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THE NEIGHBORHOOD EFFECT ON PERCEPTIONS OF CORRUPTION

COMPARATIVE SPATIAL AUTOCORRELATION ANALYSIS

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Abstract

This article aims to investigate the factors influencing the perception of high corruption levels in a country and examines the potential existence of spatial dependence in the distribution of these factors. It specifically focuses on exploring the interdependence between the Corruption Perception Index (CPI) and forty-four other factors categorized into six distinct categories. The central hypothesis posits that the interdependence between the CPI and these factors is more pronounced at the domestic level compared to its influence on indicators in neighboring countries. To assess the degree of interdependence between the CPI and each of the other indicators, the Pearson's Coefficient of Determination is employed, enabling an evaluation of corruption levels based on domestic state-specific factors. Furthermore, Moran's Bivariate Spatial Autocorrelation Index is utilized to elucidate the extent to which the CPI in one country influences one of the forty-four indicators in neighboring countries. Additionally, the Index of Spatial Interdependence is employed to ascertain the significance of domestic and international factors for each indicator. The research findings provide several noteworthy conclusions. Firstly, the neighborhood effect proves to be particularly significant for indicators that hold universal relevance for all governments, such as demographic and standard of living indicators. Conversely, indicators influenced by institutional, historical, and cultural differences exhibit stronger interrelations within the state. Lastly, the study establishes that the Pearson's Index holds greater significance than the Bivariate Moran's Index of Spatial Autocorrelation and the Index of Spatial Interdependence, thereby confirming the proposed hypothesis.

Keywords:

the neighborhood effect; comparative spatial analysis; comparative spatial autocorrelation; Corruption Perception Index; Moran's Index; Pearson's Coefficient of Determination Index; Index of Spatial Interdependence; corruption

Corruption is a pervasive issue that affects countries worldwide, transcending national boundaries. It is often regarded as a characteristic of developing societies with weak or absent formal institutions [Heidenheimer, Johnston 2002]. The study of informal institutions is essential for understanding political behavior's underlying motives [Helmke, Levitsky 2007]. Informal institutions may either replace or complement formal institutions when political

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actors perceive the latter as ineffective. Corruption, as an informal institution, can expedite decision-making processes and guarantee outcomes that would otherwise be unattainable [Scott 1972]. In states where formal institutions are dysfunctional, corruption becomes ingrained in government narratives and societal behavior, resulting in a "frozen" political and administrative environment that limits alternative participation in decision-making processes [Gawthorpe 2017].

Given the pervasiveness of corruption, which extends beyond third-world and post-Soviet countries [Helmke, Levitsky 2007], it is crucial to examine the factors that contribute to the high level of perceived corruption in each country and explore whether there is a spatial dependence in the distribution of these factors. This article aims to analyze the factors that potentially influence a country's corruption level, with a particular focus on spatial analysis utilizing the Local Indicators of Spatial Association (LISA) and Index of Spatial Interdependence (ISI) methodologies. By employing these spatial analysis techniques, the study seeks to provide insights into the spatial patterns and relationships associated with corruption levels in different countries.

Territorial dependence, often referred to as the “neighborhood effect”, suggests that countries in close proximity should exhibit greater similarities than those that are more distant. The hypothesis under investigation posits that the interdependence between the Corruption Perception Index (CPI) and other factors is stronger within a country compared to the influence of the CPI on indicators in neighboring countries. Previous research by Daniel Treisman [Treisman 2000] has identified federalism as a contributing factor to increased corruption levels, while factors such as Protestantism, the British political tradition, a developed economy, higher import levels, and a democratic regime have been associated with lower levels of corruption.

Economists Lorenzo Pellegrini and Reyer Gerlagh [Pellegrini, Gerlagh 2008] conducted econometric modeling to examine corruption. They found that factors such as Anglo-Saxon law, the legacy of the British Empire, Protestantism, ethnolinguistic divisions, availability of natural resources, import revenues, level of decentralization, democratic governance, newspaper circulation, state intervention in the economy, and political stability all play a role in determining corruption levels. Their research revealed a negative relationship between corruption and support for democratic governance, while political instability was associated with higher corruption levels. Additionally, newspaper circulation was found to be inversely correlated with corruption.

Chedraui et al. [Chedraui, Arcaraz, Botero 2016] focused on the economic factors influencing corruption. Their findings indicated that corruption tends to increase with a decrease in GDP per capita and also affects the Human Development Index and Social Progress Index. Stephen Gazenov conducted a multicollinear analysis examining sixteen variables, including the rule of law, violence and instability, country wealth, democracy, and education level, which influence corruption levels [Gazenov 2017].

The work of Ransford Quarmyne Churchill, William Agbodohu and Peter Arhenful [Churchill, Agbodohy, Arhenful 2013] examined the impact of economic openness, democracy, freedom of the press, differences between natural resource exports and overall goods exports, urban population, political stability, and economic freedom on corruption. Ning He [He 2016] criticized the Western approach, highlighting that some of the indicators leading to increased corruption are subjective and predominantly specific to Western countries, such as Protestantism and democratic traditions.

Goel and Nelson [Goel, Nelson 2010] conducted a cross-state analysis of historical, geographical, and political factors influencing corruption. Seldadyo and Haan [Seldadyo, Haan 2006] conducted a robustness study on significant determinants of corruption, examining 70 economic and non-economic factors. They found that the regulatory capacity index, created through factor analysis using 12 clustered variables, was the most robust variable in explaining corruption. These variables primarily reflected the government's capacity to

regulate and enforce laws [Seldadyo, Haan 2006: 34].

Several works have explored the geographic perspective of corruption and its relation to territorial regimes of power. Doshi and Ranganathan [Doshi, Ranganathan 2018] examined how corruption becomes politicized within territorial contexts using geographic and cognate disciplinary approaches. Another notable book by B. Warf [Warf 2019] delved into the historical and cultural factors of corruption, focusing on the Corruption Perception Index (CPI) across different regions of the world. While Warf's work provides case studies of various countries and acknowledges the impact of geography on corruption patterns, it primarily categorizes countries into "classical" world regions rather than utilizing spatial analysis or considering the neighborhood effect.

Despite the multitude of factors identified in determining corruption, many of them have been of an economic or political nature and subjected to linear analysis of interdependencies among indicators. Goel and Nelson [Goel, Nelson 2007] examined the effect of neighboring corruption using state-level US data from 1995 to 2004 and found a positive and statistically significant neighboring effect, suggesting that corruption can be contagious. Goel and Saunoris [Goel, Saunoris 2014] explored the relationship between corruption and the shadow economy, emphasizing geographic spillovers. Becker, Egger, and Seidel [Becker, Egger, Seidel 2009] employed Moran's Index in their analysis of 123 economies and confirmed that corruption exhibits regional patterns.

However, it is important to note that none of the aforementioned studies utilized local indicators of spatial autocorrelation (LISA) or the Index of Spatial Interdependence (ISI).

The study begins by outlining the methodology employed to investigate the research question. The factors influencing corruption perception are categorized into distinct groups, encompassing politics, demography, the standard of living, economy, and values. The interdependencies between these factors and the Corruption Perception Index (CPI) are analyzed using statistical measures such as the Coefficient of Determination, Moran's Index of Spatial Association, and a novel Index of Spatial Interdependence proposed by the authors.

The researchers' rigorous analysis uncovers notable cases where the CPI and specific indicators exhibit discernible clusters among countries. The authors employ the Local Indicators of Spatial Association of the CPI to further explore these patterns, providing more detailed insights into the spatial relationships within and across countries.

Drawing upon their comprehensive methodology and findings, the authors present their research conclusions, shedding light on the spatial dynamics and associations of corruption perception in diverse regions and countries.

Methodology

The research methodology employed in this study utilizes the Corruption Perception Index[1] (CPI) compiled by Transparency International[2] as the foundation for analysis. The authors emphasize the fact that international experts warn some of the organizations' activities are politically biased, sometimes its actions go beyond declared aims and proclaimed goals, and it is also infamous for interfering in internal affairs of different states. However, the authors use the data base solely for scientific purposes. The choice of the data base source was motivated by the fact, that the CPI assesses 180 countries and territories, which is the most complete data base on corruption perception in the world. This makes the research valid in terms of the number of cases for the quantitative analysis. Besides, the focus of the article is in testing spatial econometric analysis and finding spatial patterns. The calculations and

[1] Corruptions Perception Index [Electronic source] // Transparency international (06.03.2023 organization was declared undesirable and banned from Russia). URL: https://transparency.org.ru/research/indeks-vospriyatiya-korruptsii/ (accessed: 23.03.2020).

[2] 06.03.2023 this organization was declared undesirable and prohibited in the Russian Federation

the further research showed that even the biased dataset did not influence the results of the spatial econometric analysis. The CPI assigns scores ranging from 0 to 100 to reflect the perceived level of corruption within each state. A score of 0 indicates high levels of corruption, while a score of 100 indicates a minimal perception of corruption. The index draws upon data from various sources, including the African Development Bank, the Bertelsman Sustainable Government Index, the Bertelsmann Transformation Index[3], and Freedom House[4], among others.

The CPI serves as a crucial indicator, capturing the extent of transparency, accountability, and corruption prevalent within the public sector. It poses fundamental questions, such as the prevalence of transparency in decision-making processes, the prioritization of public interests over personal interests by government officials, the consequences faced by officials engaged in bribery, the effectiveness of state efforts to combat corruption, and the societal and governmental attitudes towards corruption.

To examine the interdependencies between variables, the CPI is treated as an independent variable, while forty-four indicators representing international influence, politics, demography, quality of life, economics, and values are considered as dependent variables. The Coefficient of Determination (R square, CoD) is then calculated for each pair of interdependent variables, providing insights into the relationship between different indicators within each country. This analysis enables the assessment of which indicators are associated with the level of perceived corruption. However, it is important to note that the CoD does not determine the independence of variables, but rather highlights the extent of their relationship.

Furthermore, the study explores the neighborhood effect, examining how the development indicators of neighboring countries correlate with the level of perceived corruption in the analyzed state. This analysis is accomplished by applying Moran's Index of Spatial Autocorrelation, which measures the degree of correlation between the indicator under examination in a specific country and the corresponding indicator in neighboring countries. This enables the identification of potential spatial dependencies and influences on the perception of corruption.

By employing these robust statistical techniques and indices, the study aims to provide a comprehensive understanding of the factors influencing corruption perception, both within individual countries and across neighboring states.

The index is calculated by the formula:

$$M = \frac{N}{W} \frac{\Sigma_i \Sigma_j w_{ij}(x_i - \acute{x})(x_j - \acute{x})}{\Sigma_i (x_i - \acute{x})}$$

where i, j are units, x_i and x_j are values in i and j units, $\acute{x}$ is a sample mean on all units/value for all units, w_{ij} are all spatial relation between i^{th} and j^{th} units, N the quantity of units, W the sum of spatial weights [Cliff, Ord 1973].

To determine the neighboring states, the spatial weights matrix was computed using the k-nearest neighbors (k-NN) algorithm with k=8, as outlined by Okunev [Okunev 2020]. This approach involved identifying the eight closest neighboring countries for each analyzed country. Subsequently, the arithmetic average of the forty-four indicators was calculated for these neighboring countries, and a correlation was established between this average and the level of corruption in the analyzed country.

To assess spatial clusters and identify regions with significant spatial dependence between corruption perception and individual indicators in neighboring countries, the Local Indicators of Spatial Association (LISA) method was employed. This method allowed for the identification of areas with statistically significant relationships between corruption percep-

[3] Bertelsman Index [Electronic source] // BTI project. URL: https://bti-project.org/en/?&cb=00000 (accessed: 09.09.2023).

[4] Freedom in the World, Table of Country Scores [Electronic source] // Freedom House. URL: https://freedomhouse.org/report/freedom-world#Data (accessed: 09.09.2023).

tion and specific indicators within the spatial context. For the calculation, the following formula was applied:

$$L = \frac{N}{\Sigma_i \Sigma_j w_{ij}} \frac{\Sigma_j w_{ij}(z_i - \acute{z})(z_j - \acute{z})}{\Sigma_i (z_i - \acute{z})^2}$$

where N is the number of items, z_i is the calculated indicator for the item i, a w_{ij} is an estimate of spatial weights reflecting whether i and j neighbors, such that if they are not, it is equal to zero, and if they are equal $1/|\delta_i|$, where $|\delta_i|$ is the number of neighboring items i [Anselin 1995].

The study employed the mapping of Local Indicators of Spatial Association (LISA) for countries where indicators exhibited a level of significance with a p-value of less than 0.05. This spatial analysis technique enabled the identification of four distinct types of local clusters. The "high-high" cluster represents areas where high values of corruption perception are spatially autocorrelated among neighboring countries. Conversely, the "low-low" cluster indicates areas with spatial autocorrelation of low values of corruption perception in neighboring countries. The "high-low" cluster refers to situations where high values of corruption perception are observed in the vicinity of a cluster with low values, while the "low-high" cluster denotes areas with low values of corruption perception near a cluster with high values.

Finally, the authors introduced their Index of Spatial Interdependence (ISI) as a measure to quantify the difference between the magnitudes of the Bivariate Index of Spatial Autocorrelation and the Coefficient of Determination (CoD):

$$\begin{matrix} INDEX\ OF\ SPATIAL \\ INTERDEPENDENCE \end{matrix} = |M_{(x,y)}| - |R_{(x,y)}|$$

where x and y are dependent and independent variables, $M_{(x,y)}$ a Bivariate Moran's index between them, $R_{(x,y)}$ – CoD between them.

The Coefficient of Determination (CoD) provides a measure of the correlation between two indicators, x, and y, indicating the degree of interdependence. On the other hand, the Bivariate Moran's index assesses the spatial autocorrelation between indicator x and the average indicator y in the neighboring countries, capturing the spatial relationships between these variables. The Index of Spatial Interdependence (ISI) evaluates the neighborhood effect, shedding light on how spatial proximity either strengthens or weakens the interdependence between indicators x and y.

In the subsequent sections, the study presents the results of the CoD, Bivariate Moran's Index, and ISI calculations for different groups of factors, including international influence, politics, demography, quality of life, economics, and values.

Politics

The indicators considered in this analysis include the Freedom of Press Index, Political Rights Index, Sustainable Governance Index, and Political Transformation Index, all measured in 2017[5]. The coefficient of determination (CoD) between the Corruption Perception Index (CPI[6]) and the Freedom of Press Index is 0.497. This indicates a strong positive correlation, suggesting that there is greater freedom of the press in societies with lower corruption levels. This can be attributed to the fact that in corrupt societies, the state often controls the media to manipulate public opinion, while in less corrupt societies, the press can operate more independently.

The Bivariate Moran's Index for this pair of indicators is -0.400, indicating a negative spatial autocorrelation. This suggests that countries with lower corruption levels have neighboring countries with less freedom of the press. This can be attributed to neighboring states' attempts to control their press to avoid power loss. However, the Index of Spatial Inter-

[5] Freedom of the Press 2017 [Electronic source] // Freedom House. URL: https://freedomhouse.org/report/freedom-press/freedom-press-2017 (accessed: 09.01.2020).

[6] Corruption Perceptions Index 2018: Full Source Description [Electronic source] // Transparency International (06.03.2023 organization was declared undesirable and banned from Russia). URL : https://www.transparency.org/CPI2018 (accessed: 04.01.2020).

dependence (ISI) for this pair is -0.097, indicating that the internal dynamics within a country play a more significant role than the external context when it comes to the relationship between corruption perception and freedom of the press.

The CoD between the CPI and Political Rights Index is 0.462, indicating a positive correlation. This implies that countries with lower corruption levels tend to have higher levels of political rights. The Bivariate Moran's Index for this pair is -0.367, suggesting that countries with lower corruption levels have neighboring countries with fewer political rights. However, the ISI for this pair is -0.095, indicating that the spatial factor is not significant in influencing the relationship between corruption perception and political rights.

The CoD between the CPI and Sustainable Governance Index is 0.756, indicating a strong positive correlation. This implies that countries with lower corruption levels are better equipped to respond effectively to social and political challenges. The Bivariate Moran's Index for this pair is 0.128, indicating that countries with higher corruption levels have neighboring countries with less effective institutions. However, the ISI for this pair is negative (-0.628), suggesting that the spatial factor hinders the spread of corruption and its association with sustainable governance in neighboring countries.

For the pair of CPI and Political Transformation Index, the CoD is 0.110, indicating a positive correlation. This suggests that successful efforts to reduce corruption are often accompanied by successful political transformation. The Bivariate Moran's Index for this pair is 0.007, suggesting a weak spatial autocorrelation. The ISI for this pair is -0.103, indicating that the spatial factor has a limited influence on the relationship between corruption perception and political transformation in neighboring countries.

Overall, the analysis reveals that political indicators are more closely related to domestic political processes than to indicators in neighboring countries. This suggests that each state operates according to its own rules and that external political processes have limited impact. This finding aligns with the idea put forward by Thomas Carothers in his work on the end of the transition paradigm, emphasizing the unique nature of political processes within each country [Carothers 2003].

Demography

The indicators in this group include annual population growth[7], life expectancy at birth[8], the proportion of the population under fourteen years old[9], the proportion of the rural population[10], the proportion of migrants in the population[11], and the index of ethnic diversity [Fearon 2003]. The coefficient of determination (CoD) for the Corruption Perception Index (CPI) and annual population growthis 0.120, indicating a weak connection. It suggests that countries with lower corruption levels tend to have lower population growth. The Bivariate Moran's index for this pair is -0.321, indicating that countries with lower corruption levels have neighboring countries with lower population growth. The Index of Spatial Interdependence (ISI) is 0.201, suggesting that spatial factors enhance the correlation between these indicators.

For the pair of CPI and life expectancy at birth, the CoD is 0.457, indicating a positive correlation. This implies that countries with lower corruption levels tend to have higher life

[7] Population growth (annual %) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SP.POP.GROW?view=chart (accessed: 10.01.2020).

[8] Life expectancy at birth, total (years) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/sp.dyn.le00.in (accessed: 10.01.2020).

[9] Population ages 0-14 ($ of total population) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/sp.pop.0014.to.zs (accessed: 10.01.2020).

[10] Rural population ($ of total population) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/sp.rur.totl.zs (accessed: 10.01.2020).

[11] International migrant stock (% of population) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SM.POP.TOTL.ZS (accessed: 10.01.2020).

expectancies. This can be attributed to factors such as reduced crime rates and better quality medical services in less corrupt societies. The Moran's index for this pair is 0.412, indicating that countries with lower corruption levels have neighboring countries with higher life expectancies. However, the ISI is -0.045, suggesting that the spatial factor does not play a significant role in this pair, and domestic factors primarily explain the correlation.

The CoD for the pair of CPI and the proportion of people under fourteen years old is 0.407. This suggests a weak correlation, but it can be inferred that more corrupt societies tend to have a higher proportion of children. This may be attributed to the lower standard of living for the lower strata of the population in corrupt states, leading to a higher birth rate. The Bivariate Moran's index for this pair is -0.417, while the ISI is 0.010, indicating that internal factors are more important and the spatial factor plays a relatively insignificant role.

For the pair of CPI and the proportion of the rural population, the CoD is 0.252, indicating a positive correlation. This suggests that more corrupt societies tend to have a higher proportion of the urban population. This can be explained by the presence of a parochial political culture, lower levels of education, and a lack of understanding of political processes among the rural population. Corruption may serve as a mechanism for faster decision-making in such contexts. The Bivariate Index of Spatial Association is -0.257, and the ISI is 0.005, indicating that the spatial factor also has limited significance for this pair, and domestic factors play a more important role.

The CoD for the pair of CPI and the proportion of immigrants is 0.173, suggesting a weak correlation. It can be assumed that countries with lower corruption levels tend to attract higher immigration flows due to comprehensible rules of conduct and functioning formal institutions. The Moran's index is 0.137, while the ISI is -0.036, indicating that the spatial factor has limited impact in this case.

The CoD for the pair of CPI and the Index of Ethnic Diversity is 0.143, indicating a weak positive correlation. This suggests that countries with higher levels of corruption tend to have greater ethnic diversity. It is possible that in multiethnic societies, reaching a consensus on political decisions is challenging, and corruption may serve as a means to expedite reconciliation and advance specific agendas. The Moran's index has a negative value of -0.244, indicating that countries with higher corruption levels have neighboring countries with greater ethnic diversity. The ISI is 0.101, suggesting that the spatial factor strengthens the correlation. This can be explained by the need for networking and agreement-building among the same ethnic groups in neighboring countries in multiethnic state interactions.

Standard of Living

The group of indicators examined in this analysis encompasses various factors such as adolescent fertility rate[12], expected years of schooling[13], suicide rate[14], HIV incidence[15], antiretroviral therapy (ART) coverage[16], diph-

[12] Adolescent fertility rate (births per 1,000 women ages 15-19) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SP.ADO.TFRT (accessed: 10.01.2020).

[13] Human Capital Index, Learning-Adjusted Years of School [Electronic source] // The World Bank. URL: https://databank.worldbank.org/reports.aspx?source=3698&series=HD.HCI.LAYS (accessed: 10.01.2020).

Human Capital Index, Learning-Adjusted Years of School [Electronic source] // The World Bank. URL: https://databank.worldbank.org/reports.aspx?source=3698&series=HD.HCI.LAYS (accessed: 10.01.2020).

[14] World Health Statistics data visualizations dashboard – Suicide [Electronic source] // The World Health Organization. URL: http://apps.who.int/gho/data/node.sdg.3-4-viz-2?lang=en (accessed: 10.01.2020).

[15] Incidence of HIV (per 1,000 uninfected population ages 15-49) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SH.HIV.INCD.ZS (accessed: 10.01.2020).

[16] Antiretroviral therapy coverage ($ of people living with HIV) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SH.HIV.ARTC.ZS (accessed: 10.01.2020).

theria tetanus pertussis (DTP) vaccination levels[17], tuberculosis incidence[18], obesity prevalence[19], probability of survival to age five[20], and survival rate between ages 15 and 60[21].

The Coefficient of Determination (CoD) for the correlation between the Corruption Perception Index (CPI) and the teenage fertility rate is 0.555, indicating that lower levels of corruption are associated with higher levels of teenage fertility. This may be attributed to the absence of corruption-related factors, such as restricted access to contraception or a lack of awareness among teenagers who often engage in anti-corruption activism and express dissatisfaction with non-transparent political processes [Kosolapov 2002; Weber 2013]. The Bivariate Moran's index of 0.464 suggests that higher corruption levels in country A correspond to lower teenage fertility rates in neighboring countries. However, the Index of Spatial Interdependence (ISI) of -0.091 indicates that spatial factors have limited significance in influencing this correlation, with domestic factors playing a more significant role.

For the CPI and indicators related to education, namely the expected year of schooling and expected duration of schooling adjusted for education outcomes, the CoDs are 0.376 and 0.517, respectively. These coefficients suggest that lower corruption levels are associated with longer durations of schooling, indicating that a less corrupt society tends to have a more educated population. The Bivariate Moran's indices of 0.317 and 0.367 indicate that higher corruption levels in country A correspond to lower expected durations of schooling in neighboring countries. However, the ISIs differ for the two indicators, with -0.059 for the expected duration of schooling and -0.150 for the expected duration of schooling adjusted for education outcomes. These values suggest that the spatial factor plays a role in diffusing the correlation for the latter indicator, while domestic factors are more influential for the former.

Regarding the CPI and ART coverage, the CoD is 0.305, indicating that lower corruption is associated with greater access to ART. This may be due to the fact that corruption hinders access to such therapy, and administrative resources are required in countries with high HIV/AIDS incidence. The Bivariate Moran's index of 0.176 suggests a positive correlation between corruption levels in country A and ART coverage in neighboring countries. However, the ISI of -0.129 indicates that the spatial factor interferes with the diffusion of this phenomenon, suggesting the presence of other significant factors. Similar results are observed for indicators related to vaccination.

For the pair of indicators comprising the CPI and the level of DTP vaccinations, the Moran's index is 0.179, indicating a positive correlation between corruption levels and DTP vaccination rates in neighboring countries. However, the ISI of 0.028 suggests that domestic factors play a more significant role in influencing this relationship, while the spatial factor has limited importance.

Regarding the CPI and the incidence of tuberculosis, the coefficient of determination is 0.667, indicating that lower corruption is associated with higher tuberculosis incidence. This may be attributed to the fact that tuberculosis spreads more rapidly in countries with a higher level of migration, which are often characterized by lower CPI values [Kufakova, Ovsyankina

[17] Immunization, Vaccines and Biologicals [Electronic source] // The World Health Organization. URL: https://www.who.int/immunization/monitoring_surveillance/en/ (accessed: 10.01.2020).

[18] Incidents of tuberculosis (per 100,000 people) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SH.TBS.INCD (accessed: 10.01.2020).

[19] Overweight and obesity. Global Health Observatory data [Electronic source] // The World Health Organization. URL: https://www.who.int/gho/ncd/risk_factors/overweight_obesity/obesity_adults/en/ (accessed: 10.01.2020).

[20] Human Capital Index, Probability of Survival to Age 5 [Electronic source] // The World Bank. URL: https://databank.worldbank.org/reports.aspx?source=3698&series=HD.HCI.MORT (accessed: 10.01.2020).

[21] Human Capital Index, Survival Rate from Age 15-60 [Electronic source] // The World Bank. URL: https://databank.worldbank.org/reports.aspx?source=3698&series=HD.HCI.AMRT (accessed: 10.01.2020).

1998]. The Bivariate Moran's index of 0.341 suggests a positive correlation between corruption levels in country A and tuberculosis incidence in neighboring countries. However, the ISI of -0.326 indicates that the spatial factor disrupts the relationship between these two indicators, highlighting the influence of other factors.

The Coefficient of Determination for the CPI and the number of people suffering from obesity is 0.134, suggesting that lower corruption levels are associated with a higher prevalence of obesity. This may be explained by the fact that obesity is more common in economically developed countries, where pursuing personal benefits through corruption is less necessary. In relatively less corrupt countries, where politicians are slimmer, the electorate is more likely to suffer from obesity [Blavatskyy 2021]. The Bivariate Moran's index for this pair of indicators is 0.259, and the ISI is 0.125, indicating that the spatial factor plays a role in the distribution of this phenomenon. Countries can be grouped into clusters where lower corruption levels in country A are associated with an increase in the number of people suffering from obesity in neighboring countries.

Lastly, for the pairs of indicators comprising the CPI and the probability of survival to the age of five and the CPI and the survival rate age 15-60, the Coefficients of Determination are 0.350 and 0.370, respectively. These values suggest that lower corruption levels are associated with higher survival rates at these age ranges, indirectly indicating that more developed countries tend to have lower corruption levels. The Moran's indices for both pairs are positive (0.324 and 0.309), indicating a positive correlation between corruption levels in country A and survival rates in neighboring countries. However, the ISI values of -0.026 and -0.061 suggest that the spatial factor is not significant for these indicators, and domestic factors play a more decisive role.

Economy

The group of indicators includes GDP PPP per capita[22], the share of agricultural production in the economy[23], output per worker[24], unemployment rate[25], poverty level[26], Gini

[22] The World Factbook. GDP — Composition, by sector of origin [Electronic source] // Central Intelligence Agency. URL: https://web.archive.org/web/20201009081734/https://www.cia.gov/library/publications/resources/the-world-factbook/fields/214.html (accessed: 09.09.2023).

[23] Report for Selected Countries and Subjects [Electronic source] // International monetary Fund. URL: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weorept.aspx?sy=2018&ey=2018&scsm=1&ssd=1&sort=country&ds=.&br=1&pr1.x=55&pr1.y=9&c=512,946,914,137,612,546,614,962,311,674,213,676,911,548,193,556,122,678,912,181,313,867,419,682,513,684,316,273,913,868,124,921,339,948,638,943,514,686,218,688,963,518,616,728,223,836,516,558,918,138,748,196,618,278,624,692,522,694,622,142,156,449,626,564,628,565,228,283,924,853,233,288,632,293,636,566,634,964,238,182,662,359,960,453,423,968,935,922,128,714,611,862,321,135,243,716,248,456,469,722,253,942,642,718,643,724,939,576,644,936,819,961,172,813,132,726,646,199,648,733,915,184,134,524,652,361,174,362,328,364,258,732,656,366,654,734,336,144,263,146,268,463,532,528,944,923,176,738,534,578,536,537,429,742,433,866,178,369,436,744,136,186,343,925,158,869,439,746,916,926,664,466,826,112,542,111,967,298,443,927,917,846,544,299,941,582,446,474,666,754,668,698,672&s=PPPPC&grp=0&a= (accessed: 10.01.2020).

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[26] Poverty headcount ration at $3.20 a day (2011 PPP) ($ of population) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SI.POV.LMIC (accessed: 10.01.2020).

coefficient[27], the share of urban population living in slums, carbon dioxide emissions[28], level of energy consumption per capita, digital payments[29], and internet access[30].

The coefficient of determination (CoD) for the pair of indicators comprising the CPI and GDP PPP per capita is 0.523, indicating a negative correlation between corruption and per capita GDP. This suggests that higher levels of corruption lead to an unequal distribution of resources in society, resulting in lower GDP per capita. The Bivariate Moran's index of 0.362 suggests a positive correlation between corruption levels in country A and lower GDP PPP per capita in neighboring countries. However, the ISI of -0.161 indicates that the spatial factor weakens the relationship between these variables.

For the pair of CPI and the share of agricultural production in the economy, the CoD is 0.310, indicating that lower corruption levels are associated with a lower share of agricultural production in the economy. The Bivariate Moran's index is -0.318, suggesting a negative correlation between corruption levels in country A and the share of agricultural production in neighboring countries. The ISI of 0.008 indicates that the spatial factor does not significantly affect the relationship between these variables.

The CoD for the pair of CPI and output per worker is 0.512, indicating a negative correlation between corruption levels and labor productivity. The Bivariate Moran's index of 0.419 suggests that higher corruption levels in country A are associated with lower labor productivity in neighboring countries. However, the ISI of -0.093 indicates that the spatial factor is not significant in this relationship.

For the pair of CPI and the unemployment rate, the CoD is 0.044, suggesting a weak correlation between corruption levels and the unemployment rate. The negative Bivariate Moran's index of -0.145 indicates that lower corruption levels in country A are associated with higher levels of employment in neighboring countries. The ISI of 0.101 suggests that the spatial factor enhances the correlation between these variables.

The CoD for the pair of CPI and the level of poverty is 0.302, indicating that higher corruption levels are associated with higher poverty levels. This can be attributed to the concentration of resources in the hands of decision-makers in corrupt societies, often at the expense of the majority of the population. However, the CoD between CPI and the Gini coefficient is 0.096, suggesting a weaker correlation between corruption levels and income inequality. The negative Bivariate Moran's index of -0.317 for the CPI and poverty pair suggests that lower corruption levels in country A are associated with lower poverty levels in neighboring countries. The ISI of 0.015 indicates that the spatial factor does not significantly affect the relationship between these variables.

The CoD for the pair of CPI and the share of the urban population living in slums is 0.229, indicating a positive correlation between corruption levels and the proportion of the population living in slums. The negative Bivariate Moran's index of -0.030 suggests that lower corruption levels in country A are associated with a lower share of the urban population living in slums in neighboring countries. The ISI of -0.199 indicates that the spatial factor weakens the phenomenon of spatial dependence between these variables.

The Coefficient of Determination for the pair of indicators CPI and the level of electrical energy consumption[31] is 0.328, indicating a pos-

[27] GINI index (World Bank estimate) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/SI.POV.GINI/ (accessed: 10.01.2020).

[28] CO2 emissions (metric tons per capita) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/en.atm.co2e.pc (accessed: 10.01.2020).

[29] G20 Financial Inclusion Indicators, Made or received digital payments in the past year (% age 15+) [Electronic source] // The World Bank. URL: https://databank.worldbank.org/reports.aspx?source=1251&series=g20_t (accessed: 10.01.2020).

[30] The Global Innovation Index [Electronic source] // URL: https://www.globalinnovationindex.org/Home (accessed: 06.01.2020).

[31] Electric power consumption (kWh per capita) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC (accessed: 10.01.2020).

Picture 1
The Bivariate Local Indicator of Spatial Association for Corruption Perception Index and Suicide rate

Source: Authors.

itive correlation between lower perceived corruption and higher electricity consumption. This can be attributed to factors such as better infrastructure and more efficient governance in countries with lower corruption levels. The Bivariate Moran's index of 0.186 suggests that lower corruption levels in country A are associated with higher electricity consumption levels in neighboring countries. However, the ISI of -0.142 indicates that the spatial factor weakens the interdependence of these variables.

For the pair of CPI and digital payments made or received, the Coefficient of Determination is 0.453, suggesting a positive correlation between lower corruption levels and higher electronic payments. This can be attributed to the transparency and efficiency of digital payment systems, which reduce opportunities for corrupt practices. The Bivariate Moran's index of 0.319 indicates that lower corruption levels in country A are associated with higher levels of digital payments in neighboring countries. The ISI of -0.134 suggests that the spatial factor weakens the interdependence of these variables.

The Coefficient of Determination for the pair of CPI and access to the Internet is 0.375, indicating a positive correlation between lower corruption levels and higher internet access. This can be attributed to factors such as freedom of information and open governance practices in countries with lower corruption levels. The Bivariate Moran's index of 0.315 suggests that lower corruption levels in country A are associated with higher levels of Internet access in neighboring countries. However, the ISI of -0.060 indicates that the spatial factor does not significantly affect the relationship between these variables.

The Local Indicators of Spatial Association of the Corruption Perception Index

The analysis of the pairs of indicators revealed the presence of spatial clusters among countries. Specifically, for the pair of indicators CPI and the quantity of fatal cases from suicide, the incidence of HIV infection, and the number of people suffering from obesity, positive index values were observed (refer to Appendix, Table 1). This led to the examination of spatial clusters using the local indicators of spatial association.

Regarding the pair of CPI and the suicide rate (see Picture 1), the Maghreb region (except Tunisia and Western Sahara) exhibited low values for both indexes, indicating a high level of corruption in country A and a low level of mortality from suicide in neighboring states.

A similar pattern was observed in the Middle East region. However, Saudi Arabia and Oman stood out as exceptions among Middle Eastern countries. While they were expected to have the same characteristics as their neighboring countries, with high CPI and low suicide rates, they displayed low CPI and high suicide rates within the neighboring countries.

The third cluster of countries consisted of the European Union (EU), where high CPI rates and high suicide rates were observed in neighboring countries.

In terms of the Bivariate Local Indicators of Spatial Association (LISA) for the Corruption Perception Index and the incidence of HIV/AIDS infection (see Picture 2), a distinct clus-

Picture 2

The Bivariate Local Indicator of the Spatial Association of Corruption Perception Index and Incidence of HIV Infection

Source: Authors.

Picture 3

The Bivariate Local Indicators of Spatial Association Index of Corruption Perception Index and the Level of Obesity

Source: Authors.

ter emerges, encompassing the countries in the Horn of Africa. These countries fall into the low-low cluster category, indicating a high level of corruption within the cluster countries and a low level of HIV infection incidence in neighboring countries.

Regarding the Bivariate Local Indicators of Spatial Association (LISA) for the Corruption Perception Index and the number of people suffering from obesity (see Picture 3), the analysis reveals the presence of several clusters among the states.

The first cluster comprises the North American countries, which fall into the high-high category. This indicates a low level of corruption within these countries and a high prevalence of obesity in neighboring states.

The second cluster includes tropical African countries, which belong to the low-low category. These countries exhibit a high level of corruption within their societies and relatively low indicators of obesity in neighboring countries.

The cluster of countries in mainland Asia also falls into the low-low category, with high corruption levels and low obesity rates in neighboring states.

Lastly, there is a cluster of low-high countries, consisting of Iran, Iraq, Syria, and Turkey. These countries demonstrate a high level of corruption and a relatively high proportion of obese individuals in neighboring countries.

* * *

The research findings indicate that the Corruption Perception Index (CPI) exhibits a strong correlation with indicators of international influence, such as the Globalization Index, Fragile States Index, state competitiveness index, national resources rent[32], innovation index[33], and expenditures on research and development (R&D)[34]. These indicators are directly influenced by the level of corruption within a state and the distribution of resources. The high coefficient of determination (CoD) observed between the CPI and political indicators can be attributed to the fact that more democratic societies tend to have a lower inclination towards corruption.

The standard of living indicators also demonstrate a high interdependence with the CPI, as they reflect the distribution of societal benefits within a state. Similarly, demographic indicators show a correlation with the CPI since the population shapes policies and resource allocation. With regard to economic indicators, except for the level of unemployment and the Gini Index, they are also interdependent with the CPI as they are influenced by the decision-makers' inclination to prioritize personal well-being at the expense of public welfare. Values, including civic culture[35] and attitudes towards corruption, are also correlated with the CPI.

Spatial indexes, although encompassing fewer indicators, are significant for certain variables where the CoD is insignificant. For instance, the "neighborhood effect" is important for indicators such as the incidence of HIV infection, the Gini Index, and the annual population growth. The spatial factor plays a role in the interdependence between the CPI and indicators of quality of life, such as the index of ethnic diversity, suicide rate, incidence of HIV, and number of obese individuals. However, the spatial factor is not significant for values and political indicators, which are influenced by domestic politics and historical/cultural factors.

In summary, corruption impacts both domestic and international factors. The interdependence of the CPI with indicators in neighboring countries suggests that formal institutions and transparent political process-

[32] Total natural resources rents (% of GPD) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/NY.GDP.TOTL.RT.ZS (accessed: 06.01.2020).

[33] The Global Innovation Index [Electronic source] // URL: https://www.globalinnovationindex.org/Home (accessed: 06.01.2020).

[34] Research and development expenditure (% of GPD) [Electronic source] // The World Bank. URL: https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS (accessed: 06.01.2020).

[35] World Value Survey 1981-2015 Longitudinal Aggregate [Electronic source] // World Value Survey. URL: http://www.worldvaluessurvey.org/WVSDocumentationWVL.jsp (accessed: 10.01.2020).

es promote adherence to rules and the establishment of more predictable international relations. Furthermore, lower levels of corruption are associated with indicators commonly found in democratic countries, indicating that democratic institutions tend to increase transparency in the political process and reduce the need for corruption as a means of personal enrichment. The neighborhood effect plays a significant role in demographic and standard of living indicators, which are universally relevant across countries. On the other hand, indicators unique to each state and influenced by institutional, historical, and cultural factors rely more on interdependence within the state.

Overall, the Pearson index has a greater impact on the interdependence of indicators compared to the Bivariate Moran's Index and the ISI, which confirms the initial hypothesis of the research. The ISI, derived from the basic level of non-spatial correlation between phenomena, indicates when the spatial factor has some limited influence on international processes and when domestic factors are more important. When a particular phenomenon is prevalent in country A, it can affect other countries with similar levels of development, as neighboring countries tend to have similar characteristics. This finding supports the idea of dividing the world into clusters or groups of countries with similar historical, economic, political, and social backgrounds.

Therefore, the spatial factor suggests that in certain cases, it is important to consider the experiences of neighboring countries and their indicators to combat corruption effectively. The more developed and democratic neighboring countries are, the more likely states will adopt better practices and strive for more predictable and stable domestic and foreign relations. Countries within the same cluster should not only address domestic corruption but also support each other through regional cooperation, leading to a reduction in corruption and an improvement of economic indicators. Ultimately, the spatial factor is significant for the economy and demography but plays a minimal role in politics and values.

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Appendix

Table 1

Calculation data of pairs of indicators (where x is the corruption perception index, y is one of forty-four indicators)

№	Independent Variables	Moran's Index of Spatial Association ISA	Coefficient of Determination CoD	Index of Spatial Interdependence ISI
International Influence				
1	Globalization Index	0,464	0,555	-0,091
2	Military Strength Index	-0,193	0,035	0,158
3	Fragile States Index	-0,466	0,780	-0,314
4	Global Competitiveness Index	0,369	0,650	-0,281
5	National Resources Rent	-0,222	0,178	0,044
6	Innovation Index	0,356	0,719	-0,363
7	R&D Expenses	0,206	0,419	-0,213

Table 1

Politics				
8	Freedom of Press	-0,400	0,497	-0,097
9	Political Rights	-0,367	0,462	-0,095
10	Index of the Sustainable Governance	0,128	0,756	-0,628
11	Index of Political Transformation	0,007	0,110	-0,103
Demographics				
12	Annual Population Growth	-0,321	0,120	0,201
13	Life Expectancy at Birth	0,412	0,457	-0,045
14	The share of population younger than 14 years	-0,417	0,407	0,010
15	Rural Population	-0,257	0,252	0,005
16	Migrant Population	0,137	0, 173	-0,036
17	Index of Ethnic Diversity	-0,244	0,143	0,101
Standard of Living				
18	Adolescent Fertility Rate	0,464	0,555	-0,091
19	Expected year of schooling	0,317	0,376	-0,059
20	Expected Years at School	0,367	0,517	-0,150
21	Suicide Rate	0,271	0,103	0,168
22	Incidents of HIV	0,186	0,086	0,100
23	Antiretroviral Therapy coverage	0,176	0,305	-0,129
24	Vaccination Levels	0,179	0,207	-0,028
DTP (diphtheria tetanus and pertussis)				
25	Incidence of Tuberculosis	0,341	0,667	-0,326
26	The number of people suffering from obesity	0,259	0,134	0,125
27	Survival to the Age of 5	0,324	0,350	-0,026
28	Survival rate age 15 to 60	0,309	0,370	-0,061
Economics				
29	GDP PPP per capita	0,362	0,523	-0,161
30	Agriculture	-0,318	0,310	0,008
31	Output per worker	0,419	0,512	-0,093
32	Unemployment Rate	-0,145	0,044	0,101
33	Poverty level	-0,317	0,302	0,015
34	GINI Index	-0,221	0,096	0,125
35	Share of urban population living in slims	-0,030	0,229	-0,199
36	CO2 Emissions	0,197	0,164	0,033
37	Use of electrical energy	0,186	0,328	-0,142
38	Digital payments in the prior year	0,319	0,453	-0,134
39	Internet Access	0,315	0,375	-0,060
Values				
40	General public trust	0,189	0,306	-0,117
41	Power Distance Index	-0,132	0,461	-0,329
42	Autonomy Index	0,174	0,315	-0,141
43	Level of religious commitment	-0,202	0,386	-0,184
44	Postmaterial values	0,203	0,334	-0,131

Source: Authors.

ЭФФЕКТ СОСЕДСТВА В ВОСПРИЯТИИ КОРРУПЦИИ НА ПОЛИТИЧЕСКОЙ КАРТЕ МИРА

ОПЫТ ПРОСТРАНСТВЕННОГО АВТОКОРРЕЛЯЦИОННОГО АНАЛИЗА

ИГОРЬ ОКУНЕВ
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Резюме

Коррупция, которая порой ускоряет процесс принятия политических решений, является тем неформальным институтом, с которым борются все государства мира. Для того чтобы выявить, какие факторы влияют на высокий уровень восприятия коррупции в той или иной стране, а также существует ли пространственная зависимость в распространении этих факторов, авторы рассмотрели взаимозависимость индекса восприятия коррупции с 44 другими факторами, разделёнными на 6 категорий (международное влияние, политика, демография, качество жизни, экономика и ценности). Авторы выдвигают гипотезу, что взаимозависимость ИВК и других факторов сильнее внутри страны, чем влияние ИВК на показатели в соседних странах. С помощью коэффициента детерминации Пирсона авторы выявили взаимозависимость между индексом восприятия коррупции с каждым из индикаторов, что позволило оценить уровень коррупции с точки зрения внутренних факторов государства. Двухфакторный индекс пространственной автокорреляции Морана позволил авторам выяснить, насколько индекс восприятия коррупции в отдельной стране оказывает влияние на один из 44 индикаторов в соседних странах, а индекс пространственной зависимости – определить, какие из факторов – внутренние или внешние – значимы для каждого из показателей. По итогам исследования авторы пришли к следующим выводам. Эффект соседства играет большую роль для показателей, касающихся демографических показателей и качества жизни, которые универсальны для всех государств. Тогда как для показателей, которые обусловлены его институциональными, историческими и культурными особенностями, важным является взаимосвязь между показателями внутри государства. В совокупности авторы приходят к выводу, что индекс Пирсона имеет большее влияние на взаимозависимость показателей, чем двухфакторный индекс пространственной автокорреляции и ИПЗ, что подтверждает выдвинутую авторами гипотезу. В связи с тем что ИВК влияет на демографические показатели и качество жизни, коррупция оказывает влияние не только на процессы внутри одного государства, но и на процессы, происходящие в соседних государствах. Это, в свою очередь, позволяет производить кластеризацию государств и выделять те, которым, для улучшения своего положения, необходимо не только повышать показатели не только внутри, но и в рамках региона.

Ключевые слова:

эффект соседства, пространственный анализ, пространственная автокорреляция, коррупция, индекс восприятия коррупции, индекс Морана, индекс пространственной зависимости, коррупция

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