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ANALYSIS OF THE IMPACT OF MACROECONOMIC INDICATORS ON THE COUNTRY'S RATING

Analyzing macroeconomic indicators and their impact on a country's global rating is crucial for understanding economic stability and international status. This study focuses on such indicators as GDP, external debt, and inflation, which are critical to Ukraine's economic stability and international rating.

The study utilized correlation analysis and the development of sophisticated linear regression models to quantitatively assess the impact of various economic indicators on Ukraine's international rating. This methodological approach reveals the complex relationships between economic activity and global evaluation

The findings emphasize the importance of comprehensive economic analysis in strategic planning and policy formulation. It was found that GDP, external debt, and inflation significantly impact the country's rating. Additionally, the research lays a foundational framework for analyzing the impact of economic indicators on a country's rating, paving the way for future investigations into the predictive capabilities of economic models in global assessments.

Features of the transformation of macroeconomic indicators into a country's rating are presented in two main directions: influence on investment attractiveness and economic confidence in the country. The study confirms the critical role of macroeconomic analysis in deciphering and enhancing a country's international standing.

K e y w o r d s : ***macroeconomic indicators, country rating, global assessment, economic stability, linear regression models, correlation analysis, gross domestic product (GDP), external debt, inflation impact, predictive economic modeling.***

AMS 2020 classification: 62H30, 34C60.

Introduction

A country's rating is an important tool for evaluating its economic, political, and social status, as well as determining its place in the international community. It is created based on various indicators and methodologies applied by rating agencies. However, the process of determining a country's rating remains a complex task that requires refinement and objectivity.

One of the key issues associated with country ratings is the lack of a unified and universally accepted methodology for their determination. Rating agencies use different approaches, significant factors, and methods, leading to varying results for the same country. This ambiguity in rating determination creates problems and uncertainty for investors, governmental institutions, and the public.

Another issue is the subjectivity and influence of political factors on the rating determination process. Since the rating is an important tool, it can be prone to being used as a political instrument to influence rating agencies. This can distort the objectivity and reliability of the evaluation results.

The application of statistical models will allow for the consideration of a wide range of indicators affecting the rating, such as economic, social, political, and other factors. This will help reduce subjectivity and political influence on the country assessment.

In this work, we will consider data from 15 countries and use the rating as an independent variable, and GDP, employment rate, corruption index, consumer price index, and national debt as dependent variables. The aim of this work is to analyze the change in Ukraine's rating over recent years and to establish a relationship between the country's rating and factors such as GDP per capita, employment rate, corruption index, consumer price index, and national debt. The research is aimed at analyzing and forecasting countries' ratings taking into account economic and social indicators, establishing statistical links between these indicators, and constructing a linear regression model to predict a country's rating based on the examined factors.

1. Methods used in our research

The methodology of this study was strategically designed to quantitatively assess the impact of various macroeconomic indicators on Ukraine's international rating, using a comprehensive approach that involved both correlation analysis and linear regression modeling. Initially, correlation analysis was employed to explore the relationships between macroeconomic indicators such as GDP, external debt, and inflation and Ukraine's global rating.

The Pearson correlation coefficient was calculated using statistical software after preprocessing the data for completeness and outliers, which helped identify the most significantly associated indicators with the country's rating. Following this, linear regression models were developed where the country's rating was the dependent variable and significant macroeconomic indicators served as independent variables. The data set was split into training and testing sets, typically in a 70–30 ratio, to validate the model's predictive power, with regression analysis applied to the training dataset to estimate the coefficients, see (Dudkin, & Plastun, 2012).

The model's validity was then tested by comparing predicted ratings against actual ratings in the test set, using metrics such as R-squared and root mean square error (RMSE) for evaluation. Additionally, sensitivity analyses were conducted by varying the assumptions and parameters of the regression model to assess the robustness of the findings. This

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comprehensive methodological application provided deep insights into the dynamics between economic indicators and Ukraine's global rating, serving as a valuable tool for policy-makers and economic strategists.

2. Our main results

The formation of a country's rating is determined by a complex of factors that affect the financial stability and creditworthiness of the country. Let's consider the key indicators that have a significant impact on the formation of a country's rating.

Gross Domestic Product (GDP) is one of the most important macroeconomic indicators considered in the formation of a country's rating. GDP reflects the volume of goods and services produced within a country over a certain period, usually annually.

This indicator is a measure of a country's economic potential and indicates the overall level of economic activity. GDP includes gross consumption expenditure, investments, government spending, and net exports of goods and services. The higher the GDP, the more resources a country can mobilize to meet the needs of its population and ensure economic growth (Table 1).

Table 1

Gross Domestic Product

	UAH		%	USD		%	Population (thousand)
2014	35834,0	3845,3	12,0	3014,6	–1015,7	–25,2	43 722
2015	46210,2	10376,1	29,0	2115,4	–899,2	–29,8	42 836
2016	55853,5	9643,3	20,9	2185,9	70,5	3,3	42 668
2017	70224,3	14370,8	25,7	2640,3	454,4	20,8	42 477
2018	84192,0	13967,7	19,9	3095,2	454,9	17,2	42 269
2019	94589,8	10397,8	12,4	3659,8	564,6	18,2	42 019
2020	100432,5	5842,6	6,2	3725,6	65,8	1,8	41 760
2021	131907,2	31474,8	31,3	4834,3	1108,7	29,8	41 389
2022	126152,3	–5754,9	–4,4				41 149

Source: Ministry of Finance

Inflation is the process of a general and sustained increase in the price level of goods and services in an economy. This phenomenon affects the purchasing power of money, leading to currency devaluation.

Inflation is significant in forming a country's rating, as it can impact financial stability and economic development. High levels of inflation may indicate instability in the economy, increasing prices for goods and services, and can negatively affect consumer confidence and the investment climate.

Let's consider a summary table of 2 consumer price indexes from 2010 to 2023 and conduct an analysis (Table 2).

Table 2

Consumer price index from 2010 to 2023

Month	3	4	5	6	7	8	9	10	11	12	Over the year
2010	100,9	99,7	99,4	99,6	99,8	101,2	102,9	100,5	100,3	100,8	109,1
2011	101,4	101,3	100,8	100,4	98,7	99,6	100,1	100,0	100,1	100,2	104,6
2012	100,3	100,0	99,7	99,7	99,8	99,7	100,1	100,0	99,9	100,2	99,8
2013	100,0	100,0	100,1	100,0	99,9	99,3	100,0	100,4	100,2	100,5	100,5
2014	102,2	103,3	103,8	101,0	100,4	100,8	102,9	102,4	101,9	103,0	124,9
2015	110,8	114,0	102,2	100,4	99,0	99,2	102,3	98,7	102,0	100,7	143,3
2016	101,0	103,5	100,1	99,8	99,9	99,7	101,8	102,8	101,8	100,9	112,4
2017	101,8	100,9	101,3	101,6	100,2	99,9	102,0	101,2	100,9	101,0	113,7
2018	101,1	100,8	100,0	100,0	99,3	100,0	101,9	101,7	101,4	100,8	109,8
2019	100,9	101,0	100,7	99,5	99,4	99,7	100,7	100,7	100,1	99,8	104,1
2020	100,8	100,8	100,3	100,2	99,4	99,8	100,5	101,0	101,3	100,9	105,0
2021	101,7	100,7	101,3	100,2	100,1	99,8	101,2	100,9	100,8	100,6	110,0
2022	104,5	103,1	102,7	103,1	100,7	101,1	101,9	102,5	100,7	100,7	126,6
2023	101,5	100,2	100,5								103,8

Source: Ministry of Finance

Analyzing Ukraine's inflation data over the years, the following conclusions can be drawn:

1. From 2010 to 2023, there were fluctuations in the inflation rate. Inflation reached its highest values in 2015 and 2022, with rates of 143,3 % and 126,6 %, respectively.
2. A noticeable increase in inflation was observed in 2014, which could be related to military actions, leading to economic instability and political turmoil in the country.
3. From 2017 to 2020, inflation showed a downward trend. However, it rose again to 110,0 % in 2021.
4. From 2018 to 2022, there was some stabilization in the inflation rate. However, it's important to note that even minor fluctuations can have a significant impact on the economic situation and financial risks.
5. Overall, inflation in Ukraine may indicate an unstable economic environment and the ineffectiveness of monetary policy.

Gross external debt is the total amount of debt obligations that need to be paid by debtors, which are liabilities of the residents of a country's economy to non-residents. In other words, it is the total indebtedness of a country for foreign loans and unpaid interest on them.

The overall trend of growth in gross external debt was observed until 2014. During this period, the debt increased by $14,655 billion or 13,2 %. However, after 2014, the gross external debt began to decrease.

In recent years, there has been a relative stabilization of Ukraine's gross external debt. From 2015 to 2022, the debt increased by $14,655 billion or 12,4 %. However, from 2020 to 2022, the growth rate of gross external debt slowed down.

The increase in gross external debt during 2010–2014 was associated with increased capital imports and the attraction of foreign loans. After 2014, the decrease in debt was due to debt restructuring negotiations and an improvement in the country's external economic situation (Table 3).

Table 3

Ukraine's gross external debt from 2011 to 2022 (USD million)

Gross external debt			%
31.12.2010	117 343,0	+13947,0	+13,5
31.12.2011	126 236,0	+8893,0	+7,6
31.12.2012	135 065,0	+8829,0	+7,0
31.12.2013	142 079,0	+7014,0	+5,2
31.12.2014	126 308,0	-15771,0	-11,1
31.12.2015	118 729,0	-7579,0	-6,0
31.12.2016	113 518,0	-5211,0	-4,4
31.12.2017	116 578,0	+3060,0	+2,7
31.12.2018	114 710,0	-1868,0	-1,6
31.12.2019	121 739,0	+7029,0	+6,1
31.12.2020	125 690,0	+3951,0	+3,2
31.12.2021	129 711,0	+4021,0	+3,2
31.12.2022	131 998,0	+2287,0	+1,8

Source: Ministry of Finance

2.1. Analysis of the Impact of Various Indicators on the Country's Rating. After conducting a general analysis, we will establish a statistical relationship between the variables. For this, we use correlation analysis and determine the degree of connection between the rating and each dependent factor. Correlation analysis will allow us to identify which factors have the most significant impact on the country's rating and the statistical significance of these connections.

After conducting correlation analysis, we build a linear regression model that will allow us to assess the impact of each dependent factor on the country's rating. This model will help us understand how variables such as GDP, employment rate, corruption index, consumer price index, and national debt affect the country's rating and how these connections can be used to predict future rating values.

We will use the following data (Table 4).

Table 4

Different country indicators

Country	Rating	GDP per capita (mln USD)	Employm. rate, %	Corruption index, %	Consumer price index, %	Government debt
Germany	100	42 726	77,3	79	116	2 367 251
USA	98	61 856	60,3	69	303	31 464 457
France	92	38 046	68,6	72	117	2950
United Kingdom	87	45 102	75,9	73	130	2537
Slovakia	76	18 181	71,8	53	228	63 190
Poland	71	15 850	71,8	55	248	1 235 952
Italy	62	31 506	61	56	120	2 789 809
Morocco	50	3291	39,1	38	118	12 952
Greece	46	18 908	88,67	52	115	401 528
Brazil	42	8538	56,2	38	6665	7 456 708
Eswatini	30	3924	69	30	112	7 346 723
Turkey	28	13 342	48,2	36	1301	4 588 112
Angola	25	2300	63,1	33	150	423 412
Moldova	25	3695	42	39	4070	2 346 723
Ukraine	15	2452	65,3	33	429	1 436 715 133

2.2. Correlation Analysis of Indicators. Correlation analysis is an important tool in statistics, used to determine and measure the degree of relationship between two variables. This method helps to identify whether there is a statistically significant correlation between indicators, and allows for the assessment of the strength (intensity) and direction (positive or negative) of this dependency. When we talk about correlation, we often refer to Pearson's correlation coefficient, which takes values from -1 to +1. The magnitude of the coefficient indicates the strength of the relationship, while the sign indicates its direction: a positive sign indicates a direct relationship, and a negative sign indicates an inverse relationship.

In our analysis, we use a correlation matrix, which is a table that contains correlation coefficients for each pair of variables being studied. It allows us to quickly assess how each indicator interacts with others, and to identify possible patterns or relationships that require further investigation (Semenog, 2020).

To construct a correlation matrix in R, the "ggcorr" function from the "GGally" package is used (Fig. 1).

The closer the correlation coefficient is to 1, the stronger the direct dependency between the indicators. The closeness of the correlation coefficient to -1 indicates a negative correlation between the indicators. A correlation coefficient of 0 suggests the absence of any dependency between the indicators.

There is a quite strong positive dependency between the rating and GDP per capita with a correlation coefficient of 0,88. This means that countries with a higher GDP per capita have a higher rating.

The employment rate also has a positive dependency with the rating, but with less strength (correlation coefficient of 0,40). This indicates that a higher employment rate may influence an increase in a country's rating, but there are other factors that also affect the rating.

The corruption index has a very strong positive dependency with the rating (correlation coefficient of 0,95). This means that countries with a lower level of corruption have a higher rating.

The consumer price index and national debt have a negative dependency with the rating, though with less strength. This means that countries with a lower consumer price index and less national debt may have a higher rating.

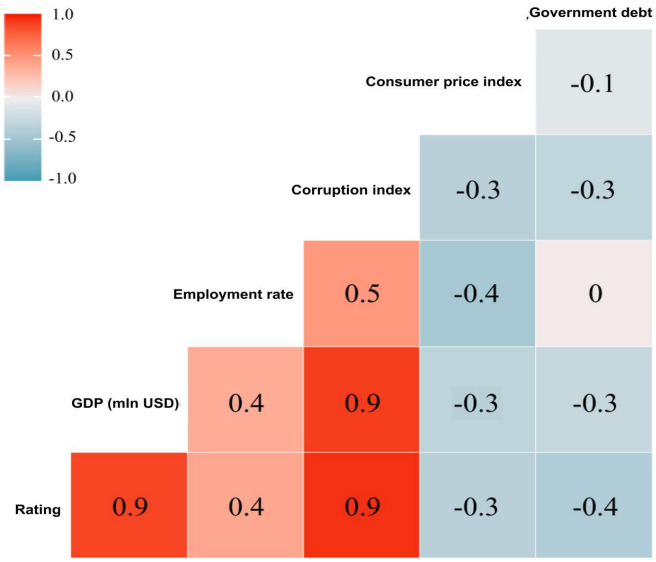

Fig. 1. "Ggcorr" function

Splitting the sample into training and testing is an important step in data analysis and modeling. This approach allows us to evaluate the accuracy and reliability of the constructed model on independent data.

In our study, we will split the sample into training and testing in a ratio of 10 to 5. In the following table, the training sample is indicated in italics, and the testing sample in regular font (Table 5).

Table 5

Training and test sample

Country	Rating	GDP per capita (mln USD)	Employm. rate, %	Corruption index, %	Consumer price index, %	Government debt
Germany	100	42 726	77,3	79	116	2 367 251
USA	98	61 856	60,3	69	303	31 464 457
France	92	38 046	68,6	72	117	2950
United Kingdom	87	45 102	75,9	73	130	2537
Slovakia	76	18 181	71,8	53	228	63 190
Poland	71	15 850	71,8	55	248	1 235 952
Italy	62	31 506	61	56	120	2 789 809
Morocco	50	3291	39,1	38	118	12 952
Greece	46	18 908	88,67	52	115	401 528
Brazil	42	8538	56,2	38	6665	7 456 708
Eswatini	30	3924	69	30	112	7 346 723
Turkey	28	13 342	48,2	36	1301	4 588 112
Angola	25	2300	63,1	33	150	423 412
Moldova	25	3695	42	39	4070	2 346 723
Ukraine	15	2452	65,3	33	429	1 436 715 133

We will construct the linear regression model using the built-in function lm, below is the code for executing the regression model:

> summary(fit)

Call:

lm(formula = Ranking ~ `GDP per capita (mln, USD)` + `Employment rate (%)` + `Corruption index (%)` + `Consumer price index (%)` + `Government debt`, data = data_train)

Evaluating the accuracy of the model involves analyzing several metrics that allow assessing how well the model fits the data. One such metric is the coefficient of determination (R-squared), which indicates the proportion of the variance in the dependent variable that can be explained by the model.

In this case, we have an R-squared value of 0,7903, meaning that the model can explain about 79,03 % of the variation in the response (rating) using the independent variables (GDP per capita, employment rate, corruption index, consumer price index, and national debt).

It is also important to consider the adjusted R-squared, which accounts for the number of variables and the degrees of freedom of the model. In this case, the adjusted R-squared equals 0,5281, which is lower than the multiple R-squared due to the model including five independent variables.

Additionally, the mean squared error (Residual standard error), in this case, is 12,33. This metric measures the average spread of the model's errors. The lower the value of the mean squared error, the better the model fits the data.

Also, comparing the predicted values for the test data, we obtained an average deviation of 11,01 Overall, the model is deemed adequate; it has good accuracy and can be used for predicting a country's rating.

3. Final results

The analysis results of the linear regression model for predicting the rating are as follows:

Intercept (the constant term of the equation): -18,91. This means that with zero values for all independent variables, the expected rating would be -18,91.

Coefficients for independent variables:

- GDP per capita: -3,417e-04
- Employment rate: -0,1297
- Corruption index: 1,762
- Consumer price index: -8,122e-04
- National debt: -1,012e-08

This can be interpreted as follows – each unit increase in the "Corruption Index" is accompanied by an increase in the rating by 1,762 units.

Discussion and conclusions

The study analyzed the dependency of the rating on various economic indicators. Using correlation analysis, it was found that the rating has a strong positive correlation with GDP per capita and the corruption index, and a weak negative correlation with the consumer price index and national debt. A linear regression model was constructed using the training sample. Analysis of the regression coefficients showed that GDP per capita, employment rate, corruption index, consumer price index, and national debt affect the rating.

The model's quality assessment showed that the model could explain approximately 79,03 % of the variation in the rating using the selected variables. Overall, the model is deemed adequate; it has good accuracy and can be used for predicting a country's rating.

Authors' contribution: Volodymyr Zubchenko – conceptualization, methodology; Mariia Herasymenko – software, empirical data collection and validation, empirical research, analysis of sources, preparation of literature review or theoretical foundations of research.

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АНАЛІЗ ВПЛИВУ МАКРОЕКОНОМІЧНИХ ПОКАЗНИКІВ НА РЕЙТИНГ КРАЇНИ

Аналіз макроекономічних індикаторів та їхній вплив на глобальний рейтинг країни є важливим для розуміння економічної стабільності та її міжнародного статусу. Пропоноване дослідження зосереджено на таких показниках, як ВВП, зовнішній борг та інфляція, що мають вирішальне значення для економічної стабільності та міжнародного рейтингу України.

У роботі використано кореляційний аналіз і розроблення складних моделей лінійної регресії для кількісної оцінки впливу різних економічних індикаторів на міжнародний рейтинг України. Цей методологічний підхід дає змогу виявити складні зв'язки між економічною активністю та глобальною оцінкою. Результати дослідження підкреслюють важливість всеосяжного економічного аналізу в стратегічному плануванні та формулюванні політики. Виявлено, що ВВП, зовнішній борг та інфляція мають значний вплив на рейтинг країни. Окрім того, дослідження закладає основу для аналізу впливу економічних індикаторів і рейтинг країни, що відкриває шлях для майбутніх досліджень прогностичних можливостей економічних моделей у глобальних оцінках. Функції трансформації макроекономічних показників на рейтинг країни представлені у вигляді двох основних напрямків: впливу на інвестиційну привабливість й економічну довіру до країни. У роботі підкреслено важливість макроекономічного аналізу для розуміння та підвищення міжнародного статусу країни.

Ключові слова: ***макроекономічні індикатори, рейтинг країни, глобальна оцінка, економічна стабільність, моделі лінійної регресії, аналіз кореляцій, валовий внутрішній продукт (ВВП), зовнішній борг, вплив інфляції, прогностичне економічне моделювання.***

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