many simultaneously and collectively acting reasons. The problem of multiple or multifactor regression analysis is the problem of studying the dependence of one dependent variable on several explanatory variables x1, x2 ..., xn in the conditions of a specific place and a specific time. The main limitations are [2]:

1. There is a linear relationship between the dependent variable y and the explanatory variables x1, x2 ..., xn.

2. With a nonlinear relationship between variables, a linear approximation is possible.

In multifactorial or multiple regression there are cases [4]:

1. Explanatory variables x_i ..., x_m have a common simultaneous effect on the dependent variable y.

2. Due to the impossibility to cover the whole set of reasons and take into account the randomness, the equation is limited to the most important explanatory

variables.

In the expression of the regression function there is an additive component e, which describes the random perturbations and the total effect of the influence of all unaccounted factors and cases.

Thus, the dependent variable is interpreted in the same way as in simple linear regression.

4. Coefficients b_i are regression parameters. The regression constant b_0 performs the clearing function in the regression equation and determines the point of intersection of the regression hypersurface with the axis of ordinates.

The values of b_i are estimates of the regression coefficients. The index at the coefficient corresponds to the index of the explanatory variable. b_i indicates the average value of the change in the factor y when changing x_i by one unit, provided that the other variables remain constant.

Based on the main characteristics of the studied economic area, the econometric model of changes in working capital can be represented by the following specification [3]:

$$y = f(x_1, x_2, x_3) \qquad (1)$$

where

y is working capital, UAH million;

x_1 is a number of employees, thousand people;

x_2 is financial result, UAH million;

x_3 is material expenditures, UAH million.

The informational background for the construction and evaluation of the econometric model of changes in working capital is given in table 1.

Table 1

Informational background for calculating the econometric model of changes in working capital*

No.	Period	y Working capital, UAH mln.	x_1 Number of employees, thousand people	x_2 Financial result, UAH mln.	x_3 Material expenditures, UAH mln.
1	2010	2229892.3	9074	141291.5	228473.4
2	2011	2506632.2	8987	141098.4	262206.9
3	2012	2921135.8	8861	175540.3	673552.2
4	2013	3069042	8515	202099.4	683587.8
5	2014	3271954	7312	792771.5	654061.8
6	2015	4108603	6589	726496.4	850835.4
7	2016	5772817	6598	367040.3	1046468.0
8	2017	5650817	6706	346707.8	1294619.9
9	2018	6285067	7089	296052.5	1548095.0
10	2019	6640282	7419	248240.6	1624162.4

* Source: formed by the author according to data [5]

As shown in Table 1, the share (or percentage) of the main indicators of current assets in relation to sales is selected as resulting features. The data extraction is equal to 10 years, 2010 – 2019 i.e., the estimated current period is equal to 1 year. The main array of information was obtained from public information of the State Statistics Service of Ukraine.

The object of the study is the working capital of Ukrainian enterprises for 2010 – 2019 period. The results of the analysis of changes in changes in the working capital of enterprises are shown in table 2.

Table 2

Working capital of Ukrainian enterprises, 2010 – 2019, UAH million *

Period No.	Years	Working capital, UAH mln.
1	2010	2229892.3
2	2011	2506632.2
3	2012	2921135.8
4	2013	3069042
5	2014	3271954
6	2015	4108603
7	2016	5772817
8	2017	5650817
9	2018	6285067
10	2019	6640282
Basic estimators		
No.	Evaluation class	Value
1	amount	42456241.44
2	average	4245624.14
3	average absolute incremental value	490043.34
4	average growth ratio	1.13
5	variance	2539329028301.02
6	mean square deviation	1593527.23
7	coefficient of variation	37.53

* Source: formed by the author according to data [5]

According to these calculations (Table 2) in 2010 – 2019 period, the average expected value of working capital of Ukrainian enterprises was equal to UAH 4245624.14 million. The average absolute incremental value of this indicator showed that for this period the average annual increase was UAH 490043.34 million and amounted to 113.5% growth. The average deviation of the indicator from the average expected value amounted to UAH 1593,527.23 million, which is equal to 37.53%.

The results of the analysis of changes of the number of employees of Ukrainian enterprises are shown in Table 3.

Table 3

Number of employees of Ukrainian enterprises, 2010-2019, thousand people*

Period No.	Years	Number of employees, thousand people
1	2010	9074
2	2011	8987
3	2012	8861
4	2013	8515
5	2014	7312
6	2015	6589
7	2016	6598
8	2017	6706
9	2018	7089
10	2019	7419
Basic estimators		
No.	Evaluation class	Value
1	amount	77149.99
2	average	7715.00
3	average absolute incremental value	-183.87
4	average growth ratio	0.98
5	variance	959448.76
6	mean square deviation	979.51
7	coefficient of variation	12.70

* Source: formed by the author according to data [5]

According to these calculations (Table 3) in 2010 – 2019 period, the average expected value of the number of employees of Ukrainian enterprises was 7715.00 thousand people. The average absolute increase of this indicator showed that for this period the average annual decrease was −183.87 thousand people. and amounted to 98.8% growth. The average deviation of the indicator from the average expected value is 979.51 thousand people, which is equal to 12.7%.

The results of the analysis of changes in the dynamics of the financial result of profitable enterprises of Ukraine are given in Table 4. According to these calculations (Table 4) in the 2010 – 2019 period, the average expected value of the financial result of Ukrainian enterprises was UAH 343733.88 million. The average absolute increase of this indicator showed that for this period the average annual growth of the indicator was UAH 11,883.24 million. and was 106% growth. The average deviation of the indicator from the average expected value amounted to UAH 221467.82 million, which is equal to 64.43%.

Table 4

Financial result of enterprises of Ukraine, 2010-2019, UAH million

Period No.	Years	Financial result, UAH mln.
1	2010	141291.5
2	2011	141098.4
3	2012	175540.3
4	2013	202099.4
5	2014	792771.5
6	2015	726496.4
7	2016	367040.3
8	2017	346707.8
9	2018	296052.5
10	2019	248240.6
Basic estimators		
No.	Evaluation class	Value
1	amount	3437338.76
2	average	343733.88
3	average absolute incremental value	11883.24
4	average growth ratio	1.06
5	variance	49047993906.94
6	mean square deviation	221467.82
7	coefficient of variation	64.43

* Source: formed by the author according to data [5]

The findings of the analysis of material costs of products changes of Ukrainian enterprises are shown in Table 5. According to these calculations (Table 5) in 2010 – 2019 period, the average expected value of material enterprises of Ukraine [5] was UAH 886606.28 million. The average absolute increase of this indicator showed that for this period the average annual growth of the indicator was UAH 1,55076.56 million and it amounted to 124% growth. The average deviation of the indicator from the average expected value amounted to UAH 462,446.29 million, which is equal to 52.16%.

According to the analysis, it should be noted that all factors influencing working capital had a general tendency to interactive decrease.

Table 5

Material costs of enterprises of Ukraine, 2010-2019, UAH million

Period No.	Years	Financial result, UAH mln.
1	2010	228473,4
2	2011	262206,9
3	2012	673552,2
4	2013	683587,8
5	2014	654061,8
6	2015	850835,4
7	2016	1046468,0
8	2017	1294619,9
9	2018	1548095,0
10	2019	1624162,4
Basic estimators		
No.	Evaluation class	Value
1	amount	8866062.80
2	average	886606.28
3	average absolute incremental value	155076.56
4	average growth ratio	1.24
5	variance	213856574920.56
6	mean square deviation	462446.29
7	coefficient of variation	52.16

* Source: formed by the author according to data [5]

The model is estimated on the basis of calculations of partial correlation coefficients and regression parameters calculated by the least square method (LCM). [4]

Partial correlation coefficients of the econometric model are obtained from the correlation matrix developed:

r (yx1) = -0.76716, the relationship between the factors is medium, inverse direction.

r (yx2) = 0.105992, the relationship between the factors is weak, straight direction.

r (yx3) = 0.963138, the relationship between the factors is close, straight direction.

r (x1x2) = -0.65542, the relationship between the factors is medium, inverse direction.

r (x2x3) = 0.106625, the relationship between the factors is weak, straight direction.

r (x1x3) = -0.70292, the relationship between the factors is medium, inverse direction.

According to estimates of partial correlation coefficients, it can be seen that the model is dominated by external connections, i.e. between the factors y←x (i). The internal relations between x (i +1)←x (i) have a small correlation effect, which does not confirm the presence of multicollinearity in the correlation matrix.

The general type of the regression equation is described by the equation:

$$y = \hat{y} + e \qquad (2)$$

y is the actual value of working capital,

$\hat{y}$ is the theoretical (regression) value of working capital,

e is the error of results.

The linear form of multifactor regression on a multiplicity of 3 factors in general is as follows:

$$\hat{y} = b0 + b1 \cdot x1 + b2 \cdot x2 + b3 \cdot x3 \qquad (3)$$

x1 is the number of employees, thousand people,

x2 is the financial result, UAH million,

x3 is the inventories, UAH million,

bi is the parameter of the regression equation calculated according to the least square method.

The multifactor model of changes in working capital has the following form:

$$\hat{y} = 9823877.435 - 869.3016x1 - 2.23345x2 + 2.13862x3 \qquad (4)$$

According to the obtained model we have the characteristics of changes in the factor y:

- with the increase in the number of employees (x1) per 1 thousand people, the working capital will decrease by UAH 869.3016 million;

- with an increase in the financial result (x2) by UAH 1 million, the working capital will decrease by UAH 2.2334 million;

- with the increase in the number of material costs (x3) by UAH 1 million, the working capital will increase by UAH 2.123862 million;

The obtained model is significant, which is confirmed by the value of the multiple coefficient of determination $R^2 = 0.9745$. Factors x (i) have 97.5% of the influence on the resulting y, and the other 2.5% of the influence belongs to factors not taken into account in the model.

The multiple correlation coefficient r (y, x1, x2, x3) is 0.9873109, which indicates a high level of closeness between the factors. The model is adequate, which confirms the calculations of Fisher's F-statistics. $F_{calc.} >= F_{theor.}$ ($\alpha = 0.05$, df1 = 3, df2 = 6), i.e. 27.75945> = 4.76.

The significance of the regression parameters is confirmed by the evaluation of Student's t-statistics at degrees of freedom (n-2, $\alpha = 0.05$) $t_{theor} = 2.31$. The significance of the model parameters showed that they are all significant: $t_{theor} = 2.31$:
- b0: t_{calc} (3.837380066)> = t_{theor} (2.31) - significant;
- b1: t_{calc} (-3.348962963)> = t_{theor} (2.31) - significant;
- b2: t_{calc} (-2.719539751)> = t_{theor} (2.31) - significant;
- b3: t_{calc} (5.120847922)> = t_{theor} (2.31) - significant.

Based on the high level of the multiple coefficient of determination and the significance of the model coefficients, we can conclude that there is no multicollinearity. The estimation of forecast fluctuations of theoretical and actual values of the model of changes in the working capital is given in table 6.

Table 6

Estimation of factor influences in econometric model

Period number	Period	Working capital, UAH mln.	Regression value of working capital, UAH mln.	Deviation of the actual value from the regression one	Lower data range	Upper data range
1	2010	2229892.3	2109179.8	120712.5	-10435608.0	14653967.5
2	2011	2506632.2	2257165.3	249466.9	-10266608.0	14780938.6
3	2012	2921135.8	3169003.8	-247868.0	-9764661.6	16102669.3
4	2013	3069041.6	3431949.1	-362907.5	-9345563.8	16209462.0
5	2014	3271954.0	3096029.4	175924.6	-10073701.2	16265760.0
6	2015	4108602.7	4292648.9	-184046.2	-8486302.1	17071600.0
7	2016	5772816.5	5506825.9	265990.6	-6754838.1	17768490.0
8	2017	5650817.4	5988498.5	-337681.1	-6554898.6	18531895.6
9	2018	6285066.6	6311228.3	-26161.7	-6632338.4	19254795.0
10	2019	6640282.4	6293712.3	346570.1	-6841189.7	19428614.3

* Source: formed by the author according to data [5]

As shown by the evaluation findings, the range of changes in the values of the parameters is within the following:

$$b_{lower} < b_i < b_{upper}$$
$$3559665.5 < b0 < 16088089.4$$
$$-1504.5 < b1 < -234.1$$
$$-4.2 < b2 < -0.2$$
$$1.1 < b3 < 3.2$$

The graph of the range of changes in the regression values of the econometric model for estimating changes in working capital is shown in Fig. 1.
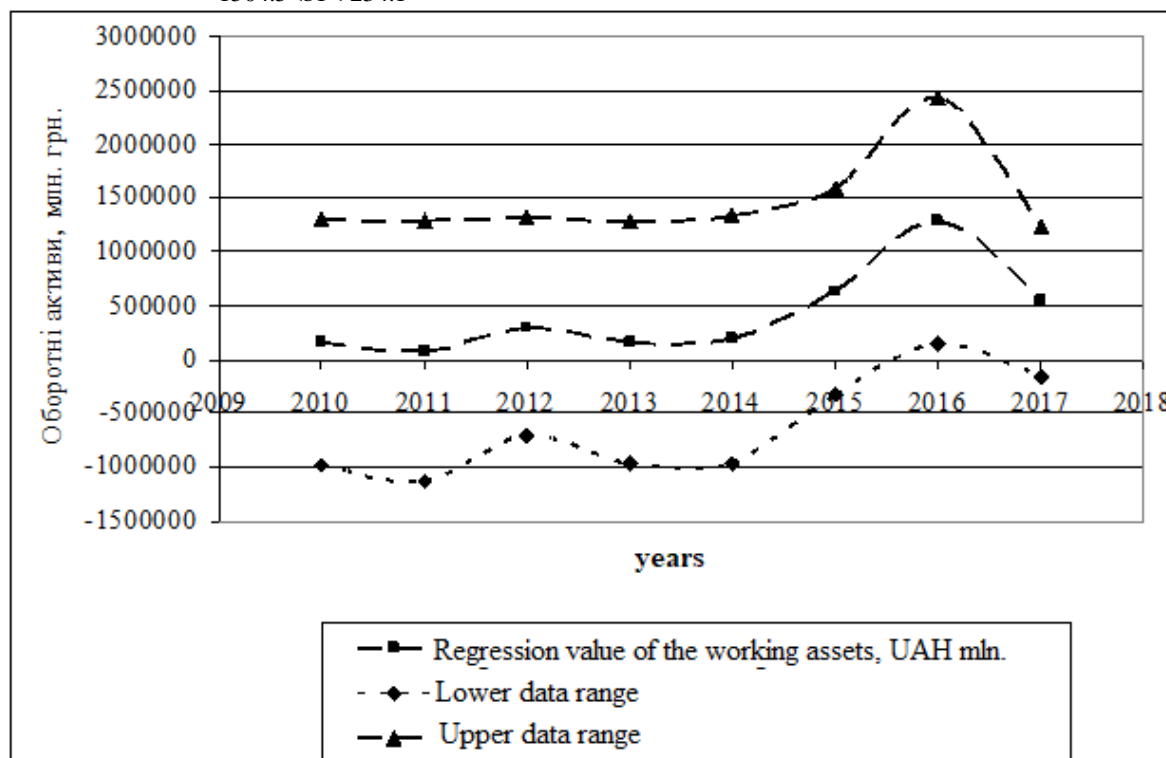

Fig. 1 Graph of the range of changes in the regression values of the econometric model of changes in working capital of Ukrainian enterprises
* Source: formed by the author according to data [5]

In general, for the period 2010 – 2019, the working capital of Ukrainian enterprises is characterized by gradually increasing changes with minor short-term fluctuations.

The analysis of deviations of the basic factors on which the model is constructed is investigated on the basis of means (table 7).

Table 7

Estimation of changes of average values of parameters of econometric model

Change parameter	Coefficient	y	x1	x2	x3
average	1	4245624.1	7715.0	343733.9	886606.3
5%	1.05	4457905.4	8100.7	360920.6	930936.6
10%	1.1	4670186.6	8486.5	378107.3	975266.9
15%	1.15	4882467.8	8872.2	395294.0	1019597.2
20%	1.2	5094749.0	9258.0	412480.7	1063927.5
25%	1.25	5307030.2	9643.7	429667.3	1108257.9

* Source: formed by the author according to data [5]

As can be seen from Table 7, with a gradual increase in the average expected value of working capital by 25%, its amount can be expected to the value of 5307030,2 million UAH under the following conditions: when the number of employees increases to the level of 9643,7 thousand people, subject to constant shares of other factors; with the growth of the financial result to 429667,3 million UAH subject to constant shares of other factors; with the increase in the cost of material costs to 1108257,9 million UAH.

The calculation of the elasticity of the factors of the studied model is shown in table 8.

Table 8

Calculation of the elasticity of the factors of the studied model

	beta coefficient	elasticity coefficient
b1	-0.5343	-1.58
b2	-0.3104	-0.18
b3	0.6206	0.45

The findings of the calculations showed that the factors have elasticity within the growth of 1% of the level of the corresponding factors x (i):

- the amount of working capital will decrease by 1,58% with an increase of the number of employees by 1%;

- the amount of working capital will decrease by 0,18% with an increase of the value of financial results by 1%;

- the amount of working capital will increase by 0,45% with an increase of the value of material costs by 1%.

According to the beta coefficient, it can be concluded that the greatest impact on working capital has a change in the number of employees and it amounts to 53.4%. Material costs have the least impact, which is at the level of 31,04%.

Conclusions. Modern requirements for the study of economic processes require the introduction of econometric methods and models that allow the analysis of working capital based on the stochastic influence of factors of the number of employees, the value of the financial result and the value of material costs.

1. The studied model has a high degree of reliability and significance, which were evaluated on the basis of calculated correlation and determination coefficients. The multiple correlation coefficient characterized the close influence between the factors (more than 0,987), and the multiple coefficient of determination showed the significance of the influence of more than 97,4% for the studied factors.

2. The study of multicollinearity showed that the model has a high level of coefficient of determination with a high level of significance of the model parameters and denies the hypothesis of multicollinearity.

3. The estimation of parameters was carried out on the basis of the least square method, which showed that the greatest impact on the resulting working capital has a factor of the number of employees. The elasticity of this factor is equal to 1.38% of the decreasing changes.

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