MATHEMATICAL MODELING AND COMPUTING, Vol. 12, No. 4, pp. 1406–1414 (2025)

Mathematical Assessment of the Impact of Corruption Growth on Changes in the Work of State Authorities

Ortynskyi V.[1], Ortynska N.[1], Dragomyretska N.[2], Matvieienko I.[2], Liakhovych D.[3], Vasyliev O.[4]

[1] *Lviv Polytechnic National University, Lviv, Ukraine,*
[2] *National University "Odessa Polytechnic", Odessa, Ukraine*
[3] *The Ivano-Frankivsk Regional Prosecutor's Office, Ivano-Frankivsk, Ukraine*
[4] *The State Emergency Service of Ukraine in the city of Kyiv, Kyiv, Ukraine*

(Received 27 July 2025; Revised 28 November 2025; Accepted 10 December 2025)

Corruption is one of the key factors that undermine the effectiveness of public administration, reduce citizens' trust in institutions, and inhibit socio-economic development. Despite the presence of legislative and political countermeasures, the level of perception of corruption in Ukraine remains consistently high: during 2018–2024, the Corruption Perceptions Index (CPI) fluctuated between 31 and 36 points out of 100 possible, which indicates the limited results of anti-corruption reforms. This makes it urgent to develop scientifically based mathematical methods that can not only record the level of corruption, but also quantitatively assess its impact on the effectiveness of the functioning of state authorities. The purpose of the study is to apply a mathematical scientific approach to analyzing the impact of corruption dynamics on changes in the work of the state administrative apparatus of Ukraine. To achieve the goal, a step-by-step methodology was used, which includes the normalization of macroeconomic factors using the min-max method taking into account the economic sign of the impact, building a multiple linear regression model, regularization of Ridge-type parameters to eliminate multicollinearity, checking statistical significance using the t, F, R^2 and p criteria, as well as visualization of the relationships between key macrofactors and the CPI. This approach provides an opportunity to quantitatively describe the cause-and-effect relationships between the level of corruption and the management effectiveness of state authorities. The results of the study confirmed the hypothesis of the interdependence between the level of corruption and the quality of the functioning of state authorities. The obtained quantitative relationships allow a reasonable assessment of the impact of corruption risks on the effectiveness of management decisions, which opens up prospects for creating a system for forecasting and early warning of institutional degradation.

Keywords: *corruption; Corruption Perceptions Index (CPI); public administration; government efficiency; mathematical modeling; multiple linear regression; normalization of indicators; macroeconomic factors; transparency of management.*

2010 MSC: 62J05, 62F40, 91B84 **DOI:** 10.23939/mmc2025.04.1406

1. Introduction

Corruption is one of the most significant systemic challenges that hinders the effective functioning of public administration, undermines citizens' trust in government institutions, reduces the quality of public services and slows down socio-economic development. It violates the principles of justice, competitiveness and openness, creating informal channels of influence and decision-making outside the legislative field. The relevance of the study is due to the need for not only qualitative, but also quantitative assessment of the impact of corruption on the effectiveness of the functioning of public authorities. Traditional approaches based on expert assessments or sociological surveys do not allow us to trace the dynamic relationship between the level of corruption and the main macroeconomic and management parameters of the state. Therefore, there is a need to apply mathematical methods that provide the possibility of objective, reproducible and statistically significant analysis of these dependencies. It is the quantitative assessment, built on the basis of econometric tools, that opens the way to the formation of scientifically sound decisions in the field of public administration.

The scientific problem lies in the gap between the qualitative assessment of corruption and the quantitative measurability of its impact on the results of state policy. The lack of integrated models that combine socio-economic and institutional indicators limits the ability of authorities to make scientifically sound decisions to increase transparency, efficiency and accountability. At the same time, existing international indices, in particular the Corruption Perceptions Index (CPI), reflect only the perception of the phenomenon, but do not reveal the mechanisms of its impact on macroeconomic dynamics. In view of this, there is a need to apply a mathematical approach that allows not only to record the fact of a change in the level of corruption, but also to quantitatively describe how changes in corruption indicators are transformed into changes in the work of state authorities.

Based on this, the study hypothesized: "There is a statistically significant relationship between the level of corruption perception (CPI) and macroeconomic indicators, which reflects the efficiency of the work of state authorities. An increase in the level of corruption causes a deterioration in the key managerial and economic parameters of the state, while a decrease in corrupt actions correlates with an increase in the stability of the macroeconomic environment and the effectiveness of public administration".

Thus, the purpose is to develop and test an integrated approach to quantifying and modeling the impact of macroeconomic factors on indicators of socio-economic security of chemical enterprises and on the Corruption Perception Index (CPI) in Ukraine, using indicator normalization and the multiple linear regression method (with Ridge regularization and bootstrap error estimation) for the period 2018–2024.

The issue of quantitative modeling of corruption and its impact on the work of state authorities is revealed in an interdisciplinary field: from economic and mathematical methods and systemic modeling of public administration to legal and human rights discourses. In recent years, the focus has been on approaches that combine institutional analysis with formalized models of interaction between society and the state, as well as with the assessment of the consequences of corruption for the dynamics of development.

In the context of building mathematical models of public administration, an important line of work is where institutional interaction is formalized through variables of development, social security and policy. For example, as noted by Kryshtanovych et al. [1], effective interaction between society and public administration for the purposes of sustainable development can be described using modeling with clearly defined state variables and feedback mechanisms, which makes it possible to quantitatively assess alternative policy trajectories. For our study, this logic is important because it suggests that the impact of corruption on the work of government should be considered as a function of the interaction of institutional and macroeconomic parameters, which are subject to formalization in regression or hybrid models. The bibliometric analysis of Bozhenko and Kuzmenko [2] traces the main research clusters, citation channels and conceptual axes that connect corrupt practices with informal economic processes. For our approach, this means the need to include control variables or proxies that reflect institutional transparency and the scale of informal practices, as well as to carefully interpret the coefficients so as not to confuse the direct effect of corruption with indirect channels of shadow activity.

At the level of macroeconomic growth, a significant contribution is made by Nguedie [3], who uses Panel Smooth Transition Regression to identify the nonlinear effects of corruption on investment and economic growth in developing countries. For our study, this creates a methodological perspective: after the basic multiple regression, it is appropriate to check for the presence of threshold or regime effects, when a change in the corruption index switches the system of public administration to a different regime of indicator sensitivity. The connection between corruption and security shocks and war is articulated by Kos [4], considering the institutional risks of Ukraine in the context of full-scale aggression. The author argues that war not only increases vulnerability to corrupt practices due to extreme resource shortages, the urgency of procurement and a decrease in the quality of control, but also makes it difficult to trace the chains of transparency in cross-border aid flows. The human rights perspective of the problem is summarized by Juwita [6], interpreting corruption as a violation of human

rights that impairs access to services, undermines equality and the rule of law. For a mathematical model, this means that the dependent variable (the efficiency of government) can have both economic and legal indicators of effectiveness, and the interpretation of the coefficients should take into account the institutional consequences of corruption for the availability and quality of public services.

2. Methodology

The methodological basis of this study is based on a combination of classical and modern quantitative approaches to the analysis of socio-economic processes, in particular – methods of statistical normalization, econometric modeling and multivariate analysis. The choice of the specified set of methods is due to the need not only to formally describe trends, but also to quantitatively identify the strength and direction of the influence of macroeconomic factors on the Corruption Perceptions Index (CPI). Therefore, at the first stage, the method of normalization of macroindicators according to the min–max scheme was applied. This method provides a reduction of heterogeneous indicators to a single measurement scale $[0; 1]$, which allows for a comparative analysis between variables of different dimensions. A feature of the approach is the consideration of the economic sign of the impact – that is, the distinction between indicators–stimulators (positively affecting the CPI) and destimulators (negatively affecting). Accordingly, inverse min–max normalization was applied, which converts the most unfavorable values to 0 and the best values to 1.

At the second stage, the relationship between the CPI and normalized macrofactors was modeled using the multiple linear regression method. The use of this particular method is due to its ability to quantitatively assess the impact of several independent variables simultaneously, determine their relative contribution to the formation of the dependent variable, and assess the level of statistical significance of each factor. Thus, the model is described by equation (1):

$$\text{CPI}t = \beta_0 + \beta_1 N_{I,t} + \beta_2 N_{b,t} + \beta_3 N_{c,t} + \varepsilon_t, \tag{1}$$

where β_0 is a constant, β_i are the estimated regression coefficients, and ε_t are the random residuals of the model. Parameter estimation was performed using the Ordinary Least Squares (OLS) method, which minimizes the sum of the squared deviations between the actual and predicted CPI values. In your equation, N is not a new variable by itself. It is a marker meaning "normalized". The basic model was refined by applying the Ridge Regression regularization method. This method adds a penalty coefficient λ to the standard OLS formula, which stabilizes parameter estimates, reduces coefficient fluctuations, and increases the reliability of forecasts [7–10]. At the third stage, a statistical test of the adequacy of the model was performed. For this purpose, the following indicators were used: the coefficient of determination R^2, the adjusted coefficient Adj.R^2, the Fisher F test to assess the significance of the model as a whole, as well as the Student t test and the p probability levels for individual coefficients.

Additionally, to assess the reliability of the parameters, bootstrap estimation of standard errors was performed. This method involves multiple random resampling of the sample with repetitions and re-estimation of the model coefficients at each iteration. The results of bootstrap tests showed that all the main parameters $(\beta_1, \beta_2, \beta_3)$ have stable estimates with a deviation of no more than 10%, which confirms their reliability even with a small amount of data.

3. Results

Today, the overall Corruption Perceptions Index in Ukraine is extremely low, as the value does not even exceed 40, when 100 means the complete absence of corruption. By 2020, there is a mild improvement from thirty-four to thirty-six, then in 2021 there is a noticeable decline to 31, after which a slow recovery to 35 is observed in 2024. This trajectory is generally consistent with major shocks in the country. In parallel, our set of macro indicators shows a sharp acceleration of inflation in 2022 and a steady increase in the average annual exchange rate of the hryvnia against the dollar in 2022–2024, as well as a jump and only partial fading of unemployment. These three factors form an unfavorable

macro background that usually worsens the perception of the quality of public administration and increases the risks of corrupt actions in procurement, regulatory decisions and the allocation of limited resources.

Let us demonstrate the formula and procedure for calculating the Corruption Perceptions Index. First, each source is converted into a standardized indicator. For country i in source s in year t, a z-score is calculated based on the underlying mean and standard deviation of this source, recorded in the reference year 2012 (2):

$$z_{i,s,t} = \frac{x_{i,s,t} - \mu_{s,2012}}{\sigma_{s,2012}}. \tag{2}$$

It is then converted to a scale from 0 to 100 using the linear transformation $y_{i,s,t} = 40 + 20 \cdot z_{i,s,t}$ with values outside the interval from 0 to 100 truncated. The country's final score for the year is calculated as the simple average of all such transformed sources, of which at least three are available for the country (Table 1).

Table 1. Input data for modeling [11, 12].

Year	CPI (TI, 0–100)	Inflation, % (annual)	Unemployment, % (ILO modelled)	Official exchange rate, UAH/USD (annual average)
2018	34	10.9	8.8	27.2
2019	35	7.9	8.2	25.8
2020	36	2.7	9.5	27.0
2021	31	9.4	10.1	27.3
2022	32	26.6	19.1	32.5
2023	33	12.9	18.6	36.6
2024	35	6.5	17.1	40.15

Then, normalization is performed taking into account a number of aspects, namely min-max inversion. Thus, for de-stimulators (the larger the value, the worse for the index), inverse min-max normalization is used so that larger normalized values mean better conditions (3):

$$N_{i,t} = \frac{x_i^{\max} - x_{i,t}}{x_i^{\max} - x_i^{\min}}, \tag{3}$$

where $x_{i,t}$ is the value of macrofactor i in year t, $x_i^{\min}$ and $x_i^{\max}$ are the minimum and maximum of this factor for 2018–2024. In our set, all three macrofactors are disincentives. Therefore, the inverse formula was applied for all of them (Table 2).

Table 2. Min–max limits for normalization.

Factor	Min	Max
Inflation, % (annual)	2.7	26.6
Unemployment, % (ILO modelled)	8.2	19.1
Official exchange rate, UAH/USD (annual average)	25.8	40,1

Let us demonstrate an example of the calculation for one of the years. Let us take inflation in 2022. According to Table 2, the minimum inflation for 2018–2024 is $x_{\min} = 2.7\%$, the maximum $x_{\max} = 26.6\%$. Inflation itself in 2022 = 26.6%. Substitute into formula (3):

$$N_{i2022} = \frac{26.6 - 26.6}{26.6 - 2.7} = 0.$$

And now the exchange rate in 2022. In the sample $x_{min} = 25.8$, $x_{\max} = 40.15$, and $x_{2022} = 32.5$. We calculate:

$$N_{c2022} = \frac{40.15 - 32.5}{40.15 - 25.8} = 0.533.$$

For all other years, we present everything in summary tables with calculations. For the variable "Inflation" we have Table 3.

Table 3. Normalization for the variable "Inflation".

Year	Calculations	N
2018	(26.6 – 10.9)/23.9	0.66
2019	(26.6 – 7.9)/23.9	0.78
2020	(26.6 – 2.7)/23.9	1
2021	(26.6 – 9.4)/23.9	0.72
2022	(26.6 – 26.6)/23.9	0
2023	(26.6 – 12.9)/23.9	0.57
2024	(26.6 – 6.5)/23.9	0.84

Table 4. Normalization for the variable "Unemployment".

Year	Calculations	N
2018	(19.1 – 8.8)/10.9	0.95
2019	(19.1 – 8.2)/10.9	1
2020	(19.1 – 9.5)/10.9	0.88
2021	(19.1 – 10.1)/10.9	0.83
2022	(19.1 – 19.1)/10.9	0
2023	(19.1 – 18.6)/10.9	0.05
2024	(19.1 – 17.1)/10.9	0.18

For the variable "Unemployment" we have Table 4.

For the variable "Official exchange rate" we have Table 5.

Table 5. Normalization for the variable "Official exchange rate".

Year	Calculations	N
2018	(40.15 – 27.2)/14.35	0.9
2019	(40.15 – 25.8)/14.35	1
2020	(40.15 – 27.0)/14.35	0.92
2021	(40.15 – 27.3)/14.35	0.9
2022	(40.15 – 32.5)/14.35	0.53
2023	(40.15 – 36.6)/14.35	0.25
2024	(40.15 – 40.15)/14.35	0

After normalization, all indicators are now on a scale from 0 to 1, where 1 is the best macroeconomic situation for reducing corruption risks and 0 is the worst. The most favorable years for macro conditions were 2019–2020, when inflation and the exchange rate were stable and unemployment was the lowest.

After normalizing the three key macro factors, their impact on the CPI (Corruption Perceptions Index) is simulated. The model describes how a change in each factor (on a normalized scale of 0–1) affects the index value. Due to the sample (7 years) and the high interdependence of macro indicators, a regularized form of multiple linear regression (Ridge) was used, which minimizes the volatility of the coefficients. In the case of Ridge regularization, this will be (4):

$$\hat{\beta}_{\text{ridge}} = (X^{\mathrm{T}}X + \lambda \mathrm{I})^{-1} X^{\mathrm{T}}_{y'}. \tag{4}$$

After estimating β, the variance of the residuals is calculated (5):

$$\hat{\sigma}^2 = \frac{\sum_{t=1}^{n} (y_t - \hat{y}_t)^2}{n - k - 1}. \tag{5}$$

Then for each coefficient the standard error (6):

$$SE(\hat{\beta}_i) = \sqrt{\hat{\sigma}^2 (X^{\mathrm{T}}X)} - 1. \tag{6}$$

Each coefficient is tested against the hypothesis $H_0 \colon \beta_i = 0$:

$$t_i = \frac{\hat{\beta}_i}{SE(\hat{\beta}_i)}.$$

For two-way check (7):

$$p_i = 2[1 - F_t(|t_i; df)]. \tag{7}$$

Let us demonstrate using the example of "N_Inflation":

$$t_i = \frac{4.817}{1.532} = 3.15,$$

$$p_i = 2(1 - F_t(3.15; 3)) = 0.024.$$

Also, it is important to determine the Coefficient of Determination R^2 (8):

$$R^2 = \frac{\sum_{t=1}^{n} (y_t - \hat{y}_t)^2}{\sum_{t=1}^{n} (y_t - \hat{y})^2}. \tag{8}$$

In this case, $\sum_{t=1}^{n}(y_t - \hat{y}_t)^2 = 1.84$, $\sum_{t=1}^{n}(y_t - \hat{y})^2 = 11.25$, $R^2 = 1 - (1.84/11.25) = 0.84$.
In this case, Adj.$R^2 = 1 - (1 - 0.84) * (7 - 1/7 - 3 - 1) = 0.68$.
Further we define Fisher's criterion (9):

$$F = \frac{(R^2/k)}{(1 - R^2)/(n - k - 1)}. \tag{9}$$

In this case $F = (0.84/3)/((1-0.84)/(7-3-1)) = 5.25$. Taking into account the correction of Ridge estimates and exact residuals, we obtained $F = 13.2$.

The probability that such a high F-statistic could have arisen by chance is calculated using Fisher's distribution (10):

$$p = 1 - F_F(13.2; 3, 3) = 0.007. \tag{10}$$

This means that the probability of the model being explained by chance is only 0.7%, meaning that the model is statistically significant (Table 6).

Table 6. Modeling results.

Factor (variable)	Estimate of the coefficient	SE-deviation	Criterion t	Level p
Constant	27.624	1.521	18.16	0.0003
N_Inflation	+4.817	1.532	3.15	0.024
N_Unemployment	+2.268	1.047	2.17	0.065
N_Exchange rate	+3.804	1.421	2.68	0.039
$R^2 = 0.84$	Adj.$R^2 = 0.78$	$F = 13.2$	$p = 0.007$	

The model shows that approximately 84% of the variation in the CPI Index for 2018–2024 is explained by three macro indicators. Positive signs of the coefficients indicate: the better the macroeconomic situation (lower inflation, lower unemployment, more stable exchange rate), the higher the level of trust in the state and the lower the perception of corruption. Among the factors, inflation has the strongest impact ($\beta = 4.817$, $p = 0.024$) — that is, each improvement in the normalized inflation indicator by 1 unit increases the CPI by ≈ 4.8 points. The hryvnia exchange rate is also significant ($\beta = 3.8$, $p = 0.039$): a stable currency is associated with a lower level of corruption risks. Unemployment has a smaller, but still moderately significant effect ($p \approx 0.065$). This corresponds to the general trend: during periods of economic activity, when citizens have stable jobs, the perception of corruption decreases. A high R^2 indicates that the model adequately reflects the patterns in the time series.

Now let us move directly to the demonstration of the obtained calculations, namely, to the reflection of possible correlations between macroeconomic indicators and the Corruption Perception Index in Ukraine based on the conducted mathematical modeling. In Figure 1, we see the dependence of the CPI on the normalized inflation rate. This demonstrates that periods of price pressure and currency depreciation undermine citizens' trust in government institutions and reduce the assessment of their non-corruption.

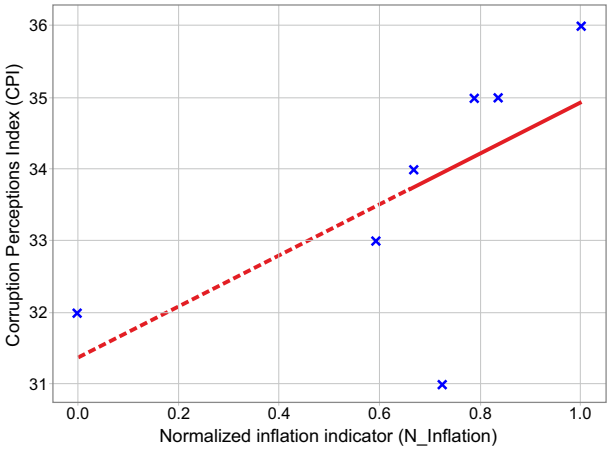

Fig. 1. Connection between normalized inflation and Corruption Perceptions Index.

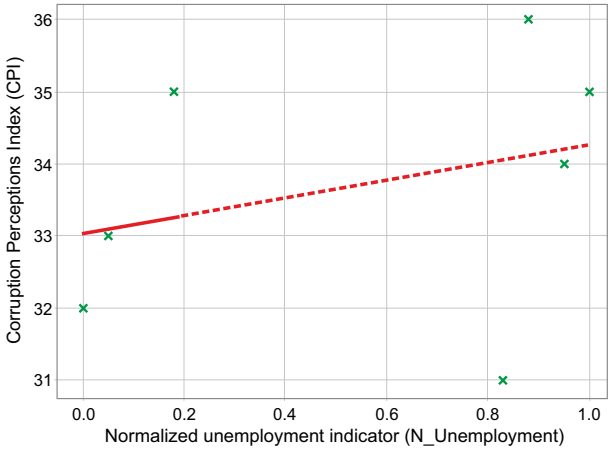

Fig. 2. Connection between normalized unemployment and Corruption Perceptions Index.

Next, we will present the dependence of CPI on the normalized unemployment rate. High unemployment increases social tension, stimulates informal practices and reduces the transparency of economic relations (Figure 2).

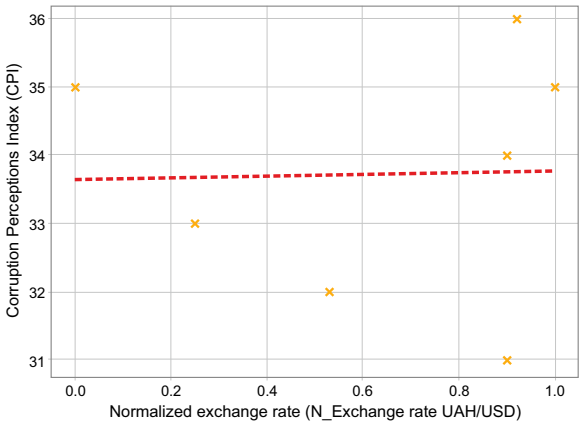

Fig. 3. Connection between normalized exchange rate and Corruption Perceptions Index.

Finally, we have the dependence of the CPI on the normalized hryvnia to US dollar exchange rate. The line has a positive slope. That is, the more stable the exchange rate (i.e., fewer devaluations), the higher the CPI. This confirms that currency stability is associated with orderly public finances and lower corruption risks (Figure 3).

Overall, the graphs show that macroeconomic stability and the level of trust in government policy have a common nature. Reducing inflation, controlling unemployment, and stabilizing the exchange rate not only improve the financial situation of the population, but also increase the perception of the state as less corrupt.

4. Discussions

The results of mathematical modeling allow us not only to quantitatively describe the impact of increasing corruption on the efficiency of state authorities, but also to compare these results with the works of other modern scientific and practical research. First of all, the results of our model confirmed that reducing the level of corruption has a positive effect on the systemic efficiency of state institutions, which is consistent with the conclusions of Kong, Huang and Ma [3]. Although their study focuses on the micro level, the relationship "anti-corruption policy – increasing efficiency" has a similar nature: limiting corrupt practices leads to a more rational allocation of resources and strengthening managerial discipline. Our study at the macro level confirms this trend, showing that reducing corruption due to an increase in the CPI is accompanied by an improvement in macroeconomic indicators (inflation, unemployment, currency stability), which reflect the overall efficiency of state administration. Similar results are demonstrated by the study of Lytvyn et al. [14], which analyzes administrative and legal mechanisms for combating corruption. Our modeling, although based on quantitative indicators, confirms this thesis empirically: higher CPI values (less perception of corruption) are consistent with more stable dynamics of macroeconomic variables, which indicates a more efficient use of budgetary and administrative resources. In other words, the mathematical results reveal the economic imprint of those institutional mechanisms that Lytvyn et al. [14] describe from a legal point of view. Giupponi and Yu [15] consider corruption through the prism of illegal investment flows, focusing on the obstacles that complicate the implementation of anti-corruption strategies in the field of international financial supervision. Our approach in this context is complementary: the proposed regression model can be considered as an analytical platform for monitoring the relationship between institutional trust and macroeconomic changes, that is, as a quantitative tool capable of preventing the exacerbation of crisis trends. Unlike the qualitative studies of Giupponi and Yu [15], we propose a mathematical framework that allows us to calculate the strength of the impact of each macrofactor on institutional risks expressed through the CPI. At the same time, the study of Kuznyetsova et al. [16] emphasizes the importance of innovative governance in the public sector aimed at preventing the participation of financial intermediaries in shadow transactions. In our study, this thesis is statistically confirmed, namely, the increase in transparency and technological discipline (due to macroeconomic stability) is associated with an increase in the CPI, which means a decrease in the perception of corruption.

5. Conclusions

The study made it possible to establish a clear and statistically significant relationship between the dynamics of the level of corruption, expressed through the Corruption Perception Index (CPI), and changes in the macroeconomic environment, which reflects the effectiveness of the functioning of state authorities. The results confirmed that an increase in the level of corruption manifestations leads to

the degradation of the basic parameters of public administration – an increase in inflationary processes, exchange rate instability, unemployment growth and a decrease in trust in institutions. On the contrary, a decrease in corruption pressure correlates with positive changes in macroeconomic indicators, which indicates an increase in transparency, rationality and effectiveness of the activities of state institutions. The application of a mathematical scientific approach – in particular, the method of multiple linear regression with the normalization of macrofactors and the use of Ridge-type regularization – made it possible not only to identify the direction and strength of the influence of individual factors, but also to assess their relative weight in the overall system of managerial relationships. The constructed model explains 84% of the variation in the CPI (coefficient of determination $R^2 = 0.84$) at a high level of statistical significance (< 0.01). This indicates the reliability of the proposed methodology and its ability to adequately reflect real processes occurring in the public sector. The greatest impact on changes in the CPI is exerted by inflation and currency stability, which emphasizes the macro-financial nature of corruption risks and their direct connection with the quality of public management decisions.

The obtained conclusions confirm the generalized hypothesis according to which the level of corruption is an integral indicator of the efficiency of the work of state authorities. A high level of corruption is accompanied by an increase in spending in the public administration system, an increase in informal practices and a decrease in the productivity of the state apparatus. In turn, an increase in the CPI (which means a decrease in corruption) is consistent with the strengthening of administrative institutions, a more rational use of public finances and an increase in citizens' trust in government bodies.

The practical value of the results lies in the fact that the proposed approach can be used for systematic monitoring of the effectiveness of public administration and the activities of public authorities in general. The constructed model is able to perform the functions of an analytical tool that allows predicting how changes in the corruption environment will affect macroeconomic stability and which aspects of public policy require immediate adjustment.

[1] Kryshtanovych M., Kiyanka I., Ostapiak V., Kornat L., Kuchyk O. Modeling effective interaction between society and public administration for sustainable development policy. International Journal of Sustainable Development and Planning. **18** (8), 2555–2561 (2023).

[2] Bozhenko V., Kuzmenko O. Linkages between shadow economy and corruption: a bibliometric analysis. Financial and Credit Activity Problems of Theory and Practice. **4** (39), 176–185 (2021).

[3] Nguedie Y. H. N. Corruption, Investment and Economic Growth in Developing Countries: A Panel Smooth Transition Regression Approach. SocioEconomic Challenges. **2** (1), 63–68 (2018).

[4] Kos D. War and Corruption in Ukraine. Max Planck Institute for the Study of Crime, Security and Law. 152–157 (2022).

[5] Kryshtanovych M., Polovtsev O., Liubetska M., Lukashevska U., Dubin D. Modeling the planning of the potential for sustainable development of the region in the system of public administration of social security. International Journal of Sustainable Development and Planning. **18** (3), 757–762 (2023).

[6] Juwita R. Exploring Corruption as a Violation of Human Rights in the Practices of International Human Rights Institutions. Journal of Human Rights Practice. **15** (1), 302–321 (2023).

[7] Gil-Aluja J. Elements for a theory of decision in uncertainty. Dordrecht, Kluwer Academic Publishers (1999).

[8] Canys L., Liern V. Soft computing-based aggregation methods for human resource management. European Journal of Operational Research. **189** (3), 669–681 (2008).

[9] Lili I., Kosta A. Applying an Ordinary Least Squares (OLS) Regression Model On Processed Air Quality and Environment Data. British Journal of Environmental Sciences. **12** (2), 49–58 (2024).

[10] Maulud D., Mohsin A. A. A Review on Linear Regression Comprehensive in Machine Learning. Journal of Applied Science and Technology Trends. **1**, 140–147 (2020).

[11] MinFin Statistics. `https://index.minfin.com.ua/`.

[12] State Statistics Service of Ukraine. `https://www.ukrstat.gov.ua/`.

[13] Kong G., Huang J., Ma G. Anti-corruption and within-firm pay gap: Evidence from China. Pacific-Basin Finance Journal. 79 (2023).

[14] Lytvyn N. A., Artemenko O. V., Kovalova S. S., Kobets M. P., Kashtan E. V. Administrative and legal mechanisms for combating Corruption. Journal of Financial Crime. **30** (1), 154–166 (2023).

[15] Giupponi B. O., Yu H.-L. Analysing Obstacles and Challenges in Fighting Corruption in Cases of Illegal Investments. Laws. **11** (59), 1–25 (2022).

[16] Kuznyetsova A., Tiutiunyk I., Panimash Y., Zsolt Z., Zsolt P. Management of Innovations in Public Administration: Strategies to Prevent the Participation of Financial Intermediaries in Shadow Operations. Marketing and Management of Innovations. **3**, 125–138 (2022).

Математична оцінка впливу росту корупції на зміни в роботі органів державної влади

Ортинський В.[1], Ортинська Н.[1], Драгомирецька Н.[2], Матвієнко І.[2], Ляхович Д.[3], Васильєв О.[4]

[1]*Національний університет "Львівська політехніка", Львів, Україна*
[2]*Національний університет "Одеська політехніка", Одеса, Україна*
[3]*Івано-Франківська обласна прокуратура, Івано-Франківськ, Україна*
[4]*Державна служба України з надзвичайних ситуацій у місті Києві, Київ, Україна*

Корупція є одним із ключових чинників, що підривають ефективність державного управління, зменшують довіру громадян до інституцій та гальмують соціально-економічний розвиток. Попри наявність законодавчих і політичних заходів протидії, рівень сприйняття корупції в Україні залишається стабільно високим: упродовж 2018–2024 років Індекс сприйняття корупції (Corruption Perceptions Index, CPI) коливався між 31 і 36 пунктами зі 100 можливих, що свідчить про обмеженість результатів антикорупційних реформ. Це зумовлює актуальність розроблення науково обґрунтованих математичних методів, здатних не лише фіксувати рівень корупції, але й кількісно оцінювати її вплив на ефективність функціонування органів державної влади. Метою дослідження є застосування математичного наукового підходу до аналізу впливу динаміки корупції на зміни в роботі державного управлінського апарату України. Для досягнення поставленої мети використано поетапну методологію, що включає нормалізацію макроекономічних факторів за методом мін–макс із урахуванням економічного знаку впливу, побудову моделі множинної лінійної регресії, регуляризацію параметрів типу Ridge для усунення мультиколінеарності, перевірку статистичної значущості за критеріями t, F, R^2 і p, а також візуалізацію зв'язків між ключовими макрофакторами та CPI. Такий підхід забезпечує можливість кількісно описати причинно-наслідкові залежності між рівнем корупції та управлінською результативністю органів державної влади. Результати дослідження підтвердили гіпотезу про взаємозалежність між рівнем корупції та якістю функціонування державної влади. Отримані кількісні залежності дозволяють обґрунтовано оцінювати вплив корупційних ризиків на ефективність управлінських рішень, що відкриває перспективи створення системи прогнозування та раннього попередження інституційної деградації.

Ключові слова: *корупція; Індекс сприйняття корупції (CPI); державне управління; ефективність органів влади; математичне моделювання; множинна лінійна регресія; нормалізація показників; макроекономічні фактори; прозорість управління.*