ESTIMATING THE SHADOW ECONOMY IN BULGARIA USING THE MULTIPLE INDICATORS MULTIPLE CAUSES MODEL

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Abstract

This paper aims to contribute to the existing literature on the shadow economy in Bulgaria, both methodologically and empirically, by providing an up-to-date evaluation of its size. The study of the temporal shifts in the shadow economy size is expected to facilitate the evaluation of unreported economic activities and assist the design of more effective government policies that may enhance revenue collection, economic efficiency, and institutional trust. The multiple indicators multiple causes (MIMIC) model for evaluating the shadow economy is utilized as a methodological approach that explores the dynamics of macroeconomic indicators related to both labour market and money market variables. Empirical estimates of the shadow economy size for the period 2003–2024 are obtained by a system of simultaneous equations. The results obtained confirm that the size of the shadow economy persistently keeps quite high levels in Bulgaria during the covered period of time: between 32 percent and 38 percent. The main factors contributing to this have been identified, namely the ratio of government employment to the labour force, the unemployment rate, and the ratio of subsidies to gross domestic product (GDP). The results indicate that expanding the role of state institutions, encouraging participation in the formal labour market, and a better targeted implementation of subsidy policies have the potential to significantly reduce the shadow economy in the country.

Keywords: Shadow Economy, Econometric Analysis, MIMIC Model, Bulgaria

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1. INTRODUCTION

It is well understood that the formal and the shadow economy in a given country are in constant interaction. For decades, since the early attempts to define the nature of the shadow economy and its scope, as well as empirically evaluating its size, it has been acknowledged that this is not an easy task. Such kinds of economic activities are also named by various terms, e.g., informal, hidden, grey, underground, and even black (Schneider & Neck, 1993; Organisation for Economic Co-operation and Development [OECD], 2002). The difficulty in obtaining accurate information for the economic activities associated with the shadow economy

originates from the concealment behaviour of those involved in this sector. The major incentives of the economic units that operate partly or entirely "in the shadow" are to gain additional profit and/or to avoid paying taxes.

However, lower levels of tax revenues in the formal economy are expected to decrease the level of public investment. Consequently, this would lead to lower economic growth and well-being levels in a country. On the other hand, in times of crisis, the economic agents involved in the shadow economy would secure additional employment and income, which would increase demand and output in the formal economy, which in turn would increase gross domestic product (GDP). Moreover, shadow economy research becomes particularly relevant when a country is facing a crisis. No matter what the crisis is — political, energy, or pandemic — the interest in the extent to which different economic actors or businesses are involved in "shadow" operations certainly intensifies.

The terms "hidden economy", "grey economy", "informal economy" or "shadow economy" are not yet distinctly and unambiguously defined, although methodological approaches to macroeconomic measurement of the shadow economy have been suggested (OECD, 2002; International Labour Organization [ILO], 2013). Blades and Roberts (2002) consider the non-observed economy as a set of economic activities that should be included in GDP but, for various reasons, are not covered by official statistical analyses and accounting records. These reasons are commonly to the evasion of taxes and social security duties and typically relate to violations of bookkeeping and accounting regulations. However, they may be ultimately linked to activities prohibited by law (e.g., smuggling, prostitution, production and/or trade of drugs) or to "informal" economic activities (e.g., production of goods and/or services for own consumption).

On the other hand, Schneider (2006) argues that the shadow economy includes all legitimate production of goods and services that are not reported to the official authorities for the following reasons: avoiding the payment of monetary duties (social security contributions, taxes, excises, license fees, etc.); avoiding the need to meet certain labour market requirements (minimum wage, maximum working hours, work clothing, etc.); non-compliance with certain administrative procedures, etc. This does not include the concept of hidden economy activities prohibited by law, frequently defined as "black" economy, or related to the informal economy. The scope of the shadow economy concept is adopted throughout the current study.

Controversy is also identified when considering the impact that the shadow economy has on the formal one. On one hand, it is generally accepted that the shadow economy causes a number of negative effects, like inefficiencies in the mechanisms of operation of the labour market, goods and services, and reduces the competitiveness of both private and public companies in the formal sector. The relocation of workers to the informal sector undermines the protection of their rights but also leads to less revenue from taxes and social insurance contributions, hence reducing the state and municipal capacity for public spending and investment. Moreover, the shadow economy destroys the trust in state institutions, inspires moral hazard, and fuels corruption practises.

On the other hand, however, a number of authors argue that the shadow economy also has a positive impact on the formal one. Smith (2002) notes that the shadow economy allows some individuals to become employed who otherwise would stay unemployed. Schneider and Enste (2013) argue that at least two-thirds of the income earned in the shadow economy is immediately spent in the formal economy, thus generating a positive net effect.

The current study aims to generate annual estimates for the size of the shadow economy in Bulgaria for the period 2003–2024, applying a version of the multiple indicators multiple causes (MIMIC) model. This technique typically operates with macro variables as "causes" and "indicators" that are integrated in its theoretical framework. The results for the estimated model are, however, very sensitive to the choice of variables and the treatment of each one as a cause or an effect. Even though, the MIMIC approach is considered a highly informative method whose main advantage is the final direct evaluation of the size of the shadow economy, although it is modelled as a latent variable determined by a set of sources (e.g., tax burden, unemployment, etc.) and manifested through another set of indicators (GDP), employment, money in circulation, etc.). The related econometric models are estimated following the MIMIC approach by incorporating indicators that reflect the dynamics of GDP, labour market, and money supply for the respective period. Alternative estimates for the share of the shadow economy in the annual GDP are derived in order to contribute to a deeper study of this problem.

For the last two decades, there has been no single country assessment of the shadow economy using the MIMIC approach except in studies where Bulgaria was included in a group related to the European Union (EU) or the Balkan region. Preliminary estimation results for the shadow economy applying the classical MIMIC framework are provided in Dimitrova (2024). The theoretical concept of the MIMIC approach applied in the current study is enhanced to include an indicator for the relative share in GDP of the money in circulation. A comparison of the causes and indicators identified with the abovementioned study proves to be analytically beneficial as it allows a deeper understanding of the causes that induce shifts in shadow economy size and its consequences for the overall economic development. The study of this size is persistently considered as essential for Bulgarian economic policies, as much as it allows an assessment of the actual scale of unreported economic activities in support of a more effective policy-making.

The structure of this article is as follows: Section 2 reviews the relevant literature on the estimation of the shadow economy in individual countries or regions using different methods, including the MIMIC model. Section 3 analyses the methodology used to conduct empirical research on the size of the shadow economy, applying the MIMIC approach. Section 4 presents the data used for the causes and indicators in the model and tracks their dynamics over the period in question.

The evaluation of the empirical results from the estimated MIMIC models regarding the size of the shadow economy for Bulgaria for the period 2003–2024 is presented in Section 5.

2. LITERATURE REVIEW

Various terms are elaborated in the specialized literature to describe the studied phenomena — e.g., hidden, grey, informal, non-observed economy — but for the goals of this study, the concept of "shadow economy" is used following the traditional cases found in this literature. In their study, Gutium and Stratan (2024) use statistics and a currency demand model to estimate Moldova's non-observed economy over the period 2000–2020. They examine the pattern of electricity consumption where the empirical results reflect the macroeconomic changes in taxes, interest rates, national per capita income, and price indices. According to this theory, the growth rate of economic activity and the growth rate of electricity consumption change in the same direction. A basic assumption in such studies is that the elasticity coefficient for the electricity consumption and GDP, including the non-observed economy, is approximately equal to one (Kaufmann & Kaliberda, 1996).

The grey economy share in Macedonia is estimated in the study of Garvanlieva et al. (2012), implementing the MIMIC approach that utilizes GDP and monetary aggregate (*M1*) indicators covering the 2000–2010 period (this analysis resembles the approach implemented by Dell'Anno, 2007, for Portugal).

In their analysis, Hallunovi and Vangjel (2023) attempt to measure the relationship between economic growth, tax revenues, and the shadow economy using the autoregressive distributed lag (ARDL) model. The evaluation of the shadow economy size in Bosnia and Herzegovina using the MIMIC model for the period 1996–2022 was conducted by Baškot et al. (2025). The indicators included by the authors are the employment rate, GDP per capita, tax revenues, and other institutional variables. These studies avoid presenting the shadow economy as a share of GDP — instead, they focus on the relative shifts in its size over time, which they believe should provide a clearer picture of its evolution. Abela et al. (2022) estimate the shadow economy in Malta using the MIMIC model and the currency demand approach.

Pickhardt and Sarda (2011) built a model to estimate the shadow economy based on a modified money deposit ratio for the period 1960–2008 in Germany. They assume that all money in circulation outside banks can be divided into two parts: one that circulates in the formal economy and another that circulates in the shadow economy. Applying various modifications, the authors evaluate the profile of the informal sector in Germany for the period under study.

Ríos Ibáñez et al. (2021) estimate the size of the shadow economy in the Spanish region of Navarra for the period 1986–2016. Several estimation methods are considered, including the MIMIC model, based on the studies of Dell'Anno (2007) and Schneider et al. (2010). A multi-country study conducted for all 28 EU countries for the period 2011–2014 by Raczkowski (2015) suggests estimates of the level of the shadow economy as a percentage of GDP, applying the MIMIC approach. The model utilized variables like GDP, monetary aggregate (*M1*), taxes, social contributions, unemployment rate, worked hours, etc.

Asllani et al. (2024) implement an improved MIMIC model for their study using economic indicator estimates for 110 countries from 1997 to 2022. They evaluate the model parameters by including fixed effects that are specific to different countries. The study shows significant differences in the engine of the shadow economy between high-income and low-income countries. Asllani et al. (2025) provide measures of the shadow economy of a group of Balkan countries from 1996 to 2021 using the MIMIC approach that utilizes a range of macroeconomic factors. The size of the shadow economy for each of the included countries is obtained as the arithmetic mean of six experimented specifications of MIMIC models. Other authors like Takanohashi et al. (2025) also apply a MIMIC model for 41 countries in Latin America and the Caribbean. This model includes traditional factor variables as well as income inequality, considered as a key factor of the shadow economy size.

Bühn and Schneider (2008) make a first attempt to improve the classical MIMIC method, where an assessment of the share of the informal economy in France is provided. Time series data for the period 1981–2006 are used for the variables monetary aggregate (*M1*) and the real GDP volume index. These authors show that the MIMIC model better quantifies the size of the shadow economy by simultaneously taking into account both long-run equilibrium relationships and short-run dynamic error corrections. Dybka et al. (2019) and Dybka et al. (2023) estimate the average size of the shadow economy and its confidence intervals for a large set of countries, applying the currency demand model. A key assumption of this model is that "most unregulated transactions are settled in cash" (Dybka et al., 2023, p. 1072).

Soares and Afonso (2019) also propose an estimate of the non-observed economy based on the application of the MIMIC model and the monetary method for the period 1970–2015 for Portugal. The authors use the monetary aggregate (*M1*) for estimating the MIMIC model, assuming that the currency in circulation outside banks in non-regular transactions involves only cash payments (Soares & Afonso, 2019). Herwartz et al. (2016) also analyse the potential impact of the shadow economy on the demand for foreign exchange across OECD countries. Dell'Anno and Davidescu (2019) provide estimates for the informal economy in Romania using quarterly data for the period 2000–2014, applying the currency demand approach, the MIMIC model, and the labour utilization approach. For the MIMIC model, they consider as indicators the real GDP index, foreign exchange ratio, and the labour force participation rate.

The shadow economy in Bulgaria has also been studied by a number of Bulgarian economists (Nenovski & Hristov, 2000; Gancheva et al., 2004; Petranov et al., 2022). Nenovski and Hristov (2000) estimate the shadow economy in Bulgaria by examining the demand for currency in circulation (with and without the tax burden) for the period 1997–1999. Estimates of the hidden economy in

Bulgaria for the period 2002–2008 were suggested by Goev and Boshnakov (2008) and Goev (2009) using a direct evaluation method based on a questionnaire survey among business representatives.

3. THE MIMIC APPROACH — METHODS AND DATA

Several major estimation approaches are implemented to measure the shadow economy in the international practice: direct, indirect, structural equation model (SEM), dynamic general equilibrium model (DGE), and MIMIC. As found in the specialized literature, the MIMIC approach seems to be one of the most widely used approaches for measuring the shadow economy, compared to alternative methods such as currency demand modelling, expert estimates, survey methods, and others. These alternative methods are limited in scope, sensitive to the information included, and have low comparability between countries.

The MIMIC model received its name in the study of Jöreskog and Goldberg (1975), as it examines the relationship between causal and latent variables. The observed variables are the causal variables, and the latent variables are hidden, unobserved variables. This approach has been adopted since the 1970s in a number of studies (Zellner, 1970; Frey & Weck-Hannemann, 1984) to estimate the shadow economy size using macroeconomic variables. MIMIC models have been utilized later in a series of studies: Schneider (2005), Schneider and Buehn (2007, 2016), Schneider and Williams (2013), and Schneider et al. (2010).

Estimates of the shadow economy for European countries using the MIMIC model are suggested: for Italy by Dell'Anno (2003); for France, Greece and Spain by Dell'Anno et al. (2007); for Romania by Dell'Anno and Davidescu (2019); for Bulgaria by Dimitrova (2024); for Czechia by Buček (2017); for Portugal by Dell'Anno (2007), Gonçalves (2010), and Barbosa et al. (2013).

The MIMIC model is a type of SEM that consists of two equations. The first equation expresses the relationship between the unobserved variables and their causes. The second equation links the observable variables to the unobservable (latent) ones. The significance of the relationship between the latent variables and the observed causes can be established by the first component of the MIMIC model. This component can be expressed by the following structural equation:

$$\eta = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_k X_j + \upsilon \quad (1)$$

where,

- η — latent variable;
- $X_1\ X_2\ X_3\ \ldots,\ X_j$ — observed factor variables;
- υ — random error.

The second component of the MIMIC model introduces the link between the unobserved (latent) variable and the observable indicators; it is presented by the following equations:

$$Y_1 = \gamma_1 + \delta_1 \eta + \varepsilon_1 \quad (2)$$

$$Y_2 = \gamma_2 + \delta_2 \eta + \varepsilon_2 \quad (3)$$

$$Y_k = \gamma_k + \delta_k \eta + \varepsilon_3 \quad (4)$$

where,

- $Y_1\ Y_2\ Y_3\ \ldots,\ Y_k$ — outcome indicator variables;
- ε — random error.

After expressing the shadow economy level as a percentage of GDP — according to the methodology of Dell'Anno (2007) and Barbosa et al. (2013) — the estimate of this level can be obtained using the structural model in Eq. (5) and (6).

$$\frac{Y_{1t} - Y_{1t-1}}{Y_{2003}} = \delta_1 - \frac{\eta_t - \eta_{t-1}}{Y_{2003}} \quad (5)$$

Time series with indirect measures for the shadow economy as a percentage of GDP are obtained using a transformation equation:

$$\frac{\hat{\eta}_t}{Y_t} = \frac{\tilde{\eta}_t}{Y_{2003}} \frac{\eta^*_{2003}}{Y_{2003}} \frac{Y_{2003}}{\tilde{\eta}_{2003}} \frac{Y_{2003}}{Y_t} \quad (6)$$

where,

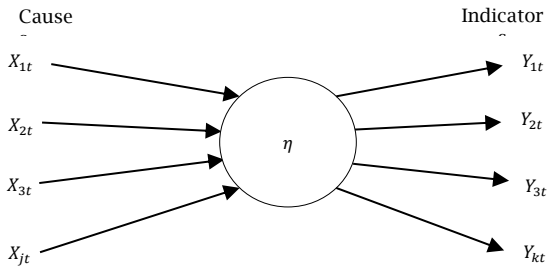
- $\frac{\tilde{\eta}_t}{Y_{2003}}$ — indices of changes in the shadow economy to GDP, calculated using Eq. (5);
- $\frac{\eta^*_{2003}}{Y_{2003}}$ — the exogenously estimated value of the shadow economy for the base period;
- $\hat{\eta}_t$ — the estimated value of the shadow economy.

Equation (6) can be simplified by transformations:

$$\frac{\hat{\eta}_t}{Y_t} = \frac{\tilde{\eta}_t}{\tilde{\eta}_{2003}} \frac{\eta^*_{2003}}{Y_t} \quad (7)$$

The scheme by which the relationships between the observed causes, the unobserved (latent) variable, and the indicator variables can be seen in Figure 1.

Figure 1. General scheme of the MIMIC model



Source: Bühn and Schneider (2008, p. 8).

One of the indicators used for the analysis using the MIMIC approach is the official GDP produced. Researchers argue about directional issues concerning the relationship between the size of the shadow economy and the official one. Some of them (Alañón & Gómez-Antonio, 2005; Schneider & Enste, 2013) believe that when the shadow economy grows, it will engage a larger share of the productive resources and factors that are considered as limited in any economy. It will, therefore, take them away from the formal economy, which should lead to a reduction in the reported GDP. Correspondingly, the reverse will also be true: if the share of

the shadow economy decreases, the official GDP is expected to increase.

However, other researchers dispute the aforementioned claims (Schneider, 2003). According to them, the poorer part of the economically active population, through the shadow economy, finds ways to produce goods and services whose increased consumption spills over into the formal economy. Thus, there could be a simultaneous growth of both types of economies.

The labour force participation rate is measured by the ratio of the labour force and the working age population. Since the full utilization of the labour force is assumed to be relatively constant over time, a decrease in employment in the formal sector should lead to an increase in employment in the informal one (Contini, 1982). Authors such as Bajada and Schneider (2005), Dell'Anno et al. (2007), and Schneider et al. (2010) include the total labour force participation rate as an indicator of shadow economy activities. Still, the impact of the latter on the shadow economy is considered controversial. According to Contini (1982), a decrease in employment in the formal economy leads to an increase in the hidden economy. However, if the employment of people in the hidden economy is in off hours, it will not lead to a reduction in the formal GDP (Bajada & Schneider, 2005).

The monetary approach for accounting for the size of the shadow economy is associated with the monetary circulation. The underlying assumption is that the activities carried out within the shadow economy are served by the use of available cash. The amount of cash required to produce official GDP in normally developed economies exhibits some stability in the short or medium term, or at least follows the variation in the size of GDP. The comparison of cash outside banks to the total money stock can be used as an index to measure the intensity of the shadow economy. Money outside banks has a significant impact on the size of the shadow economy. Alañón and Gómez-Antonio (2025) find a positive relationship between GDP, money demand, and the size of the shadow economy. This suggests that cash held outside the banking system facilitates informal activities, as a substantial share of transactions is conducted in cash to avoid traceability.

In this paper, the causes of the shadow economy that are included in the analysis are: public sector employment, self-employment, unemployment, taxes, government subsidies and social benefits.

Most of the researchers share the opinion that tax burden is one of the main factors for the emergence of the shadow economy. Increasing taxes and tax rates on businesses and households leads to evasion of income that otherwise should be taxed (Frey & Weck-Hannemann, 1984). However, according to Johnson et al. (1999), a higher tax burden may not mean a stronger hidden economy if other factors like tax breaks and/or the availability of other legal ways of avoiding taxation work in the opposite direction. The government employment rate is the indicator that measures the burden of the public sector on the economy. There is no consensus among researchers on whether the relationship is positive or negative between government employment and the size of the shadow economy relative to the GDP. Some researchers believe that higher government employment gives firms more incentives to engage in shadow economy activities (Belev, 2003). Others share the opinion that since the state agents participate fully in the formal economy, higher public employment means less private employment. Therefore, the reduced number of those employed in the private sector would also reduce the number of individuals able to enter the informal sector. Also, a higher level of government regulation should be a higher barrier to such shifts. This group of analysts estimated a negative sign for the coefficient associated with this variable.

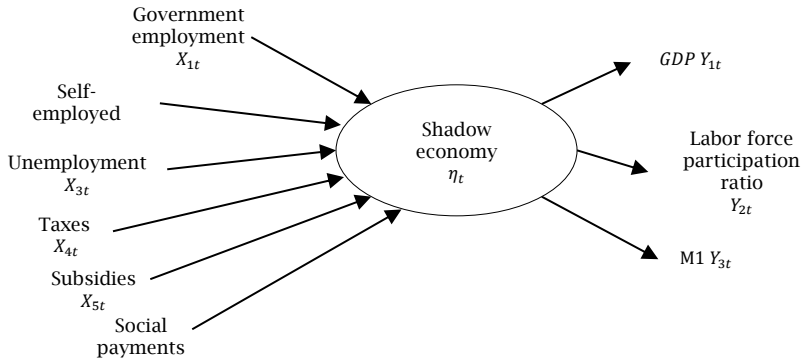
The shadow economy has a very strong positive correlation with self-employment as a percentage of the labour force. The self-employed have many more opportunities to hide income, for example, by not declaring part of their revenues. They also have many more opportunities to avoid paying taxes. Unemployment is a quantity that is measured and relates only to the formal economy — the unemployment rate does not take into account those employed in the shadow sector. It is known that individuals who claim to be unemployed and may even receive unemployment benefits are actually employed in the informal sector. Others are not counted as unemployed because they are not actively looking for a job and, at the same time, are actually participating in the shadow economy. The third segment of cases works in both formal and informal sectors. For these reasons, formal unemployment is expected to interact weakly with the grey economy share (Dell'Anno, 2007; Dell'Anno and Davidescu, 2019).

Social assistance benefits are paid to households in order to provide social support for the costs related to unemployment, sickness, childbirth, child raising, etc. The link between the increase in the share of social assistance in GDP and the hidden economy is not only in one direction. On one side, only those working in the formal economy are entitled to some official social benefits, thus incentivising those working in the shadow economy to relocate and participate in the formal one. But from the other side, some social benefits, such as childcare and energy benefits, could not be received by individuals who have official incomes, thus tempting them not to work in the formal economy, but in the shadow one (Mara, 2021).

The subsidy variable is measured by the amount of non-repayable financial aid provided by the state to businesses and municipalities. According to Dell'Anno (2007), the relationship between subsidies and the hidden economy is mixed. Subsidies to formal businesses reduce the cost of output and services, which should make analogous production in the shadow economy less competitive and hence should lead to its contraction. However, if subsidies are not allocated efficiently in the formal sector, this may lead to temptations for unsubsidised businesses to shift some of their activities to the shadow economy.

On the basis of the relationships between indicators and causes described above, a more extended MIMIC model for the study of the shadow economy is suggested here (Figure 2).

Figure 2. Schematic presentation of the MIMIC model 6–1–3 for the shadow economy



Source: Authors' construction.

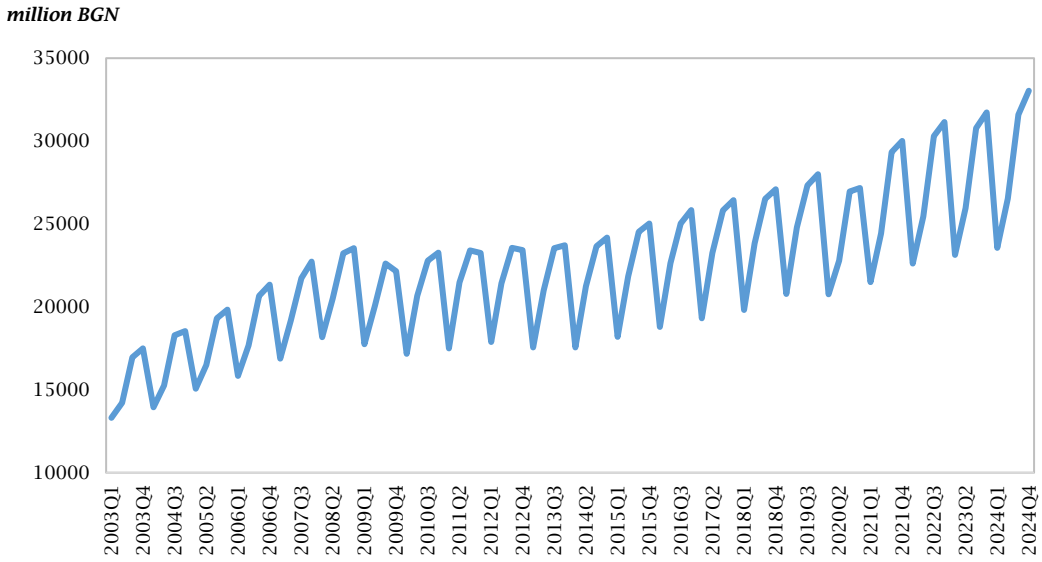
The indicators used in the framework of the MIMIC approach in this study are GDP (at fixed prices), the labour force participation rate, and the ratio of money outside banks to the monetary aggregate (*M1*). The "causes" variables that are considered to reflect the hidden economy dynamics in Bulgaria are the unemployment, government employment, and self-employment ratios. Additionally, the amounts of taxes, subsidies and social benefits taken as ratios to the GDP are also added to the causes list.

4. DATA ANALYSIS

Quarterly data for the macroeconomic indicators involved in the study are utilized for 22 years period (2003–2024) extracted from official sources, e.g., the National Statistical Institute (NSI, https://www.nsi.bg/), the Ministry of Finance (MoF, https://www.minfin.bg/) and the Bulgarian National Bank (BNB, https://www.bnb.bg/). NSI provides the data for labour force variables, government employment, self-employed, unemployment rate, and GDP. In order to provide for real GDP levels, all nominal values have been re-based at the 2015 price level. MoF is the source of the data on collected taxes, distributed subsidies, and provided social benefits — all evaluated at the consolidated state budget level. The latter includes the revenues and expenditures of the consolidated central and local governments, state social insurance funds, and the National Health Insurance Fund. BNB publishes regularly non-bank money and monetary aggregate (*M1*), necessary for the third indicator in the MIMIC model.

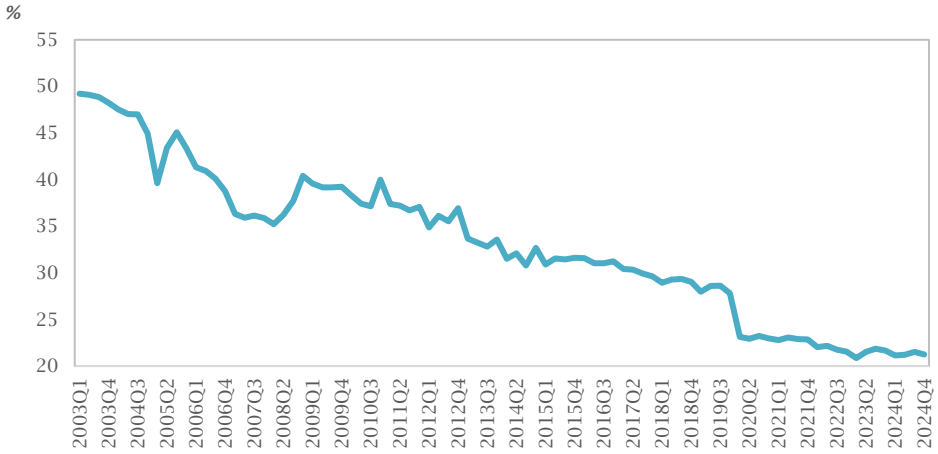
For empirical analysis by the MIMIC models, quarterly real GDP (2015 prices) is used to introduce a scale control by the amount of goods and services produced in each year of the period. The chosen price level year is to some extent equidistant from the beginning and the end of the period under study. The real GDP in Bulgaria has been growing at a roughly constant rate, with GDP of BGN 13 Bn in the first quarter of 2003 reaching BGN 33 Bn in the last quarter of 2024 (Figure 3). On an annual basis, Bulgaria's real GDP has increased from BGN 62 Bn in 2003 to BGN 115 Bn in 2024, with only 2009 and 2020 seeing a decrease in the value of GDP from previous years. These are the two years in which there are crises: the 2008 global financial crisis and the 2020 COVID-19 pandemic crisis.

Figure 3. Quarterly GDP growth in Bulgaria for the period 2003Q1–2024Q4



Source: Authors' construction based on the data from the NSI.

Figure 4. Dynamics of the quarterly indicator of money outside banks to monetary aggregate (*M1*) for Bulgaria for the period 2003Q1–2024Q4



Source: Authors' construction based on the data from the BNB.

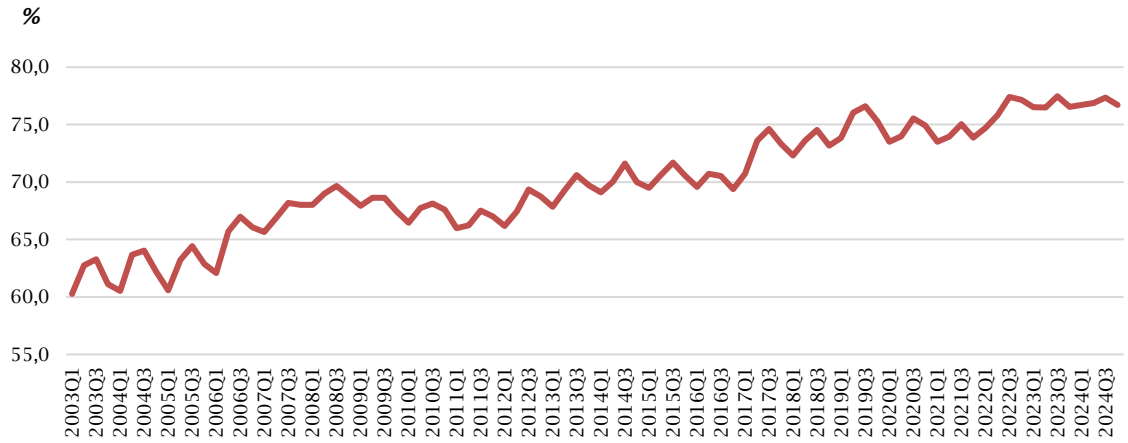
Another important indicator when examining the shadow economy is the quantity of money outside the banks. These are funds that could be involved in transactions of untraceable activities. For the current analysis, a relative indicator of money outside banks to monetary aggregate (*M1*) is calculated (Figure 4). For the entire period of study, this indicator exhibits a steady decline mainly due to the increase in non-cash payments by economic agents, leading to a reduction in the need for cash.

In the first quarter of 2003, the percentage change in the ratio of non-bank money to the monetary aggregate (*M1*) was 49%, declining steadily in the following years to 21% in 2024. This may stem from the fact that the majority of economic agents in Bulgaria have increased their non-cash payments in recent years. During the 2020–2022 health crisis, Bulgarian households also preferred to place orders for supplies and to make payments online.

The labour force participation rate is a leading labour market indicator that shows what proportion of the population aged 16 to 64 is employed in a country's economy. According to the NSI data (Figure 5), the labour force participation rate has been increasing from 60% in the first quarter of 2003 to 75% in the last quarter of 2024. Yet again, after the 2008–2009 crisis, followed by a recovery period up to 2013, a decline in the labour force participation rate has been observed in the country.

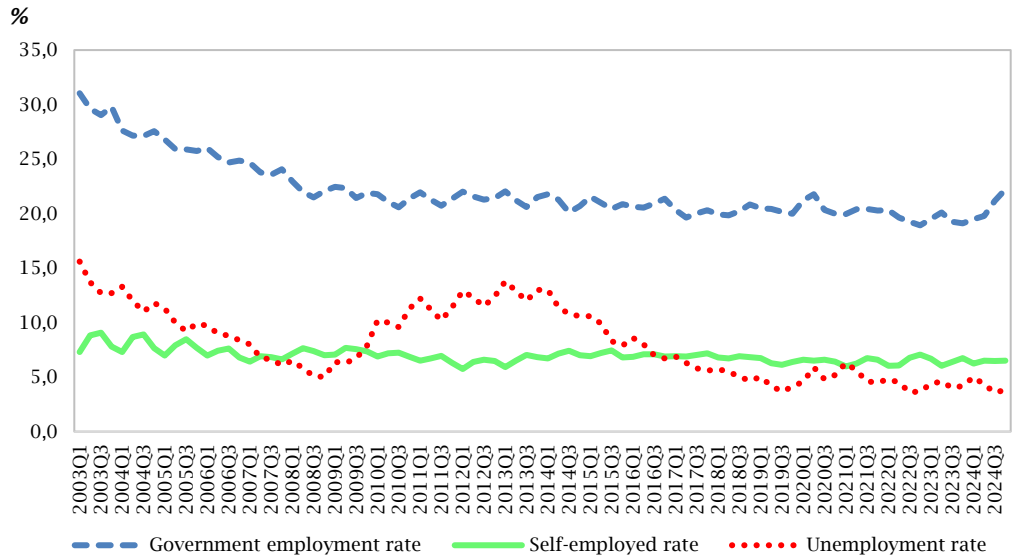
Other important labour market indicators are the unemployment rate, the government employment rate, and the self-employment rate. These ratios have a mixed impact on the size of the grey economy. The lower the unemployment rates and the self-employed in the official economy, the fewer opportunities seem to be available for individuals to find employment in the shadow economy. Public employment consists of individuals allocated entirely in the formal economy, so higher public employment rates should mean lower private employment opportunities for individuals who, in other cases, would be tempted to participate in the shadow sector.

Figure 5. Quarterly labour force participation rate for Bulgaria for the period 2003Q1–2024Q4



Source: Authors' construction based on the data from the NSI.

Figure 6. Dynamics of quarterly unemployment, state and self-employment rates for Bulgaria for the period 2003Q1–2024Q4



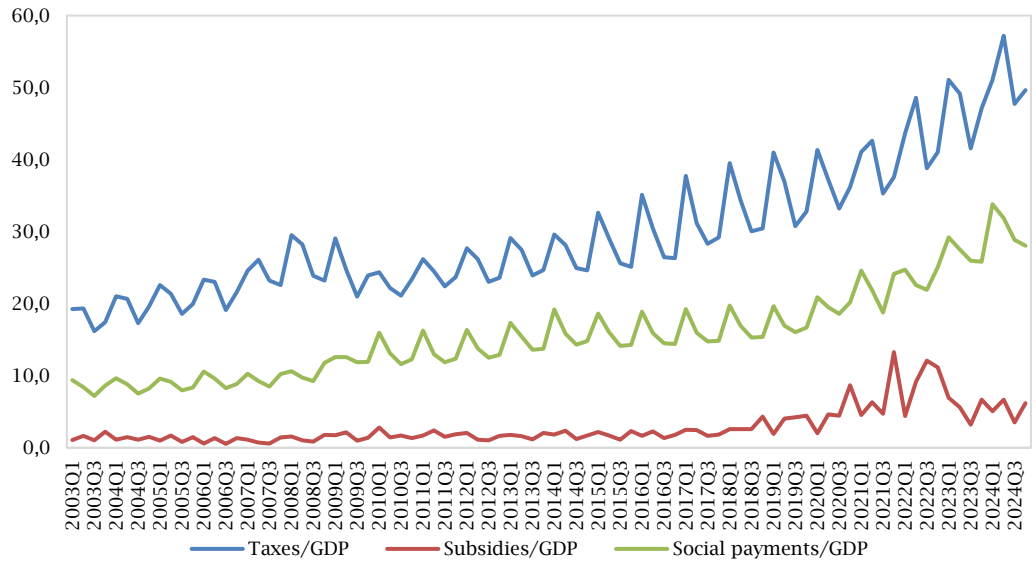
Source: Authors' construction based on the data from the NSI.

The dynamics of unemployment, state employment, and self-employment rates for Bulgaria are shown in Figure 6. Public sector employment in Bulgaria in the first quarter of 2003 was 31%, which declined to 22% at the end of 2008. In the next period (2009–2024), the relative share of the public sector fluctuates between 20–22%. The self-employment rate for the early period (2003–2005) varies between 7% and 9%; however, for the rest of the study period, it stabilized to a level of 6-7%.

The period 2003–2008 was characterised by a declining trend in the unemployment rate, from 15.6% in the first quarter of 2003 to 5% in the fourth quarter of 2008. Since the launch of the 2008 global crisis, the unemployment rate in Bulgaria increased to 13% in the fourth quarter of 2014. In the next period, a gradual decline followed for this indicator, reaching a record low level of 3.8% in the fourth quarter of 2024.

The share of the tax burden over the period 2003–2024 showed a stable rate of increment. As a ratio to the real gross value added (at 2015 price level), taxes used to rise from 18% in 2003 to 50% in 2024. Despite the relatively lower tax levies for businesses, the tax ratios in Bulgaria have been rising noticeably over the last ten years. The tax burden is borne for the most part by individuals, as there has been a continuous increase in local taxes in recent years. Although value-added tax (VAT) is paid by businesses, it is ultimately transferred to the final consumers. Furthermore, tax revenues also increased due to the expansion of the aggregate domestic turnover.

Figure 7. Share of taxes, subsidies and social benefits in GDP at 2015 prices for Bulgaria for the period 2003Q1–2024Q4



Source: Authors' construction based on the data from the MoF and NSI.

Social assistance amounts paid to individuals and households also increased during the period of study — its share in the real GDP increases from 10% in 2003 to 33% in 2024. Subsidies provided by the state to businesses and municipalities in the period 2003–2024 vary from 0.5% to 2.5% of real GDP. The exception is the COVID-19 pandemic crisis years 2020–2022, when the subsidies reached 10–13% of GDP (at 2015 prices). A significant increase in this ratio is observed in the last four years, namely during the 2020–2022 pandemic years, when the state approved exceptional programs to support businesses during the COVID-19 constraints.

5. EMPIRICAL RESULTS ABOUT THE SHADOW ECONOMY IN BULGARIA

Initially, variables for a 6–1–3 MIMIC model — six determinants X_1, X_2, X_3, X_4, X_5, X_6, one latent variable η, and three indicator variables Y_1, Y_2, Y_3 — are generated to facilitate the estimation procedures. The following equation is estimated initially:

$$\eta_t = \alpha + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \beta_5 X_{5t} + \beta_6 X_{6t} + \upsilon_t \quad (8)$$

The exogenous reasons included in the MIMIC 6-1-3 model for assessing the shadow economy of Bulgaria are:

- X_{1t} — government employment;
- X_{2t} — self-employment;
- X_{3t} — unemployment rate;
- X_{4t} — taxes to real GDP;
- X_{5t} — subsidies to real GDP;
- X_{6t} — welfare to real GDP.

There are three observed indicator variables, and the component of the MIMIC model that relates the observables to these indicators is expressed by the following equations:

$$Y_{1t} = \gamma_1 + \delta_1 \eta + \varepsilon_1 \quad (9)$$

$$Y_{2t} = \gamma_2 + \delta_2 \eta + \varepsilon_2 \quad (10)$$

$$Y_{3t} = \gamma_3 + \delta_3 \eta + \varepsilon_3 \quad (11)$$

where,

- Y_{1t} — real GDP index;
- Y_{2t} — labour force participation rate;
- Y_{3t} — the ratio of cash to the monetary aggregate (*M1*).

MIMIC 6-1-3 is estimated by a system of observable causes and indicators for Bulgaria, applying the maximum likelihood (ML) method to generate estimates of the system parameters. In order to optimize the econometric model, those coefficients that are statistically insignificant are eliminated, resulting in a MIMIC 5–1–3a model (see Table 1). The resulting significant coefficients in MIMIC 5–1–3 are:

- X_{1t} — government employment to labour force;
- X_{3t} — unemployment rate;
- X_{4t} — taxes to real GDP;
- X_{5t} — subsidies to real GDP;
- X_{6t} — social benefits to real GDP.

Table 1. Results from the assessment of the MIMIC model for Bulgaria

Model	X_1	X_2	X_3	X_4	X_5	X_6	Y_2	Y_3
MIMIC 6-1-3	-3.545*	0.485	-4.334*	-2.466*	2.961**	2.984*	0.146*	-0.225*
	(-2.880)	(0.090)	(-4.185)	(-2.987)	(2.452)	(3.000)	(7.426)	(-5.17)
	FIML = -780.607		r = 0.768					
	AIC = 18.848							
MIMIC 5-1-3a	-3.484*	-	-4.361*	-2.485*	2.963**	2.990*	0.146*	-0.225*
	(-2.991)	-	(-4.329)	(-3.005)	(3.898)	(2.462)	(7.465)	(-4.992)
	FIML = -834.428		r = 0.713					
	AIC = 19.214							

*Note: * and ** denote the coefficients of the observed exogenous "causes" that are statistically significant at 1% and 5%. The z-statistics of the coefficient estimates are given in parentheses. The system constants are not reported in the table, but both are statistically significant. FIML is full information maximum likelihood, AIC is Akaike information criterion.*
Source: Author's calculations.

When operating such a multivariate model, we need to check whether there is multicollinearity among the set of factors. The tests are performed by the variance inflation factor (VIF) indicator. For this purpose, all variables are included in the initial calculations. It was found that for X_4 and X_6, VIF criterion values above 10 were reported. When only factor X_6 (social benefits to GDP ratio) is removed, all the VIF criterion values are below 10 (Table 2). Therefore, we will estimate MIMIC model 5-1-3b with all the remaining factors X_1 to X_5.

Table 2. Results of the VIF criterion

Results obtained for the regression model with 6 independent variables				*Results obtained for the regression model with 5 independent variables*			
Variable	*Coefficient variance*	*Uncentered VIF*	*Centered VIF*	*Variable*	*Coefficient variance*	*Uncentered VIF*	*Centered VIF*
X_1	0.958	191.356	2.815	X_1	0.854	157.026	2.31
X_2	12.313	241.861	2.031	X_2	13.351	241.402	2.027
X_3	0.74	22.531	3.095	X_3	0.579	16.239	2.231
X_4	0.505	198.62	17.435	X_4	0.106	38.247	3.357
X_5	0.86	4.978	2.212	X_5	0.836	4.453	1.979
X_6	1.102	125.234	16.459				

Source: Author's calculations.

Table 3. Results from the assessment of the MIMIC model for Bulgaria

Model	X_1	X_2	X_3	X_4	X_5	X_6	Y_2	Y_3
MIMIC 5-1-3b	-4.724*	0.920	-3.041*	-0.650	3.817*	-	0.146*	-0.225*
	(-3.835)	(0.163)	(-2.873)	(-1.300)	(2.991)	-	(7.572)	(-5.032)
	FIML = -838.61		r = 0.827					
	AIC = 19.287							
MIMIC 3-1-3	-3.982*	-	-2.494*	-	2.825**	-	0.146*	-0.225*
	(-3.498)	-	(-3.264)	-	(2.359)	-	(7.413)	(-5.207)
	FIML = -841.274		r = 0.815					
	AIC = 19.301							

*Note: * and ** denote the coefficients of the observed exogenous "causes" that are statistically significant at 1% and 5%. The z-statistics of the coefficient estimates are given in parentheses. The system constants are not reported in the table, but both are statistically significant.*
Source: Author's calculations.

The significance of the coefficients for the variables was tested using the z-statistic. Since the variables X_2 and X_4 did not meet the requirements of the z-statistic, they were also eliminated from the previous step MIMIC model 5-1-3b. Now, in the estimated MIMIC 3-1-3 model, all coefficients are significant according to the z-tests. A normality check was performed on the residuals of the MIMIC 3-1-3 model. According to the Jarque-Bera test (JB = 4.098, Sig[JB] > 0.05), there is evidence for assuming that the residual component variable is normally distributed.

The resulting Eq. (8) with the calculated coefficients for the factor variables is as follows:

$$\eta_t = 235.935 - 3.982X_{1t} - 2.494.X_{3t} + 2.825.X_{5t} + \upsilon_t$$

The coefficients in the estimated model can be compared directly since the macroeconomic data for the causes and indicators are in the same unit of measure (percentage), each explaining an aspect related to the dynamics of the shadow economy. The interpretation of parameter estimates is similar to the partial regression coefficients in the multiple regression analysis. Their magnitude indicates the change in the shadow economy associated with a unit increment in the respective "causal" variable, other things equal (i.e., other variables held constant).

The signs of the regression coefficients for the ratio of the government employment to the labour force and the unemployment rate are negative. Decreasing the public employment rate leads to an increase in the shadow economy level, other things equal. It is confirmed that lower public employment is associated with higher private employment; hence, the increased private sector employment size would also increase the size of those available to enter the grey sector. The negative sign of the unemployment rate coefficient provides grounds for a conclusion that a decrease in unemployment leads to an increase in private employment, which can have a similar effect on the availability of labour for shadow economy employment.

The ratio of subsidies to GDP has a positive sign on the shadow economy level, other things equal — i.e., increasing the subsidies may lead to increments in the share of the shadow economy in GDP. This provides evidence that for the study period in Bulgaria, the subsidies are not allocated efficiently, and as a result, a fraction of the business activities is transferred to the shadow economy.

Applying the methodology of Dell'Anno (2007) and Barbosa et al. (2013), the latent variable estimates are obtained by a backward calculation. Using the estimate of the shadow economy for the baseline period provided by Schneider et al. (2010) — $\frac{\eta^*_{2003}}{Y_{2003}} = 35.6\%$ — the exogenously estimated value of the shadow economy rate to GDP can be calculated for the remaining years of the period.

Table 4. Shadow economy estimates for the period 2003-2024 in Bulgaria

Year	*Shadow economy percentage of GDP (%)*
2003	35.6
2004	35.6
2005	36.4
2006	35.8
2007	36.5
2008	37.5
2009	38.3
2010	36.4
2011	34.9
2012	33.4
2013	33.5
2014	34.7
2015	35.1
2016	35.1
2017	36.1
2018	36.2
2019	35.8
2020	36.8
2021	36.0
2022	37.0
2023	34.2
2024	32.2

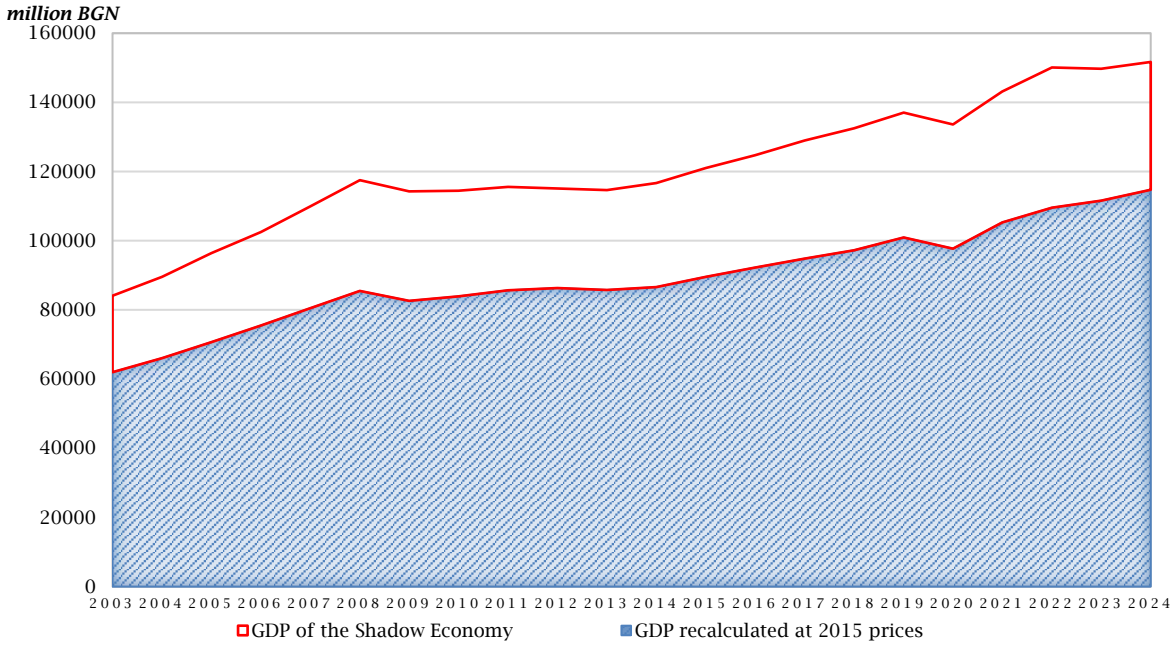
Source: Author's calculations.

The dynamics of the shadow economy (Table 4) show that its share in GDP increased from 36.4% to 38.3% over the period 2005–2009. In 2012 and 2013, the shadow economy share of GDP varied around 33%, and for the period 2014–2021, it continued to vary at a slightly higher level (around 35–36% of GDP). The highest level reached during the studied period is observed in 2022: 37%. In the last two years of the covered period, a slight decrease in the share of the shadow economy in GDP in Bulgaria is observed to levels of 34% in 2023 and 32% in 2024, respectively. As the main reasons for this can be identified as the ratio of government employment to labour force (X_{1t}), the unemployment rate (X_{3t}), and the ratio of subsidies to real GDP (X_{5t}).

Government employment (as a share of the total labour force) declined from 31% in the first quarter of 2003 to 22% at the end of 2024; the unemployment rate also declined over this period. However, the average quarterly rate of

decline for government employment is estimated at 1% and for unemployment, 2% respectively, while the subsidies as a share of GDP used to increase at an average quarterly rate of 2%. This way, an offsetting effect of the included "causes" of the shadow economy in Bulgaria is observed for the period 2003–2024. Of course, the high values for 2008, 2009 and 2010 could also be explained by the global financial crisis of 2008–2009, which, although in a milder version, forced the private sector enterprises to transfer part of their activities to the grey economy to spend less on taxes, social security, and to save themselves from bankruptcy.

Figure 8. Annual real GDP (2015 prices) and GDP in the shadow economy in Bulgaria for the period 2023–2024



Source. Author's calculations.

After deriving the estimates for the annual ratios of shadow economy to GDP for the covered period, they can be used for calculating the absolute amount of the GDP generated by the grey sector. The official GDP is thus augmented by the non-reported amounts estimated by the MIMIC method. Figure 8 presents the dynamics of the annual real GDP (at 2015 prices), including both reported and non-reported components, as well as the share of the shadow economy calculated by the estimated MIMIC model. The shadow economy keeps its persistent size during the study period, reflecting slightly two turbulent events within its scope, e.g., the global crisis of 2008–2009 and the pandemic of 2020–2021.

The discussion of the presented results shows that the dynamics of the relative change in the shadow economy in Bulgaria remain practically unchanged for the period under consideration compared to the preliminary study (Dimitrova, 2024), which confirms the stability regardless of the specification of the MIMIC model used. The distinction between the implemented approaches only pertains to the choice of indicator variables. Upon applying the classical MIMIC model, in addition to public sector employment, the level of unemployment, the share of subsidies, and the share of tax revenues in GDP are found as statistically significant factors. The introduction of the indicator for the share in GDP of money in circulation (outside the banking system) directly leads to the loss of significance of the effect of the share of tax revenues in GDP. This might be due to the fact that this indicator should capture the effect of the tax burden for eventual suppression of economic activity more directly and with higher sensitivity, leading to a partial overlap of the information contained in the two indicators. As a result, tax revenues lose their independent explanatory power in the presence of an indicator having a more direct effect on the shadow economic activity.

5. CONCLUSION

The empirical analysis suggested by the current study implements the MIMIC approach for the estimation of the shadow economy share in the Bulgarian economy in terms of the real GDP using quarterly data for the period 2003–2024. The grey economy still represents a large segment compared to the formal economy of the country. For the period 2008–2009, its share in GDP reached 37.5%, but for the period 2014–2022 remained steady at around 35–37% of GDP. In the last two years, a slow decline in the shadow economy level is observed to 34% in 2023 and 32% in 2024, respectively, with the main contributing factors being the ratio of government employment, the unemployment rate, and the ratio of subsidies in GDP.

It is evident from the study that the reduction in government employment as a percentage of the workforce in 2024 relative to 2003 is associated with higher levels of GDP, although the shadow economy levels reflect a mixed impact over the studied period. Declining unemployment in

Bulgaria from 10% in 2003 to 4% in 2024 leads to an increase in GDP, and the results show its impact on the grey economy. The sign of the unemployment variable coefficient is negative, which can lead to the conclusion that a reduced unemployment rate can lead to an increase in employment in both the official and the shadow economy. The latter has maintained a relatively constant level (as a share of the official GDP) over the last ten years, which confirms the widely shared opinion that many individuals participate in different kinds of grey economy activities.

In recent decades, Bulgarian tax policy has focused on diminishing the overall tax burden by reducing the share of direct taxes at the expense of the indirect ones. The abolition of progressive taxation and its replacement by a proportional (flat) tax on personal income, as well as the dividend tax reduction from 10% to 5% in 2007–2008, clearly show the long-term intentions of the tax policy in Bulgaria. At the same time, the share of VAT and excise revenues in GDP increased significantly over the period under review. This is due not only to the change in the direct and indirect taxes, but also to changes in the social and health insurance contributions, increases in the minimum wage, along with the minimum and maximum insurance levels. All this gradually increased the tax collection, even though the growth in official GDP was considered insufficient. Manipulating the tax burden ratios did not succeed in reducing the shadow economy levels — there are still other factors that act in the opposite direction, such as the bureaucratic barriers and ineffective law enforcement, tax control mechanisms, etc.

Increased subsidies to GDP should reduce the cost of production and services in the formal sector, which should make the analogous production supplied by the grey economy less competitive, thus the informal sector should decrease. However, the positive sign obtained from the study on the subsidy's variable shows a unidirectional relationship between subsidies and the shadow economy in Bulgaria during the study period. This most likely implies an inefficient distribution of subsidies to the formal sector, facilitating, in a way, some shifts of resources and labour to grey sector operations.

This study contributes to the empirical literature by providing a quantitative assessment of the size of the shadow economy in Bulgaria, based on the extended MIMIC model, which combines information from the real and monetary sectors. The model integrates indicators for official economic activity, including GDP and employment, as well as a monetary indicator for the share of money in circulation outside the banking system, which captures hidden forms of economic behaviour. Concurrently, the main causes of the shadow economy in Bulgaria are identified and evaluated, including employment in the public sector, the unemployment rate, and the share of subsidies in GDP. A significant contribution of the article is the demonstrated robustness of the dynamics in the shadow with alternative model specifications, which confirms the reliability of the results obtained and limits the risk of specification distortions. The analysis shows that the choice of indicators affects the identification of determinants without changing the profile of the latent variable, which has important meteorological implications. The significance of the study for future analysis lies in the proposed applicable framework for the shadow economy in Bulgaria, which allows for the integration of additional factors (fiscal, institutional, monetary, etc.). The results obtained provide a basis for comparative studies between Bulgaria and other countries, as well as for a more in-depth study of the interaction between economic policy and shadow economic activity.

Given the methodological assumptions of the MIMIC approach, the results obtained in this study should be considered with caution. Based on previous estimates of the ratio of the Bulgarian shadow economy in GDP, a first attempt is made here to generate empirical estimates for this ratio by applying the MIMIC method. This multivariate approach systematically proved to be a useful and reliable tool for evaluating and understanding the dynamics of the shadow economy in any country. Still, the relevance of the variables selected for causes and indicators plays a crucial role in the success of the implementation of this methodology. Their selection should reflect the determining variables influencing the shadow economy to ensure the reliability and accuracy of the results. This allows the results to guide the development of effective policies and strategic decision-making in practice.

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