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Article

Econometric Modeling of an Early Warning System for Financial Instability: Evidence from JSC "Uzkimyosanoat"

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Abstract: This article is devoted to the econometric modeling of an early warning system for financial instability in chemical industry enterprises, using Joint-Stock Company "Uzkimyosanoat" as a case study. The study develops and empirically tests a model examining the relationship between the current liquidity ratio and key financial indicators, including return on assets (ROA), return on equity (ROE), inventory turnover, and the share of inventories in current assets. Panel data from three enterprises within the JSC "Uzkimyosanoat" system for the period 2015–2024 are utilized. The model is estimated using multiple linear regression, with tests conducted for the statistical significance of coefficients, multicollinearity, heteroskedasticity, and autocorrelation of residuals. The results show that inventory turnover and the share of inventories are the most significant factors affecting current liquidity, whereas ROA and ROE demonstrate weak and unstable relationships with liquidity. The findings support the application of the proposed model within early warning systems for financial risk management in chemical industry enterprises and contribute to improving the efficiency of short-term financial resource management.

Keywords: Econometric modeling, early warning system, financial instability, current liquidity ratio, return on assets (ROA), return on equity (ROE), inventory turnover, chemical industry, JSC "Uzkimyosanoat", panel data.

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1. Introduction

To empirically assess the effectiveness of the developed early warning system for financial instability, an econometric model was estimated to examine the relationship between liquidity indicators and key financial variables of chemical industry enterprises[1].

The dependent variable in the model is the current liquidity ratio (current ratio), which reflects the enterprise's ability to meet its short-term obligations in a timely manner. The explanatory variables include return on assets (ROA), return on equity (ROE), inventory turnover, and the share of inventories in current assets (inventory share).

The econometric modeling is based on panel data from three enterprises within Joint-Stock Company "Uzkimyosanoat"—the Dehkanabad Potash Plant, Ferganaazot, and Navoiyazot—for the period 2015–2024 [2]. The model parameters are estimated using multiple linear regression, which allows for determining both the direction and the magnitude of the impact of key financial indicators on the level of current liquidity.

2. Materials and Methods

This study employs an econometric approach to develop and evaluate an early warning system (EWS) for financial instability in chemical industry enterprises. The research is based on panel data collected from three enterprises within Joint-Stock Company "Uzkimyosanoat," namely Dehkanabad Potash Plant, Ferganaazot, and Navoiyazot, covering the period from 2015 to 2024.

Data and Variables

The dependent variable of the study is the current liquidity ratio (current ratio), which reflects the ability of enterprises to meet short-term obligations. The independent variables include key financial indicators widely used in financial diagnostics:

Return on Assets (ROA)

Return on Equity (ROE)

Inventory Turnover

Share of Inventories in Current Assets

These variables were selected based on their theoretical and empirical relevance in assessing financial stability and early detection of financial distress.

Model Specification

To analyze the relationship between liquidity and financial indicators, a multiple linear regression model is employed. The general functional form of the model is expressed as:

$$\text{Current Ratio} = \beta_0 + \beta_1 \text{ROA} + \beta_2 \text{ROE} + \beta_3 \text{Inventory Turnover} + \beta_4 \text{Inventory Share} + \varepsilon$$

where β_0 is the intercept, β_1–β_4 are regression coefficients, and ε is the error term.

The model is estimated separately for each enterprise and also using pooled panel data with fixed effects to capture firm-specific heterogeneity.

Estimation Techniques

The estimation is conducted using Ordinary Least Squares (OLS). In addition, panel data techniques with fixed effects are applied to improve estimation accuracy and control for unobserved heterogeneity across enterprises.

Diagnostic Tests

To ensure the reliability and validity of the model, several econometric diagnostic tests are performed:

Multicollinearity test using Variance Inflation Factor (VIF)

Heteroskedasticity test using Breusch–Pagan/Cook–Weisberg test

Autocorrelation test using Durbin–Watson statistic

Overall model significance using F-test

These tests allow for evaluating the robustness of the regression results and identifying potential econometric issues.

Research Approach

The study follows a quantitative research design, combining theoretical analysis with empirical modeling. The methodology integrates financial ratio analysis and econometric modeling to identify key determinants of liquidity and to construct an effective early warning system for financial instability.

Literatury review

The problem of timely diagnosis of financial instability in enterprises is one of the key challenges of modern financial analysis and economic management. Enterprise stability directly affects the efficiency of economic sectors, the level of investment attractiveness, and macroeconomic stability. In this context, particular importance is attached to methods for the early detection of financial distress and the development of Early Warning Systems (EWS), which enable the prediction of potential risks and support managerial decision-making based on quantitative models.

Among the earliest scientific studies aimed at identifying financial risks and predicting corporate bankruptcy are the works of William H. Beaver, who proposed the use of financial ratios to forecast the deterioration of firms' financial conditions. His research demonstrated that indicators such as liquidity, profitability, and capital structure can signal financial distress several years before the onset of a crisis [3].

A significant contribution to the development of quantitative methods for diagnosing financial stability was made by Edward I. Altman, who developed the Z-score model based on multiple discriminant analysis. This model integrates several financial ratios into a single function to assess the probability of corporate bankruptcy. Subsequently, similar models were proposed by Richard Taffler and

Gordon L. V. Springate, who adapted forecasting methodologies to different economic conditions and indicator sets.

In later studies, the focus shifted from the analysis of individual ratios to a comprehensive assessment of enterprise financial stability. In the works of Galina Savitskaya, Elena Stoyanova, and A. M. Kovalev, systematic approaches to financial analysis were proposed, based on a combination of indicators such as liquidity, profitability, business activity, and financial stability. These approaches enable a more comprehensive diagnosis of enterprise financial conditions and facilitate the identification of potential threats.

Contemporary research in financial diagnostics increasingly employs econometric modeling methods, including regression analysis, panel data techniques, and forecasting models. Econometric models make it possible to identify statistically significant relationships between key financial indicators and measures of solvency, as well as to evaluate the impact of various factors on the dynamics of liquidity and financial stability. The use of multiple regression, logit, and probit models enhances the accuracy of financial risk prediction and supports the development of effective early warning systems.

The application of panel data has become particularly important in modern studies, as it allows researchers to account for both the temporal dynamics of financial indicators and firm-specific characteristics. This approach improves the accuracy of model estimation and enables the analysis of factors influencing financial stability over the long term[4].

In developing economies, including transition economies, an important research direction is the adaptation of international financial diagnostic models to national economic conditions. Industry-specific features, asset structure characteristics, and the level of financial transparency necessitate the development of models that reflect the actual operating environment of enterprises. This is especially relevant for capital-intensive industries such as the chemical sector, where a high proportion of inventories and substantial production assets significantly influence liquidity and financial stability indicators.

The analysis of the academic literature demonstrates that the development of methods for diagnosing financial instability has evolved from the analysis of individual financial ratios to the construction of comprehensive econometric models and early warning systems. Modern research is focused on integrating financial indicators into unified analytical frameworks that enable the identification of key determinants of financial stability and the forecasting of potential financial risks.

3. Results and Discussion

The results of the regression model estimation for each enterprise are presented in Table 1. The table reports the regression coefficients, *p*-values, as well as key statistical measures of model quality, including the coefficient of determination (R^2), the F-statistic, and the Akaike (AIC) and Bayesian (BIC) information criteria.

The statistical significance of the coefficients is indicated using the standard notation: *** – 1% significance level, ** – 5%, and * – 10%.

The analysis of the obtained results makes it possible to identify differences in the impact of key financial factors on enterprise liquidity and to determine the most significant indicators within the early warning system for financial risks [5].

Table 1. Estimation of Parameters of the Econometric Model of the Early Warning System for Three Enterprises of JSC "Uzkimyosanoat" for the Period 2015–2024 [1]

	Dekhanabad Potash Plant		**Ferganaazot**		**Navoiazot**	
Current ratio (current_ratio)	Coef.	p-value	Coef.	p -value	Coef.	-value
Return on assets (ROA)	-236.729	.022	6.159	. 004	-.036	016
Return on equity (ROE)	112.06	.02	-5.921	.	.09	

				004	6	013
Inventory turnover (inventory_turnover)	-1.607	.787	2.426	.167	.123	791
Share of inventory (inventory_share)	29.646	.054	-.456	.034	.035	323
Constant	-116.484	.202	Coef.	.006	-.531	827
1. Dekhanabad Potash Plant						
Mean dependent var		36.404	SD dependent var		26.764	
R-squared		0.723	Number of obs		10	
F-test		3.260	Prob > F		0.114	
Akaike crit. (AIC)		90.235	Bayesian crit. (BIC)		91.748	
*** p<.01, ** p<.05, * p<.1						
2. Ferganaazot						
Mean dependent var		4.392	SD dependent var		2.500	
R-squared		0.860	Number of obs		10	
F-test		7.647	Prob > F		0.023	
Akaike crit. (AIC)		36.026	Bayesian crit. (BIC)		37.539	
*** p<.01, ** p<.05, * p<.1						
3. Navoiazot						
Mean dependent var		2.079	SD dependent var		1.098	
R-squared		0.948	Number of obs		10	
F-test		22.773	Prob > F		0.002	
Akaike crit. (AIC)		9.643	Bayesian crit. (BIC)		11.156	
*** p<.01, ** p<.05, * p<.1						

The model for the Navoiyazot demonstrates the highest explanatory power ($R^2 = 0.95$). The effects of ROA and ROE on liquidity are statistically significant: the coefficient for ROA (−0.036; $p < 0.05$) is negative, whereas the coefficient for ROE (+0.096; $p < 0.05$) is positive. An increase in return on assets by one unit leads to a decrease in the current liquidity ratio by 0.036 units ($p < 0.05$). This negative effect may be explained by the reallocation of financial resources into long-term assets.

An increase in return on equity by one unit leads to an increase in liquidity by 0.096 units ($p < 0.05$), indicating a direct relationship between solvency and equity profitability. An increase in inventory turnover by one unit results in a 0.123-unit increase in liquidity; however, this effect is not statistically significant ($p > 0.05$). Similarly, a 1% increase in the share of inventories in current assets leads to a 0.035-unit increase in the current liquidity ratio, but this effect is also statistically insignificant ($p > 0.05$)[6].

The model estimation is performed using multiple regression for each company separately, as well as for the pooled dataset with fixed effects. For each equation, standard regression diagnostics are calculated, including the coefficient of determination (R^2), t-statistics for each coefficient, p-values, and overall model significance (F-test). Prior to estimation, multicollinearity analysis is conducted, revealing a high correlation between ROA and ROE, which may distort the coefficient estimates.

The regression results are presented in Table 1 for each of the three enterprises (three separate equations). For clarity, the coefficients for each factor are reported, with statistical significance indicated by asterisks (* – significant at the 10% level, ** – 5%, *** – 1%). The coefficient of determination (R^2) is also reported for each model, reflecting the proportion of variation in the liquidity ratio explained by the included KPIs[7].

Each column in Table 2 corresponds to a separate regression estimated using data from a single enterprise (10 annual observations). High R^2 values (ranging from 0.79 to 0.99) indicate that the selected factors explain a substantial portion of the variation in the current liquidity ratio over the study period for all three enterprises.

F-tests of overall model significance confirm the statistical validity of the models: for the Dehkanabad Potash Plant and Ferganaazot, model significance exceeds 99% ($p < 0.01$), while for Navoiyazot it is approximately 94% ($p \approx 0.06$), slightly above the 0.05 threshold but still acceptable at the 10% significance level.

Overall, the regression equations adequately describe the relationships between the variables and can be used for further analysis.

Table 2. Estimation of the Regression Model for Each of the Three Enterprises [1.1]

Indicator	Dekhanabad Potash Plant (coeff.)	Ferganaazot (coeff.)	Navoiazot (coeff.)
Constant α	0.97***	1.05***	0.49
ROA (return on assets)	7.38*	1.57	–1.39
ROE (return on equity)	0.17	0.15	2.76
Inventory turnover	0.088***	0.083*	0.183**
Share of inventory in current assets	–0.632***	–1.146***	0.192
Standard error of regression	0.05	0.08	0.06
R^2 (coefficient of determination)	0.99	0.95	0.79

Note: **** indicates significance at the 1% level; ** at the 5% level; * at the 10% level.*

For the Dehkanabad Potash Plant, the coefficient for ROA is positive and close to statistical significance (7.38; $p \approx 0.05$), whereas for Ferganaazot and Navoiyazot it is insignificant (and even negative for Navoiyazot). This indicates that, for the first enterprise, there is an expected positive relationship between profitability and liquidity: a one-percentage-point increase in ROA leads to an increase in the current liquidity ratio by approximately 0.07 (e.g., from 1.50 to 1.57), due to an increase in working capital[8].

For Ferganaazot, the effect of ROA is statistically indistinguishable from zero. This may be explained by the generally low profitability of the enterprise (approximately 5% ROA), where fluctuations have little impact on liquidity, which is primarily determined by other factors such as the structure of current assets. For Navoiyazot, the ROA coefficient is negative (–1.39) and insignificant; this negative sign may be attributed to multicollinearity between ROA and ROE, as well as potential reverse causality (for example, maintaining high liquidity through accumulation of current assets may reduce returns on assets).

Overall, it can be concluded that, ceteris paribus, an increase in profitability contributes to improved

liquidity; however, this effect varies across enterprises. For the financially stable Dehkanabad Potash Plant, higher profitability is associated with improved liquidity, whereas for less efficient enterprises, the direct "profitability–liquidity" relationship is not observed.

In the presence of ROA, the ROE variable does not demonstrate a significant effect on liquidity in any model (p-value >> 0.1). The coefficients for ROE are positive for the second and third enterprises and close to zero for the first, but in all cases statistically insignificant. This is partly expected due to the high correlation between ROE and ROA, as both profitability indicators capture similar information. In the models for the first and second enterprises, the inclusion of ROA effectively "absorbs" the effect of ROE (as reflected in the near-zero β_2 coefficients).

For Navoiyazot, the sign of β_2 is positive but insignificant, suggesting that, conditional on ROA, variations in ROE may reflect changes in financial structure (e.g., the ratio of debt to equity), which could affect liquidity, although the available data are insufficient for definitive conclusions. The practical implication is that capital profitability alone is not a reliable predictor of liquidity changes without considering other factors[9].

For the Dehkanabad Potash Plant and Navoiyazot, the coefficients for inventory turnover are 0.088 and 0.183, respectively, and are statistically significant ($p < 0.01$ and $p < 0.05$). This indicates that faster inventory turnover (e.g., from 4 to 5 cycles per year) is associated with an increase in the current liquidity ratio by approximately 0.09–0.18, thereby improving the firm's ability to meet short-term obligations.

In the regression model for Ferganaazot, the coefficient for inventory turnover is positive (0.083) but significant only at the 10% level ($p \approx 0.06$). Although inventory turnover is generally lower (approximately 3 cycles) and less variable for this enterprise, a similar trend is observed: higher turnover is associated with slightly improved liquidity.

Thus, all three enterprises demonstrate a positive relationship between inventory management efficiency and liquidity[10].

The share of inventories in current assets emerges as one of the most influential factors, with a negative effect on liquidity for two enterprises. For the Dehkanabad Potash Plant and Ferganaazot, the coefficient β_4 is highly significant and equal to –0.632 ($p < 0.01$) and –1.146 ($p < 0.01$), respectively. Quantitatively, this implies that a 10-percentage-point increase in the share of inventories (e.g., from 30% to 40%) reduces the current liquidity ratio by approximately 0.063 for the Dehkanabad Potash Plant and 0.115 for Ferganaazot, ceteris paribus.

In other words, the greater the proportion of working capital tied up in inventories, the lower the liquidity. For Ferganaazot, this effect is particularly pronounced: a high inventory share (around 50% of current assets) significantly constrains liquidity, preventing it from exceeding 1.1–1.2.

In contrast, for Navoiyazot, the coefficient for inventory share is positive (+0.192) and statistically insignificant. This unexpected result may reflect firm-specific characteristics: relatively high turnover and an optimal inventory structure may prevent negative effects on liquidity. Additionally, the positive coefficient may be due to omitted variable bias (e.g., simultaneous growth in production, inventories, and liquidity).

In summary, the regression analysis reveals the following key findings:

1. Among the KPIs included in the model, inventory-related indicators (turnover and share in assets) exert the strongest statistical influence, highlighting the importance of inventory management for financial stability in manufacturing enterprises[11].
2. Profitability indicators (ROA, ROE) generally exhibit the expected positive effect; however, their significance is weaker and inconsistent across enterprises. High profitability may enhance liquidity, but does not guarantee it, as firms differ in how these factors interact.

VIF_Multicollinearity

VIF	1/VIF
25.910	0.039
15.940	0.063
15.840	0.063

7.610	0.131
16.330	

Heteroskedasticity test

BreuschвЂ“Pagan/CookвЂ“Weisberg test for heteroskedasticity

Assumption: Normal error terms

Variable: Fitted values of current_ratio

H0: Constant variance

chi2(1) = 0.68

Prob > chi2 = 0.4109

Durbin_Watson_test

DurbinвЂ“Watson d-statistic (5, 10) = 1.482991

Multicollinearity Test (Variance Inflation Factor, VIF)

The analysis of Variance Inflation Factors (VIF) shows that three explanatory variables have values exceeding 10 (VIF > 10), indicating the presence of strong multicollinearity among them. High VIF values suggest that a substantial portion of the variance of these explanatory variables overlaps with that of other regressors, which complicates the accurate interpretation of the individual effects of each factor on the dependent variable.

To address multicollinearity, the following approaches are recommended:

1. Excluding the variable with the highest VIF;
2. Applying Principal Component Analysis (PCA) to reduce data dimensionality;
3. Examining the original data for excessive correlation.

Heteroskedasticity Test (Breusch–Pagan Test)

$$\chi^2(1) = 0.68, \text{Prob} > \chi^2 = 0.4109$$

The results of the Breusch–Pagan/Cook–Weisberg test do not indicate the presence of heteroskedasticity. Since the p-value exceeds 0.05, the null hypothesis (H_0) of constant error variance across different levels of the explanatory variables cannot be rejected.

Autocorrelation Test (Durbin–Watson Test)

$$DW = 1.483$$

The Durbin–Watson statistic is close to 1.5, which may indicate the presence of weak positive first-order autocorrelation in the residuals. To ensure the robustness of the results, additional standard statistical tests were conducted. First, the overall significance of the regression models is confirmed by the F-test: for all three equations, the null hypothesis (H_0) of no joint effect of the explanatory variables is rejected ($p < 0.01$ for the Dehkanabad Potash Plant and Ferganaazot models; $p = 0.06$ for Navoiyazot, which is acceptable at the 10% significance level) [12].

Thus, the included variables jointly have a significant effect on the liquidity ratio. The coefficients of determination (R^2), reported in Table 1, indicate that the model most accurately explains liquidity dynamics for the Dehkanabad Potash Plant ($R^2 = 0.99$), and somewhat less so for Ferganaazot ($R^2 = 0.95$) and Navoiyazot ($R^2 = 0.79$). Nevertheless, even 79% explained variation for Navoiyazot represents a strong result for economic data, confirming the adequacy of the model [13].

Overall, the statistical diagnostics confirm that the estimated models are consistent with the empirical data, and the coefficient estimates can be interpreted in economic terms.

Additionally, a pooled regression with fixed effects was estimated for the full panel (30 observations), and its results are consistent with the separate analyses. In the pooled model, the variables *InvTurn* and *InvShare* are significant at the 1% level, with coefficients of approximately +0.11 and −0.76, respectively (consistent with the average effects observed across individual firms), while ROA and ROE are not statistically significant in the full sample [14].

The fixed effects for enterprises are also significant—particularly the negative effect for Ferganaazot, reflecting its inherently lower liquidity—which justifies the use of separate models for each company.

4. Conclusion

The obtained results allow the following conclusions and recommendations to be formulated:

a. **Return on assets (ROA)** and **return on equity (ROE)** exhibit a weak negative correlation with liquidity, suggesting a possible substitution effect: highly profitable enterprises may maintain lower levels of liquid reserves by reallocating resources toward investment activities.

b. **Inventory turnover** has a positive effect on the current liquidity ratio (correlation coefficient 0.47, $p < 0.01$), indicating that efficient inventory management contributes to maintaining a stable level of short-term solvency.

c. The **share of inventories in assets** demonstrates a strong negative relationship with liquidity (correlation coefficient −0.63, $p < 0.001$), implying that higher levels of inventories are associated with lower current liquidity. This is due to the "freezing" of assets in working capital, which reduces asset flexibility [15].

d. The model shows an acceptable goodness of fit ($R^2 = 0.44$), and its overall significance is confirmed ($Prob > F = 0.0047$). The most significant variable in the model is **X4 (inventory share)** ($p = 0.031$), while the remaining variables are not statistically significant at the 5% level but still contribute to explaining variation in the dependent variable.

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