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MODELING FINANCIAL LIQUIDITY OF CONSTRUCTION COMPANIES USING ERROR CORRECTION MODEL

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ABSTRACT

Financial liquidity is one of the most important economic categories in the functioning of the company. Numerous assessment methods of company's liquidity are available, ranging from ratio analysis to advanced models of cash flows. This paper presents econometric model of financial revenues, which was used to analyze the liquidity of the three construction companies. This analysis was made using indicator methods.

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INTRODUCTION

The most common cause of business failure is the loss of liquidity and not the lack of efficiency (profitability)[6]. In the long term, loss of liquidity is inseparably linked to earning a profit by the company. Lack of positive effects of business activity eventually leads to the inability to pay liabilities. Besides the category of profitability in business, the following important determinants of liquidity exist: (Stryjewski, 2009):

- Timeliness of cash receipts for the sale of products or services.
- The availability of other financial resources, including funding from foreign sources.

[6] http://www.forbes.pl/jakie-sa-powody-bankructwa-firm-,artykuly,203165,1,1.html

While the availability of funding sources is a derivative of the economic situation of the company or the assessment of its business plan, the timeliness of cash receipts is a very important element linked to operating activities.

Constant relationship between sales and the proceeds is an important factor in terms of analytical assessment of the company. The study of such a relationship is not limited to the factor of one variable affecting the other, but also to interpretation of its level, short-term fluctuations and the speed of adjustments - i.e., company's reaction rate to overdue receivables. The reaction is linked with the possibility of company's impact on the environment, and in principle with the force of its impact on the counterparties (Porter, 2006).

The aim of the study is a comparative analysis of the constructor sector companies in terms of the relationship between the proceeds and sales. In addition to the analysis of public methods, econometric model of financial liquidity will be used as proposed in the work (Stryjewski, 2009).

RATIO ANALYSIS[7]

The main activity of the Company A is building construction. The company gets most of its revenue based on contract management. The company revenue is at a stable level, slightly above 1 billion PLN annually. The company employs approximately 600 people, with the management team comprising a large part of it staff.

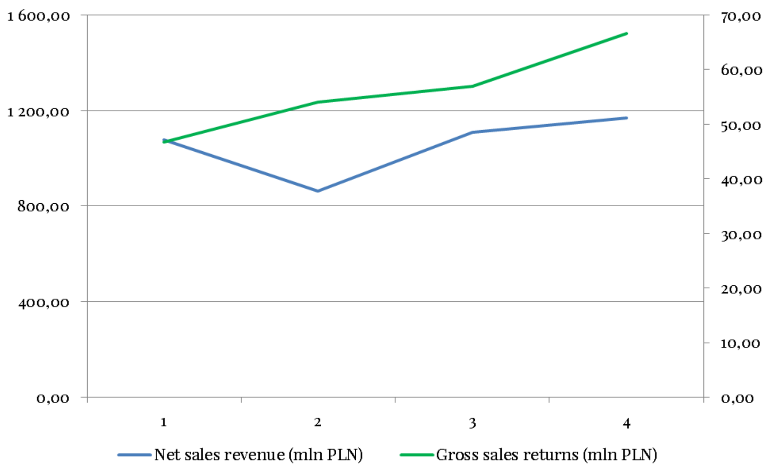

Figure 1. Revenue and returns on sales for Company A
Source: own work.

[7] All data presented herein have been multiplied by a common multiplier to change the level of variables, while keeping their dynamics and proportions.

Table 1. Basic indicators of liquidity in Company A

A.	Financial liquidity	2013	2014	2015
1.	Current	1.5	1.4	1.8
2.	Quick	1.5	1.4	1.8
3.	Immediate	0.2	0.3	0.3
B.	Fiscal cycle	2013	2014	2015
4.	The receivables turnover ratio (number of cycles)	4.4	5.2	4.7
5.	The receivables cycle ratio (day)	83	70	77
6.	The liabilities turnover ratio (number of cycles)	3.3	3.9	4.0
7.	The liabilities cycle ratio (day)	110	94	91
C.	Profitability	2013	2014	2015
8.	Return on Sales (ROS)	6.27%	5.14%	5.70%
9.	Return on Equity (ROE)	3.44%	4.95%	4.47%
10.	Return on assets (ROA)	1.34%	1.54%	1.60%
11.	Gross profitability	1.37%	1.48%	1.40%
12.	Net profitability	0.98%	1.10%	0.98%

Source: own work.

Analyzing the data in Table 1, it is clear that the company shows good financial parameters. The liquidity ratio is within the normative limits (cf. Bień W. (1999)). Comparison of the current ratio and the quick ratio and finding basically the same values for both emphasize a significant fact that the audited company has no inventory.

An important element affecting the liquidity of a mutual relationship between the ratio of cycles of receivables and liabilities. In the analyzed case, the ratio of receivables cycle calculated in days falls below the corresponding instrument for liabilities. This means that the company is always able to discharge its liabilities from current receipts. Profitability ratios show on a profitable level, therefore, in the long term the company is also able to meet its liabilities.

Analyzing the abovementioned company using BCG matrix methodology (cf. Gierszewska, Romanowska, 2012), developed by the Boston Consulting Group, you can define it as a “cash cow”. This is evidenced by both stable revenues and margins achieved.

Company B operates in the segment of infrastructure construction. Its business activity brings a high growth momentum in both revenues and margins, as confirmed by Figure 2. The BCG matrix would be marked as a “star”, as quoted revenues grow more than 100% annually, while their value indicates that company market share is still relatively small.

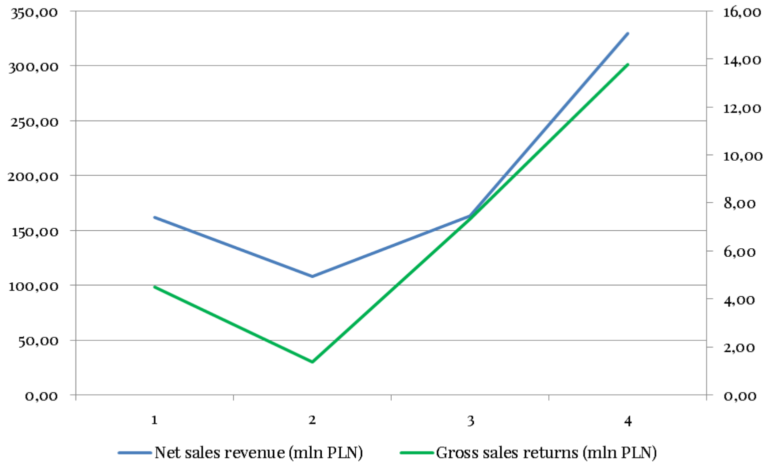

Figure 2. Revenue and Return on Sales for Company B
Source: own work.

Table 2. Basic indicators of liquidity in Company B

A.	Financial liquidity	2013	2014	2015
1.	Current	2.5	2.0	3.3
2.	Quick	2.3	1.9	3,2
3.	Immediate	0.6	0.9	2.2
B.	Fiscal cycle	2013	2014	2015
4.	The receivables turnover ratio (number of cycles)	3.8	7.7	15.9
5.	The receivables cycle ratio (day)	96	47	23
6.	The liabilities turnover ratio (number of cycles)	4.9	6.7	11.6
7.	The liabilities cycle ratio (day)	75	54	32
C.	Profitability	2013	2014	2015
8.	Return on Sales (ROS)	1.27%	4.49%	4.18%
9.	Return on Equity (ROE)	7.83%	14.26%	24.09%
10.	Return on assets (ROA)	3.85%	5.22%	9.92%
11.	Gross profitability	3.10%	4.12%	4.47%
12.	Net profitability	2.35%	3.18%	3.51%

Source: own work.

Analysis of data in Table 2 shows that the company falls into excess liquidity. In most cases, ratios of cycles of receivables and liabilities are also formed at the correct level of mutual relationship. The relationship is unfavorable for the company only in the first analyzed period. Profitability ratios show high growth dynamics.

Company C provides specialized construction services to industrial facilities. A relatively new activity results in the company falling under the characteristics of a "question mark" by BCG matrix. Figure 3 and Table 3 confirm this thesis.

Figure 3. Revenue and returns on sales for Company C
Source: own work.

Table 3. Basic indicators of liquidity in Company C

A.	Financial liquidity	2013	2014	2015
1.	Current	2.0	1.1	1.1
2.	Quick	2.0	1.1	1.1
3.	Immediate	0.9	0.0	0.0
B.	Fiscal cycle	2013	2014	2015
4.	The receivables turnover ratio (number of cycles)	2.1	15.1	5.5
5.	The receivables cycle ratio (day)	171	24	67
6.	The liabilities turnover ratio (number of cycles)	2.7	6.7	3.5
7.	The liabilities cycle ratio (day)	135	54	104
C.	Profitability	2013	2014	2015
8.	Return on Sales (ROS)	3.43%	4.32%	-1.55%
9.	Return on Equity (ROE)	11.59%	81.14%	1.57%
10.	Return on assets (ROA)	2.07%	8.53%	0.13%
11.	Gross profitability	2.74%	3.84%	-0.20%
12.	Net profitability	2.53%	4.82%	0.10%

Source: own work.

It follows that the high growth dynamics of production is not always reflected in the margins. Most of the ratios are unstable over time. First, all liquidity ratios allow the company to qualify for the increased risk group. It is the property of companies that are in early stages of development.

ECONOMETRIC MODEL OF LIQUIDITY

In the literature, econometric models of enterprises focus on various aspects of their business. On the one hand, we have models that describe a particular feature of the examined entity, for example, discriminant analysis (see Altman 1968, Gruszczyński 2003), or on the other hand, describe the company as a whole system (see Stryjewski 2006, Wiśniewski 2015). Presented models also include different tasks posed at the basis of their structure. They can be used to identify the causal link, describe some aspects (ratios) of a company or serve as a basis for simulation of economic decisions (see Naylor 1975, Stryjewski 2012). This paper is an intermediate aspect between the ratio modeling of a business, for example, discriminant analysis and a description of the causal link for selected aspects of business.

The study used error correction model described in the other works (see Davidson et al, 1978; Engle; Granger, 1987; Charemza, Deadman, 1997; Welfe, 2003). In the paper (Engle, Granger, 1987), the authors defined the cointegration in the following manner: Let $Z_t' = [Y_t, X_t]$ be the stochastic processes vector size N x 1. The elements of this vector are cointegrated by the order of d, b determined as $Z_t \sim CI(d,b)$ if:

1. All vector Z_t components are integrated in order of d.
2. There is a nonzero vector λ, such that the linear combination $Q_t = \lambda' Z_t$ is integrated in the order d-b, wherein b> 0. Vector λ is called cointegration vector.

Cointegration model can be formulated as the relation:

$$y_t = \alpha_1 x_t + \eta_t \tag{1}$$

Where: y_t and x_t are non-stationary processes in variance I(1), and η_t is a stationary residual process I(0). Equation 1 is a long-term relationship with the cointegration vector $[1, -\alpha_1]$.

Engle and Granger presented the two-stage cointegration test method (Engle, Granger, 1987):

1. Testing the degree of integration of the variables specified in the model. If there are two variables in the long-term relationship, they must have the same degree of integration. If there are more variables in the equation 1, the degree of integration of the dependent variable cannot be higher than any of the explanatory variables. If there are explanatory variables with the degree of integration higher than the dependent variable, the number must be at least two.
2. Next, we test the stationarity of the residuals of the equation 1. If the residuals are stationary, equation 1 is a cointegration equation describing the long-term relationship.

Cointegration indicates the presence of a sustainable, long-term relationship between two or more integrated processes.

An important special case occurs when the variables x_t, y_t are CI(1,1) and have a cointegrating vector equal [α1, -1], so that the deviations y_t from its long-term path are I(0). This case can be described by the model for the first increments, including a mechanism for error correction (Davidson et al, 1978; Charemza, Deadman, 1997):

$$\Delta y_t = \beta_1 \cdot \Delta x_t + \beta_2 (y_{t-1} - \alpha_1 x_{t-1}) + \varepsilon_t \quad (2)$$

In Equation 2, all the processes are stationary - I (0). If β_2 is negative, the element next to this parameter is called error correction mechanism.

The parameters next to increments of (β_1) show the short-term adjustments in time t to equilibrium in period t-1. Negative parameter $\beta 2$ shows the speed of return to equilibrium, which is determined by the cointegrating relation through α_1 parameter (cf. Piłatowska, 2003; Osińska et al., 2007).

Error correction model is primarily used in the analysis of dynamic macroeconomic series. This article is an attempt to implement a microeconomic analysis of time series. Thus, the abovementioned companies were tested for liquidity using the model proposed in the work by Stryjewski 2009, in the form of:

1. Long-term relationship equation:

$$cash_t = \alpha_0 + \alpha_1 sale_t + \eta_t \quad (3)$$

2. Short-term relationship equation:

$$a(u)\Delta cash_t = \beta_0 + \beta_1(u) \cdot \Delta rec_t + \beta_2(u) \cdot \Delta sale_t + \beta_3 (cash_{t-1} - (\alpha_0 + \alpha_1 sale_{t-1})) + \varepsilon_t \quad (4)$$

Where: SALE - the net value of the invoices issued by the company for production and services rendered; CASH - value of gross proceeds; REC - value of receivables and a(u), β_1(u), β_2(u) - autoregressive operators of equal or different orders for individual processes and u - is a lag operator.

Advantages and disadvantages of the model presented above were also presented in another paper (Stryjewski, 2009). In the analyzed case, a slightly modified description of the short-term relationship is presented because due to the heterogeneity of receivables over time a decision was made not to include it in the study. Bearing in mind the possibility of a deterioration of the statistical properties of the second equation, an attempt was made to apply description of such a simplified model to the description of the liquidity in individual companies.

All data used in the study have a monthly frequency observations. In the case of the model for the enterprise, data cover the period from January 2007 to September 2016. In the case of Companies B and C, data start respectively from January 2011 and 2010 and end in September 2016. This results in 117 observations for Company A, 69 for Company B and 81 for Company C.

The essence of the error correction model is long- and short-term relationship analysis. It is therefore necessary to settle the question of the applicability of the ECM model to microeconomic data in the case described to the description of long-term relationships. Of course, the test procedure contained in the work (Engle, Granger, 1987) must be met, nevertheless, the number of observations must be large enough to settle the dependencies between the variables in the long run. Resolving this matter with the theory of economics and business management can be done in two ways. In the first way, the definition of a long period of microeconomics states that this is the time required to change the technology (production capacity), with particular emphasis on fixed assets used in production (Nasiłowski 1996; Nordhaus, Samuelson, 2012). Therefore, you should determine whether within approximately 6 years (the smallest attempt), described companies are able to meet this condition.

The tested companies' production process is based on project management – individual production (Drucker, 2005). These companies related to the construction industry operate based on budgets for the project. The budget refers to both the demand for movable (liquid) and non-movable (fixed) assets. In each project, a corresponding technology is used, necessary to carry out the work. Therefore, we can specify that the period of change in production capacity (a long-term period) is associated primarily with the life cycle of the project (PMBOK 2008). In the analyzed cases, the average duration of the contract is approximately 14 months and the longest is two years. It can be concluded that the smallest trial period of approximately six years far exceeds the length of the examined projects. What remains is the question concerning the possibility of changing the processes performed by the functional departments (support). Analysis of revenue growth in Companies B and C (the smallest number of observations), indicates that there is a high probability of reorganization in the structures of companies with such dynamic growth of production.

Another way to determine the length of time is to compare the length of attempts to survival rates of companies in the industry. Research in SME field indicates that the survival rate of construction industry companies within 6 years (2007-2012) is 26.6%.[8] We can therefore conclude that the 6-year period of survival in the construction industry is a crucial period of organizational and technological change in the long term. It seems, therefore, that the test trial period allows us to use the ECM model also in the analysis of long period.

Engle and Granger procedure involves first examining the occurrence of unit root for each variable, and the residues of the equation 3. The results of this analysis using the Augmented Dickey-Fuller test are shown in Table 12 in the Appendix.

Analyzing the models of long-term relationship, we should note that no autocorrelation residues of the first degree occurred in all three cases. Slight exceedances occurred in Quenouille Test (see Kufel, 2004) for higher orders, but it is quite correct for a model with a single explanatory variable. Assessment value of the long-term relationship parameters in all companies must fall within the range of 1.08 and 1.23, which has to do with the existing combination of company tax rates on goods and services and the remaining security deposits to remove defects. In most cases, a good value of the coefficient of determination was reached, with values above 70% in two companies and approximately 50% in the third. Long-term relationship models showed a good model hypothesis – RESET test showed no errors in the specification, and CUSUM test pointed to the stability of the parameter estimates in time. However,

[8] The 2013 report on the state of small and medium companies in Poland, PARP Warsaw, 2013.

the assumption of normality and homoscedasticity of random component generally has not been met.

Given the estimated assessment model parameter of long-term relationships, the study led to the identification of the average payment period for invoices. This allowed a comparison of parameter estimates found in models for individual companies and as a result of stationary residues, go to modeling of short-term relationships.

Table 4 contains summarized information obtained from the analysis of the parameter rating equation of the first model of liquidity.

Table 4. Basic data as a result of long-term relationship

	Company A	Company B	Company C
The average payment period	30 days	60 days	60 days
Coefficient α_1	1.10192	1.18343	0.999671

Source: own work.

The average payment period has been identified based on the analysis of delays for the long-term model. This means that the parameter estimate for quick sales value showed the greatest impact on the value of the variable cash receipts in the case of Company A, while in other cases the greatest value for the variable was delayed for one period (month). Then, in the long-term relationship equation, a delayed variable was modeled - such a case existed for Companies B and C.

As can be seen, the Company C has a systemic, long-term liquidity problem. Rating of the long-term relationship parameter falls below the expected level. This means that the company does not generate sufficient cash flows from operating activities and must support itself with the appropriate, ad hoc external financing. This case is no stranger in the period of intensive development and confirms the correct classification in the BCG matrix.

Differences in the value of the evaluation parameter for Companies A and B are mainly due to the structure of contracts, and thus, the structure of guarantee deposits, which in the case of Company A, with larger and longer-timed orders, presented a more significant value.

To determine the internal structure of the processes contained in the hypothesis of model equations for each short-term relationship, we used the methodology of compatible models (cf. Talaga, Zieliński 1986). This method allows identifying the individual deterministic components, such as seasonality and sets the appropriate series of delays. Short-term relationship models were characterized by a good fit to the data - over 80% and the corresponding properties of the model (good choice of analytical model, stability parameters and a lack of autocorrelation of residues).

The most important element of the comparative analysis of short-term models is assessment of the parameter describing liquidity adjustment rate to long-term relationships - these results are presented in Table 5.

Company A, which is the most stable organization, has adjustment level coefficient equal to approx. 80% - this means that in the case of deviations from and disturbances in long-term relationships, most of the cash proceeds will be corrected within a month.

Table 5. Assessment of error correction mechanism parameter

	Company A	Company B	Company C
ECM(-1)	-0.794259	-1.96474	-0.485506
Standard dev.	0.104599	0.188525	0.204578

Source: own work.

The quickest alignment is reflected in the case of Company B. It means that a PLN deviation within a month brings approx. a correction of PLN 2, which means that within a month the company displays a double adaptation. Accordingly, Company B is characterized by a rapid adjustment process. This has grounds in the large share of short contracts related to the scope of infrastructure repairs, which result in a rapid circulation of money.

As was to be expected after an earlier analysis of both the long-term equation and the data in Table 3, the worst adjustment ratio is shown by Company C. The value of this ratio indicates that for one PLN deviation, situation returns to long-term relationships within over two months.

Application of procedures for the analysis of liquidity using the error correction model described by the first and second equation, provide additional information as well. It is a statistically significant assessment of parameters of the models of short-term relationships. For example, Company A recorded large seasonal variations and an important determinant of cash proceeds deviations is an autoregressive process of the first stage and the current deviation of sales. In Company B model, the causes of significant deviations in cash proceeds are autoregressive process and sales delays equal to one and two periods. On the other hand, what is important for Company C, are long autoregressive processes and delays in the sales of up to over one year. Such cause-and-effect analysis can provide additional information on the evolution of the process of liquidity described as a relationship between sales and cash proceeds.

CONCLUSION

Comparative analysis of the model of liquidity for the three companies in the construction industry presented herein showed that the presented model describing the company liquidity can be effectively used in practice and as a tool, constitutes a supplement to traditional methods such as ratio analysis. This model is a valuable source of additional information about the average payment period, the rate of company's reaction to deviations as well as other determinants of liquidity. It allows discovering the cause-and-effect, which always becomes the basis for decision-making.

Described models correctly indicated the differences among tested companies, respectively classifying them in terms of ability to generate cash revenues. Information obtained through the use of model goes further than traditional methods and can become the basis for more effective control of the described processes.

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