**Nataliia Bak**
Candidate of Economy Sciences, Associate Professor of the Department of Finance and Credit, Yuriy Fedkovych Chernivtsi National University, Chernivtsi, Ukraine;
e-mail: n.bak.chnu@gmail.com
ORCID: 0000-0003-3774-1745
(Corresponding author)

**Tetiana Kalyta**
Candidate of Economy Sciences, Associate Professor of the Department of Tax Administration, State Tax University, Irpin, Ukraine;
ORCID: 0009-0008-6387-1889

**Volodymyr Tarashchenko**
Candidate of Economy Sciences, Doctoral Student, Associate Professor of the Department of Audit, State Financial Control and Analysis, State Tax University, Irpin, Ukraine;
ORCID: 0000-0002-4873-982X

**Dmytro Riznyk**
Candidate of Economy Sciences, Doctoral Student, Ivan Franko National University of Lviv, Lviv, Ukraine;
ORCID: 0000-0003-3188-5158

**Mykyta Artemchuk**
Candidate of Philosophical Sciences, Chief Product Officer Prom.ua, Kyiv, Ukraine;
ORCID: 0000-0003-0793-1265

# THE IMPACT OF THE SHADOW ECONOMY ON THE REDUCTION OF TAX REVENUES TO THE STATE BUDGET

## ABSTRACT

The aim of the study was to assess and analyse the shadowing of the national economy, as well as to determine the impact of its shadowing on the reduction of tax revenues to the state budget. The research employed general scientific, economic, and mathematical assessment methods, such as regression analysis, correlation analysis, interval forecasts, as well as econometric models of Lacko's household electricity approach, as well as modelling of the shadowing level using the multiple indicators-multiple-causes (MIMIC) model. The calculations and analysis gave grounds to determine the level of the shadow economy of Ukraine based on the state statistics of shadowing trends. There is currently an upward trend estimated to be 37.1% of GDP in 2022 compared with international data, which indicates a rapid growth of the shadow economy from 27% in 2019 to 44% in 2022. An alternative method of assessing the shadowing level was proposed in order to level the peculiarities of calculating the level of shadowing of the economy. According to the calculations, it was 43% in 2022. It was determined that the rapid growth of the shadow economy is an indicator of a reduction in tax revenues, especially in 2022 — by almost 8%. The correlation analysis proved that the increased shadowing level is an indicator of the reduction of tax revenues to the budget of Ukraine. The conducted analysis has certain limitations, therefore it is advisable to further test the hypothesis regarding the indicator of tax revenue reduction on a larger range of data and to apply an alternative method of assessing the shadowing level for developed economies, such as the countries of the European Union (EU).

**Keywords:** shadow economy, tax revenues, shadowing level, MIMIC model, household electricity approach, crime dynamics method

**JEL Classification:** H00, H20, H70, H71, O17

## INTRODUCTION

*Relevance*

For many decades, the national economies of countries with different degrees of development of the economic system have suffered the serious challenge of shadowing the economy. In this context, the shadow component of the economy has a negative impact on tax revenues, i.e., shadowing determines the reduction of state revenues. It is the determination of the impact of shadowing and the search for ways to reduce it that determines the relevance of the chosen research topic. It is difficult for researchers to determine the sources and causes of the shadow economy because of its different dimensions. Despite the lack of official indicators, many researchers have attempted to estimate the shadow economy over the past three decades (Canh et al., 2021). It reduces government tax revenues and government spending, especially on infrastructure and services (governance, rule of law, and regulation), reducing overall economic growth. Clarifying the causes and consequences of this phenomenon could make a significant contribution to the economic literature. Many factors, including the tax burden, unemployment, heavy regulation, and labour costs, are commonly considered drivers of the shadow economy.

Recent studies are based on the need to define the essence of the concept, structure, and methods for assessing the scale of the shadow economy (Baklouti & Boujelbene, 2020).

*Unexplored issues*

It is unexpected that most studies do not pay attention to methods of evaluating the shadow economy and use calculated statistics from official sources, which are not always adjusted for internal factors in the country itself (Mamontova & Havruk, 2023; Al-Raggad et al., 2024). Ukraine was chosen as the basis of the study as the European country with the highest level of shadow economy. Ukraine was also chosen because there are no studies on the shadowing of the economy, the reduction of tax revenues in the conditions of a hybrid war (2014-2022), the COVID-19 pandemic, as well as a full-scale war from 2022. These issues of the functioning of the tax system in parallel with the growth of the shadowing level under the condition of the destruction of established market mechanisms and the existing gaps are of special academic interest.

## LITERATURE REVIEW

Shadowing can be characterized as the process of seizing the national economy of the state or the global economic system by the shadow processes. Baklouti and Boujelbene (2020) note that the concepts of the underground, criminal, informal or parallel economy are also used to define the shadow economy. Discussions about the main definition of the study have been going on since the 1970s, especially after Gutman, who estimated the share of the shadow economy in the United States (Rahman et al., 2023a).

In recent years, researchers have noted that a large size of the informal economy can cause several new problems (Nguyen & Nguyen, 2023; Nguyen & Schinckus, 2022). They explain that a high level of the informal sector can cause a high level and intensity of energy consumption, which can have a negative impact on the environment. In this regard, Nguyen and Nguyen (2023) documented that the size of the shadow economy can cause more deforestation worldwide in the long run. Other studies show that high levels of the shadow economy can lead to greater income inequality and a range of social problems (Yap et al., 2018; Esaku & Tajani, 2021). Rahman et al. (2023b), and Canh et al. (2021) point out that countries with a significant amount of shadowing examine the impact of the shadow component only by determining unreasonable macroeconomic indicators. This bias is especially characteristic of developing countries, where a significant part of the production of goods and services is accounted for by illegal production. In particular, the study discusses the need to find determinants of control over shadow economic activity and the tax burden in Pakistan. The development of the financial sector, particularly financial institutions, attracts shadow economic activity into the formal sector, credit and other services.

The impact of the development of the financial sector on the spread and the effect of shadowing is also widely studied (Mamun et al., 2018). The economic consequences of shadow banking are examined in the existing literature mostly in terms of macro-level aspects, such as the vulnerability of the financial system, the effectiveness of monetary policy, the distribution of credit resources, the capital and liquidity of the banking sector, the distribution of credit resources, the creation of capital and liquidity in the banking sector (Allen et al., 2019; Chen et al., 2020; Zhu et al., 2019). In contrast, there is much less literature on the impact of shadow banking on the micro-level of companies. The existing literature can be divided into two categories: "shadow banking facilitation view" and "shadow banking risk view'.

In addition to financial institutions, financial markets (both stock and bond markets) also play the same role in providing funds to businesses to carry out their economic activities (Ali et al., 2022a; 2022b). Dang et al. (2023) suggested that corruption and institutional quality are key determinants that positively and negatively affect shadowing. In addition, in case of economic risk (which reflects the economic situation of the country in the future), the country faces high inflation, budget deficit, current account deficit, and a high risk of default. The researchers from the UAE (Arnaut et al., 2023) study shadowing in terms of its impact on the energy market, because the shadow economy covers all types of activities outside the formal economy. Activities in the shadow economy are mostly hidden from tax officials and regulators, and the existence of the shadow economy is likely to influence energy conservation and carbon reduction policies (Mazaraki et al., 2021; Tiutiunyk et al., 2021).

Recent research suggests that the shadow economy accounts for a significant proportion of economic activity in Africa (Dada & Ajide, 2021). The role of the shadow economy in the development process has been widely discussed (Berdiev & Saunoris, 2019). Some researchers suggest that the shadow economy can be seen as a training ground for budding entrepreneurs. It is a sector that provides income to people living in poverty thanks to relaxed entry requirements and lack of regulation (Churchill & Danquah, 2022; Prokopenko et al., 2022).

Ukrainian researchers pay attention to the optimization of the taxation system to reduce the shadow economy and reduce the tax burden, improve communication between the tax authorities and taxpayers (Mamontova & Havruk, 2023). The researchers (Davydenko et al., 2020) conclude that the shadow economy completely deforms the system of public finances and inhibits the fulfilment of social obligations to the population. They emphasize that the recovery of the economy from manifestations of shadowing is the main global priority of state policy.

## AIMS AND OBJECTIVES

The aim of the study is to determine the impact and extent of shadowing on the reduction of tax revenues to the state budget.

The aim involved the fulfilment of the following research objectives:

▪ study the difference between the results of state statistics on shadowing and international statistics on the illegal economy in Ukraine;

▪ propose an alternative method of determining the level of shadowing of the economy;

▪ evaluate and analyse the relationship between shadowing and tax revenues.

## METHODS

### Research design

The research design involves an assessment of the scope of the shadow economy in the first stage to determine the scope of the impact on budget revenues, and in the second stage – an analysis of the shadow economy's impact on the reduction of state tax revenues (Figure 1).
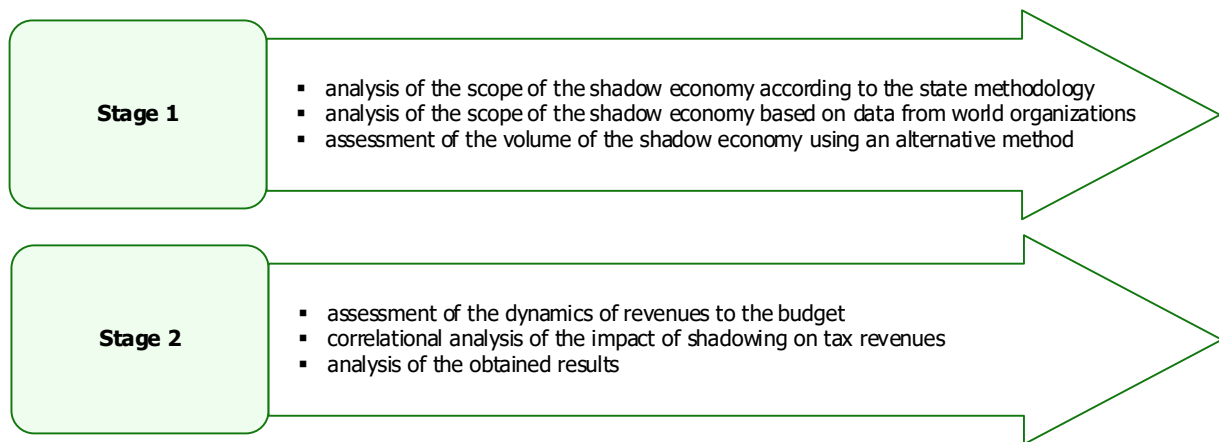
**Stage 1**
- analysis of the scope of the shadow economy according to the state methodology
- analysis of the scope of the shadow economy based on data from world organizations
- assessment of the volume of the shadow economy using an alternative method

**Stage 2**
- assessment of the dynamics of revenues to the budget
- correlational analysis of the impact of shadowing on tax revenues
- analysis of the obtained results

**Figure 1. Research design.**

### Sampling

The economy of Ukraine was chosen as the basis of the study because Ukraine is the most shaded among European countries. The period of 2014-2022 was chosen as the period for analysis, as the war began in 2014, followed by a period of pandemic and crisis, and already a full-scale invasion which began in 2022. All these periods of time characterize the state of shadowing of the economic system of Ukraine in different ways. There are no similar studies and similar analysis of this aspect. Because of the significant coverage of methods and variables, the sample includes the GDP of Ukraine, indicators and trends of the shadow economy of Ukraine, according to state assessment methods, the scale of the shadow economy based on the assessment of international organizations, as well as data on the electricity consumption in Ukraine, the dynamics and structure of crimes, volume of foreign exchange transactions, volume of money supply and tax revenues to the budget of Ukraine (World economics, 2024; Ministry of Economy of Ukraine, 2022; Minfin, 2022).

*Methods*

Despite the availability of approved state and global methods for determining the scope of the shadow economy, it is proposed to also apply alternative assessment methods in order to most fully take into account all factors of the increase in shadowing. In this study, it is proposed to use the synthesis of three alternative theoretical methods — Latsko's household electricity approach, the MIMIC econometric model, and the dynamics of crimes.

The essence of Lacko's method can be described by two equations (Antypov, 2006):

$$Ln\ E_i = a_1 ln\ C_i + a_2\ ln\ PR_i + a_3\ G_i + a_4 Q_i + a_5 H_i + u_i, a_1 > 0,\ a_2 < 0, a_3 > 0,\ a_4 < 0,\ a_5 > 0; \tag{1}$$

$$H_i = \beta_1\ T_i + \beta_2\ (S_i - T_i) + \beta_3\ D_i,\ \beta_1 > 0,\ \beta_2 < 0,\ \beta_3 > 0, \tag{2}$$

where $i$ – serial number of the feature; $E_i$ – household electricity consumption per capita in the country $i$, million tons per year; $C_i$ – real household consumption excluding electricity consumption per capita in the country $i$; $PR_i$ – the real price of 1 kW of household electricity per year; $G_i$ — the number of months per year in which full heating of houses in the country is required; $Q_i$ – the ratio of the use of energy sources (excluding electricity) to all energy sources in households; $H_i$ – the share of the shadow economy per capita; $T_i$ — the ratio of the sum of incomes of individuals, profits of corporations and taxes on goods and services to GDP; $S_i$ — the ratio of the amount of government spending on social transfers to GDP; $D_i$ — the total number of dependents over 14 years old per 100 active persons.

The next stage of the assessment is the calculation of the MIMIC econometric model proposed by F. Schneider (Mazur, 2005; Schneider & Enste, 2013).

https://vdoc.pub/documents/the-shadow-economy-an-international-survey-42m0kf48e150). The essence of this model is to identify the determinants of the indicators of the shadow economy derived from the growth of the shadow economy. The entire MIMIC model is defined as follows: $\eta$ — a scalar (unobservable variable) variable (the size of the shadow economy); $y` = (y_1, y_2, ..., y_p)$ is a vector of "indicators"; $x` = (x_1, x_2, ..., x_q)$ — a vector of "causes"; $(p \times 1)$ and $(q \times 1)$ are parameter vectors; $\varepsilon$ and $\zeta$ — scalar random errors. The model itself is represented by two equations:

$$y = \lambda \eta + \varepsilon \tag{3}$$

$$\eta = \gamma' x + \zeta \tag{4}$$

Converting equation (3) into equation (4), the model can be considered as a multivariate regression module:

$$Y = \Pi x + z, \tag{5}$$

where $\Pi = \lambda \gamma'$, $z = \lambda \zeta + \varepsilon$.

The last component of the model is the method based on crime dynamics, which is based on two assumptions:

- ▪ "shadow" agreements are concluded mainly with the help of cash and barter;
- ▪ the real speed of money circulation is determined based on the rate of increase in the number of crimes.

The method is calculated in 7 stages, which are schematically shown in Figure 2.

The research design (Figure 2) provided for conducting a correlation analysis at the second stage using a scatter diagram: a graphical method that allows you to determine whether there is a correlation between two indicators and, if any, what is its type — direct or inverse. A correlation coefficient is also calculated, which helps determine the relationship between two values using a value in the range from (-1;1). All values greater than 0.8 are taken as a strong correlation, values in the range from 0.4 to 0.8 indicate the presence of a correlation, and values less than 0.4 indicate the absence of the correlation.
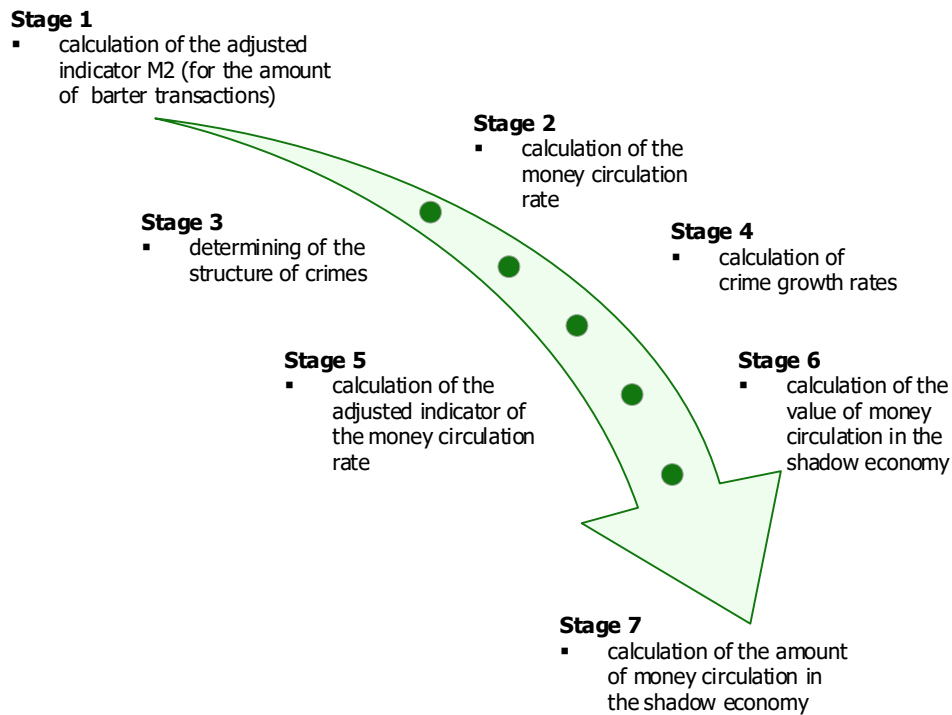
**Stage 1**
- calculation of the adjusted indicator M2 (for the amount of barter transactions)

**Stage 2**
- calculation of the money circulation rate

**Stage 3**
- determining of the structure of crimes

**Stage 4**
- calculation of crime growth rates

**Stage 5**
- calculation of the adjusted indicator of the money circulation rate

**Stage 6**
- calculation of the value of money circulation in the shadow economy

**Stage 7**
- calculation of the amount of money circulation in the shadow economy

**Figure 2. Calculation scheme of the crime dynamics method.** *(Source: developed by authors based on Mazur (2005))*

## RESULTS

Based on the logic of the research, the first stage is the analysis of the available indicators of the shadow economy of Ukraine according to the data of the officially approved methodology for calculating the volume of the shadow economy, which is presented in Table 1.

**Table 1. Volume of the shadow economy in Ukraine for 2014-2022.** *(According to the state assessment methodology)*

| Period | Shadow economy, % of GDP | Real GDP, USD million | The volume of the shadow economy, USD million |
|--------|--------------------------|------------------------|-----------------------------------------------|
| 2014 | 43.0 | 86,619.48 | 37,246.38 |
| 2015 | 40.0 | 59,595.42 | 23,838.17 |
| 2016 | 35.0 | 75,349.26 | 26,372.24 |
| 2017 | 32.0 | 86,907.85 | 27,810.51 |
| 2018 | 30.0 | 111,394.8 | 33,418.45 |
| 2019 | 27.0 | 155,159.5 | 41,893.06 |
| 2020 | 30.0 | 135,646.7 | 40,694.02 |
| 2021 | 31.0 | 160,543.9 | 49,768.6 |
| 2022 | | 96,403.49 | |

However, the government statistical authorities do not provide such information for 2022 because of the full-scale war in the country. To avoid the gap, an interval forecast was used regarding the volume of the shadow economy (Table 2).

**Table 2. Forecast of the volume of the shadow economy and the level of shadowing in 2022.**

| Period | The volume of the shadow economy, USD million | | | Shadowing level, % | | |
|---|---|---|---|---|---|---|
| | Realistic forecast | Optimistic forecast | Pessimistic forecast | Realistic forecast | Optimistic forecast | Pessimistic forecast |
| 2014 | 37,246.38 | 37,246.38 | 37,246.38 | 43.0 | 43.0 | 43.0 |
| 2015 | 23,838.17 | 23,838.17 | 23,838.17 | 40.0 | 40.0 | 40.0 |
| 2016 | 26,372.24 | 26,372.24 | 26,372.24 | 35.0 | 35.0 | 35.0 |
| 2017 | 27,810.51 | 27,810.51 | 27,810.51 | 32.0 | 32.0 | 32.0 |
| 2018 | 33,418.45 | 33,418.45 | 33,418.45 | 30.0 | 30.0 | 30.0 |
| 2019 | 41,893.06 | 41,893.06 | 41,893.06 | 27.0 | 27.0 | 27.0 |
| 2020 | 40,694.02 | 40,694.02 | 40,694.02 | 30.0 | 30.0 | 30.0 |
| 2021 | 49,768.6 | 49,768.6 | 49,768.6 | 31.0 | 31.0 | 31.0 |
| 2022 | 35,804.22 | 32,742.52 | 38,865.93 | 37.1 | 34.0 | 40.3 |

Given the results of the assessment in Table 2, it can be concluded that even with an optimistic forecast, the level of shadowing will increase by 3% and would amount to 34% of the GDP of Ukraine. In a realistic forecast, it would amount to 37.1%. This indicator will be taken as the main one until 2022 in further study. The forecast is graphically shown in Figure 3.
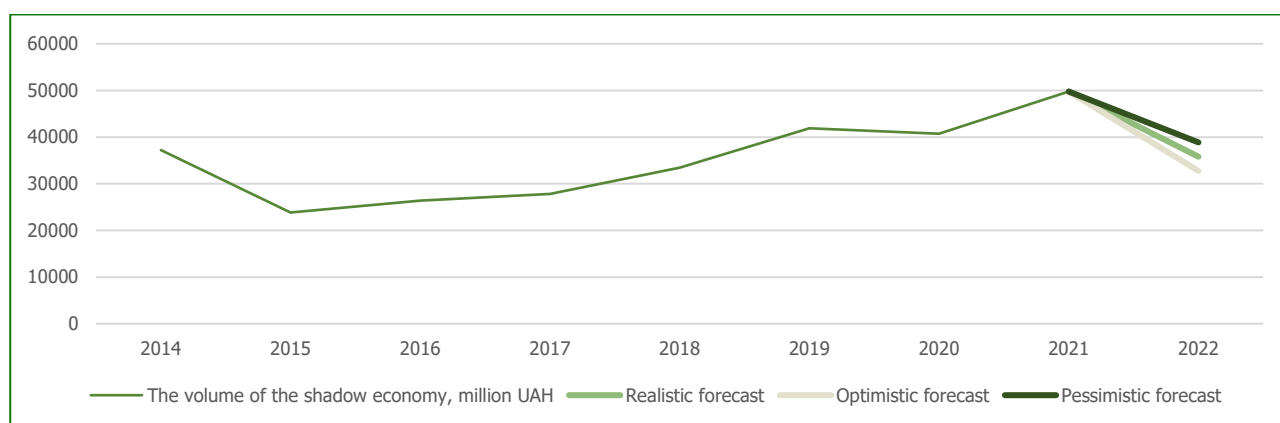


**Figure 3. Forecast of the volume of the shadow economy in Ukraine in 2022.** *(Source: developed by authors based on Minfin (2022)*

Summarizing the above calculations, Table 3 shows a comparison of the results of estimating the volume of the shadow economy according to the state method and according to the methods of international organizations.

**Table 3. Dynamics of the level of shadowing in Ukraine in 2014-2022.**

| Period | State statistics | | International statistics | | Difference | |
|---|---|---|---|---|---|---|
| | Shadow economy, % of GDP | The volume of the shadow economy, USD million | Shadow economy, % of GDP | The volume of the shadow economy, USD million | % | USD million |
| 2014 | 43.0 | 37,246.38 | 37.8 | 32,742.16 | 5.2 | 4,504.213 |
| 2015 | 40.0 | 23,838.17 | 44.8 | 26,698.75 | -4.8 | -2,860.58 |
| 2016 | 35.0 | 26,372.24 | 36.0 | 27,125.73 | -1.0 | -753.493 |
| 2017 | 32.0 | 27,810.51 | 33.0 | 28,679.59 | -1.0 | -869.079 |
| 2018 | 30.0 | 33,418.45 | 30.0 | 33,418.45 | 0.0 | 0 |
| 2019 | 27.0 | 41,893.06 | 27.0 | 41,893.06 | 0.0 | 0 |
| 2020 | 30.0 | 40,694.02 | 40.0 | 54,258.7 | -10.0 | -13,564.7 |
| 2021 | 31.0 | 4,9768.6 | 43.0 | 69,033.86 | -12.0 | -19,265.3 |
| 2022 | 37.1 | 35,804.22 | 44.2 | 42,610.34 | -7.1 | -6,806.12 |

Analysing the given data, we can conclude that starting from 2020, the level of the shadow economy according to international statistics is higher than the state estimate, on average by 10%. A particularly large difference is observed in 2021. However, comparing the data in Table 3 and the forecast in Table 2, it becomes obvious that even the pessimistic forecast of the level of the shadow economy is less than that given by international organizations. It is interesting that in 2018-2019 the indicators of the dynamics of the shadowing level coincide in both versions of the analysis.

MS Excel package was used to conduct a regression analysis for solving the equations of Lacko's approach (Table 4).

**Table 4. Regression analysis for the Lacko's household electricity approach.**

| Regression statistics | | | |
|---|---|---|---|
| Multiple R | 1 | | |
| R-squared | 1 | | |
| Normative R-squared | 65535 | | |
| Standard error | 0 | | |
| | | | |
| **Analysis of variance** | | | |
| | df | SS | MS |
| Regression | 3 | 0.760535 | 0.253512 |
| Remainder | 0 | 0 | 65535 |
| Result | 3 | 0.760535 | |
| **Regression statistics** | | | |
| | Coefficient | Lower 95% | Upper 95% |
| Y-intersection | 1.02141E-14 | 1.02141E-14 | 1.02141E-14 |
| Variable X1 | 1.06925 | 1.06925 | 1.06925 |
| Variable X2 | -1.033 | -1.033 | -1.033 |
| Variable X3 | 1.72555 | 1.72555 | 1.72555 |

Table 4 shows that the coefficient of determination is equal to 1. This means that the model has a high functional dependence. The results of the calculation of the shadowing level using Lacko's household electricity approach are presented in Table 5.

**Table 5. The level of the shadow economy of Ukraine according to Lacko's household electricity approach in 2018-2022.**

| Years | Level of shadowing, % | GDP, USD million |
|---|---|---|
| 2019 | 5.6 | 155,159.5 |
| 2020 | 6.7 | 135,646.7 |
| 2021 | 5.7 | 160,543.9 |
| 2022 | 6.3 | 96,403.49 |

In view of the given calculation, Lacko's household electricity approach cannot reliably illustrate the level of shadowing of the economy. So, it is necessary to use more reasonable and multifactorial models or include the results of this method in broader evaluation methods.

F. Schneider lists the following mechanisms and variables that lead to the growth of the informal economy: income fluctuations, government intervention and regulation of the economy, tax morality, public goods and transfers from the government, the state of the economy and the practice of cash settlements.

The following reasons can be identified for Ukraine (these are variables in the calculations). The ratio of direct and indirect taxes, social protection, social transfers, tax discipline (tax discipline is measured by the share of taxes paid to the state treasury of Ukraine) and the unemployment rate. The following indicators were determined depending on the reasons for the growth of the shadow economy: employment rate, GDP growth rate, and cash growth rate per capita. To calculate the MIMIC model, the scalar product of the vector parameters was found and reduced to equation (5). Using this equation, a regression analysis was performed and coefficients P and z were determined (Table 6).

**Table 6. The regression equation coefficients.**

| Coefficients | |
|---|---|
| Y-intersection | 68,69871899 |
| Variable X | -0,005032924 |

After the mathematical calculation, equation (5) was transferred to the main equations of the model (3) and (4), and the results of the evaluation of the MIMIC econometric model were determined (Table 7).

**Table 7. The level of shadowing of Ukraine in 2018-2022 according to the MIMIC model.**

| Years | GDP, USD million | The level of shadowing according to the state method, % | The level of shadowing according to the MIMIC method, % |
|---|---|---|---|
| 2019 | 155,159.5 | 27.0 | 21.3 |
| 2020 | 135,646.7 | 30.0 | 20.5 |
| 2021 | 160,543.9 | 31.0 | 17.9 |
| 2022 | 96,403.49 | 37.1 | 20.1 |

These results illustrate the shadow economy in the sector of production of goods and services. These data are closer to the official calculations of the Ministry of Economy of Ukraine. However, the MIMIC method does not fully take into account all the sources of the shadow economy of Ukraine. Therefore, an additional calculation was carried out using the crime dynamics method to supplement the above calculations. The results are presented in Table 8.

**Table 8. The level of criminalization in Ukraine according to the crime dynamics method in 2018-2022.**

| Years | GDP, USD million | Shadowing level, % |
|---|---|---|
| 2019 | 155159,5 | 17,35 |
| 2020 | 135646,7 | 14,55 |
| 2021 | 160543,9 | 12,62 |
| 2022 | 96403,49 | 17,31 |

In view of the given data, there is a reduction in the level of shadowing in the period from 2019 to 2021. In 2022, it is possible to see a significant increase in the share of the shadow economy in Ukraine, which may be caused by a full-scale invasion of the territory of the state. The calculations given in Table 4-7 are separate parts of the assessment of the shadow economy according to its structure, namely:

▪ the informal economy (this is the economic activity of households: the production of goods and services and their consumption in the household and for its own needs);

▪ the illegal economy (a legal activity that is hidden or deliberately understated by producers in order to avoid paying taxes or fulfilling other obligations);

▪ and criminal economy (illegal activity prohibited by law, production and distribution of goods and services prohibited by law).

Following this logic, the given calculation results were summarized and the following results were obtained in Table 9.

**Table 9. The total size of the shadow economy according to alternative assessment methods.**

| Years | Lacko's household electricity approach, % | MIMIC model, % | The crime dynamics method, % | The general level of shadowing, % |
|---|---|---|---|---|
| 2019 | 5.6 | 21.3 | 17.35 | 44.25 |
| 2020 | 6.7 | 20.5 | 14.55 | 41.75 |
| 2021 | 5.7 | 17.9 | 12.62 | 36.22 |
| 2022 | 6.3 | 20.1 | 17.31 | 43.71 |

The above calculations are closer to the assessment of international experts and, in our opinion, are quite reliable, given the war in Ukraine and the preceding pandemic crisis.

According to the research design, the second stage is the assessment and analysis of the dynamics of tax revenues to the budget of Ukraine (Table 10).

**Table 10. Dynamics of tax revenues to the budget of Ukraine in 2014-2022.**

| Year | Tax revenues, USD | Percentage of tax revenues in the consolidated budget, % | Absolute change, USD | Growth rates, % |
|---|---|---|---|---|
| 2014 | 23,319.28 | 80.58 | - | - |
| 2015 | 21,151.5 | 77.85 | 8,891.12 | 38.13 |
| 2016 | 24,103.03 | 83.14 | 5,964.41 | 28.20 |
| 2017 | 29,429.95 | 81.45 | 6,569.52 | 27.26 |
| 2018 | 35,633.98 | 83.29 | 5,621.52 | 19.10 |
| 2019 | 45,180.32 | 82.98 | 3,033.72 | 8.51 |
| 2020 | 40,379.65 | 82.57 | 2,801.41 | 6.20 |
| 2021 | 53,488.01 | 87.46 | 11,265.25 | 27.90 |
| 2022 | 33,496.88 | 61.16 | -4,068.40 | -7.61 |

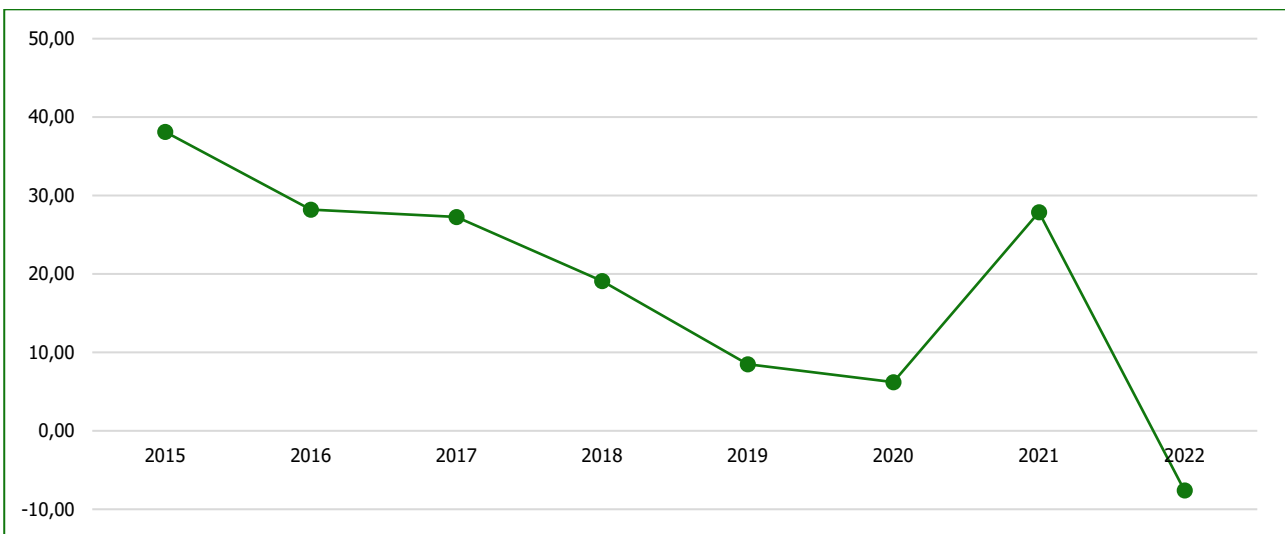For clarity, the results of the dynamics analysis are shown in Figure 4.



**Figure 4. Growth rate of tax revenues to the budget of Ukraine for 2014-2022.** *(Source: developed by authors based on Minfin (2022)*

According to the calculations and the schedule, one can see a constant tendency towards the reduction of tax revenues in the budget from 2017 to 2020. However, this indicator increased rapidly in 2021, which may be caused by digitalization and the introduction of such tools as Diia and Diia.City, which are aimed at reducing bureaucratic procedures, as well as introducing a special taxation regime for IT companies and IT workers. However, a sharp reduction to -7.6% is observed in 2022. This indicator is related to the occupation of the territory of Ukraine, as well as the hostilities in almost 25% of the country.

The initial data for the correlation analysis are the results of the assessment of the shadow economy and the amounts of tax revenues to the budget of Ukraine. Figures 5-7 show the results as a scatter diagram.
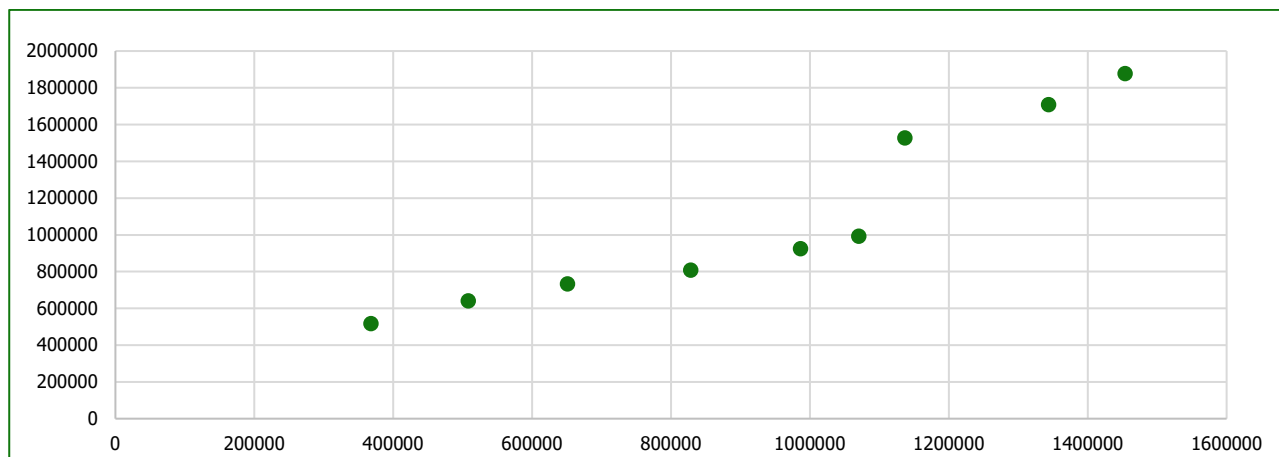
**Figure 5. Scatter diagram for indicators of the size of the shadow economy according to international statistics and tax revenues to the budget.**
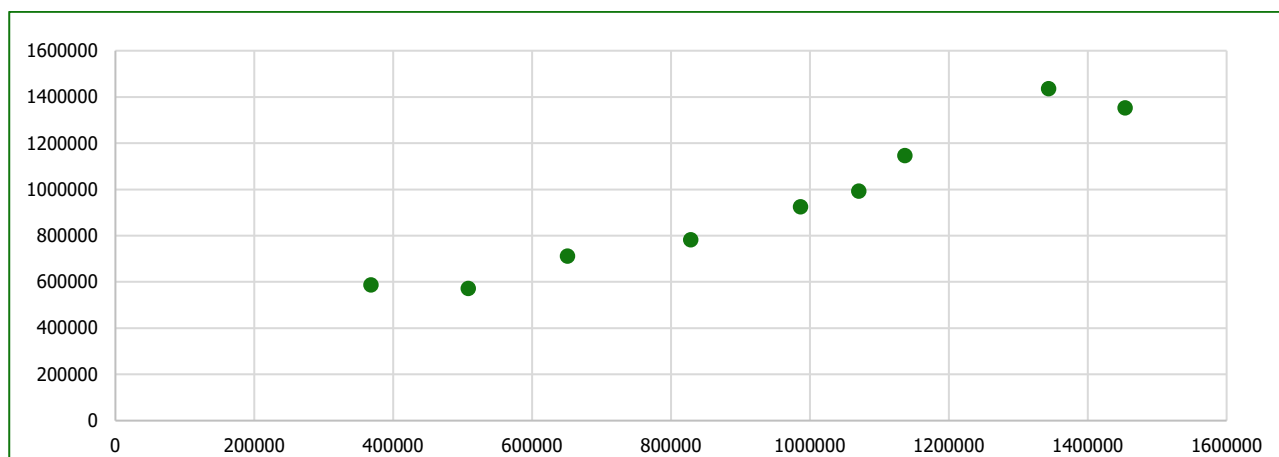


**Figure 6. Scatter diagram for indicators of the size of the shadow economy according to state statistics and tax revenues to the budget.**
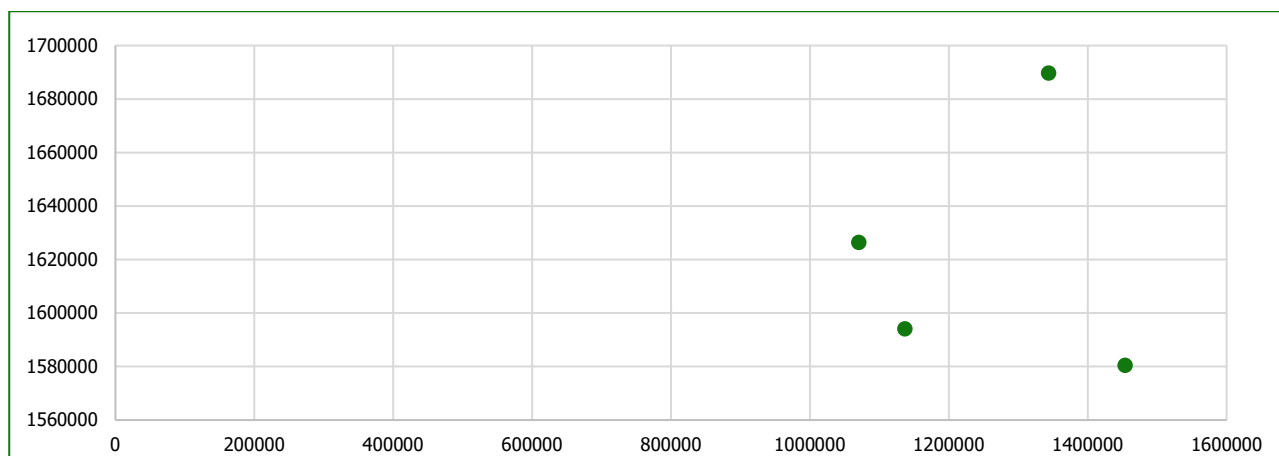


**Figure 7. Scatter diagram for the size of the shadow economy according to an alternative method and tax revenues to the budget.**

The diagrams show that there is a direct correlation between the shadow economy and tax revenues to the budget. This means that the increase in the shadow economy is an indicator of a decrease in tax revenues to the state budget. This hypothesis is confirmed by correlation coefficient calculations. It is 0.96 for the pair shadowing according to state statistics and tax revenues, which indicates a strong correlation. For the pair "the amount of shadowing according to international statistics and tax revenues" the correlation coefficient is 0.93, which also indicates a strong correlation. However, for the pair "the amount of shadowing estimated by the alternative method and tax revenues" is slightly less than 0.73. This, however, also indicates a significant correlation.

Therefore, all calculations confirm the hypothesis regarding the impact of the shadow economy on the reduction of tax revenues to the state budget. According to experts (Tarasovskiy, 2019), the largest are budget losses, that is, the largest sources of the shadow economy are illegal schemes at customs (the so-called grey import) — from 2.25 to USD 3.32 billion. Illegal wages rank second — USD 0.89-2.64 billion per year, as well as various offshore schemes — USD 0.79-1.29 billion of budget losses per year. The high level of the informal economy causes the national budget losses amounting to billions of dollars and the growth of the shadow economy. It should be, however, noted that the current state of growth of shadowing and lack of tax revenues is determined to a greater extent by a full-scale invasion.

## DISCUSSION

The study revealed a stable correlation (which is an average of 0.9) between an increase in the shadow economy and the reduction of tax revenues to the budget. Our study correlates with the study of Baklouti and Boujelbene (2020), which focuses on determining the causes and effects of the growth of the shadow economy because of the growth of overall tax and social load. The researchers Baklouti and Boujelbene (2020) state that this can lead to erosion of the tax base and social security and, ultimately, reduce tax revenues, and therefore further increase the budget deficit or further increase the tax rates, which will lead to additional growth of the shadow economy, and so on. This hypothesis is proven in our study because the growing level of shadowing leads to a reduction in tax revenues. The growth of the shadow economy can be considered as a reaction of people who feel overburdened by the state. So, a hypothesis on the indicative features of increasing the level of shadowing is proved.

The studies by Aktas et al. (2019), and Zhang et al. (2020) focus on the fact that the financial sector of the economy suffers the formation and increase in the level of shadowing. Faced with high income and, accordingly, high risks of shadow banking, management can be guided by selfish motives and act shortly, which increases agency costs and information asymmetry, forcing management to hide more specific information and, as a consequence, increases the synchronism of prices (Aktas et al., 2019; Zhang et al., 2020). However, the authors do not take into account a tax burden, and our results prove the need to introduce taxation factor into models proposed by the researchers, because the increase in prices leads to increased taxes and, accordingly, to reduced tax revenues.

Although financial development can potentially shift the balance of costs and benefits for the private sector in a more traditional prospect of rational choice, as Dada and Ajide (2021) found at the macro level, our study uses a slightly different approach. We deliberately support the rational equivalence between formal and informal economies in terms of expected tax revenues.

In general, the existing academic literature emphasizes that the private sector plays an important role in the economic development of the country. This is why the loans of commercial banks provided to the private sector are considered compared to the size of the economy as a whole. The role of financial institutions in directing funds into the private sector, thereby contributing to the depth of financial institutions, are accurately measured (Arnaut et al., 2023). However, in developing countries, a fairly high level of tax burden does not allow to fill the budget qualitatively. In this study, we also agree that financial revenues can adversely affect the depth of financial institutions because of corruption. This negative impact on the financial depth can be softened with the help of better economic and institutional policy (Canh et al., 2021). This set of institutional factors was covered in our study by comparing international statistics on shadowing, state statistics on shadowing, as well as the introduction of an alternative method of assessing the impact of the shadow economy, and this is undoubtedly the advantage of our study.

A significant number of studies (Kim et al., 2021) indicates that fluctuations in macro-level prices are mainly related to the law of commercial secrets, mixed property reform (Wang et al., 2022), the use of financial derivatives (Su et al., 2022), the opening of high-speed railways (Zhou et al., 2023), the liberalization of the stock market (Li et al., 2022), as well as political signals (Hou & Yang, 2021), which are also the reasons for increasing the shadow economy. All these researchers justify the reasons for increasing the level of shadowing, and there is no specific indicator of an increase in the shadow economy. The ways of determining the volume of the shadow economy are not considered. An extended analysis on the basis of state statistics, international statistics and alternative methodology made it possible to take into account the maximum number of exogenous and endogenous factors contributing to the growth of the shadow economy.

## CONCLUSIONS

Summing up, we can conclude that the study is extremely relevant, especially in view of the rapid reduction of tax revenues to the state budget, which is now in a state of war. Moreover, in the context of hostilities, the shadowing of the economy

is increasing because the main mechanisms of the market economy are broken. In this context, the study of the impact of the shadow economy on the reduction of tax revenues to the budget is especially relevant, as the economic situation reaches a critical level. On the one hand, the budget requires filling, while broken market mechanisms stimulate the increase in of shadow economy.

After conducting various calculations, it has been confirmed that the hypothesis regarding the impact of the shadow economy on the reduction of tax revenues to the state budget is true. The evaluation process involved two main stages: assessing the impact and determining the relationship between the shadow economy and the reduction of tax revenues. The findings show that there is a direct correlation between the shadow economy and tax revenues to the budget. This means that an increase in the shadow economy is a sign of a decrease in tax revenues to the state budget. This hypothesis is confirmed by the calculations of the correlation coefficient. For the pair "shadowing according to the state statistics and tax revenues," it is 0.96, which indicates a strong correlation. For the pair "shadowing according to the international statistics and tax revenues" it is 0.93, which also indicates a strong correlation. However, for the pair "shadowing according to the alternative methods and tax revenues" it is slightly less than 0.73, however, this also indicates a significant correlation.

The results of the study can be used to develop a strategy for reducing the level of shadowing and the implementation of measures to stimulate tax revenues to local and state budgets. The proposed alternative methodology for determining the level of the shadow economy is of theoretical and practical interest for further research into the volume of the shadow economy.

First, it is appropriate to conduct research at a larger time interval, for example, for the period from 2008 to 2023 inclusive, as well as determine the correlation between the shadow economy and tax revenues to the budget for the regions separately in order to draw conclusions about the structure of revenues and shadowing. Second, it is necessary to confirm the versatility of the proposed alternative methodology for estimating shadowing, to apply it to developed economies, such as EU countries.

## ADDITIONAL INFORMATION

### AUTHOR CONTRIBUTIONS

**Conceptualization:** *Nataliia Bak*
**Data curation:** *Tetiana Kalyta, Volodymyr Tarashchenko, Mykyta Artemchuk*
**Formal Analysis:** *Volodymyr Tarashchenko*
**Methodology:** *Nataliia Bak, Tetiana Kalyta, Mykyta Artemchuk*
**Resources:** *Dmytro Riznyk, Mykyta Artemchuk*
**Supervision:** *Nataliia Bak*
**Validation:** *Volodymyr Tarashchenko*
**Investigation:** *Tetiana Kalyta, Dmytro Riznyk, Mykyta Artemchuk*
**Visualization:** *Volodymyr Tarashchenko, Dmytro Riznyk*
**Project administration:** *Nataliia Bak*
**Writing – review & editing:** *Nataliia Bak*
**Writing – original draft:** *Dmytro Riznyk*

### FUNDING

### CONFLICT OF INTEREST

*The Authors declare that there is no conflict of interest.*

## REFERENCES

1. Aktas, N., Andreou, P.C., Karasamani, I., & Philip, D. (2019). CEO duality, agency costs, and internal capital allocation efficiency. *British Journal of Management, 30*(2), 473-493, https://doi.org/10.1111/1467-8551.12277

2. Ali, A., Ramakrishnan, S., & Faisal, F. (2022a). Financial development and natural resources. Is there a stock market resource curse? *Resources Policy, 75*, 102457. https://doi.org/10.1016/j.resourpol.2021.102457

3. Ali, A., Ramakrishnan, S., Faisal, F., Sulimany, H. G. H., & Bazhair, A. H. (2022b). Stock market resource curse: the moderating role of institutional quality. *Resources Policy, 78*, 102929. https://doi.org/10.1016/j.resourpol.2022.102929

4. Allen, F., Yiming, Q., Guoqian, T., & Frank, Y. (2019). Entrusted loans: A close look at China's shadow banking system. *Journal of Financial Economics, 133*(1), 18-41. https://doi.org/10.1016/j.jfineco.2019.01.006

5. Al-Raggad, M., Al-Raggad, A., Al-Raggad, M., Alraggad, A., Al-Mahasneh, A., & Huson, Y. (2024). Examining bribery as a financial crime in the private sector within the framework of Jordanian penal legislation. *Pakistan Journal of Criminology, 16*(1), 635-648. https://doi.org/10.62271/pjc.16.1.635.648

6. Antypov, V. I. (2006). *Shadow economy and economic crime: global trends, the Ukrainian realities and legal controls (theoretical and methodological generalizations).* Vinnytsia: DP DKF.

7. Arnaut, M., Dada, J.T., Sharimakin, A., & Al-Faryan, M.A.S. (2023). Does environmental quality respond (a)symmetrically to (in)formal economies? Evidence from Nigeria. *Society and Business Review, 18*(4), 646-667. https://doi.org/10.1108/SBR-07-2022-0181

8. Baklouti, N., & Boujelbene, Y. (2020). Shadow Economy, Corruption, and Economic Growth: An Empirical Analysis. *The Review of Black Political Economy, 47*(3), 276-294. https://doi.org/10.1177/0034644619885349

9. Berdiev, A.N., & Saunoris, J. W. (2019). On the Relationship Between Income Inequality and the Shadow Economy. *Eastern Economic Journal, 45*, 224-249. https://doi.org/10.1057/s41302-018-0120-y

10. Canh, P. N., Schinckus, C., & Thanh, S. D. (2021). What are the drivers of shadow economy? A further evidence of economic integration and institutional quality. *The Journal of International Trade & Economic Development, 30*(1), 47-67. https://doi.org/10.1080/09638199.2020.1799428

11. Chen, Z., He, Z., & Liu, C. (2020). The financing of local government in China: Stimulus loan wanes and shadow banking waxes. *Journal of Financial Economics, 137*(1), 42-71. https://doi.org/10.1016/j.jfineco.2019.07.009

12. Churchill, S. A., & Danquah, M. (2022). Ethnic Diversity and Informal Work in Ghana. *The Journal of Development Studies, 58*(7), 1312-1331. https://doi.org/10.1080/00220388.2022.2061852

13. Dada, J.T., & Ajide, F.M. (2021). The Moderating Role of Institutional Quality in Shadow Economy-Pollution Nexus in Nigeria. *Management of Environmental Quality, 32*(3), 506-523. https://doi.org/10.1108/MEQ-10-2020-0238

14. Dang, V. C., Nguyen, Q. K., & Tran, X. H. (2023). Corruption, institutional quality and shadow economy in Asian countries. *Applied Economics Letters, 30*(1), 3039-3044. https://doi.org/10.1080/13504851.2022.2118959

15. Davydenko, N., Zhovnirenko, O., & Olifer, I. (2020). The Influence of the Shadow Economy on the Country's Tax System. *Entrepreneurship and Innovation, 13*, 94-98. https://doi.org/10.37320/2415-3583/13.18

16. Esaku, S., & Tajani, F. (2021). Does the shadow economy increase income inequality in the short- and long-run? Empirical evidence from Uganda. *Cogent Economics & Finance, 9*(1), 1912896. https://doi.org/10.1080/23322039.2021.1912896

17. Hou, X., & Yang, R. (2021). Policy signaling and stock price synchronicity: Evidence from China. *Journal of International Financial Markets, Institutions and Money, 75*, 101355. https://doi.org/10.1016/j.intfin.2021.101355

18. Kim, Y., Su, L., Wang, Z., & Wu, H. (2021). The effect of trade secrets law on stock price synchronicity: Evidence from the inevitable disclosure doctrine. *The Accounting Review, 96*(1), 325-348. https://doi.org/10.2308/tar-2017-0425

19. Li, Q., Liu, X., Chen, J., & Wang, H. (2022). Does stock market liberalization reduce stock price synchronicity? — Evidence from the Shanghai-Hong Kong Stock Connect. *International Review of Economics & Finance, 77*, 25-38. https://doi.org/10.1016/j.iref.2021.09.004

20. Mamontova, N. A., & Havruk, N. O. (2023). Optimization of Tax Revenues in the Context of Detinization of the Economy. *ECONOMICS: time realities, 2*(66), 44-47. https://doi.org/10.15276/ETR.02.2023.6

21. Mamun, M. A., Sohag, K., Shahbaz, M., & Hammoudeh, S. (2018). Financial markets, innovations and cleaner energy production in OECD countries. *Energy Economics, 72*, 236-254. https://doi.org/10.1016/j.eneco.2018.04.011

22. Mazaraki, A., Tarasiuk, M., Solonenko, Y., Galenko, O., Lysyniuk, M., & Fayvishenko, D. (2021). Strategic brand management in the market. *Estudios de Economia Aplicada, 39*(5). https://doi.org/10.25115/eea.v39i5.4829

23. Mazur, I. I. (2005). Corruption as an institution of the shadow economy. *Economy of Ukraine, 8*, 68-74.

24. Minfin. (2022). Revenues of the state budget of Ukraine. https://index.minfin.com.ua/ua/finance/budget/gov/income/2022/

25. Ministry of Economy of Ukraine. (2022). Trends of the shadow economy. https://www.me.gov.ua/Documents/List?lang=uk-UA&id=e384c5a7-6533-4ab6-b56f-50e5243eb15a&tag=TendentsiiTinovoiEkonomiki

26. Nguyen, C.P., & Nguyen, B.Q. (2023). Environmental foe or friend: The influence of the shadow economy on forest land. *Land Use Policy, 124*, 106456. https://doi.org/10.1016/j.landusepol.2022.106456

27. Nguyen, C.P., & Schinckus, C. (2022). The Effect of Global Economic Policy Uncertainty on Public Spending: A Perspective on the External Debt and Shadow Economy. *Review of Development Finance, 12*(1), 16-30. https://hdl.handle.net/10520/ejc-rdfin_v12_n1_a2

28. Prokopenko, O., Järvis, M., Prause, G., Kara, I., Kyrychenko, H., Kochubei, O., & Prokopenko, M. (2022). Economic Features of the Use of Electric Vehicles in Delivery Services in Estonia. *International Journal of Energy*

*Economics and Policy, 12*(6), 340-349. https://doi.org/10.32479/ijeep.13617

29. Rahman, S., Faisal, F., Ali, A., Sulimany, H. G., & Bazhair, A. H. (2023a). Investigating the financial market development and shadow economy nexus in the presence of country risk in an emerging economy. *Heliyon, 9*(7), E17791. https://doi.org/10.1016/j.heliyon.2023.e17791

30. Rahman, S., Faisal, F., Sami, F., & Schneider, F. (2023b). Does country risk moderates the financial market development and shadow economy nexus? Evidence from fast-emerging countries analysis. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJOEM-09-2022-1472

31. Schneider, F., & Enste, D. (2013). The Shadow Economy: An International Survey. https://vdoc.pub/documents/the-shadow-economy-an-international-survey-42m0kf48e150

32. Su, K., Zhang, M., & Liu, C. (2022). Financial derivatives, analyst forecasts, and stock price synchronicity: Evidence from an emerging market. *Journal of International Financial Markets, Institutions and Money, 81*, 101671. https://doi.org/10.1016/j.intfin.2022.101671

33. Tarasovskiy, U. (2019). Where and how much does the budget lose? Analysis of tax evasion schemes. LIGA.net. https://finance.liga.net/ekonomika/novosti/gde-i-skolko-teryaet-byudjet-analiz-shem-ukloneniya-ot-nalogov

34. Tiutiunyk, I., Kuznetsova, A., & Spankova, J. (2021). Innovative approaches to the assessment of the impact of the shadow economy on social development: an analysis of causation. *Marketing and Management of Innovations, 3*, 165-174. https://doi.org/10.21272/mmi.2021.3-14

35. Wang, W., Cheng, S., Nahar, S., Alhaleh, S.E.A., & Wang, H. (2022). Does mixed-ownership reform restrain stock price synchronicity? Evidence from China. *Economic Analysis and Policy, 73*, 390-404. https://doi.org/10.1016/j.eap.2021.11.003

36. World economics. (2024). Countries. https://www.worldeconomics.com/Country-Data/

37. Yap, W. W., Sarmidi, T., Shaari, A. H., & Said, F. F. (2018). Income inequality and shadow economy: a nonparametric and semiparametric analysis. *Journal of Economic Studies, 45*(1), 2-13. https://doi.org/10.1108/JES-07-2016-0137

38. Zhang, L., Zhang, Z., Jia, M., & Ren, Y. (2020). A tiger with wings: CEO–board surname ties and agency costs. *Journal of Business Research, 118*, 271-285. https://doi.org/10.1016/j.jbusres.2020.06.026

39. Zhou, L., Wang, Y., Bai, C., & Xiao, W. (2023). How does high-speed railway opening affect stock price synchronicity? *International Review of Economics & Finance, 88*, 154-177. https://doi.org/10.1016/j.iref.2023.06.009

40. Zhu, F., Chen, J., Chen, Z., & Li, H. (2019). Shadow banking shadowed in banks' balance sheets: Evidence from China's commercial banks. *Accounting and Finance, 59*(5), 2879-2903. https://doi.org/10.1111/acfi.12558

*Бак Н., Калита Т., Таращенко В., Різник Д., Артемчук М.*

## ВПЛИВ ТІНІЗАЦІЇ ЕКОНОМІКИ НА ЗМЕНШЕННЯ ПОДАТКОВИХ НАДХОДЖЕНЬ ДО БЮДЖЕТУ ДЕРЖАВИ

Мета дослідження – оцінка та аналіз тінізації економіки держави, а також визначення впливу саме тінізації на скорочення податкових надходжень до бюджету держави. У дослідженні використані загальнонаукові та економіко-математичні методи оцінки, такі як регресійний аналіз, кореляційний аналіз, прогнозування методом інтервалів, а також застосовані економетричні моделі електричного методу Лацко та моделювання рівня тінізації за допомогою моделі MIMIC. На основі проведеного розрахунку було визначено рівень тінізації економіки України на основі державної статистики тенденцій тінізації, що наразі має тенденцію до зростання й 2022 року за прогнозом складає 37,1% від ВВП порівняно з міжнародними даними, які вказують на стрімке зростання тіньової економіки з 27% 2019-го до 44% 2022 року. Для нівелювання особливостей підрахунку рівня тінізації економіки запропоновано альтернативну методику оцінки рівня тінізації, яка за підрахунками 2022 року склала 43%. Визначено, що стрімке зростання тінізації економіки є індикатором скорочення податкових надходжень, особливо 2022 року – майже на 8%. Доведено за допомогою кореляційного аналізу, що зростання рівня тінізації є індикатором скорочення податкових надходжень до бюджету України. Проведений аналіз має певні обмеження, тому доцільно надалі перевірити гіпотезу щодо індикатора скорочення податкових надходжень на більшому діапазоні даних та застосувати альтернативну методику оцінки рівня тінізації для країн із розвиненою економікою, наприклад країн Європейського Союзу.

**Ключові слова:** тіньова економіка, податкові надходження, рівень тінізації, модель MIMIC, електричний метод оцінки, метод динаміки злочинів

**JEL Класифікація:** H00, H20, H70, H71, O17