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The Relationship between Corruption and the Shadow Economy in Ukraine and Other Central and Eastern European Countries

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Abstract

The article investigates the causes, essence, and peculiarities of corruption and the shadow economy, as well as how they are related, in Ukraine in comparison with other Central and Eastern European countries. A correlation-regression analysis of statistical data revealed a direct correlation connection of different strengths and statistical significance between levels of corruption and the shadow economy in all Central and Eastern European countries. However, the degree to which corruption impacts the variation in the levels of the shadow economy differs significantly in countries across the region. The key conclusion is that in countries with relatively high levels of corruption and the shadow economy, corruption causes a smaller share of the shadow economy than in countries with relatively low levels of these phenomena. Causes of the weak correlation between levels of corruption and the shadow economy in Ukraine were identified. The main corruption and non-corruption factors of Ukraine's economy shadowing were determined. It was concluded that policy and measures to counteract corruption and the shadow economy in Ukraine should be aimed at eliminating their root causes rather than manifestations.

Keywords: corruption, shadow economy, correlation

JEL: E26, H26, K42, O17, O57

Introduction

Ukraine belongs to a group of countries in which political and bureaucratic corruption is deeply rooted in various spheres of life and has become an organic element of social relations. At the same time, the level of corruption is closely linked to the state of the economy. Corruption distorts the functioning of market mechanisms that regulate the economy and impedes the country's economic growth, making it vulnerable and dependent on foreign economic conditions and international lenders. Corruption leads to revenue losses of the state budget due to tax evasion, the inefficient use of budget funds, and a reduction in domestic and foreign investment, and it increases the uncertainty of the environment in which economic agents function. A major consequence of corruption is a reduction in the efficiency of the economy due to the rising cost of capital and reducing its productivity in the face of high risks of doing business in the country. In addition, corruption constrains the development of state institutions and undermines the well-being of citizens, because it hinders the proper implementation of state social functions (for example, in medical and educational spheres), increases income inequality, raises poverty, and reduces the level of public trust. These factors, in turn, also have a negative impact on economic development (Boitsun et al. 2016; Burakovskyi et al. 2018).

Ukraine is the most corrupt country in Europe and has the largest share of the shadow economy in GDP among European countries. Since gaining independence in 1991, the shadow economy in Ukraine has consistently exceeded 30% of GDP and reached 50% of GDP in some years. A significant level of the shadow economy is one of the most dangerous threats to Ukraine's economic security, which exacerbates the socio-economic crisis in the country and negatively affects its international image.

The main objectives of our research are:

- to investigate the basic reasons for the emergence of certain types of corruption and their impact on the economy of Ukraine, especially the shadow economy;
- to study the root causes and peculiarities of the shadow economy in Ukraine;
- to explore the degree and nature of the relationship between levels of corruption and the shadow economy in Central and Eastern European countries;
- to determine what share of the shadow economy is sensitive to changes in the level of corruption in Ukraine in comparison with other countries of Central and Eastern Europe;
- to identify the corruption and non-corruption factors of Ukraine's economy shadowing;
- to determine priority areas to combat corruption and the shadow economy in Ukraine.

This article aims to confirm the hypothesis that in countries with higher levels of corruption and the shadow economy, it is corruption factors that mostly determine the variation in shadow economy volumes.

The value of this article is a comparative study of the relationship between levels of corruption and the shadow economy in post-socialist countries of Central and Eastern Europe, that have undergone a profound economic transformation in past decades. In addition, unlike other studies, we are not going to limit ourselves to confirming the existence of the relationship between these phenomena; we intend to determine which part of the shadow economy is caused by corruption factors and which by non-corruption factors in each of the studied countries.

The methodological basis of the study is statistical methods: a comparison of averages, and graphical, correlation, and regression analysis.

Literature review

In recent years, many scientific papers have been devoted to the study of the relationship between corruption and the shadow economy in different countries and regions. However, this relationship remains ambiguous, and its significance varies greatly from country to country, depending on income level, political system, and historical background.

In particular, Duc Hong Vo, Dao Thi-Thieu Ha, and Thinh Hung Ly found empirical evidence to support the view that there is a causal relationship between the shadow economy and corruption for the ASEAN countries from 1995 to 2014. The shadow economy is positively correlated with corruption and vice versa. These two relationships are statistically significant. In addition, they noted that the effect of corruption on the shadow economy was more significant than the effect of the shadow economy on corruption. The findings from their study indicate that controlling the shadow economy (and/or corruption) may be a better way to reduce the level of corruption (and/or shadow economy). However, for developing ASEAN countries, it may be more appropriate to start with policies to reduce the level of corruption than the other way round (Vo et al. 2015).

Similar conclusions were made by Turkish scientists, who studied the effect of corruption and the rule of law on the shadow economy in 11 transition economies of Central and Eastern Europe over the 2003–2015 period with panel cointegration and causality tests that considered heterogeneity and cross-sectional dependence. The cointegration coefficients revealed a complementary interplay between the size of the shadow economy and corruption. Furthermore, the causality analysis indicated that there was a bilateral causality between control of corruption and the shadow economy in all the cross-section units (Bayar et al. 2018).

Dreher and Schneider also addressed the dual relationship between corruption and the size of the shadow economy. They believe that the relationship might differ between high and low-income countries. However, dividing countries into these two groups can be an issue considering that in some countries, a significant part of income is being earned and spent in the shadow economy, and is not represented in official

statistics. They hypothesized that the shadow economy and corruption are substitutes in high-income countries. Conversely, in low-income countries, they expected the shadow economy and corruption to be complements. However, their results showed that there is no robust relationship between corruption and the shadow economy when perception-based indices of corruption are used. When employing an index of measured corruption, the results showed that corruption and the size of the shadow economy are complements in countries with low income, while there is no robust relationship in high-income countries. They admit that one of the most important problems in empirical studies of corruption and the shadow economy is the unavailability of high-quality data over time. Such data do not exist and given the hidden nature of corruption and the size of the shadow economy expecting clear-cut results might arguably be too ambitious (Dreher and Schneider 2010).

The paper by Robert Gillanders and Sinikka Parviainen, for the most part, found that corruption and the shadow economy are complements at the country level. Their analysis at the level of subnational units using Enterprise Surveys data likewise found that the two illicit phenomena are strongly and significantly positively correlated. Regions with more of a problem with one tend to have more of a problem with the other. Expressing measures of the problems in terms of deviations from national averages showed a similar pattern. Relatively more corrupt regions tend to be relatively more burdened by the shadow economy. Motivated by interesting findings in the literature, they split the sample into groups defined by broad global regions. They found that while their results hold in the Europe and Central Asia, and Latin America and Caribbean groups, these relationships are not evident in sub-Saharan Africa (Gillanders and Parviainen 2015).

Romanian scholars investigated the relationships between corruption and the shadow economy among the European Union countries between 2005 and 2014. They found that about one-fifth of the European Union's GDP is lost due to the shadow economy. Bulgaria, Romania, Hungary, Estonia, Greece, and Italy were found to have the highest levels of corruption and the shadow economy. At the same time, Nordic countries such as Denmark, Finland, and Sweden, followed by the Netherlands, and then Austria and Luxembourg, were found to have the lowest level of corruption. This study's descriptive statistics revealed that the most corrupt countries with the biggest shadow economies are located in low-income, mostly post-communist countries. In addition, a high and positive relationship between corruption and the shadow economy was found among the EU countries, which means that a higher level of corruption results in a higher level of the shadow economy. Researchers also revealed strong and negative effects of corruption and the shadow economy on the economic growth of EU countries in the period 2005–2014 (Borlea et al. 2017).

Jay Pil Choi and Marcel Thum developed a simple framework to analyze the links between corruption and the shadow economy and their implications for the official economy. In a model of self-selection with heterogeneous entrepreneurs, they showed that the entrepreneurs' option to flee to the underground economy constrains cor-

rupt officials' abilities to introduce distortions to the economy for private gains. The unofficial economy thus mitigates government-induced distortions and, as a result, leads to enhanced economic activities in the official sector. In this sense, the presence of the unofficial sector acts as a complement to the official economy, but a substitute for corruption. This result is in sharp contrast to the existing models of the unofficial economy where the official and unofficial sectors compete for resources and the existence of the informal sector is viewed as harmful for economic growth. However, when corruption is defined as "the abuse of public power for private benefit," and its avoidance is the main reason for the shadow economy, any efforts to eradicate the shadow economy without tackling the principal problem of corruption would be counterproductive. Their model thus suggests the importance of considering the genesis of the shadow economy to evaluate its implications for resource allocations (Choi and Thum 2005).

Therefore, the relationship between corruption and the shadow economy is not entirely clear in the literature. Researchers suggest plausible cases for both complementarity and substitution that is for positive and negative corruption and the shadow economy relationship, respectively. Some empirical studies find support for both cases. However, in different countries, various storylines are possible within each case, which makes empirical results difficult to interpret. In our opinion, the correlation between corruption and the shadow economy, as well as its effects, goes far beyond the concepts of complementarity and substitution. We support Travis Wiseman, who steps away from the designations of "complement" and "substitute," instead arguing that the relationship might be better defined as either collusive (crony) or non-collusive, i.e., either corrupt public officials and shadow economy participants work together or they do not. Therefore, it is not enough to determine the strength and direction of the correlation between corruption and the shadow economy in order to characterize the relationship between these phenomena in a certain country. It is essential to take into account the socio-political system, the state of the economy and its structure, as well as the history and traditions of a particular country (Wiseman 2016).

The essence of corruption and shadow economy in Ukraine

Corruption and the shadow economy are multifaceted phenomena and can take different forms depending on the country's political system and level of economic development. Transparency International identifies corruption as "the abuse of entrusted power for private gain," and it identifies three types of corruption: political, grand and petty, depending on the amounts of money lost and the sector where it occurs.[1]

1 Official website of Transparency International, https://www.transparency.org/ (accessed: 5.01.2020).

In Ukraine, at the legislative level, the term "corruption" is defined as the use by a person (a subject of corruption offense) of rendered powers or related possibilities to obtain an illegal benefit or receiving such a benefit or accepting a promise/offer of such a benefit for himself or other persons or, respectively, making a promise/offer or giving an illegal benefit to a specified person or other persons or legal entities on request in order to induce this person to illegally use rendered powers or related possibilities (Verkhovna Rada 2014).

This definition is almost in line with the definition of "corruption" used by Transparency International. At the same time, scientists emphasize the need to differentiate political corruption and bureaucratic corruption of different levels. The main criterion for distinguishing political and bureaucratic forms of corruption is their place in the process of policy development and implementation. Thus, political corruption occurs at the stage of policy-making (political decision-making, the establishment of "rules of the game"), while bureaucratic corruption takes place at different stages of policy implementation (the implementation of relevant decisions). The introduction of this criterion is conditioned by differences in the nature of political (standard-setting activity) and bureaucratic (administrative and executive activity) functions. Thus, subjects of political corruption use power to establish legal rules that are in line with their private interests and set up "by pass" ways to ignore other rules. Bureaucratic corruption means violating of established rules and standards (Armash 2017).

Political corruption in Ukraine first arose in the 1990s as a result of the large-scale privatization of large industrial enterprises by a limited group of individuals who subsequently began to use their economic power to influence political decision-making. Thus, an oligarchic political regime was formed in Ukraine, as oligarchs use monopolized sectors of the economy to concentrate political power in their hands, and political power to multiply their own capital. Now, Ukrainian oligarchs own a wide range of assets which are economic (industrial enterprises and financial institutions), informational (print and electronic media), and political (parties, parliamentary groups and factions, important government positions, influence on first persons in the state) (Davydenko et al. 2016; Kushnarov 2018). Therefore, political corruption in Ukraine covers:

- party corruption (violations of the order of party financing, making party decisions bypassing the mechanisms of internal party democracy, the sale of seats in the potentially passable part of the party list, the use of "false donors" to bypass limits on donations to parties, etc.);
- electoral corruption (violations of the rules of election fund formation, various forms of bribing voters and members of election commissions, the use of administrative resources in the interests of certain subjects of elections, etc.);
- lobby corruption (non-transparent actions aimed at shadow promotion of stakeholders' interests at the legislative level for reward, etc.);
- representative corruption (bribery of deputies of parliament and local authorities in order that they adopt desired legislative and regulatory acts);
- judicial corruption (courts implementing political orders).

An example of political corruption is the introduction of a moratorium on agricultural land sales in 2001 and its annual extension. As a result, millions of Ukrainians are deprived of the right to legally buy and sell agricultural land, while agrarian oligarchs receive super-profits due to land lease at much lower prices than in neighboring countries. In March 2020, the Verkhovna Rada voted for land reform in Ukraine, which will introduce a land market from July 1, 2021. However, the adopted law is quite controversial, introduces a long transition period, contains significant corruption risks, and may be amended or repealed before entry into force.

The impact of political corruption on the economy means the introduction of prohibitions or restrictions on certain types of economic activity and financial transactions, which leads to the bankruptcy of the subjects of these activities or their transition to the shadow economy sector. In addition, political corruption inhibits the entry of new players (in particular, foreign players) into the domestic market, and it contributes to the monopolization of certain economic sectors, ensuring the dominance of oligarchic structures in them. The main consequences of political corruption are violations of economic rights and freedoms of population and business, low level of investments, technological backwardness and the inefficiency of production in a number of economic sectors.

High-level bureaucratic corruption is the result of controversial legislation that gives public officials considerable discretionary powers and opportunities for abuse. The main forms of high-level bureaucratic corruption in Ukraine are (Krut 2018):

- non-transparent appointments to civil service positions;
- the opaque disposal of state and communal property in the interests of related parties (opacity of privatization and leasing of property, as well as the distribution of land and natural resources);
- abuses in public procurement in favor of related commercial structures;
- financing private enterprises by granting exemptions, subsidies, and subventions;
- combining a position in public authority that regulates a certain type of economic activity with entrepreneurial activity in the same sphere;
- promoting the monopolization of a certain type of commercial activity in the region where they exercise authority;
- protecting shadow (including illegal) economic activity;
- making artificial barriers and timing violations when granting permits, licenses, etc. (so-called trade in discretionary power).

High-level bureaucratic corruption affects the economy, providing competitive advantages to certain entrepreneurs (in particular, those related to officials) who avoid requirements or receive privileges and, therefore, operate on more favorable conditions than other market participants. As a result, other entrepreneurs become uncompetitive and are compelled to either cease their activity or work under the protection of officials, paying them corrupt rent. Bribes and corrupt rent are considered to be expenses and are included in the cost of goods and services, leading to higher prices of Ukrainian products and making them uncompetitive.

Low-level bureaucratic corruption in Ukraine has emerged as one of the informal institutions of interaction between citizens and various institutions that provide public services or which are authorized to take actions on behalf of the state. Sociological surveys show that Ukrainians most often face corruption in medical institutions (46%), higher education institutions (22%), local authorities (13%), schools (10%), and patrol police (9%). It is noteworthy that 33.3% of citizens give bribes in order to accelerate the solution to an issue that had to be resolved anyway, 25.7% simply to make officials perform their official duties, and only 14.4% to resolve an issue in their favor unlawfully and 4.7% to cancel or reduce a punishment or fine (Sukharyna 2017). At the same time, in many cases, low-level bureaucratic corruption is caused by insufficient state funding of the institutions involved, which means low salaries and poor motivation of the employees, as well as poor material and technical condition. Thus, low-level bureaucratic corruption replaces or complements the formal order of functioning of these institutions that were established by regulatory acts.

Therefore, it can be concluded that each type of corruption affects the economy in different ways. Political corruption suppresses economic freedom, leads to the monopolization of certain economic sectors, and inhibits economic growth. High-level bureaucratic corruption distorts the functioning of competitive mechanisms in certain economic sectors or regions, which prompts business entities to cease their activity or transit to the shadow sector; it also provides protection for illegal business activities. Low-level bureaucratic corruption partially eliminates disproportions in the economy and ensures the survival of the population in difficult socio-economic conditions caused by ineffective reforms on the way from a planned to a market economy.

In scientific circles, there is no single view on the definition of the shadow economy. This study will use the definition proposed by Schneider, which is used by the International Monetary Fund, namely: "the shadow economy includes all economic activities which are hidden from official authorities for monetary, regulatory, and institutional reasons. Monetary reasons include the avoidance of paying taxes and all social security contributions, regulatory reasons include avoiding governmental bureaucracy or regulatory burden, institutional reasons include corrupt legislation, the quality of political institutions and the weakness of rule of law. Thus, the shadow economy reflects mostly legal economic and productive activities that, if recorded, would contribute to national GDP. The definition of the shadow economy, in this case, does not include illegal or criminal activities, do-it-yourself, or other household activities" (Medina and Schneider 2018). The "shadow economy" is also often used interchangeably with "informality" (Kelmanson et al. 2019).

In our opinion, the concept of "the shadow economy" comes from the physical phenomenon of shadow from light, and it reflects the official economy. The shadow economy is not a separate sector of the economy and it may exist in any sector of the official economy and be closely intertwined with it. Therefore, it is impossible to define its boundaries clearly. The main types of shadow economic activities in Ukraine are cash transactions without accounting, concealing incomes or overstating expendi-

tures, unofficial employment and the payment of illegal wages, bribes and kickbacks, clandestine production, and economic activities that are not regulated by the current legislation.

The shadow economy in Ukraine is the result of a systemic crisis in the economy that arose due to the discrepancy of methods of implementing market reforms to the needs of society. The transformation processes in the economy were accompanied by the destruction of established distribution relationships and the construction of new ones that substantially violate the balance of interests of economic entities, the parity of development of economic sectors, and motivation to manage effectively. Thus, shadow economic relations in Ukraine should be viewed as a means of restoring balance in the economy, which has been violated by both corrupt and non-corrupt factors. Accordingly, the shadow economy includes both corrupt and non-corrupt components.

The relationship between corruption and the shadow economy

To investigate the relationship between corruption and the shadow economy, it is necessary to determine what part of the shadow economy is due to corruption and what is caused by other factors. This problem in Ukraine and other Central and Eastern European countries has virtually not been researched. This paper deals with the relationship between corruption and the shadow economy in post-socialist countries that have undergone a deep economic transformation. Statistical analysis of the correlation between levels of corruption and the shadow economy in 13 countries in Central and Eastern Europe is based on data from the International Monetary Fund and Transparency International. The average values of the indicators are shown in Table 1.

Table 1. Average values of the shadow economy and corruption in the region

Country	Average values of indicators	
	The level of the shadow economy between 1991 and 2015, % of GDP	The relative level of corruption between 1998 and 2019*
Belarus	44.52	0.60
Bulgaria	29.17	0.44
Czech Republic	14.83	0.34
Estonia	23.80	0.18
Hungary	25.23	0.34
Latvia	22.23	0.37
Lithuania	25.15	0.29
Moldova	43.43	0.65
Poland	25.10	0.34
Romania	30.14	0.50
Russia	38.42	0.78

Table 1. (continued)

Country	Average values of indicators	
	The level of the shadow economy between 1991 and 2015, % of GDP	The relative level of corruption between 1998 and 2019*
Slovakia	15.33	0.37
Ukraine	44.80	0.77
The average value across the region	29.40	0.46

* Calculated as the ratio of the country's rank in the Corruption Perceptions Index to the total number of countries in the ranking.
Source: author's own calculations based on Medina and Schneider, 2018 and data from the official website of Transparency International at https://www.transparency.org/ (accessed: 10.11.2019).

Distributions of the countries by the average value of the shadow economy level, as well as the average values of corruption level, are presented in Figures 1 and 2, respectively.

The highest levels of the shadow economy are observed in Ukraine, Belarus, Moldova, and Russia; the lowest ones are in the Czech Republic and Slovakia; average levels are found in Bulgaria and Romania; below average levels are found in Hungary, Lithuania, Poland, Estonia, and Latvia (see Figure 1).

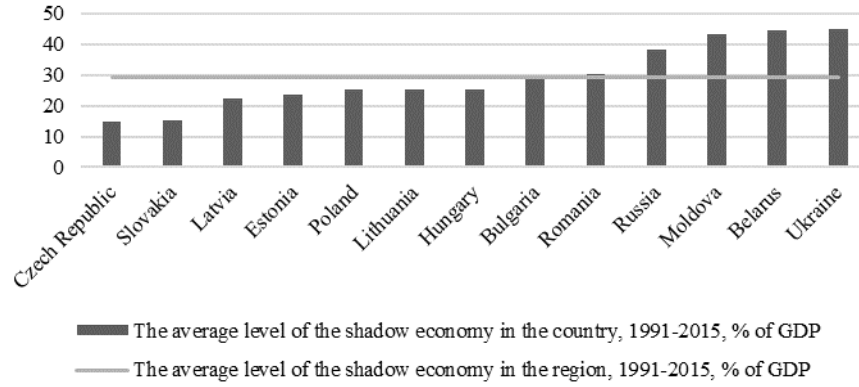

Figure 1. Distribution of the countries by the average level of the shadow economy
Source: author's own calculations based on Medina and Schneider 2018.

The highest levels of corruption are observed in Russia and Ukraine, the lowest in Estonia, and average levels in Bulgaria and Romania (see Figure 2). The level of corruption in Moldova and Belarus is almost 40% higher than the average throughout the region, while in other countries it is lower.

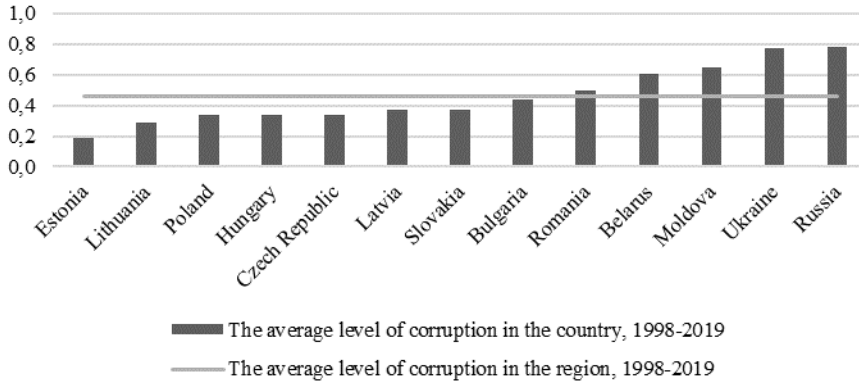

Figure 2. Distribution of countries by the average level of corruption
Source: author's own calculations based on data from the official website of Transparency International at https://www.transparency.org/ (accessed: 12.11.2019).

Further research was aimed at establishing a statistical link between levels of the shadow economy (Y) and levels of corruption (X) in Central and Eastern European countries.

The research was carried out on the basis of the correlation-regression analysis of data presented in the form of two samples of the same volume n:

$$X = \begin{pmatrix} x_1 \\ \dots \\ x_i \\ \dots \\ x_n \end{pmatrix}, \quad Y = \begin{pmatrix} y_1 \\ \dots \\ y_i \\ \dots \\ y_n \end{pmatrix}. \tag{1}$$

The correlation analysis of the relationship between levels of the shadow economy and levels of corruption in Central and Eastern European countries was preceded by a study of the correlation fields of the link between these indicators.

The resulting scatter diagrams confirmed the existence of a direct correlation between levels of the shadow economy and levels of corruption in all countries studied, i.e., rising levels of corruption are accompanied by an increase in levels of the shadow economy (see Figure 3).

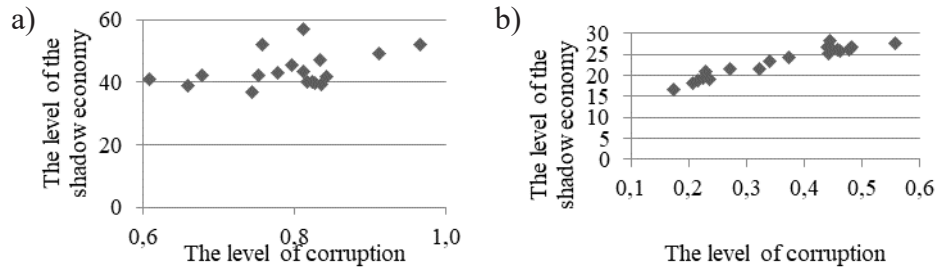

Figure 3. Correlation fields of the link between levels of the shadow economy and levels of corruption in Ukraine (a) and Poland (b)
Source: author's own calculations.

The measure of the correlation between X and Y is the Pearson correlation coefficient (linear correlation coefficient), which can be calculated from one of the dependencies (Rudenko 2012; Bilichenko and Kuzhel 2013):

$$r = \frac{\sum_{i=1}^{n}(x_i - \overline{x})\cdot(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2 \cdot \sum_{i=1}^{n}(y_i - \overline{y})^2}}. \quad (2)$$

$$r = \frac{\overline{xy} - \overline{x}\cdot\overline{y}}{\sigma_x \cdot \sigma_y}. \quad (3)$$

n – sample size;
x_i ., y_i . – the value of the i-th element of samples X and Y respectively;
$\overline{x}, \overline{y}$ – averages of samples X and Y respectively;
$\overline{xy}$ – the average value of product $x_i \cdot y_i$;
$\overline{x^2}$, $\overline{y^2}$ – the average value of squared X and Y respectively;
σ_x, σ_y – mean square deviations of corresponding values, which are defined as follows:

$$\sigma_x = \sqrt{\overline{x^2} - \overline{x}^2}\ ,\ \sigma_y = \sqrt{\overline{y^2} - \overline{y}^2}\ .$$

Applying of the Pearson correlation coefficient is correct only when the form of the correlation field indicates that there is a linear relationship. The Pearson correlation coefficient allows us to estimate the strength and direction of the linear relationship between X and Y. It is a number in the range from –1 to 1. T sign of the number determines the direction of the relationship, and its absolute value determines the strength of the relationship. Positive coefficient values indicate a direct relationship between the indicators, and negative ones show an inverse relationship (i.e., when the value of one indicator increases, the sd indicator decreases). A value of zero may indicate the ab-

sence of a linkage. However, zero general correlation may only indicate the absence of linear dependence, not the absence of any statistical connection.

For the linear regression, the correlation coefficient *r* is not only a criterion for the strength of the relationship, but for the accuracy of approximation (selecting the formula which expresses dependence). Estimating the accuracy of approximation by curvilinear dependence is made using the correlation index (Stavytskyi 2004; Bilichenko and Kuzhel 2013):

$$\eta = \sqrt{1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)}{\sum_{i=1}^{n}(y_i - \overline{y})}}. \quad (4)$$

$\hat{y}_i$. – the value of the i-th element of sample Y, calculated from the regression equation (theoretical value).

Unlike the linear correlation coefficient, the correlation index does not characterize the direction of the relationship. It varies in the range $0 \le \eta \le 1$. If $\eta > r$ the curve more accurately approximates the dependence than a straight line; $\eta = r$. for a straight line.

As an additional estimate of the accuracy of data approximation by nlinear dendence, the average relative error of approximation $\overline{\varepsilon}$ is often used, which is determined by the formula:

$$\overline{\varepsilon} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{y_i - \hat{y}_i}{y_i}\right| \cdot 100\%. \quad (5)$$

To convert the quantitative characteristics of the strength of the correlation between two indicators into qualitative ones, the Chaddock scale can be used (see Table 2).

Table 2. Chaddock Scale for qualitative correlation analysis

The absolute value of the correlation coefficient (correlation index)	Qualitative characteristic of correlation between two indicators
up to 0.3	practically absent
0.31–0.5	weak
0.51–0.7	notable
0.71–0.9	strong
0.91–0.99	very strong
1	functional

Source: Sydorova et al. 2019.

The significance of the pair correlation coefficient *r* is tested by the Student's criterion (actually, the hypothesis about the equality of correlation coefficient to zero is checked), which is calculated by the formula (Stavytskyi 2004):

$$t_{\partial} = \frac{r^2 \cdot \sqrt{(n-2)}}{\sqrt{1-r^2}}. \quad (6)$$

r – the value of the correlation coefficient;
n – sample size.

The calculated value of the Student's criterion is compared with the critical value from the Student's t-distribution with given statistical significance α and a number of degrees of freedom.

If the calculated value of the Student's criterion t_{∂} is greater than its critical value $t_{\hat{e}\partial}$. ($t_{\partial} > t_{\alpha;k}$), the correlation coefficient is significant at the level of significance α (level of reliability $p = 1 - \alpha$.), indicating the non-random nature of the statistical relationship between the variables.

Establishing a mathematical model of the relationship between dependent variable Y and independent variable X (obtaining dependence of the type $Y = f(X)$.) can be done by conducting a regression analysis of the data. In the c pair correlation, the investigated data can be approximated by various functions, such as a straight line, second-order parabola, hyperbola, logarithmic function, power function, exponential function, arithmetic or geometric progressions, algebraic polynomial, or trigonometric series.

After identifying a sufficiently strong linear relationship between the X and Y indicators, the problem of determining the regression equation, that describes this relationship, arises (Holikov 2006):

$$y = b_1 \cdot x + b_0, \quad (7)$$

Linear regression makes it possible to detect how much the average value of one indicator changes with the change of another. The parameters of linear regression b_1. and b_0 are calculated using the least squares method. The essence of the method is to select a line with parameters b_1 and b_0, for which the sum of the squares of the residual deviations will rotate at a minimum:

$$\sum_{i=1}^{n} \left(y_i - \hat{y}_i \right)^2 \rightarrow min .$$

Parameters of linear regression are calculated by formulas (Lukianenko and Krasnikova 1998):

$$b_1 = \frac{\sum_{i=1}^{n} (x_i - \overline{x}) \cdot (y_i - \overline{y})}{\sum_{i=1}^{n} (x_i - \overline{x})^2} \text{ or } b_1 = \frac{\overline{xy} - \overline{x} \cdot \overline{y}}{\overline{x^2} - \overline{x}^2}. \quad (8)$$

$$b_0 = \overline{y} - b_1 \cdot \overline{x}. \tag{9}$$

In more complex cases of connection, polynomial dependences of the n-th order can be used:

$$y = a_0 + a_1 \cdot x + a_2 \cdot x^2 + \ldots + a_n \cdot x^n . \tag{10}$$

The values of parameters $a_0, a_1, a_2, \ldots, a_n$ are found by solving the system of normal equations.

To determine which part of the variation (%) of the dependent variable is due to the variation of the independent variable, the determination coefficient R^2 is used (Lukianenko and Krasnikova 1998):

$$R^2 = \frac{\sum_{i=1}^{n} \left(\hat{y}_i - \overline{y}\right)^2}{\sum_{i=1}^{n} \left(y_i - \overline{y}\right)^2} . \tag{11}$$

variance explaining regression;
$\sigma^2_{\text{çàã}}$ – total variance.

The determination coefficient is always positive and varies from zero to one $\left(0 \le R^2 \le 1\right)$. It is connected with the correlation coefficient by the dependence:

$$R^2 = r^2 . \tag{12}$$

The adequacy of the model of pair regression is checked by Fisher's criterion. The actual value of Fisher's criterion is determined by the formula (Stavytskyi 2004):

$$F_{\Phi} = \frac{R^2 \cdot \left(n-2\right)}{1-R^2} \tag{13}$$

and is compared with the critical values of Fisher's statistics with *1* and (n – 2) degrees of freedom and reliability level (1 – α): $F_{\kappa\rho} = F\left(1, n-2, 1-\propto\right)$. If $F_{\Phi} \ge F_{\kappa\rho}$, the model is statistically significant (adequate).

In order to avoid cumbersome calculations and to reduce computational volumes, statistical analysis of the relationship between levels of the shadow economy and levels of corruption in Central and Eastern European countries was conducted using modules Basic Statistics/Tables, Multiple Linear Regression and Advanced Linear/Nonlinear Models of the Statistica package (Lupan et al. 2015).

The critical values of the statistics were determined using the Probability Distribution Calculator (Toptunova et al. 2008).

At the first stage of the study, a linear correlation-regression analysis of the data was performed to establish the strength and direction of the correlation connection and to make a qualitative assessment (see Table 3).

The data show that a weak linear correlation between levels of corruption and levels of the shadow economy is observed in Russia, while it is notable in Moldova, Bulgaria, and Belarus; in other countries of the region, it is strong or very strong. The linear correlation between levels of the shadow economy and the levels of corruption in Ukraine is weak and statistically insignificant according to Student's criterion, with a probability of 95% (*1.8754 < 2.1199*).

Given that the strength of the pair correlation connection is significantly influenced by the form of connection (linear, nonlinear), nonlinear correlation-regression analysis of the relationship between levels of the shadow economy and levels of corruption was conducted.

Summary results of the linear and nonlinear correlation-regression analysis of the relationship between the indicators are presented in Table. 4.

Table 3. Characteristics of the linear correlation between levels of the shadow economy and levels of corruption in Central and Eastern European countries

Country	Number of observations *n*	Correlation coefficient *r*	Student's criterion		Qualitative characteristic of correlation
			t_p	t_{kp}	
Poland	20	0.9639	15.3587	2.1009	very strong
Latvia	18	0.9174	9.2209	2.1199	very strong
Romania	19	0.9022	8.6244	2.1098	strong
Slovakia	18	0.8935	7.9588	2.1199	strong
Hungary	21	0.8889	8.4580	2.0930	strong
Lithuania	17	0.8708	6.8599	2.1314	strong
Estonia	18	0.8430	6.2687	2.1199	strong
Czech Republic	20	0.8382	6.5208	2.1009	strong
Belarus	18	–0.5874	2.9033	2.1199	notable
Bulgaria	18	0.5388	2.5583	2.1199	notable
Moldova	17	0.5323	2.4353	2.1314	notable
Russia	20	0.4689	2.2523	2.1009	weak
Ukraine	18	0.4245	1.8754	2.1199	weak

Source: author's own calculations.

The data show that the correlation between levels of corruption and the shadow economy in all countries of the region is significant, according to the Student's criterion, and the Fisher test proves that regression equations fit the actual data well. At the same time, the degree of influence of corruption on the variation of the shadow economy levels in Central and Eastern European countries is very different (see Figure 4). Thus, the variation in the shadow economy levels depends on the impact of corruption by approximately 81–92% in Poland, Latvia, and Romania, by 71–80% in Slovakia, Hunga-

ry, Lithuania, and Estonia, by 60–70% in the Czech Republic, Moldova, Russia, and Belarus, by 48% in Bulgaria, and only by 26% in Ukraine.

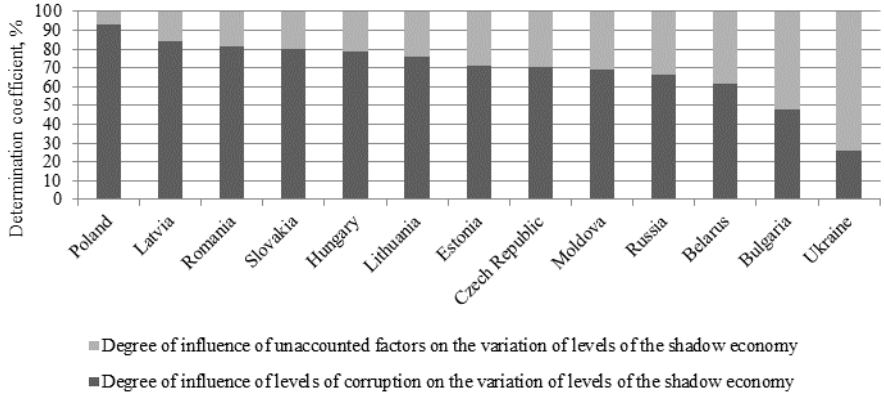

Figure 4. Variation of the shadow economy levels due to the influence of corruption and other factors
Source: author's own calculations.

Table 4. Results of nonlinear the correlation-regression analysis of the relationship between levels of the shadow economy and corruption in Central and Eastern European countries

№	Country	Model of correlation y = f(x)	Correlation ratio	Qualitative characteristic of correlation	Student's criterion		Fisher's criterion		Determination coefficient
					t_p	$t_{кр}$	$F_ф$	$F_{кр}$	
1	Poland	$y = 29.576x + 12.717$	0.96	very strong	15.36	2.10	236.19	4.41	0.93
2	Latvia	$y = 21.619x + 12.224$	0.92	very strong	9.22	2.20	85.02	4.49	0.84
3	Romania	$y = 22.589x + 16.845$	0.90	strong	8.62	2.11	74.42	4.45	0.81
4	Slovakia	$y = 20.789x + 6.049$	0.89	strong	7.96	2.20	63.36	4.49	0.80
5	Hungary	$y = 21.736x + 16.578$	0.89	strong	8.46	2.09	71.52	4.38	0.79
6	Lithuania	$y = 47.461x + 8.7732$	0.87	strong	6.86	2.13	47.05	4.54	0.76
7	Estonia	$y = 48.271x + 12.376$	0.84	strong	6.27	2.20	39.29	4.49	0.71
8	Czech Republic	$y = 21.185x + 6.4547$	0.84	strong	6.52	2.10	42.51	4.41	0.70
9	Moldova	$y = 4977.6x^4 - 14415x^3 + 15443x^2 - 7233.3x + 1289.9$	0.83	strong	5.81	2.13	9.29	4.54	0.69
10	Russia	$y = -22750x^4 + 71297x^3 - 82838x^2 + 42301x - 7975.7$	0.81	strong	5.93	2.10	35.18	4.41	0.66
11	Belarus	$y = 623.49x^3 - 1109.4x^2 + 598.79x - 51.873$	0.79	strong	5.10	2.12	26.03	4.49	0.62
12	Bulgaria	$y = 7161.5x^4 - 16828x^3 + 14387x^2 - 5265.6x + 722.4$	0.69	notable	3.81	2.12	15.01	4.49	0.48
13	Ukraine	$y = -106404x^5 + 425953x^4 - 676921x^3 + 533781x^2 - 208819x + 32458$	0.53	weak	2.38	2.12	5.24	4.49	0.26

Source: author's own calculations.

In our opinion, the weak correlation between the levels of the shadow economy and levels of corruption in Ukraine is due to the following factors:

- Insufficient official statistics that the assessment of the level of the shadow economy is based on. For instance, the last population census in Ukraine was in 2001, but its data is still used to calculate key macroeconomic indicators. Given that since then, the size and structure of the population have changed significantly due to mass emigration, the annexation of Crimea, and the occupation of territories in the east of Ukraine, there is currently no reliable data on the number of people actually living and working in Ukraine. Therefore, GDP per capita, as well as employment rates, cannot be considered reliable.
- Large-scale capital outflow from Ukraine. Corrupt officials prefer to store and spend unofficial revenues abroad rather than in Ukraine. That is, the funds acquired illegally, in particular, by corrupt means, mostly do not come into shadow turnover in Ukraine, but are transmitted abroad. Thus, according to Global Financial Integrity, Ukraine ranks 14th in the world in terms of hidden capital outflow, losing, on average, $11.6 billion annually (Global Financial Integrity 2015).
- The subjectivity of corruption perception indicators due to the predominance of one form of corruption or another in a particular country. Political and high-level bureaucratic types of corruption have the greatest impact on the shadow economy in the country; however, their manifestations can be extremely diverse and not always obvious to the general public. Consequently, most individuals and entrepreneurs are likely to estimate the extent of corruption in their country based on their own experience of low-level bureaucratic corruption cases.

Therefore, it is appropriate to highlight the corruption and non-corruption factors of the shadow economy in Ukraine. Corruption factors include:

- the complexity, inconsistency, and instability of legislation. Making amendments to legislation in the interests of certain oligarchic structures leads to legal uncertainty in entrepreneurial activity and social relations;
- the significant discretionary powers of officials in granting privileges to citizens and enterprises without personal responsibility for the decisions made;
- deficient procedures to register and re-register property rights due to the incompleteness of state registers of property rights, as well as the significant complexity, duration, and costs to protect these rights;
- abuses in the field of public procurement, i.e., artificially limiting the range of tenderers by imposing discriminatory requirements and purchases of overpriced goods and services;
- the unsatisfactory performance of state social functions, in particular, poor quality medicine and education, as well as low a level of social security of vulnerable sections of the population, which motivates individuals and enterprises to evade taxes;

- the ineffectiveness of the judiciary and the low level of public trust in it (only 12.3% of Ukrainians "trust" or "somewhat trust" courts) (Kyivskyi mizhnarodnyi instytut sotsiolohii 2018);
- complex and lengthy procedures to prepare tax reports and pay taxes; it requires 328 hours a year, far exceeding average regional and global indicators (PwC and World Bank Group 2020);
- high rates of tax and customs duties on imported products, overstatement of their customs value, as well as considerably complex and lengthy customs clearance, which results in significant amounts of smuggling (Dubrovskyi and Cherkashyn 2017).

Non-corruption factors of the shadow economy in Ukraine include:

- the transformation of socio-economic relations in the transition from a planned to a market economy, which was associated with the emergence of private property and entrepreneurship and slow changes in the public consciousness;
- Ukraine's economy is oriented to exporting raw materials, which determines its strong dependence on the conditions in the world commodity markets, i.e., levels of income and employment in Ukraine mostly depend on world prices for raw materials rather than decisions of Ukrainian authorities and actions of officials;
- the annexation of Crimea and the presence of areas which are not controlled by Ukrainian authorities due to armed conflict in eastern Ukraine and the related introduction of trade and transit restrictions;
- macroeconomic instability, in particular, the depreciation of the national currency by 250% between 2014 and 2018, and galloping inflation;
- the instability of Ukraine's banking system, in particular, the closure of 115 banks between 2014 and 2018, as well as a significant proportion of non-performing loans in portfolios of the remaining banks reaching 50%;
- the emergence and rapid development of virtual information services that enable the sale of goods and services without official registration or paying taxes (for example, Uber and Uklon in the taxi market; Booking.com and Airbnb in the rental housing market);
- the increasing popularity of employment forms that do not require presence in the workplace or the need to officially register employment relations;
- the increasing popularity of cryptocurrencies as a means of paying for goods and services on virtual trading platforms.

Conclusion

The article dealt with the causes, essence, and mechanisms of influence of high- and low-level political and bureaucratic corruption on Ukraine's economy, in particular the shadow economy.

The study of the nature of the shadow economy allowed us to conclude that in countries studied, it is caused mainly by transformation processes in the economy, and includes both corruption and non-corruption components.

The correlation-regression analysis of the relationship between levels of corruption and the shadow economy in Central and Eastern European countries over a 20-year period revealed the existence of strong links between these phenomena in all countries, except Ukraine. The resulting regression models enabled us to quantify the degree of influence of corruption on the change in the amount of the shadow economy in each country of the region.

We found out that the degree of influence of corruption on the variation in the shadow economy levels in these countries differs significantly. Thus, the variation depends on the impact of corruption by approximately 81–92% in Poland, Latvia, and Romania, by 71–80% in Slovakia, Hungary, Lithuania, and Estonia, by 60–70% in the Czech Republic, Moldova, Russia, and Belarus, by 48% in Bulgaria and only by 26% in Ukraine.

Hence, we did not confirm our hypothesis that in countries with relatively high levels of corruption and the shadow economy, it is corruption factors that are most responsible for the variation in the amount of the shadow economy. On the contrary, in countries with relatively high levels of corruption and the shadow economy, corruption accounts for a smaller share of the shadow economy than in countries with relatively low levels of these phenomena. Thus, in Ukraine, which has some of the highest levels of corruption and the shadow economy in the region, there is the lowest degree of impact of corruption factors on the variation in the amount of the shadow economy. In our opinion, this may be due to the shortcomings of Ukrainian official statistics, peculiarities of these phenomena in Ukraine, and the large-scale outflow of corrupt funds outside Ukraine.

We have highlighted the main corruption and non-corruption factors of Ukraine's economy shadowing. At the same time, the root causes of corruption and shadowing of Ukraine's economy require further research and consideration when developing policy to counteract them. The measures to combat these phenomena are inadequate for Ukraine. In particular, those borrowed from foreign experiences and aimed at combating their manifestations rather than causes are not only ineffective but sometimes lead to the opposite effect.

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Streszczenie

Związek między korupcją a szarą strefą na Ukrainie i w innych krajach Europy Środkowo-Wschodniej

W artykule dokonano analizy przyczyn, charakteru i cech korupcji oraz szarej strefy, a także związków między nimi, na Ukrainie, na tle innych krajów Europy Środkowo-Wschodniej. Analiza korelacyjno-regresyjna danych statystycznych ujawniła bezpośrednią liniową korelację o różnej sile i istotności statystycznej między poziomem korupcji a rozmiarami szarej strefy we wszystkich krajach Europy Środkowej i Wschodniej. Jednakże stopień wpływu korupcji na zróżnicowanie wielkości szarej strefy w poszczególnych krajach regionu istotnie się różni. Kluczowy wniosek jest taki, że w krajach o relatywnie wysokim poziomie korupcji i dużych rozmiarach szarej strefy korupcja ma mniejszy wpływ na rozmiary szarej strefy niż w krajach o relatywnie niskim poziomie tych zjawisk. Zidentyfikowano przyczyny słabej korelacji między poziomem korupcji a rozwojem szarej strefy na Ukrainie. Określono główne korupcyjne i niekorupcyjne czynniki rozwoju szarej strefy na Ukrainie. Stwierdzono, że polityka i środki zwalczania korupcji i szarej strefy na Ukrainie powinny mieć na celu wyeliminowanie ich pierwotnych przyczyn, a nie przejawów.

Słowa kluczowe: korupcja, szara strefa, korelacja