ИКОНОМИЧЕСКИ ИЗСЛЕДВАНИЯ
ECONOMIC STUDIES

Volume 31 (2), 2022

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SHADOW ECONOMY AND PRODUCTION FACTORS: RESULTS FROM AN EMPIRICAL ANALYSIS WITH A PANEL DATA SET[6]

The main objective of this article is to examine the existence of a relationship between the shadow economy and macroeconomic factors of production. Based on a dataset of 50 countries over the period from 1991 to 2015, we find that the size of the shadow economy is inversely related to all three macroeconomic production factors – labour, capital stock and total factor productivity. This result provides an explanation for the fact that, in many cases, the shadow economy has a negative impact on economic development. We also find that the strength of the relationship is not the same for all factors of production. While for capital and for total factor productivity, the inverse relationship with the size of the shadow economy is strong, in the case of labour, this relationship exists, but it is weaker. The reason for this is the specific nature of many of the shadow practices, related to undeclared work, which allow such an effect.
The results of the present study could provide arguments for the formation of effective economic policy measures to limit the negative effects of the shadow economy.
Keywords: shadow economy; undeclared work; economic development; GDP per capita; GDP per capita growth rates; macroeconomic factors of production
JEL: E22; E24; E26; O17; O43

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[6] This research paper is financed by the "Scientific Research" Fund under project № 80-10-192/ 06.04.2021.
This paper should be cited as: *Petranov, S., Zlatinov, D., Velushev, M., Georgieva, L., Ivcheva, R. (2022). Shadow Economy and Production Factors: Results from an Empirical Analysis with a Panel Data Set. – Economic Studies (Ikonomicheski Izsledvania), 31 (2), pp. 44-64.*

Introduction

The shadow economy and the official economy are not isolated from each other but are in constant interaction. From the point of view of economic theory, the effects of this interaction can work in different directions. On the one hand, it can be expected that lower tax revenues, a natural outcome of the shadow economy, will result in lower levels of public services and public investment. This would lead to lower economic growth and lower gross domestic product (GDP). On the other hand, the existence of an informal sector can play the role of a safety net in times of crisis, as well as provide employment and additional income that increase demand and thus stimulate production in the formal sector of the economy. This would lead to a higher gross domestic product, other things being equal.

Empirical data on the relationship between the size of the shadow economy and GDP are also ambiguous. There is evidence to support the hypothesis that such a relationship exists and that it is inverse: the shadow economy slows down economic growth and economic development. But there is also evidence to support the alternative hypothesis.

In this paper, we examine the shadow economy and GDP per capita nexus and find empirical arguments for the existence of a statistically significant inverse relationship between these two variables. However, this paper does not focus on the result, but its main objective is to examine the existence of a relationship between the shadow economy and macroeconomic factors of production. To the best of our knowledge, this issue has not been addressed in the economic literature so far. The results of the study of this issue can shed light on the specific reasons for the existence of a relationship between the shadow economy and economic development, as well as on the channels through which such a relationship is demonstrated in practice. This would help to better understand the processes of interaction between the formal and informal sectors of the economy, as well as the formulation of appropriate policies to limit the shadow economy. Moreover, such results may be important for analyzing the issue of causality in the relationship between shadow economy and economic development.

Our study is based on the logical assumption that if there is a relationship between the size of the shadow economy and GDP per capita, there must be a similar relationship between the shadow economy and some of the macroeconomic factors of production such as labour, capital, and technological progress.[7] On this basis, we analyzed a panel of data for fifty countries in the period 1991-2015. The countries analyzed consist of almost all European countries: both EU member states and not[8], as well as the former republics of the Soviet Union.

The article is organized into four different sections: each contains different aspects of the conducted research. In Section 1 we provide a literature review on the theoretical arguments and the empirical results related to our study. Section 2 presents our findings with respect to the relationship between the shadow economy and the GDP per capita nexus, including the

[7] We refer to the macroeconomic production factors according to Solow's growth model. Other possible production factors are out of the scope of this study.

[8] All countries in Europe are included except for Andorra, Lichtenstein, Monaco, San Marino, and Vatican City.

methodology used and the data set. In Section 3 we analyze the role of macroeconomic production factors: capital, labour, and technological progress. More precisely, Section 3.1 reveals the theoretical rationale for the expected relationships with respect to the factors of production – here, our reasoning is based on Solow's growth model. Then, in sections 3.2-3.4, the empirical results from our study for the possible impact of the shadow economy on production factors are presented and analyzed separately for each factor of production. We find that the shadow economy is negatively associated with all three macroeconomic factors of production, but the strength of this inverse relationship is different for the different factors/varies among the different factors. Section 4 presents our main conclusions from the study and provides some ideas for future research.

1. Is the Shadow Economy a Booster or a Bottleneck to Growth? A Literature Review

The shadow economy has been studied by many economists and there is an extensive literature in this field. Some of the main research directions and the most widely used methodological approaches are presented in Schneider & Williams (2016a) and Fleming, Roman & Farrell (2000).

Historically, the damage that the shadow economy causes on public finances has been a priority topic in research (Tanzi, 1999; Kanniainen, Pääkkönen, Schneider, 2004). Although this is logical and indisputable, recently, some authors have been focusing on a wider range of effects related to the economic and social development. Hoinaru et al. (2020) and Baklouti & Boujelbene (2020) put the emphasis on the relationship between the shadow economy and economic development, poverty, corruption, and human capital. Other researchers are more focused on determining the size of the shadow economy and comparing it by countries and regions to examine the indirect links to the socio-economic progress (Enste, 2015) and (Williams, Schneider, 2016).

Various arguments can be given about the relationship between the size of the shadow economy and GDP growth. Some researchers point out the strictly negative trade-off between the two variables due to tax evasion and subsequent budget problems[9], overestimated unemployment and inflation, lack of social protection[10] under unofficial employment status, corruption, and inefficient public administration. Other scientists find positive effects stemming from the shadow economy: additional workplaces are created, and new income sources are available for households that help to partially balance inequality and poverty reduction.

Schneider (2005) considers the relationship between the shadow economy and economic growth: it is positive in industrialized and transition countries and negative in developing countries. His argument is that economic agents in high-income countries are overburdened by taxes and regulation, so that the shadow economy stimulates economic activity by relaxing

[9] Shadow economy research rarely pays attention to tariff violations which lead to lower budget revenues. See Madanski (2019).

[10] Low social protection and insecurity are one of the main reasons for workplace conflicts bringing additional negative effects due to shadow economy practices. See Mihaylova (2022).

the tight regulations that governments implement. In the same manner, Williams (2006) claims there is a positive correlation between the underground economy and GDP growth when hidden entrepreneurs find ways to avoid strict government regulations.

Almenar, Sánchez & Sapena (2020) consider that the primary drivers of the shadow economy in Greece, Italy, Portugal, and Spain are the tax and social security payment burden. However, Denmark, Finland, and Sweden are among the EU Member States with the highest tax burden that amounts to over 50% of GDP, as well as among the top ten countries with the lowest size of the shadow economy (Krumplytė, 2010). Austria, Denmark, the Netherlands, Finland, Sweden, and Germany are also examples of that higher level of economic development is associated with a lower size of the shadow economy (Ginevicius, Kliestik, Stasiukynas, Suhajda, 2020). Such practical observations show that tax incentives can neither be the single, nor even the most important factor that determines the nature of the relationship between the shadow economy and GDP.

Tunyan (2005) stresses that many shadow activities such as small-scale production factories and unregistered street vendors provided employment and income to many Armenian families during the transition from centrally planned to market economy in the early 1990s. These activities fostered entrepreneurial skills and allowed new businessmen to accumulate initial capital, in order to shift their activity into the official sector of the economy. Similar arguments are provided for Baltic countries (Remeikiene, Gaspareniene, 2015) and for Russia by Mandroshchenko, Malkova & Tkacheva (2018). Dell'Anno (2008) also finds a positive correlation between unofficial economy and GDP in Latin American countries: during the transition to market economy factors, such as the lack of competence of official institutions, weak enforcement of legislation, unprotected property rights[11], and high costs of business development stimulated informal business activity which in turn facilitated demand-driven economic growth. In Bulgaria, this issue has been addressed in several publications of the Center for the Study of Democracy (Gancheva et al., 2004). However, the so-called "transitory effect" is ambiguously confirmed and limited: Zaman & Goschin (2015) failed to identify a significant positive impact of the shadow economy on economic growth in Romania, although they concluded that a long-run relationship between the shadow economy and GDP exists.

In an earlier research, Eilat & Zinnes (2000) estimate a negative impact of the size of the shadow economy on official GDP for 24 transition countries from Central and East Europe and the former Soviet bloc. A strong inverse relationship between shadow economy and GDP using a structural VAR model covering 2000-2013 is also found for Romania by Davidescu (2014). Moreover, Wu and Schneider (2019) find a non-linear relationship between the shadow economy and GDP which implies that the shadow economy can coexist with different levels of development.

Regarding developing countries, Kirchler (2007) estimated that 41% of all economic activities in South America and over 70% in Africa are in the unofficial sector. Based on the experience of Latin American countries in the early 1990s, Loayza (1996) also concludes

[11] In other aspects, the economic and social risks from higher protection of property rights are discussed in Shalamanov (2018).

that an increase in the size of the informal sector has a negative effect on GDP growth due to a large tax burden and poor legislation. Ineffective allocation of resources in these countries, combined with corruption and criminal activity, is a strong bottleneck to growth, which causes a prolonged economic stagnation. The negative effects that the shadow economy causes, i.e., a decrease in tax revenues, low productivity, and higher public expenditures that aim to compensate the subdued corporate activity but, in fact, stimulate corruption, are prevailing and researchers find a strong negative correlation between shadow economy and economic growth. Hoinaru et al. (2020) stress that the shadow economy is poverty-driven and correlated with low levels of both economic and sustainable development, which is highly valid for low-income countries. This conclusion is also evident for emerging and developing Asian economies (Nguyen, Luong, 2020) and Colombia (Schneider, Hametner, 2014).

One of the most recent and complex research on the relationship between shadow economy and GDP is conducted by Wu and Schneider (2019) using data for 158 countries in 1996-2015. They identify a U-shaped relationship between the size of the shadow economy and the level of economic development, which shows that "the economies at a low development level witness a negative relationship between the size of the shadow economy and GDP per capita, but when GDP per capita exceeds a threshold, the size of the shadow economy goes up with per capita income" (p. 4).

The research of Wu and Schneider (2019) not only summarizes the observations from past research, but it is also one of the few studies that examine the effect of factors of production on the size of the shadow economy, which is the focus of our paper. Wu and Schneider (2019) discuss the link between productivity improvement and technological advancement that may support the long-run expansion of the shadow economy thanks to a high level of human capital achieved. They also refer to stronger institution capacity and better social infrastructure that bring firms and individuals from the informal to the formal sector.

According to Mandroshchenko, Malkova & Tkacheva (2018), shadow economy firms do not invest in R&D and they also negatively affect the labour force available for production in the formal economy. Considering this negative effect on capital and labour, we can conclude that the authors view the shadow economy as a bottleneck to the long-run economic growth and potential GDP growth. Remeikiene & Gaspareniene (2015) conclude that the imperfections of the labour market are the most significant determinant of the shadow economy in the Baltic States. Unfavourable crediting policies and business conditions have a negative impact on the capital in Lithuania and Estonia and also foster shadow economy practices. Yaskal et al. (2021) consider labour market rigidities as one of the main reasons for the generation of informal employment that directly affects the labour market in the official economy. La Porta & Shleifer (2008) emphasize that human capital is lower in the unofficial economy because informal workers, on average, have a lower education level which leads to lower levels of innovation and productivity. Baklouti & Boujelbene (2020) focus that a reduction in the tax base because of shadow economy activities negatively affects the investment in public infrastructure, which, in turn, may harm the economic growth. Naghdi et al. (2015) draw attention to the fact that the underground economy has negative effects on the financial sector, as well as on the macroeconomic performance through capital accumulation.

Following the literature review we provided, one can conclude that the impact of the shadow economy on economic development and growth is very complex. It is not only related to purely fiscal effects but also to poverty, inequality, efficiency of governance, reforms implemented, and business cycle phase, as well as to the income level of the country. Therefore, it makes sense for research efforts to focus on the specific factors that stimulate or hinder the shadow economy at a certain phase of economic development. Although some researchers have drawn attention to the possible impact of the shadow economy on the factors of production, to the best of our knowledge, this issue has not been extensively researched with respect to all factors of production at the macroeconomic level and particularly with empirical evidence based on official statistical data. We believe this issue deserves more in-depth study and in the following sections, we have tried to fill this research gap, in order to deepen the analysis of the effects of the shadow economy.

2. Shadow Economy and Economic Development

The phenomenon of the shadow economy existence is historically connected to the centralization of political power and the emergence of the State. From the viewpoint of the government, any economy consists of an informal and an official (formal) sector. The informal sector is defined as the production of goods and services that have market value, but do not generate taxes and other contributions to the budget (OECD 2002). There are certain ambiguities connected to that definition that largely stem from the fact that the informal sector comprises three different types of activities: activities that are legal per se but are not subject to taxes nor obey government regulations, activities that are illegal, so they cannot be taxed or regulated, and, finally, activities that are not counted in GDP like charitable work and household activities, for example.

Like most of the other studies on the subject, we distinguish between the three types of activities, and in our study, we consider only the activities that are legal in nature but evade taxes or regulations. For those, we use another term, shadow economy, as per Schneider (2012) and Medina and Schneider (2018), who use this expression to describe the production of legal goods and services that is hidden from the government and labour that is hidden from public authorities but is employed in any production of legal goods and services.

There are several theories explaining the existence, as well as the size of the shadow economy, which point at different causes (Zolkover at al., 2020). The modernization theory connects the shadow economy with the stage of economic development of the country. According to this theory the more the economy of a country develops, the larger the number of shadow economy businesses that will abandon the informal sector and will enter the official sector. On the other hand, the neoliberal theory explains the existence and size of the shadow economy with the level (degree of?) of centralization of power, the efficiency of bureaucracy, the excessive regulation, and the (frequency of?) state interventions. The political economy theory points out that the informal sector will appear and grow whenever the State is uninvested in the well-being of its citizens. The institutional theory considers that the shadow economy is a result of formal rules and regulations that do not reflect what economic agents perceive as fair.

In essence, all mentioned theories conclude that the shadow economy is expected to be larger in the underdeveloped, emerging economies and its share and significance diminish as the economies and the societies develop. Yet there is a point to be made, that the shadow economy phenomenon is persistently present in all contemporary economies. There are estimates that currently, the shadow economy in the European economies ranges between less than 10 and over 40 per cent of GDP and its size tends to increase during recession and contracts in times of economic upturn (Kelmanson et al., 2019). The main reason for the existence of the shadow economy is that it provides something which the official sector cannot – market rules without government intervention. The shadow economy adds to the gross value-added by producing goods and services with a market value that might not be produced if government restrictions are applied. But at the same time, the shadow economy does not contribute to the redistribution of national income. It provides jobs mainly for the unskilled and illegal workers, but those jobs are usually low paid and/or dangerous. It helps with coping with cyclical downturns as it provides means to survive to people at or under the poverty line, but it diverts the workforce from the official sector.

In this section, we examine the relationship between real GDP (RGDP) per capita and its growth rate on the one hand and the shadow economy on the other. We do this for two purposes: firstly, we want to contribute to the discussion on the relationship between the shadow economy and economic development with concrete empirical results. As can be seen from the literature review, in some cases, there are conflicting opinions about this relationship. In addition, we will use these results as a basis on which to analyze the relationship between the shadow economy and macroeconomic factors of production in the following sections.

As we want to find out whether the level of economic development is correlated with the size of the shadow economy, we find it helpful to examine more observations of countries that are somewhat connected but are at different stages of their economic development. For this reason, we chose to study the data for 50 countries in Europe and Central Asia that share social values and civilizational paths and have strong trade relations. Namely, those are all of the European Union member states, the rest of the European countries, as well as the majority of the former republics of the Soviet Union. Thus, in this section, as well as in the following sections, we examine a panel database of 50 countries with annual data for each country for 1991-2015: the longest period for which we have comparable data. The list of countries in the current study is presented in Appendix I.

For the purposes of our study, we use estimates of the size of the shadow economy published by Medina and Schneider (2018)[12], which are presented as a percentage of the official GDP. RGDP data in constant prices (international 2011 USD) is taken from IMF (2017), while population data is from the World Bank database, available as World Bank Open Data on the

[12] This publication does not include estimates for Kosovo, Montenegro, Serbia, and Northern Macedonia. Therefore, for these countries we use estimates published by Kelmanson et al. (2019). In both cases the authors have used the so-called MIMIC (Multiple Indicators Multiple Causes) approach which is based on structural equations modeling.

institution's website. By dividing RGDP by population, we obtain data for RGDP per capita. These data are shown in Appendix I[13].

To find out whether there is a statistically significant relationship between RGDP per capita and the size of the shadow economy, we use cross-country correlation coefficients between the average RGDP and the average size of the shadow economy. The variables that we examine are 25-year averages (for the period 1991-2015), 17-year averages (for the period 1993-2009) and 20-year averages (for the period 1993-2012). From a formal point of view, we calculate $corr\ (\overline{RGDP},\ \overline{SE})$, where:

$$\overline{RGDPC_i} = \frac{1}{n}\sum_{t=1}^{n} RGDPC_{it}; \overline{SE_i} = \frac{1}{n}\sum_{t=1}^{n} SE_{it}$$

$RGDPC_{it}$ – real GDP per capita in country i for year t;

SE_{it} – size of the shadow economy in country i for year t;

n – number of years for the period under study.

We do these calculations using different time periods for robustness check. On the one hand, it is logical for the study to include as much data as possible in order to cover the longest period and thus to give an idea of the long-term characteristics. At the same time, the countries under study are at different phases of their business cycles that are not synchronized; therefore, the results for a single specific time period can be influenced by the business cycle phase. For this reason, in addition to the longest time period, we consider two additional periods, which cover one and two business cycles, respectively[14], within the period 1991-2015. The period 1993-2009 covers the business cycle, which started from the trough in 1993, because of the crisis of the centrally planned economies, to the trough in 2009, which was a result of the global financial crisis. The period up to 2012 includes, in addition to the above cycle, also the short cycle to the trough in 2012, following the debt crisis in Europe. The results are shown in Figure 1 of Annex II and in Table 1, Appendix III.

Figure 1 shows a scatter plot in terms of the average size of the shadow economy and the average RGDP per capita for the period 1991-2015, with each country included in the study presented separately. As seen(observed) from the graph, there is a clear inverse relationship between the two variables: countries that have a low size of the shadow economy are characterized by high real GDP per capita and vice versa. For example, Switzerland, Austria, Luxembourg, the Netherlands, which have estimates for the average size of the shadow economy between 7% and 11%, also have average real GDP per capita between 37 thousand and 47 thousand US dollars. At the same time, countries such as Georgia, Azerbaijan, Ukraine, Belarus, which have estimates for the average size of the shadow economy between 44% and 64%, similarly have average real GDP per capita between 6.8 thousand and 11 thousand US dollars per capita.

[13] The data sources for the variables used in the other sections are provided in the relevant sections.
[14] Cycles are with respect to the overall economy of the region – i.e.. Europe and Central Asia in total.

The conclusion from the graph for the presence of an inverse relationship between the two studied variables is also confirmed when calculating the correlation coefficients between them (Table 1, Appendix III). The coefficients for all three considered periods show the presence of a statistically significant[15], strong inverse relationship.

Once the inverse relationship between the shadow economy and real GDP per capita has been established, we apply the same procedure and analyze in the same way the possible relationship with respect to the growth rates of real GDP per capita. It turns out that in this case, the relationship changes.

Figure 2 in Annex 2 shows a scatter plot diagram of the average size of the shadow economy and the average growth rates of real GDP per capita for the period 1992-2015. The correlation coefficients for the three studied periods are presented in Table 1, Annex III and they show that in the period 1991-2015, there is no statistically significant correlation. However, if we consider the other two periods, which are consistent with the business cycles of the region, a correlation exists and it is statistically significant at 5% at 10% level, respectively. Moreover, the relationship is positive, i.e., countries with a larger size of the shadow economy are associated with higher growth rates of real GDP per capita.

At first glance, the above result contradicts the previous one that countries with a larger shadow economy are associated with a lower GDP per capita. Naturally, one could expect that higher growth rates of real GDP per capita should lead to higher levels of GDP per capita, not the opposite. But our interpretation of this result is that the inverse relationship between the shadow economy and GDP per capita is a long-term characteristic, while the positive relationship (or lack of relationship) between the shadow economy and the growth rate of GDP per capita is a short-term characteristic. Among the countries studied are many countries from Central and Eastern Europe, as well as from Central Asia, which in the early 1990s started their transition from a centrally planned to a market economy. They began their development after a major crisis of transformation, which led to a very low start base, and during the period under review, generally achieved higher growth rates than the developed economies in Western Europe. But as these growth rates are because of the low base, they are the result (outcome?) of the catch-up effect while the developed economies in Western Europe have already reached or are close to their steady-state development trajectories. In other words, the possibility to observe both high values for the size of the shadow economy and high values for the rates of real GDP per capita derives from the specifics of the studied period and is a temporary and transitional characteristic.

3. The Role of Production Factors

3.1. Why production factors are important

The volume of GDP for a given period depends on the factors of production that are included in the production process during the respective (given) period. It follows that if there is a relationship between real GDP per capita and the size of the shadow economy, then there

[15] In Table 1 p-values are equal to zero due to rounding.

should be a relationship between the shadow economy and some or all of the factors of production.

To formalize this idea, we use the apparatus of the Cobb-Douglas production function in the context of Solow's growth model. It relates the output of an economy to its productive inputs:

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \quad (1)$$

where:

Y_t – real GDP in year t;

K_t – capital stock in year t;

L_t – labour employed in year t;

A_t – total factor productivity in year t;

α – output elasticity of capital;

$1 - \alpha$- output elasticity of labour.

Dividing both sides of the above equation (1) to the value of population P_t and after rearrangements, we arrive at the following result:

$$\frac{Y_t}{P_t} = \frac{A_t K_t^{\alpha} L_t^{1-\alpha}}{P_t} = \frac{A_t K_t^{\alpha} L_t^{1-\alpha}}{P_t^{\alpha} P_t^{1-\alpha}} = A_t \frac{K_t^{\alpha}}{P_t^{\alpha}} \frac{L_t^{1-\alpha}}{P_t^{1-\alpha}}$$

In this way, we derive the following equation:

$$\left(\frac{Y}{P}\right)_t = A_t \left(\frac{K}{P}\right)_t^{\alpha} \left(\frac{L}{P}\right)_t^{1-\alpha} \quad (2)$$

The obtained equation, which is a macroeconomic production function in intensive form with respect to the population, shows that GDP per capita is a function of the capital stock per capita, labour per capita and total factor productivity. At the same time, the results in Section 2 show that there is an inverse relationship between the shadow economy and GDP per capita. This conclusion, along with equation (2), shows that the shadow economy can be expected to have a similar inverse relationship with respect to capital per capita or with respect to the amount of labour employed per capita or with respect to total productivity. In the following sections, we analyze these issues.

3.2. Capital

The first factor of production that we examine for a relationship with the shadow economy is capital stock. There are many arguments based on economic logic, which give reason to expect a negative relationship between the size of the shadow economy and the amount of capital stock in a country. Some of them are highlighted in the literature review in Section 1.

Such is the argument of Baklouti & Boujelbene (2020) that the erosion of the tax base due to shadow practices negatively affects the investment in public infrastructure, as well as the conclusion of Naghdi et al. (2015) that the shadow economy has negative effects on the financial sector and as a result on capital accumulation.

But in our opinion, these are not the only channels through which the spread of shadow practices can affect investment activity and, ultimately, the amount of physical capital. We could add other options. For example, the reduced tax base not only decreases investment in public infrastructure, but also reduces investment opportunities in state-owned enterprises. In addition, shadow practices taking place in enterprises lead to an artificial reduction of their financial results. This, in turn, makes access to official financing of these enterprises from banks or from the capital market more difficult and consequently leads to lower volumes of investments. It is also very important to consider the impact of the investment climate in general. The relatively large size of the shadow economy creates an unfavourable investment environment in many aspects, and this naturally has a negative impact on investment.

To test the relationship between the size of the shadow economy and the amount of capital, we use annual data from the IMF (2017) for the capital stock in the relevant countries.[16] In accordance with equation (2), we divide the amount of capital by the value of population[17], in order to obtain the amount of capital per capita for each year of the period 1991-2015. Then, we calculate the average capital per capita for each country separately for the three periods studied.

Figure 3, Appendix II, shows a scatter plot diagram illustrating the relationship between the average size of the shadow economy and the average amount of capital per capita for the period 1991-2015, each point representing a separate country. Visual inspection of the graph clearly shows (illustrates) the inverse relationship between these two variables. The graph shows that countries where the level of capital per capita is high, for instance, Austria, Denmark, Switzerland, Norway, Luxemburg, tend to have a smaller size of the shadow economy. For these countries, the amount of average capital per capita is in the range between USD 112 th. (Austria) and USD 159 th. (Luxembourg) while the average size of the shadow economy is estimated to be between 7% (Switzerland) and 14% (Norway). On the other hand, countries whose shadow economy is estimated to be relatively large/countries with relatively large size of the shadow economy: like Georgia, Azerbaijan, Belarus, Ukraine, Moldova tend to have a small amount of capital per capita. For these countries, the amount of the average capital per capita varies between USD 5.4 th. (Azerbaijan) and USD 22.6 th. (Ukraine), while the average size of the shadow economy is estimated to be between 43% (Moldova) and 64% (Georgia).

This conclusion based on the visual inspection is also confirmed analytically by the respective correlation coefficients, which are presented in Table 1, Appendix III. As evident from Table 1 there is a statistically significant inverse relationship between shadow economy

[16] Data series for all countries are expressed in billions of constant 2011 international dollars (purchasing power parity adjusted), using the corresponding component-specific deflators from OECD, Penn World Tables, and World Bank databases.
[17] Population data are described in Section 2.

and capital per capita. The correlation coefficients show a strong inverse relationship, and their significance is confirmed by the low (zero due to rounding) values of p-value.

This correlation provides a possible explanation for the existence of a relationship between the shadow economy and GDP per capita. The informal economy is counterproductive to investment activity. The widespread use of shadow practices worsens the investment environment, limits access to finance for companies and directly reduces opportunities for private and public investment. This leads to less capital per capita and hence indirectly to less GDP per capita, other things being equal. According to the results in Table 1, this conclusion is stable over time. The strength and the direction of the correlation does not change significantly in the different periods considered.

3.3. Labour

The labour market plays a central role in any market economy. Having access to stable and protected employment is vital for escaping poverty and promoting inclusion. At the same time, shadow practices are often widespread on the labour markets. In many countries, the labour markets continue to be characterized by persistent informality and undeclared employment. This is not a surprise given the fact that some of the most important motives for the implementation of shadow practices are related to the labour market regulations. Very often, the practice of undeclared employment, "envelope wages", "moonlighting"[18] or bogus self-employment is motivated by the willingness to deliberately circumvent the payment of social security contributions and taxes or different requirements for the working conditions.

The above arguments give reason to expect that there might be a certain relationship between the size of the shadow economy and the amount of labour used to produce the official GDP. To test the probable existence of such dependence, we use data for employment from the International Labour Organization (2020).[19] The data is harmonized to account for differences in national data and scope of coverage, collection and tabulation methodologies, as well as for other country-specific factors.

The amount of labour employed in the production process is best described by the number of man-hours worked. But in our case, we use data on the number of people employed. This is due to the lack of harmonized time series data for such a wide range of countries as included in our study. This is an inevitable compromise for such type of comparative analysis. We believe that the number of people employed still gives a very good approximation for the labour input.

For testing the relationship between the size of the shadow economy and the amount of labour, we follow the procedure applied in Section 3.2 with respect to the capital stock. In accordance with equation (2), we divide the number of people employed by the number of

[18] An idiom for working on the side (at a secondary job), often in the evening or at night.

[19] ILOSTAT, Employment statistics. According to ILO's definition employed comprise all persons of working age who during a specified period were in one of the following categories: a) paid employment (whether at work or with a job but not at work); or b) self-employment (whether at work or with an enterprise but not at work).

the population[20] to obtain the ratio between employed and population[21] for the period 1991-2015. Then, we calculate the average employment rate per capita for each country separately for the three periods studied.

Figure 4 in Annex II shows a scatter plot diagram for the average size of the shadow economy and the average employment per capita for the period 1991-2015, where each country included in the study is depicted as a separate point. Visual inspection of the graph shows that in this case, again, we observe an inverse relationship between the two variables, but this relationship is clearly less strong than in the case of the capital stock.

Most countries concentrate around the line running from south-east to north-west. Countries with a low average size of the shadow economy tend to have higher employment per capita ratio. For example, Switzerland, Austria, the UK, the Netherlands have average employment per capita ratio between 0.5 and 0.55, while for countries with a relatively high share of the shadow economy like Armenia, Bosnia and Herzegovina or Kyrgyzstan, this ratio is between 0.34 and 0.37. But at the same time, there are countries that do not fit into such a model. For example, Georgia, Azerbaijan, Ukraine, Belarus, and several others seem to be outliers with respect to this pattern. These countries are characterized by both a large size of the shadow economy and a relatively high employment per capita. Such characteristics formally reduce the strength of the correlation relationship, and the respective statistics are shown in Table 1, Appendix III.

In this case, as it can be seen from Table 1, there is a moderate inverse relationship between employment per capita and the shadow economy. The relationship, in this case, is weaker[22] , but the correlation coefficients remain statistically significant. For two of the three periods examined in the study, the significance is at 5% confidence level, and for the other period (1993-2009), the significance is at 10% confidence level.

The relatively weaker relationship can be explained: the reason is rooted in the various forms through which the labour force participates in shadow practices and the ways in which labour is recorded in official statistics. There are several fundamentally different forms of undeclared labour that can be implemented to varying degrees depending on the circumstances. One possibility is for people working in an official/formal enterprise to accept a second job that is not officially declared for another enterprise or for a household. If the first job is officially declared, whether full-time or part-time, then these people will be included in official statistics as employed, although their second job generates shadow income. In this case, it is possible to have a large share of the informal economy and, at the same time, a relatively high official employment. A similar possibility is for employees to be (officially) part-time workers, but to work full-time and to receive an "envelope wage" funded from the sales of undeclared products. In this case, too, these workers still will be

[20] Population data is described in Section 2.
[21] The indicator obtained in this way is analogous to the employment rate, with the difference that the employment rate is calculated not based on the whole population but based on the working age population.
[22] If the outliers listed above are excluded from the sample, the strength of the correlation relationship is similar to that with respect to the capital stock.

counted in the official statistics as employed, meaning that both high employment and a high share of the shadow economy can coexist.

A special case is when there is a significant number of immigrant workers in a country who are not officially registered[23]. They can be cross border workers or permanent residents, but because they are not officially registered, they are not part of the official workforce. Therefore, their participation in the shadow economy does not affect national labour statistics and there is no obstacle for the latter to record high employment. The effect would be similar when people who are not included in the official workforce (not only immigrants, but also, for example, pensioners or students) are involved in shadow activities.

The above possibilities do not cover all cases. For example, there might be people who officially declare themselves as unemployed but at the same time work informally. Such people are part of the formal workforce but will not be counted as employed and therefore, their shadow work will not affect the employment per capita ratio. So even in this case, the presence of shadow practices does not necessarily lead to a reduction for the employment per capita.

There are, of course, situations in which the size of the informal economy and the officially employed per capita will be inversely related. This happens when individuals who are officially employed in an economic activity leave their jobs or lose their jobs and join the shadow economy. The opposite will happen when individuals working in the shadow economy leave or reduce their activity in this sector and at the same time accept a formal job. In these cases, the growth of the shadow economy will lead to a decrease in employment per capita and vice versa.

The latter situation is well documented by Lemieux et al. (1994). They analyze labour supply decisions in the underground economy based on microdata from a survey conducted in Canada. Their empirical findings indicate that "participation rates and hours worked in the underground sector also tend to be inversely related to the number of hours worked in the regular sector". In the same vein, Bajada & Schneider (2009) examine the relationship between the unemployment rate and the shadow economy and conclude that a relationship exists between changes in the unemployment rate and the shadow economy activity: short-term fluctuations in unemployment directly contribute to short-term fluctuations in the shadow economy.

3.4. Technological Progress

Economic theory adopts technology as a key driver of economic growth and views prosperity as dependent on technological progress. However, the mechanisms through which technology is incorporated in production are complex and often ambiguous to be formally

[23] Immigrant workers might contribute to the increase of the shadow economy in the recipient country and at the same time their remittance transfers to their home country might be a source for investment. For more details see Minassian & Yotzov (2021) and Minassian (2020).

expressed. The theoretical framework of our analysis provides us with the concept of total factor productivity (TFP). It refers to productivity in the production process, which is attributable not to any factor of production but to all factors. It measures the ability to employ the factors of production in the most effective way to achieve maximum output and studies show that its value typically increases over time. The causes of this growth are explained with the improved quality of equipment, the availability of innovative technologies, but also with the improved qualification of workers and managers, as well as the accumulated knowledge, embodied in organizational strategy. In a broader sense, TFP is considered as a measure of an economy's long-term technological change.

From equation (1), TFP can be calculated by dividing output by the weighted geometric average of labour and capital input with the relevant weighting for the inputs. Respectively, it follows that

$$A_t = \frac{Y_t}{K_t^{\alpha} L_t^{1-\alpha}} \tag{3}$$

Adopting the neoclassical theory, if the factor markets are competitive, then the marginal product of each input equals its factor price – the wage rate and the rental rate of capital, respectively. Under these assumptions, the output elasticities α and $1-\alpha$ are capital's and labour's share in total output.

When applying the Cobb-Douglas production function, it is usual to assume that the parameter is constant over time (see, for example, Giorno et al. (1995)). In our analysis, we adopt this assumption and assume the same specification of the Cobb-Douglas function for all countries under study, which enables us to use a uniform parameter α for all countries[24].

In our research, we rely on the estimates obtained by the International Labour Organization (2019). According to them, the average adjusted[25] labour income share for the region of Europe and Central Asia for the period 2004-2017 is 56%. As a result, we assume that $1-\alpha$ = 0.56 and hence α = 0.44. For robustness check, we have calculated TFP using other values for the elasticities as well: $1-\alpha$ = 0.65 and α = 0.35. The results using different parameters, show consistency. Figure 6 in Appendix II illustrates the scatter plot for all countries under study with respect to the average TPF calculated on the basis of different values for α (0.44 and 0.35). As shown, the two estimates are so close to each other, that all points are located almost perfectly on the 45-degree straight line. Obviously, both values for the parameter α provide very similar estimates for TFP, which are stable, not very sensitive with respect to the choice of α within the range between 0.44 and 0.35.[26]

Further on, we follow the same procedure as for the other factors of production. After obtaining the annual values of TFP for each country, the average values are calculated for

[24] Such assumption is often applied in the economic literature. For example, Denis et al. (2006) calculate the potential output for the EU countries assuming uniform Cobb-Douglas function for all countries. For the parameter $1-\alpha$ they take the value 0.63 which is the mean labor share in output for the EU-15 countries over the period 1960-2003.

[25] The adjustment takes into account the income received by the self-employed.

[26] It is unlikely the average capital share in income to be outside this interval.

the three periods examined. Then, the correlation between these averages and the average size of the shadow economy for the relevant periods is calculated. Figure 5 in Appendix II and Table 1 in Appendix III present the results.

The scatter plot on Figure 5 is with respect to the average size of the shadow economy and the average TFP for the period 1991-2015 in the fifty countries under study. The figure implies once more time a clear inverse relationship between the two variables: the smaller the size of the shadow economy, the larger the TPF in a country and vice versa. Countries with a small size of the shadow economy like Austria, the Netherlands, Switzerland, or the UK have an average TFP for the period 1991-2015 around 0.16-0.17[27], while countries with large size of the shadow economy like Ukraine, Georgia or Belarus have an average TFP around 0.7-0.11. The correlation coefficients in Table 1 confirm the existence of an inverse relationship. For all three considered periods, the coefficients are statistically significant, relatively large and with negative signs.

There is solid economic logic backing this result about productivity. One explanation is connected to the analysis in Section 3.2., where we find an inverse relationship between shadow economy and capital per capita. Countries with large shadow sector tend to have fewer investments, which leads to slower advances in the development of new technologies and the adoption of existing ones. This clearly has a negative impact on productivity. Another possible explanation is the relationship with the level of education. Countries with large shadow sector would suffer from low government revenues and as a result, the resources allocated for education would be insufficient. The latter leads to low values of human capital, which is key for the implementation of new technologies, for the implementation of effective forms of organization and ultimately, as a result, for productivity.

On the other hand, technology allows state revenue agencies to improve their detection, control, and tracking mechanisms. In some countries,[28] all of the cash registers should be directly connected to the Tax Authorities and have fiscal memory of all transactions with the purpose to tackle the practice of tax evasion by not issuing cash receipts. At the same time, big data techniques and data modelling allow national revenue agencies to analyze big datasets, which allows them to detect risk behaviour better and appoint appropriate further inspections in a timely manner. Technological progress also encourages the use of electronic money, decreasing the use of cash, hindering shadow activity. The use of electronic money and digital transactions might be imposed by law, as in many countries, making transactions in cash above a certain limit is forbidden[29]. Such a policy measure, along with the growing convenience of electronic money, puts obstacles in front of conduction shadow activities, limiting the possibilities to hide transactions or record a lesser value than the real one. When public authorities take advantage of technological progress by improving their control

[27] The size of the TFP depends on the units of measurement. In our case capital stock is measured in thousands of constant international, 2011 US dollars, while the amount of labor is measured by the number of people employed.
[28] Bulgaria is one of them.
[29] For Bulgaria payments above 5,000 euro cannot be done in cash legally.

mechanisms using innovations, combined with adopting changes in legislation, they can conduct effective policies tackling the shadow activity.

Conclusions

Based on the analysis carried out in the framework of the present study, several conclusions can be drawn that shed some light on the impact of the shadow economy on economic development. The empirical data that are the subject of the study refer to fifty countries in Europe and Central Asia for the period 1991-2015. They show that in the period under review, there is an inverse relationship between the size of the shadow economy and GDP per capita. At the same time, it turns out that for the same countries and for the same period, a relationship between the shadow economy and the growth rates of GDP per capita is either missing or a positive one. At first glance, these facts contradict each other. But we believe that while the first relationship is long-term and sustainable, the second one is rather a specific, short-term characteristic. In our opinion, this specific characteristic stems from the fact that in the group of countries under consideration, there are many in this period which are in transition, meaning that they start their development as market economies from a relatively low base. As a result, their economies are relatively far from the steady-state trajectory of development and therefore, they are subject to the catch-up effect.

The present study shows that the inverse relationship between the shadow economy and GDP per capita can be explained by the impact of the shadow economy on the factors of production. We find that the size of the shadow economy is inversely related to all three macroeconomic production factors – labour per capita, capital stock per capita and total factor productivity. Empirical data show that countries with large shadow economies tend to be associated with low levels of factors of production and this leads to a low level of economic development. In addition to the empirical basis of these results, we present logically sound theoretical explanations as to why such a relationship exists.

Another conclusion from the study is that the strength of the relationship is not the same for all factors of production. While for capital and for total factor productivity, the inverse relationship with the size of the shadow economy is strong, in the case of labour, this relationship exists, but it is weaker. The data show that for some countries large size of the shadow economy and relatively high employment can coexist. The reason for this is the specific nature of many of the shadow practices, related to undeclared work, which allow such an effect.

The results of the present study may serve as a ground for future studies. One possible direction is to investigate analytically the issues related to the causality of the described relationships. This, in turn, could provide arguments for the formation of effective economic policy measures to limit the negative effects of the shadow economy.

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Appendix I

Examined countries

EU Countries			Non-EU countries		
Country	Size of SE* (% of GDP)	RGDP per capita* (thous. international 2011 USD)	Country	Size of SE* (% of GDP)	RGDP per capita* (thous. international 2011 USD)
Austria	8,93	39,37	Albania	6,361	32,72
Belgium	20,57	37,202	Armenia	5,842	42,59
Bulgaria	29,17	11,649	Azerbaijan	9,555	52,19
Croatia	28,81	16,849	Belarus	11,468	44,52
Cyprus	31,3	18,295	Bosnia and Herzegovina	6,575	34,21
Czech Republic	14,83	23,606	Georgia	6,832	64,87
Denmark	15,19	40,378	Iceland	35,576	14,2
Estonia	23,8	17,222	Kazakhstan	14,853	38,88
Finland	13,49	34,842	Kosovo	7,316	38,33
France	14,08	34,569	Kyrgyzstan	3,507	37,92
Germany	11,97	38,187	Moldova	5,698	43,43
Greece	27,06	26,27	Montenegro	12,256	38,35
Hungary	25,23	19,745	North Macedonia	9,239	37,59
Ireland	13,89	40,447	Norway	58,641	14,06
Italy	24,95	34,257	Russian Federation	17,815	38,42
Latvia	22,23	20,845	Serbia	9,973	34,59
Lithuania	25,15	15,177	Switzerland	49,806	7,24
Luxembourg	10,67	47,75	Tajikistan	2,64	42,99
Malta	29,8	20,332	Turkey	14,422	31,38
The Netherlands	10,77	41,475	Turkmenistan	4,866	n/a
Poland	25,1	16,211	Ukraine	34,007	11,08
Portugal	21,88	24,862	United Kingdom	8,482	44,8
Romania	30,14	13,26	Uzbekistan	5,231	n/a
Slovakia	15,33	16,791			
Slovenia	24,09	24,174			
Spain	24,52	30,175			
Sweden	13,27	38,111			

*Average size of the variables for the period 1991-2015.

Sources: Medina and Schneider (2018), Kelmanson et al. (2019), World Bank, IMF, authors' calculation.

Appendix II

Scatter plots for the period 1991-2015

Figure 1

Shadow economy and RGDP per capita

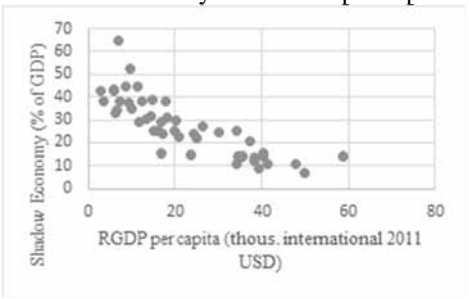


Figure 2

Shadow economy and RGDP per capita growth rate

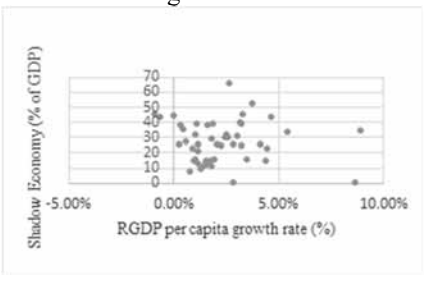


Figure 3
Shadow economy and capital per capita

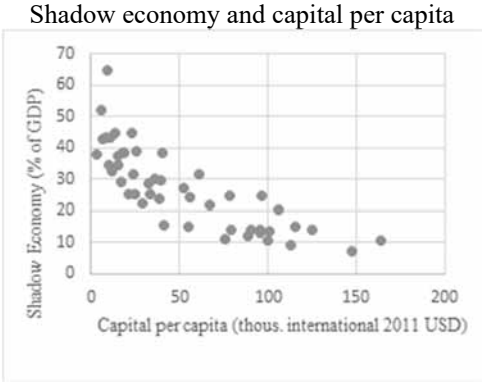


Figure 4
Shadow economy and employment per capita

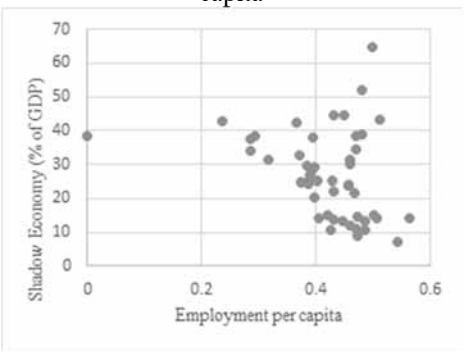


Figure 5
Shadow eonomy and total factor productivity

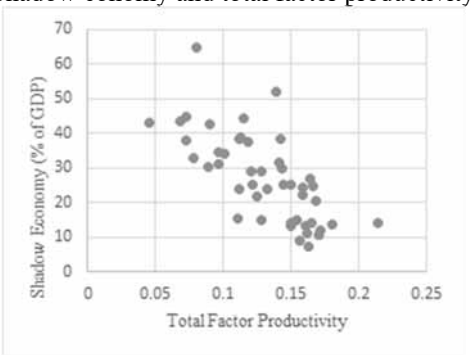
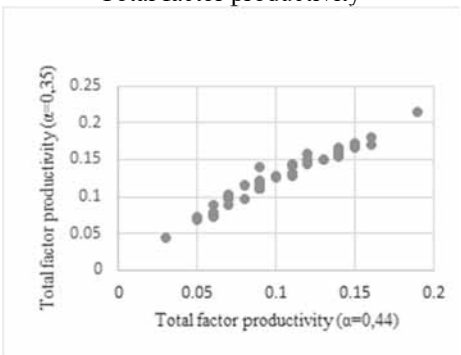


Figure 6
Total factor productivity



Sources: Medina and Schneider (2018), Kelmanson et al. (2019), World Bank, IMF, ILO, authors' calculation.

Appendix III

Table 1
Correlation coefficients between averages (p-values in brackets)

Period	Shadow economy and RGDP per capita	Shadow economy and RGDP per capita growth rate	Shadow economy and capital stock per capita	Shadow economy and labour per capita	Shadow economy and TFP
1991-2015	-0.829644*** (0.0000)	0.105720 (0.4794)	-0.804053 (0.0000)	-0.293699* (0.0451)	-0.776015 (0.0000)
1993-2012	-0.835992*** (0.0000)	0.322832** (0.0269)	-0.804244 (0.0000)	-0.279155** (0.0574)	-0.786695 (0.0000)
1993-2009	-0.833164*** (0.0000)	0.268849* (0.0672)	-0.804856 (0.0000)	-0.294026* (0.0449)	-0.783777 (0.0000)

* Significant at 10% level, **Significant at 5% level, *** Significant at 0.1% level
Source: Authors' calculation