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ECONOMETRIC AND ENVIRONMENTAL FACTORS ASSESSMENT OF ENTERPRISE ACCOUNTS PAYABLE*

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Abstract

The authors have constructed a linear model of trade accounts payable multiple regression depending on its financial indicators by considering the environmental concerns in digital era. Authors used a sample of monthly non-stationary time series with a deterministic trend from January 2016 to December 2019. To build the regression, the time series were reduced to a stationary form by switching to the differences in the initial levels. Connection of accounts payable with the financial indicators revealed the connection of accounts payable and the turnover ratio receivables turnover in accounts payable, as well as a ratio of own working capital. The assumption about the connection between accounts payable and gross profit of the enterprise has not received reasoned confirmation. The reliability of the results obtained was confirmed by Fisher, Student, Durbin-Watson, and White tests. The results of the obtained empirical estimates confirmed the feasibility of practical use of this approach in modeling the company's accounts payable in order to forecast it. Forecasting accounts payable will allow the company creating a budget for receipts and payments to optimize accounts payable. The authors note that the forecast will allow managing the amount of accounts payable by changing the maturity of the debt.

Keywords: accounts payable, environmental factors, false correlation, linear regression, time series

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1. Introduction

Borrowed funds, including accounts payable, occupy a significant proportion of the sources of financing the organization. An increase in accounts payable has a twofold effect. On the one hand, accounts payable allow the organization to use free of charge non-monetary funds in its turnover. On the other hand, a significant amount of such debt may indicate a deterioration in the financial situation and stability of the organization. The analysis of accounts payable is the most important part of the analysis of financial and economic activities of the organization, because it allows to manage and to develop an optimal schedule in order to timely repay obligations and prevent lenders from imposing penalties. The proper management of accounts payable is one of the important tasks in the functioning of the enterprise. If there is a clear, well-established mechanism and proper work with accounts payable, the company can optimally use borrowed funds, which will improve financial performance (Semenikhina and Galimova, 2016). Accounts payable management is a process of developing and implementing management decisions to coordinate its size and turnover, ensuring the optimal amount of free cash (Kulikova et al., 2016). It is important for an enterprise to be able to determine the level of accounts payable at which it will work effectively, and to assess the factors that affect the accounts payable (Kulikova et al., 2016).

The goal of the study is to measure connection between accounts payable and gross profit indicators, the turnover ratio of accounts receivable, the turnover ratio of accounts payable, and the ratio of providing own working capital. The main hypothesis of the study is that an increase in the company's profit is associated with a decrease in accounts payable (to the budget, suppliers, staff, and other contractors). Analysis of economic phenomena is difficult to imagine without the use of econometric models. The most common of these are linear multiple regression models. Earlier studies have already analyzed the dependence of accounts payable on long-term and short-term sources. At the same time, such factors as equity, accounts payable, short-term loans and long-term liabilities played a key role (Yakupova et al., 2017). In the course of the study calculations were made using econometric models to prove the connection between accounts payable and financial performance of the organization.

2. Methods

The study used monthly data from 2016 to 2019 of the trading company. Descriptive statistics of the variables used are presented in Table 1. In the case of modeling multidimensional time series when constructing a regression of one variable to another, the slope coefficient may be significant, but there is no cause-and-effect (qualitative) connection. This effect is called false correlation and is discussed in (Brooks, 2008; Stock and Watson, 2011).

Table 1. Descriptive statistics of the used variables

Variable	*Designation*	*Average*	*Standard deviation*	*Minimum*	*Maximum*
Accounts payable, RUB	Y_t	639610,3477	767281,3588	46274	3842600
Gross profit, RUB	X_{1t}	271360,3225	1145304,723	-444277,77	7772834,84
Accounts payable turnover ratio (X2)	X_{2t}	9,540192558	10,55185855	0	44,64165827
Accounts receivable turnover ratio (X3)	X_{3t}	1,06343601	0,843671773	0	4,127641711
Equity Ratio (X4)	X_{4t}	0,074017643	0,020775458	0,030227553	0,149007589

The source: estimated by the authors according to the financial statement data

In a regression analysis, the influence of a factor can be eliminated if we fix the effect of this factor on the result and other factors included in the model. This technique is widely used for regression with time series in the presence of a deterministic trend in at least one series. A time series with a deterministic trend can be brought to a stationary form by taking the differences of the initial levels of the series. This will clear the source variables from the trend according to the Frisch-Waugh-Lowell theorem.

A time series with a stochastic trend can be brought to a stationary form by taking the differences of the initial levels of the series.

In the study, the usual least squares method was used to evaluate regression dependencies, and the Fisher, Student, Durbin-Watson and White tests were used to verify the obtained models.

3. Results and discussion

Figure 1 shows graphs of the actual levels of all variables used in this study. As can be seen from Fig.1, we are dealing with stochastic trends. As can be seen from the matrix of linear coefficients of pair correlation (Table 2), the highest absolute value belongs to the linear coefficient of pair correlation between the increase in accounts payable and the increase in the turnover ratio of accounts payable. Then, according to the degree connection tightness, there are gross profit and the security ratio of own funds. Their impact on accounts payable is considered weak, because the correlation coefficients value of these factors (modulo) are less than 0.3. The smallest effect is exerted on the accounts receivable turnover ratio, since the company repays its accounts payable mainly due to the borrowed source, and not the receivable. No collinear regressors were detected.

In the study (Table 3) the linear multiple regression models were evaluated using the usual least squares method for a complete set of factors (1) and after eliminating redundant variables (2) (William, 2018; Wooldridge, 2013).

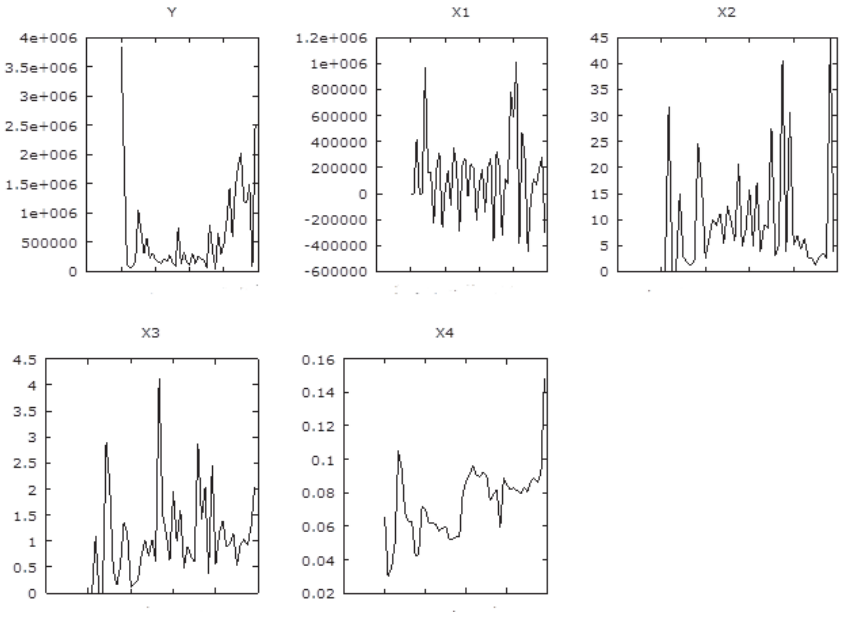

Fig. 1. Graphs of actual levels of time series

According to Table 3, we can conclude that there is a high correlation between gross profit, receivables and payables ratios, equity ratios, and payables in accordance with the

Cheddock scale, as the plural R equals to 0.730921 and is close to 1. The determination coefficient (R-squared) equals to 0.534245. It shows that the variation in accounts payable around the average value of 53.42% is due to a change in the above factors. The normalized R-square equals to 0.489887 and gives an estimate that does not depend on the factors number in the model and therefore can be compared with different models with a various number of factors. The variance analysis of accounts payable is presented in Table 4.

The regression equation reliability is estimated by the Fisher F-criterion test. According to Table 4, it is clear that the calculated value of the Fisher test (F) is 12.0440, and the probability of accepting the Fisher test null hypothesis was 0.00000131, which does not exceed the permissible significance level of 0.01. Therefore, the obtained value of the determination coefficient is not accidental; it was formed under the influence of existing regressors, i.e. the statistical significance of the entire regression equation is confirmed. Table 5 shows the parameters of the multiple regression equation.

Table 2. Matrix of pair correlation linear coefficients

	ΔY_t	ΔX_{1t}	ΔX_{2t}	ΔX_{3t}	ΔX_{4t}
ΔY_t	1				
ΔX_{1t}	-0,18	1			
ΔX_{2t}	-0,63	0,42	1		
ΔX_{3t}	0,10	0,38	0,31	1	
ΔX_{4t}	0,22	0,15	0,01	0,11	1

The source: obtained by authors in MS Excel

Table 3. Regression analysis of accounts payable

Indicators	*Values*
Multiple R	0,730921
R-square	0,534245
Normalized R-square	0,489887
Standard error	485911,524
Observations	47

Table 4. Analysis of accounts payable

Index	*df*	*SS*	*MS*	*F*	*F value*
Regression	4	1,1375E+13	2,8437E+12	12,044	0,00000131
Remainder	42	9,9166E+12	2,3611E+11		
Total	46	2,1291E+13			

Table 5. Parameters of the multiple regression equation

Indicators	*Coefficients*	*Standard error*	*t-statistics*	*P-value*	*Lower 95%*	*Upper 95%*
Y-crossing	-48 290	71 372	-0,6766	0,5024	-192 323	95 744
ΔX_{1t}	-0,0105	0,0513	-0,2048	0,8387	-0,1141	0,0930
ΔX_{2t}	-29 474	4 834	-6,0970	0	-39 230	-19 718
ΔX_{3t}	182 796	68 376	2,6734	0,0106	44 807	320 784
ΔX_{4t}	8 128 861	4 446 602	1,8281	0,0746	-844 745	17 102 466

Analyzing the data in Table 5, we can conclude that only X_{2t}, X_{3t}, X_{4t} factors are significant, since the t-statistics value of these factors is modulo higher than the table value (t_{table}= 2, 01808). This is also indicated by the probability of accepting the null hypothesis of the Student's test (P-value). For X_{2t}, X_{3t}, and X_{4t}, this value is no more than the accepted

error probability levels (0.01, 0.05, and 0.1). Therefore, the parameter values for X_{2t}, X_{3t}, X_{4t} are not random, i.e. they are statistically significant and reliable.

As a result of the study, the following equation was obtained (Eq. 1):

$$\Delta Y_t = -48290 - 0{,}0105\Delta X_{1t} - 29474\Delta X_{2t} + 182796\Delta X_{3t} + 8128861\Delta X_{4t} + \varepsilon_t, \quad (1)$$

Model (1) shows that the dependence between variables Y_t and X_{2t} is negative, between X_{3t} and Y_t – positive, i.e., with an increase in the payables turnover ratio by one point, the accounts payable will decrease by an average of 29,474 rubles, and with an increase in the accounts payable turnover ratio by one point, the accounts payable will increase by an average of 182,796 rubles. The increase in the ratio of own funds by 1 point causes an increase in accounts payable by an average of 8128861 rubles. The company uses borrowed funds in its turnover.

After excluding the statistically insignificant X_{1t} variable, the following parameters were obtained (Table 6):

The multiple regression linear model of accounts payable with significant regressors has the following form (Eq. 2):

$$\Delta Y_t = -47802 - 29816\Delta X_{2t} + 178970\Delta X_{3t} + 8002239\Delta X_{4t} + \varepsilon_t \quad (2)$$

The determination coefficient (R-square) is 0.533779. It shows that the variation in the accounts payable amount around its average value of 53.38% is due to X2, X3, X4 regressors. The calculated value of the Fisher criterion (F) is 16.4104, and the probability of accepting the null hypothesis of the Fisher test was 2.9697E-07, which does not exceed the acceptable significance level of 0.01.

Next we compare the quality of fitting models (2) and (1) using the "short – long" test (Eqs. 3-8):

$$H_0 : R^2_{UR} = R^2 R \quad (3)$$

$$H_1 : R^2_{UR} > R^2_R \quad (4)$$

$$F = \frac{R^2_{ur} - R^2_r}{1 - R^2_{ur}} \cdot \frac{n - m - 1}{k} = \frac{0{,}534245 - 0{,}533779}{1 - 0{,}534245} \cdot \frac{47 - 4 - 1}{1} = 0{,}0429 \quad (5)$$

$$F_{0,1,3,42} = 2{,}8260 \quad (6)$$

$$F_{0,05.3.42} = 4{,}0670 \quad (7)$$

$$F_{0,01,3,42} = 7{,}2636 \quad (8)$$

Table 6. Parameters of the multiple regression equation

Indicators	***Coefficients***	***Standard error***	***t-statistics***	***P-value***	***Lower 95%***	***Upper 95%***
Y-пересечение	-47802	70532	-0,6777	0,5016	-190044	94440
ΔX_{2t}	-29816	4484	-6,6483	0,0000	-38860	-20771
ΔX_{3t}	178970	65039	2,7517	0,0086	47805	310136
ΔX_{4t}	8002239	4354085	1,8379	0,0730	-778610	16783089

The observed value of the Fisher statistics does not exceed the critical value at all significance levels, so the null hypothesis of an insignificant difference in the determination

coefficients of the "long" and "short" models cannot be rejected with a reliability of 90%, 95% and 99%. This confirms the correlation between the turnover ratio of accounts payable, the turnover ratio of accounts receivable, and the equity security ratio with accounts payable.

The observed value of the Durbin–Watson statistics is 1.2977 for critical d_1=1.42. d_2=1.57 less than d_1 means positive autocorrelation in the regression residuals, and the third assumption of the least squares method in the model (2) is violated. A simplified version of the White test was used in the study to test the regression residuals for heteroscedasticity. According to this test, the squares regression of residuals to the original variables was evaluated (Table 7).

We are only interested in the value of the R^2 determination coefficient, equals to 0.058418, hence the statistics is the following (Eq. 9):

$$\begin{aligned} \chi^2 &= n \cdot R^2 = 47 \cdot 0,058418 = 2,745646 \\ \chi^2_{0,1;43} &= 55,2302 \\ \chi^2_{0,05;43} &= 59,3035 \\ \chi^2_{0,01;43} &= 67,4593 \end{aligned} \tag{9}$$

The observed χ^2 statistics is less than the critical value at all possible significance levels, which means that the White test null hypothesis on residues homoscedasticity cannot be rejected. From the Student's test for the residuals squares regressors coefficients, it can also be seen that the residuals squares with regressors are not correlated. The second premise of the least squares method in model (2) is confirmed.

Table 7. Results of squared residual regression for Wight test performance

Regression statistics						
Multiple R					0,241697174	
R-square					0,058417524	
Normalized R-square					-0,007274277	
Standard error					4,34376E+11	
Observation					47	
Analysis of variance						
	df	SS	MS	F	Significance F	
Regression	3	5,03367E+23	1,6778E+23	0,889266	0,454347731	
Residual	43	8,11335E+24	1,8868E+23			
Total	46	8,61672E+24				
	Factors	Standard error	t-statistics	P-value	Lower 95%	Upper 95%
Intercept	2,2236E+11	63766443569	3,4872	0,0011	93770315108	3,5096E+11
ΔX2	-244757331	4054561690	-0,0604	0,9521	-8421560263	7932045601
ΔX3	7624224367	58800548639	0,1297	0,8974	-1,1095E+11	1,2620E+11
ΔX4	-6,4243E+12	3,93639E+12	-1,6320	0,1099	-1,4362E+13	1,5141E+12

We apply the Box-Jenkins methodology (Kadochnikova et al., 2019; Kadochnikova et al., 2019) to obtain a forecast estimate of the company's accounts payable. According to the Dickey-Fuller test and the analysis of the autocorrelation function and the partial autocorrelation function, the forecast for the initial levels of the time series is feasible using the ARIMA (1,1,1) model estimated by the maximum likelihood method (Eq. 10).

As can be seen in Fig. 2, the ARIMA (1,1,1) model predicts a decrease in accounts payable. We obtain an alternative predictive estimate based on the linear regression model (2). Growth forecasts for X_{2t}, X_{3t}, X_{4t} will be obtained on the basis of ARIMA models (p, d, q) (Tables 8-9).

$$Y_t = -12936{,}7 + 0{,}406217 Y_{t-1} - 0{,}695501 \varepsilon_{t-1} + \varepsilon_t \quad (10)$$

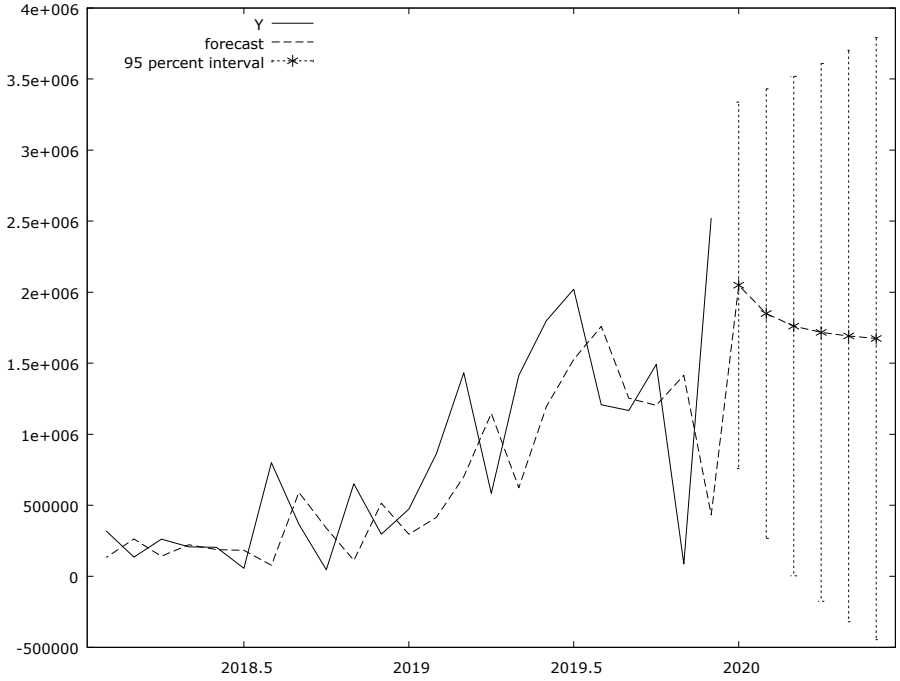

Fig.2. Forecast of accounts payable of the enterprise according to the ARIMA model (1,1,1)

Table 8. Forecast assessment of enterprise accounts payable according to the ARIMA model (1,1,1)

Month	***Forecast***	***Standard error***	***Lower forecast line***	***Upper forecast line***
2020:01	2048397.04	657947.369	758843.90	3337950.19
2020:02	1849359.67	807191.033	267294.32	3431425.02
2020:03	1760825.64	896598.615	3524.64	3518126.63
2020:04	1717179.97	965759.169	-	3610033.16
2020:05	1691768.73	1025913.080	-	3702521.42
2020:06	1673764.63	1081084.478	-	3792651.27

The obtained least square method estimates of the model coefficient (2) can be interpreted as follows: with an increase in the payables turnover ratio by one point, the accounts payable will decrease by an average of 29816 rubles, and with an increase in the receivables turnover ratio by one point, accounts payable increase by an average of 178970 rubles. The increase in the equity ratio by one point causes an increase in accounts payable by an average of 8002239 rubles.

Table 9. Predictive assessment of enterprise accounts payable according to the linear model of multiple regression

Month	*Growth forecast X_{2t}*	*Growth forecast X_{3t}*	*Growth forecast X_{4t}*	*Growth forecast Y_t*	*Forecast Y_t*
2020:01	6,028078	-0,92649	-0,0135	-501368	2018097
2020:02	-0,30603	-0,05516	-0,02556	-253046	1765051
2020:03	0,030143	-0,00121	-0,00702	-105125	1659925
2020:04	-0,00297	-2,7E-05	-0,00143	-59177,5	1600748
2020:05	0,000292	0	0,000255	-45770,1	1554978
2020:06	-2,9E-05	0	0,000765	-41679,4	1513298

4. Conclusions

Accounts payable are an integral part of monetary relations and occupy an important place in the company's activities. The amount of accounts payable directly affects the final indicators of economic activity. Therefore, an econometric assessment of variables related to accounts payable is necessary for each enterprise (Hyndman and Athanasopoulos, 2013). Regression analysis is used when there is no functional connection between the analyzed indicators. Due to the regression model, two issues can be resolved: studying the correlation between the studied indicators and quantifying the degree of analyzed factor influence on the studied indicator (Box and Jenkins, 1970). Factors identification that directly affect the amount of accounts payable will affect the process improvement of managing accounts payable. The constructed model can be used to forecast the amount of accounts payable depending on the receivables turnover ratio, the turnover ratio of accounts payable and the ratio of own funds. This allows the company to maintain the value of accounts payable at an optimal level.

The study of the connection between accounts payable and financial indicators revealed that there is no correlation between accounts payable and gross profit of the enterprise. This is proved by the results of constructing a linear model of accounts payable multiple regression, the estimates of which are obtained by the method of the least squares. The peculiarities of the commercial enterprise functioning entail the appropriate specifics in management decisions. Trade enterprises have a need to regulate the volume of supplies and inventory, and, accordingly, with respect to accounts payable, they usually pursue goals aimed at optimizing it.

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