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COMPARATIVE ANALYSIS AND ADAPTATION OF METHODS FOR ASSESSING THE NON-OBSERVED ECONOMY (CASE OF THE REPUBLIC OF MOLDOVA)

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Abstract

The non-observed economy is the object of research, and the purpose of the study is to calculate it for the Republic of Moldova. Many evaluation methods have been described in the scientific literature and used by researchers. Therefore, a comparative analysis of these methods is needed in order to identify their advantages and disadvantages. In this study, based on the particularities of the development of the economy of the Republic of Moldova and the availability of statistical data, the currency demand model was adapted to estimate the non-observed economy of the Republic of Moldova for 2000-2020. The results of the empirical study show that changes in taxes, interest rate, national income per capita and price index contribute to the modification of the non-observed economy, but wages do not.

Keyword: non-observed economy, methods of assessing the non-observed economy, Laspeyres price index, currency demand approach.

JEL Classification: E26, O17, C39

1. Introduction

The study of the non-observed economy became especially relevant at a time when the national economy of the Republic of Moldova suffered as a result of the drought in 2020, the COVID-19 pandemic and the energy crisis in 2021. Any crisis that has an impact on the economy forces entrepreneurs to put part of their business in the shadows, which leads to the development of the informal sector of the economy. The non-observed economy influences the formation and distribution of income, internal and external trade, capital flows, economic security (food security, energy security, etc.), the growth of the national economy.

The main goal of economic agents who are fully or partially working in the shadows is to obtain additional profit. In this regard, we should distinguish two groups of entrepreneurs: the first group includes those who are obsessed with getting as much money as possible, and the second group - those who have to go into the shadows to survive in the economic and financial crisis, tax

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incidence and fiscal pressure generated by poorly designed fiscal policy, bureaucratic exaggerations, etc. The first group persists in any phase of economic growth, both in the expansion phase and in the economic recession phase. The number of participants in the second group is increasing especially in times of crisis.

The non-observed economy influences not only economic but also social processes. In addition, it has both a negative and a positive impact on economic activity. Among the negative effects can be highlighted: state budget losses, caused by tax evasion, reduced investment in the legal economy, increased population polarization and social tension, creating disproportion in structure of the national economy, etc. The positive effects are: the possibility of preventing bankruptcy, especially for small and medium enterprises, alleviating labor market tensions by creating new jobs in the informal sector, meeting demand by offering goods and services at a lower price, etc. Gutiu and Ganciuov (2018).

The phenomenon of the non-observed economy as a research object has been scientific attractions of scholars in different countries for less than a century. One of the first researchers is PhD Edwin Sutherland (1940) from the USA, who had written about „White-collar criminal”. The scientist pointed out that the elements of the hidden economy are part of the big business. The first to describe the urban informal economy in a particular country (Ghana) is Keith Hart (1973). The English sociologist studied urban occupation and divided informal employment according to the impact on the national economy into legitimate and illegitimate. Legitimate is the one that still has a positive impact on the national economy, and the illegitimate one does not lead to economic growth.

The first international conference on the non-observed economy was held in Germany in 1983, and in 1991 a conference of statisticians on the evaluation of the informal economy was held in Geneva, resulting in a methodological guide to assessing the non-observed economy. In international practice, different types of evaluation methods are used: direct, indirect, modelling (structural equations model (SEM), dynamic general equilibrium model (DGE), etc.). Despite the fact that the number of researches in which one or the other method is applied is not small, however, not enough attention is paid to the comparative analysis of these methods. That's why in this article the authors analyze the applied methods in order to choose the one that will be applied to assess the impact of influencing factors on the non-observed economy, based on the availability of statistical data and the distinctive features of the development of the national economy of the Republic of Moldova. The novelty of the research consists in further develops the currency demand approach for estimate the non-observed economy of the Republic of Moldova. In this article, the authors have tested the following hypothesis: the Laspeyres price index is one of the determinants of the level of the non-observed economy in Moldova. Previous researchers overlooked this factor. The author proved the need to take into account the Laspeyres price index in calculating the level of the non-observed economy for Moldova because this country is an emerging country with an open economy and is an importer of energy resources, food, and manufactured goods. The Laspeyres price index takes into account changes in prices not only for domestic goods but also for imported goods, including energy resources (unlike the Paasche index).

2. Literature review of methods for assessing the non-observed economy

There is no universal method of assessing the non-observed economy that is recognized by researchers in different countries. When calculating the level of the non-observed economy, experts encounter difficulties, because not all its components can be measured and evaluated. Depending on the purpose of the evaluation, a researcher uses one from the developed methods

in the last thirty years. For example, the revenue-expenditure method based on the National Accounts System (SNA) methodology is applied to assess the non-observed economy at the macroeconomic level, and in particular the hidden production of goods and services. The model of natural-value inter-branch balance adapted in accordance with the SNA is applied for estimating the non-observed economy in the real sector in order to assess the losses of the state budget. This model is relevant for the control bodies, because it allows the detection of the elements of the underground economy by goods: illegal import, illegal export, hidden production, Ganciuov and Gutium (2018).

Applying different methods gives different results, in case of using direct methods the result obtained is lower compared to that obtained by applying indirect methods or modeling methods. The methods differ not only in the results obtained, but also in the fields of application. Each of the methods has both advantages and disadvantages (Table 1).

Table 1. The main methods of assessing the non-observed economy

Methods	Advantages	Disadvantages	Scientific sources
Direct methods			
Interviewing	It provides information about the structure of the non-observed economy.	The reliability of the data obtained is low, since not all respondents are ready to report about non-observed economic activities, about payments in envelopes, etc.	Horodnic and Williams (2016)
Fiscal audit	It allows obtaining information about the structure and composition of those who work in the non-observed economy.	Estimates based on the selective fiscal audit reflect only a part of the revenue of the non-observed economy; it does not allow the calculation of the growth of the non-observed economy over a long period of time.	Williams (2014)
Natural-value inter-branch balance adapted in accordance with the SNA	It determines the elements of the non-observed economy by goods, by the types of activity.	It covers only the real sector; the model is complicated and its application requires deep knowledge.	Ganciuov Gutium (2018)
Indirect methods			
Electricity consumption method	The method is very easy to implement.	This method ignores envelope salaries, shadow services and criminal economic activity; the coefficient of elasticity of electricity consumption in relation to GDP changes over time.	Kaufmann and Kaliberda (1996)
Income-expenditure method based on	Quantifying the hidden part of productive economic activity; identification of productive sectors of the	Inability to quantify criminal activity; it does not take into account shadow incomes that	Schneider and Kearney (2013)

Methods	Advantages	Disadvantages	Scientific sources
the methodology of SNA	non-observed economy and assessment of their scale.	are transferred abroad and hidden expense.	
Monetary methods (cash deposit ratio method, transaction method, etc.)	These methods use indicators of official statistics, which are calculated on the basis of data provided by the Central (National) Bank, the financial supervisors and the tax authorities.	Methods are not universal; they are not recommended to apply them in countries with poorly developed commodity-money relations; methods do not take into account inflation.	Gutmann (1977), Tanzi (1983), Feige (2016), Awad et al. (2020)
Modeling methods			
Multiple-indicators multiple-causes model (MIMIC)	The model uses more than one cause-effect relation.	This model leans on a complex evaluation strategy making it subject to measurement errors; high probability of double counting because the model use of national income statistics.	Frey and Week-Hannemann (1984), Medina and Schneider (2018), Almenar et al. (2020)
Dynamic general equilibrium model (DGE)	It has a wide base of variables for analysis.	The distribution of households' labor between the formal and non-observed economies may deviate from what the model suggests.	Elgin and Oztunali (2012), Elgin and Schneider (2013)

Source: Systematization by authors.

Analyzing the groups of methods applied to the evaluation of the non-observed economy, we have concluded that it is quite obvious that direct methods should be used predominantly at the microeconomic level. Indirect methods are usually used to analyze macroeconomic indicators, which allows the assessment of the underground economy at the country level. The MIMIC model could be used to assess not only the level of the non-observed economy, but also the digital non-observed economy (Gasparenenè, 2018). B. Kelmanson et al. (2019) combined empirical research and the MIMIC model. An empirical approach is applied to test various hypotheses: the positive impact of unemployment on the non-observed economy (Manes et al., 2016); the existence of a correlation between the non-observed economy, human development and foreign direct investment (FDI) inflows (Bayar et al., 2020), etc.

N. Suslov and E. Meltenisova (2016) applied the modeling method and showed that there is a positive correlation between the level of the non-observed economy and the price of energy resources, since rising energy prices contribute to the growth of the underground economy. The model developed by these two scientists can be adapted to the new trends in the world economy, namely the shift from the gas pricing mechanism OPE (Oil Price Escalation) to pricing mechanism GOG (Gas-on-gas Competition), Gutiu (2021).

3. Restrictions on the application of various methods for estimating the non-observed economy in the case of the Republic of Moldova

In the Republic of Moldova, very little research is carried out in the field of estimating the non-observed economy. Most of the studies are devoted to the analysis of the features of this phenomenon. Gheorghe Costandachi, who for many years was concerned with analyzing the evolution of the non-observed economy, criticizes the methodology applied by the National Bureau of Statistics of the Republic of Moldova (NBSRM), which consists in “determining the number of persons involved in the non-observed economy by comparing their number in Household Labor Force Survey with that obtained in Statistical Survey of Enterprises”, Costandachi (2016). According to the scientist, the size of non-observed economy obtained after calculation is underestimated. Next, we analyze the obstacles that researchers face in assessing the non-observed economy, which includes hidden production in the formal sector, production in the informal sector, household production for own consumption and illegal production. According to the methodology applied by the NBSRM, the last component is not taken into account when estimating the non-observed economy.

The electricity consumption method is based on the notion that the growth rate of economic activity and the growth rate of electricity consumption change in the same direction; and the coefficient of elasticity of electricity consumption E_e in relation to the total Gross Domestic Product (GDP) including the non-observed economy, is usually approximately equal to one, Kaufmann and Kaliberda (1996):

$$E_e = \frac{\Delta EC\%}{\Delta GDP_t\%} \approx 1 \quad (1)$$

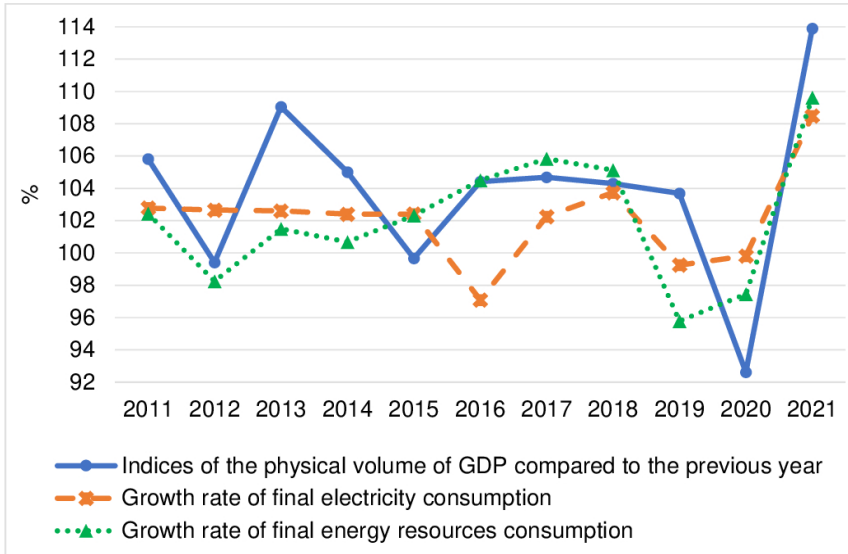
where: $\Delta EC\%$ is the growth rate of electricity consumption, GDP_t is total Gross Domestic Product which is equal officially calculated GDP plus the non-observed economy.

Johnson et al. (1997) modified this relationship using a correction factor of 1.15. In the case of GDP expansion, the growth rate of electricity consumption is divided by 1.15, and in the case of GDP reduction - it is multiplied by the correction factor. This method of estimating the non-observed economy can be applied in countries with stable economies, since in their case the results obtained are relatively correct. However, this method is currently not applicable for the Republic of Moldova, since we will get erroneous results even if we replace “growth rate of electricity consumption” ($\Delta EC\%$) with “growth rate of energy resources consumption” ($\Delta ERC\%$) in the algorithm:

$$E_{er} = \frac{\Delta ERC\%}{\Delta GDP_t\%} \approx 1 \quad (2)$$

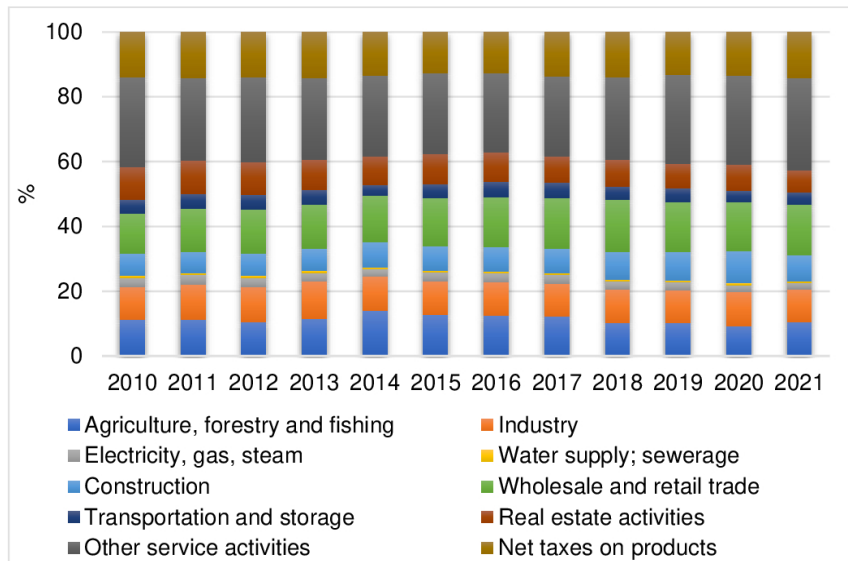
The dynamics of the index of the physical volume of GDP and the growth rate of final electricity consumption show that there is no direct correlation between these two indices (Figure 1).

Figure 1. Evolution of GDP and electricity/energy resources consumption



Source: National Bureau of Statistics of the Republic of Moldova (NBSRM) data.

Figure 2. Structure of Gross Domestic Product by economic activities



Source: Authors' computations using data of NBSRM.

During 2010-2021 real GDP declined significantly in 2012, 2015, 2020, primarily due to natural disasters, which had a significant impact on agriculture - the basic industry of the real sector. Another cause of the 2020 crisis is the COVID-19 pandemic. In these three years, the economic

structure changed, and the share of agriculture, forestry, and fishing in GDP decreased by 1.0 percentage points in 2012, 1.3 p.p. in 2015, and 0.8 p.p. in 2020 (Figure 2).

In 2015, the share of transportation and storage in GDP increased by 1.1 p.p., the proportion of wholesale and retail trade in GDP rose by 0.5 p.p., and final energy resources consumption grew by 2.3%, including consumption of energy products in transport increased by 8.7%, in trade and public services by 5.8%. The cause is the increase in the import of agricultural products.

In 2020, there were follow changes in the structure of GDP: the proportion of agriculture fell, and the share of transportation and wholesale and retail trade decreased (by 0.6 p.p. and 0.5 p.p.). This situation is caused by the COVID-19 pandemic. During the period of isolation, the consumption of energy products by the population increased by 5.5%.

The dynamics of growth of electricity consumption and growth of energy resources consumption is not identical to the evolution of the real GDP growth; therefore, the elasticity coefficients are not constant and take both positive and negative values (Table 2). The electricity consumption to the GDP was elastic during the years of natural disasters (2012, 2015). In 2020 the electricity consumption and energy resources consumption were inelastic because apart from the drought, there was an economic depression. Another problem faced by researchers is the lack of necessary statistical data for a period of more than 20 years; data are available only for the last 11 years.

Table 2. The coefficient of elasticity of electricity/energy resources consumption in relation to the total Gross Domestic Product

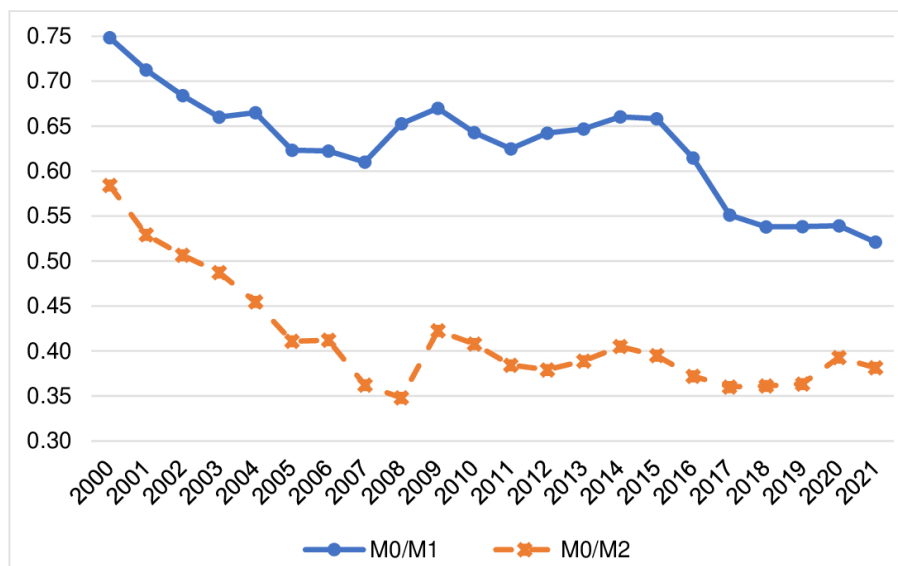
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
E_e	0.48	-4.50	0.29	0.48	-7.12	-0.66	0.48	0.87	-0.20	0.02	0.61
E_{er}	0.42	2.97	0.17	0.14	-6.84	1.02	1.25	1.19	-1.15	0.35	0.69

Source: Authors' computations.

The monetary method of estimating the non-observed economy is based on the hypothesis that shadow transactions are usually carried out with the help of cash, so an increase in the level of the non-observed economy leads to an increase in the demand for cash. An analysis of the dynamics of the share of cash outside banks (M0) in the monetary aggregates M1 and M2 shows that the periods of growth and decline of both indicators coincide (Figure 3).

Therefore, the non-observed economy can be calculated by comparing the ratio of cash outside banks to monetary demand or the ratio of currency to deposits in a given year with the corresponding ratio in the base year. It is considered that the most complicated step in applying this method is to determine the base year with the lower level of the non-observed economy. In order to obtain true results, it is necessary to establish as a base year that year in which the level of the non-observed economy tends to zero. In the case of the Republic of Moldova, this task is difficult to achieve. The main problem facing researchers is the lack of necessary statistical data. In addition, many macroeconomic time series databases are interrupted due to changes in the calculation methodology used by the NBSRM. Therefore, in the case of the Republic of Moldova, the authors recommend that such methods could be applied to the analysis of the dynamics of the non-observed economy and not to the estimation of its level.

Figure 3. Evolution of the share of currency (M0) in the monetary aggregates M1 and M2



Source: Authors' computations using data of National Bank of Moldova.

The authors assessed the non-observed economy by applying the Cash to Deposits Ratio (CDR) method (equation (3), Safuana et al, (2021)) for the period 2001-2021, the base year being 2000:

$$NOE_i = GDP_i \times \frac{(M0_i - M0_b)}{(M0_b + D_i)} \quad (3)$$

where: NOE is the size of non-observed economy, i represents an analyzed year, b is the base year, $M0$ is cash outside banks, D is bank deposits.

Time series data on GDP was interrupted, because in 2018 the NBSRM started to estimate the GDP according to the new methodology of the System of National Accounts (SNA), version 2008. As a result, GDP calculated according to the new methodology (2008 SNA) for 2010-2017 is 19%-20% higher than GDP calculated according to the old methodology (1993 SNA). That is why the authors modified equation (3) in such a way as to directly calculate the share of the non-observed economy in GDP by applying Cash to Deposits Ratio method ($NOE\%_{CDR}$):

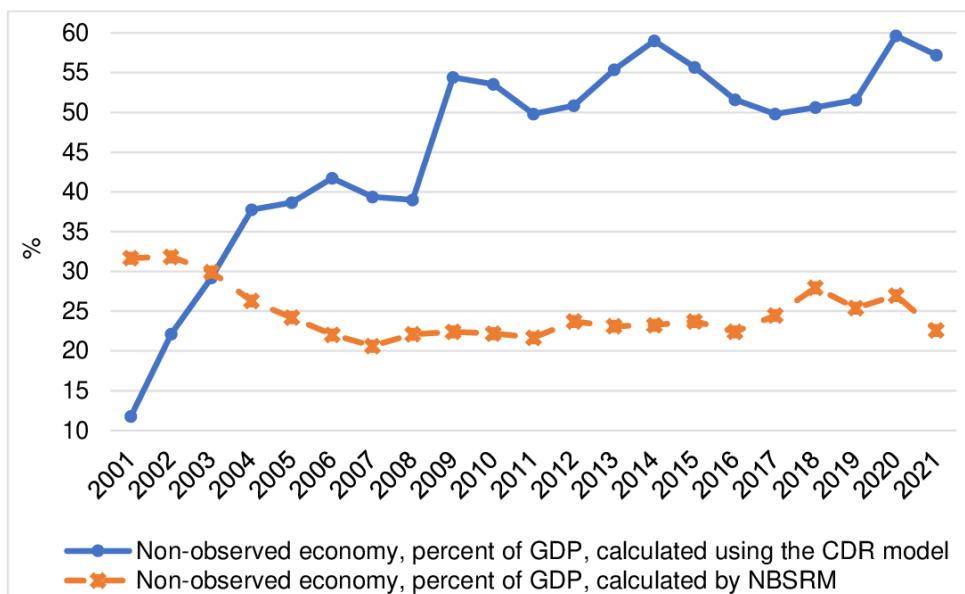
$$NOE\%_{CDR} = \frac{NOE_i}{GDP_i} \times 100\% = \frac{(M0_i - M0_b)}{(M0_b + D_i)} \times 100\% \quad (4)$$

Results obtained based on equation (4) differ from those obtained by BNSRM (Figure 4). Kelmanson et al. (2019) argue that the share of the informal economy in GDP during the global financial crisis from 2008-2009 peaked in many countries. The Republic of Moldova is no exception.

The authors' calculations show that in the year of the financial crisis the share of the non-observed economy in GDP registered a significant increase, but according to the NBSRM calculations the change of this indicator is so small that it is not even visible on the chart (+0.3 percentage points).

The analysis of the evolution of the non-observed economy calculated using Cash to Deposits Ratio method shows that considerable increases took place in 2009, 2014 and 2020. The reason for the increase in this indicator in 2014 is "the theft of a billion", and in 2020 - the economic crisis caused by the COVID-19 pandemic. However, according to the results obtained by the NBSRM, the share of non-observed economy in GDP recorded a visible increase of 3.5 percentage points in 2018 - a year not marked by economic shocks, but in 2014 and 2020 - only by 0.1 and 1.6 percentage points respectively.

Figure 4. Share of non-observed economy in GDP calculated using the CDR model and by NBSRM



Source: Authors' computations and the NBSRM's computations.

Therefore, both methods are not perfect. Cash to Deposits Ratio method overestimates the non-observed economy, but it provides good results in the analysis of the dynamics detecting the years of growth of the unobserved economy caused by financial crises and other economic disturbances. According to the authors, the method applied by BNSRM does not allow to detect the growth peaks caused by economic, financial and other crises, since this method smooths out these peaks.

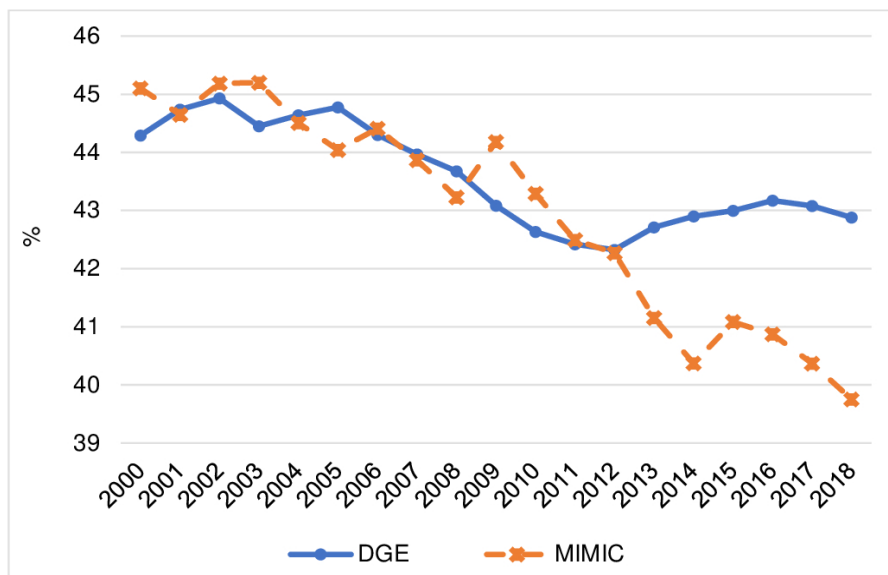
The World Bank has used the MIMIC and DGE models for the assessment of the informal economy in the Republic of Moldova, but since 2019 these estimates are no longer made (Figure 5).

It should be noted that the veracity of the developed models directly depends on the length of the statistical data series. However, the main problem facing researchers is the availability of a few observations, since the methodology for assessing macroeconomic indicators has recently changed, and the National Bureau of Statistics of the Republic of Moldova has not adjusted these

indicators according to the new methodology for previous years, or the data have been recalculated only for a few years.

The authors have taken into account the compatibility of data, the change in the methodology for estimating indicators: Household Budget Survey methodology was modified in 2019; starting with 2019, a new Labor Force Survey is carried out according to the revised definition of employment; in 2018, the BNSRM proceeded to estimate GDP according to the new SNA methodology (2008 SNA); starting with 2017, a new indicator “investments in fixed assets” is calculated, which is not compatible with the indicator “investments in long-term tangible assets”; starting with 2014, the “number of population with habitual residence” is calculated, which is not compatible with the indicator “number of stable population”; etc.

Figure 5. Informal economy size in the Republic of Moldova: DGE and MIMIC models



Source: World Bank Group data.

Because the data series (21 observations in each) of some basic indicators and causal factors are missing, the authors did not obtain veridical models (MIMIC, DGE). But, the application of the currency demand approach (CDA) allowed to obtain a model of the non-observed economy that was validated using statistical tests.

4. Development and application of the currency demand approach for estimating the non-observed economy of the Republic of Moldova

The method of estimating the non-observed economy in terms of money demand is based on the assumption that all shadow transactions are serviced in cash. With the help of econometric

methods, it is possible to estimate the part of cash $M0$ circulating in the shadow economy. Tanzi (1983) proposed and used the following equation:

$$\ln \frac{M0}{M2} = \alpha_0 + \alpha_1 \times \ln t + \alpha_2 \times \ln wage + \alpha_3 \times \ln r + \alpha_4 \times \ln Y_{pc} + \xi \quad (5)$$

with expected values $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 < 0$, $\alpha_4 < 0$, where: t is an income tax, $wage$ represents wages ratio in the national income, r is the interest rate, Y_{pc} is national income per capita, ξ is a random error term.

I.M. Awad and W. Alazzeah (2020) have extended Tanzi's equation (5) and included the variable "rate of workers in their private business to the real ration of workers" ($work$) and replacing the "income tax" with "tax revenue in the GDP" (TR_y). They obtained the following values of the parameters $\alpha_1 < 0$, $\alpha_2 > 0$, $\alpha_3 < 0$, $\alpha_4 < 0$, $\alpha_5 > 0$, but didn't explain why α_1 is negative in equation:

$$\ln \frac{M0}{M2} = \alpha_0 + \alpha_1 \times \ln TR_y + \alpha_2 \times \ln wage + \alpha_3 \times \ln r + \alpha_4 \times \ln Y_{pc} + \ln work + \xi \quad (6)$$

We will analyze this particularity. Raising taxes leads to the transfer the part of business into the shadows. As a result, total tax revenue will decrease, and GDP calculated using the expenditure approach will remain the same or decrease but not in the same proportion as the tax revenue. In the end, non-observed economy will increase. Therefore, in the case of the income tax the parameter α_1 will take positive values, and in the case of TR_y - negative.

Authors used regression equations 5 and 6 to estimate the relation between the main influencing factors and cash to money supply, based on the time series for 2000-2020. The following two regression equations were obtained using EViews 9.

Regression equation A:

$$\ln \frac{M0}{M2} = -0.349 + 0.037 \ln t - 0.022 \ln wage - 0.175 \ln r - 0.251 \ln Y_{pc} \quad (7)$$

$$R^2 = 0.7947$$

Regression equation B:

$$\ln \frac{M0}{M2} = -1.5 - 0.36 \ln TR_y - 0.18 \ln wage - 0.08 \ln r - 0.16 \ln Y_{pc} - 0.1 \ln work \quad (8)$$

$$R^2 = 0.8810$$

These two regression equations A and B are tested in Table 3. The results show that only the coefficient α_4 of the regression equation A and the coefficients α_1 and α_4 of the regression equation B are statistically significant. That is, cash to money supply are significantly affected by tax revenue in the GDP and national income per capita.

In the process of adapting the currency demand approach to estimate the non-observed economy of the Republic of Moldova, the authors tested various influencing factors and finally obtained the following regression equation C:

$$\ln \frac{M0}{M2} = -2 - 0.56 \ln TR_Y - 0.29 \ln r - 0.19 \ln Y_{pc} + 1.25 \ln I_L + 0.23 d09 \quad (9)$$

where: I_L represents price index (Laspeyres), $d09$ is dummy variable (it takes value 1 in 2009; it takes value 0 in 2000-2008 and 2010-2020).

Table 3. The results of null hypothesis testing that the regression parameters are equal to zero

	Regression equation A		Regression equation B		Regression equation C	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
t	1.2822	0.2180	–	–	–	–
TR_Y	–	–	-3.2620	0.0053	-7.5802	0.0000
$wage$	-0.0845	0.9337	-1.0388	0.3154	–	–
r	-1.3484	0.1963	-0.7807	0.4471	-4.1466	0.0009
Y_{pc}	-3.6964	0.0020	-2.9630	0.0097	-5.5836	0.0001
$work$	–	–	-1.2492	0.2307	–	–
I_L	–	–	–	–	5.0935	0.0001
$d09$	–	–	–	–	4.7623	0.0003
Marginal level of the test	2.583	0.01	2.602	0.01	2.602	0.01

Source: Authors' computations using EViews 9.

The inclusion of the exogenous variable such as price index in the model is due to the results obtained in the study of the impact of the 2021 energy crisis on the non-observed economy and the correlation between energy prices (P_{ER}) and the Laspeyres price index:

$$P_{ER} \uparrow \Rightarrow I_L \uparrow \Rightarrow NOE \uparrow \quad (10)$$

If the price of electricity and the price of natural gas increase by 10 percentage points, then the Laspeyres price index will increase by 4.24 percentage points (Gutiu, 2019). Rising prices for energy resources generates a chain reaction on the prices of all goods and services.

An uplift in energy prices are affecting both producers and consumers. First of all, the energy component increases in the cost structure of manufactured products and services provided (Stratan et al., 2009; Duca et al. 2017), so the selling price rises and as a result the price index grows too. Secondly, the increase in prices makes domestic goods less competitive in comparison with imported analogue goods, and in order to reduce costs, part of the business goes into the shadows and, as a result, increases the non-observed economy.

The null hypothesis that the parameters of regression equation C are equal to zero is rejected. The t-statistic and p-values in Table 3 prove that all coefficients are statistically significant.

Next, we will apply the Ramzey RESET test for the regression equation C. The results are represented in Table 4.

Table 4. Result of Ramzey RESET test (regression equation C)

	Value	df	Probability
F-statistic	0.319709	(2, 13)	0.7319
Likelihood ratio	1.008307	2	0.6040

Source: Authors' computations using EViews 9.

Choosing the correct functional form is very important because it affects the interpretation of the estimated parameters. We see that F-statistic Probability $0.7319 > 0.05$ (5%). Probability of accepting the null hypothesis is 73.19%. The auxiliary regression is wrong, but the functional form (logarithmic) of regression equation C is right.

Table 5 presents the results of the statistical test of the regression equation C.

Table 5. Result of multiple regression test (regression equation C)

	Value		Value
R-squared	0.954544	Mean dependent variable	-0.887655
Adjusted R-squared	0.939392	S.D. dependent variable	0.140007
S.E. of regression	0.034468	Akaike info criterion	-3.662624
Sum squared residuals	0.017820	Schwarz criterion	-3.364189
Log-likelihood	44.45755	Hannan-Quinn criterion	-3.597856
F-statistic	62.99831	Durbin-Watson statistic (DW)	1.518691
Probability (F-statistic)	0.000000		

Source: Authors' computations using EViews 9.

Since $0.633 < DW < 1.712$, the hypothesis of the absence of autocorrelation is in the area of uncertainty, i.e. we cannot say whether there is autocorrelation or not. Next, it is necessary to check the autocorrelation using the Breusch-Godfrey test. In the case of lag 2 the probability of accepting the null hypothesis is greater than 1% ($Probability=0.6418$), so lag 2 is insignificant. In the case of lag 1, we get $Probability=0.4673$, this is more than 1%. Therefore, the null hypothesis of no autocorrelation of random deviations can be accepted.

The Glejser test and the Breusch-Pagan test can be used to establish the presence or absence of heteroscedasticity of random deviations of the model. The results of the Glejser test showed that the residuals of the model do not depend on any of the exogenous variables ($Probability(\ln TR_Y) = 0.5344$; $Probability(\ln r) = 0.1649$; $Probability(\ln Y_{pc}) = 0.2775$; $Probability(\ln I_L) = 0.3392$), The results of the Breusch-Pagan test are presented in Table 6. There is no heteroscedasticity in the model ($Probability F = 0.8724$).

Table 6. Results of the Breusch-Pagan-Godfrey test for heteroscedasticity (regression equation C)

	Value		Value
F-statistic	0.353016	Probability F(5,15)	0.8724
Obs*R-squared	2.210946	Probability Chi-Square (5)	0.8193
Scaled explained SS	1.293811	Probability Chi-Square (5)	0.9356

Source: Authors' computations using EViews 9.

It is necessary to test the null hypothesis that the residuals are normally distributed (Table 7).

Table 7. Results of the normality test (regression equation C)

	Value		Value
Mean	4.02e-16	Jarque-Bera	1.477192
Median	-5.55e-17	Probability	0.477784
Maximum	0.047353		
Minimum	-0.076813		
Standard deviation	0.029850		
Skewness	-0.632817		
Kurtosis	3.293922		

Source: Authors' computations using EViews 9.

Since Probability = 0.477784 > 0.05 (5%). H_0 is accepted, the residuals of the model are normally distributed.

The next step is to check structural stability for 2012 and 2015 (Table 8).

Table 8. Chow Breakpoint test results for 2012 and 2015 (regression equation C)

	2012		2015
F-statistic	1.859069	F-statistic	2.256845
Log likelihood ratio	10.84493	Log likelihood ratio	12.58331
Wald Statistic	7.436277	Wald Statistic	9.027381
Probability F(4,11)	0.1880	Probability F(4,11)	0.1289

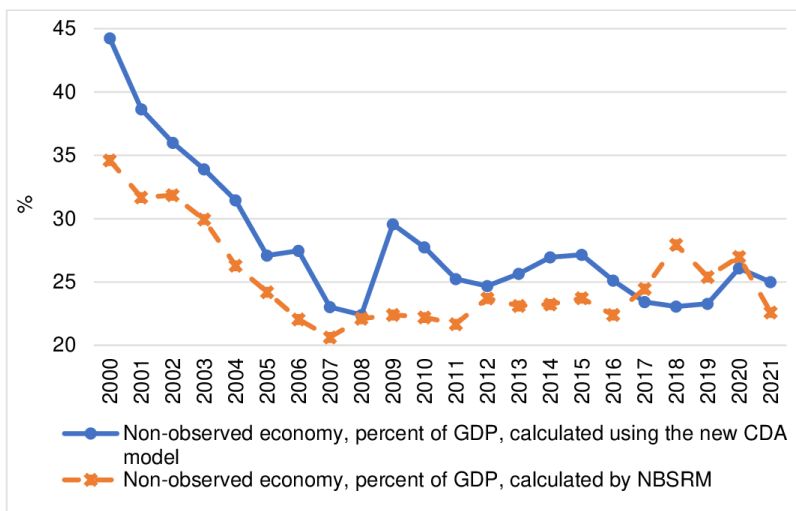
Source: Authors' computations using EViews 9.

Null Hypothesis that no breaks at specified breakpoints (2012 and 2015) is accepted. The model is stable.

After completing the first stage, which consists in adapting the currency demand approach and developing a regression equation for assessing the non-observed economy of the Republic of Moldova, it is necessary to proceed to the next stages: calculate MOt by years using the developed regression equation (in our case, it is equation 9); estimate MOt^* using the same equation but with the condition that taxes are equal to zero, and the Laspeyres price index is equal to 1; evaluate illegal cash by years, which is calculated as the difference between MOt and MOt^* ; estimate the

non-observed economy by multiplying illicit cash by the velocity of circulation $V \left(V = \frac{GDP}{M2} \right)$; calculate share of non-observed economy in GDP (Figure 6).

Figure 6. Share of non-observed economy in GDP calculated using the new CDA model and by NBSRM

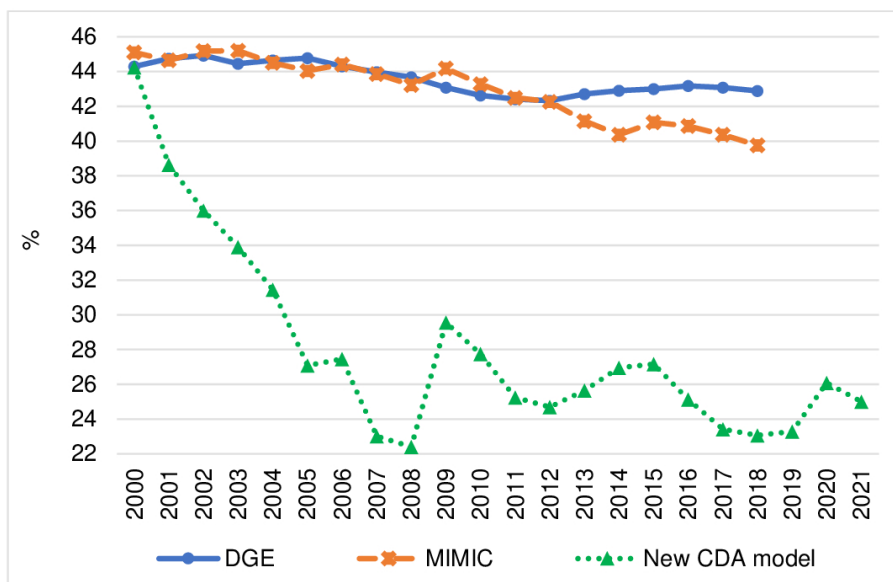


Source: Authors' computations and the NBSRM's computations.

One of the criteria by which the authors test the adequacy of the obtained model is the increase in the share of the non-observed economy in GDP during the years of economic crises. Since, firstly, the share of businesses that have moved to the shadow is increasing in these years. And secondly, the value of the indicator in the denominator (GDP) is decreasing.

The results of calculation have a high degree of reliability. The share of the non-observed economy in GDP evaluated using the new CDA model registered significant increases during the crises in 2009 (by 7.15 percentage points) and in 2020 (by 2.79 percentage points).

Figure 7. Share of non-observed economy in GDP calculated using the new CDA model, DGE and MIMIC models



Source: Authors' computations and World Bank's computations.

Note: Since 2019, the World Bank does not calculate the informal economy in the Republic of Moldova.

The results obtained by the new CDA model and DGE and MIMIC models (World Bank's computations) differ (Figure 7). The authors described the characteristics of the DGE and MIMIC models in the previous Sections. The reasons for the different results are as follows:

- The data used in the listed models differ. The World Bank used data provided in 2018 by the NBSRM, for example, GDP which is calculated by SNA-1993 / ESA-1995 methodology, but the authors used GDP which is estimated by SNA-2008 / ESA-2010. The NBSRM provided these data in 2022. Another clarification is following: the NBSRM takes into account elements of the unobserved economy in the calculation of GDP. The authors used corrected data of GDP (GDP without unobserved economy) in developing a new model (which increases the reliability of the developed model).
- The models use different variables. The MIMIC model relies on a structural equation model with various indicators and causes. The MIMIC model uses variables that reflect the tax burden and intensity of regulation, unemployment, and GDP per capita (in dollars). The DGE model uses only labor factors in the production function of the informal sector. The DGE model applies variables and determinants such as consumption, investment, official output (GDP), employment, and taxes. The World Bank staff used parameter calibration when elaborating the DGE and MIMIC models. The variables of the new CDA model are as follows: money demand, interest rate, tax revenue in the GDP, price index (Laspeyres), national income per capita.

5. Conclusion

Summing up this study, it can be stated that the variety of used methods indicates the absence of a universal method for estimating the parameters of the non-observed economy, which would be reliable for any country. Applying different methods to estimating the non-observed economy gives different results. No model can accurately estimate the size of the non-observed economy. Each calculation method has specific advantages and disadvantages. Therefore, a more objective assessment of the non-observed economy is possible by applying several methods in constructing econometric models that include a combination of various factors.

The most actively developed are indirect methods based on the evaluation of special indicators. A great advantage of these methods is the ability to compare the results obtained in different countries and over different periods of time. The authors have adapted the currency demand approach to calculate the non-observed economy, taking into account the peculiarities of the development of the economy of the Republic of Moldova and the availability of statistical data. The resulting Model C (new currency demand approach model) is adequate and can be used to estimate the size of the non-observed economy for Moldova.

In this survey, the authors confirmed the hypothesis that the Laspeyres price index is one of the determinants of the level of the non-observed economy in Moldova. As a result of the study, it can be argued that the volume of the non-observed economy is influenced by the following factors: indicators of state fiscal policy, interest rate, national income per capita, price index. Therefore, in the context of declining the level of the non-observed economy, it is necessary to strengthen the incentive and distribution functions of the tax system, to reduce the transaction costs of tax administration, to promote the efficient management of energy resources, which will not allow a rapid increase in tariffs, to develop a program for the legalization of shadow activities, which should be based on a balanced use of incentives and restrictions.

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