Przegląd Statystyczny. Statistical Review, 2021, vol. 68, 2, 20–37 DOI: 10.5604/01.3001.0015.2730
Received: 13.04.2021, revised: 4.08.2021, accepted: 9.08.2021

How the shadow economy can be detected in National Accounts[1]

Sami Oinonen,[a] Matti Virén[b]

Abstract. The paper examines how indicators of the shadow economy correspond to the National Accounts values. More precisely, we focus on household accounts assuming that the shadow economy should be visible in the difference between household income and consumption, as household (disposable) income is grossly underreported. Household consumption seems therefore to be a more accurate indicator in this context, as most shadow economy income is eventually spent on consumption. This implies that household savings figures should be negatively related to the values of the shadow economy; consequently, if the values relating to the shadow economy are high, savings should be low, or even negative, and vice versa. We verify this hypothesis using European cross-country data covering the years 1991–2017 with the application of MIMIC model calculations as a point of reference. The estimation results lend very little support to the hypothesis assuming that the shadow economy depresses household savings, even though we can otherwise explain comparatively well the cross-country variation in household savings and consumption growth rates.

Keywords: shadow economy, National Accounts, saving behaviour

JEL: C390, C510, C820, H110, U170

1. Introduction

Literature on the shadow economy presents numerous methods of measuring the volume of this kind of economy, which is not surprising, as measuring it in the same way as other economic phenomena is difficult. Thus, most methods are indirect to some degree, as seen in the extensive survey of e.g. Kirchgässner (2017) or United Nations Economic Commission for Europe (UNECE, 2008). To sum up, there are various survey studies, studies using payment media data (e.g. Takala & Virén, 2010), employment data or discrepancies in national accounts, as well as analyses dealing with tax receipts (tax gap) and different model-based analyses. In this latter category, the most popular set-up involves the MIMIC model approach, propagated by Friedrich Schneider in particular (see e.g. Medina & Schneider, 2019; Schneider & Buehn, 2016). In this model the unobservable (latent) shadow economy variable is modelled by observable forcing variables, using the model restrictions of the (presumed) theoretical model (for details see Schneider & Buehn, 2016).

[1] Useful comments from Kari Takala and an anonymous referee are gratefully acknowledged. The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Finland or the Eurosystem.

[a] Bank of Finland, Monetary Policy and Research Department, Snellmaninaukio, PO box 160, 00101, Helsinki, Finland, e-mail: sami.oinonen@bof.fi, ORCID: http://orcid.org/0000-0001-9707-1232.
[b] University of Turku, School of Economics, Rehtorinpellonkatu 3, 20500, Turku, Finland, e-mail: matti.viren@utu.fi, ORCID: http://orcid.org/0000-0002-6132-3474.

The concept of the 'shadow economy' in relation to National Accounts is used as an aggregate of all the economic activities which are missing from National Accounts. Thus, they consist of what is referred to as the grey economy (mainly tax evasion), the illegal economy and unreported income. According to National Accounts, household production is not considered a part of the shadow economy.

When analysing the shadow economy, we use the estimates of Medina and Schneider (2019) as a point of reference, as they are by far the values most widely published and referred to, and because they relate to practically all the countries in the world.[2] The aim is to see how these values correspond to the official National Accounts measures. Our hypothesis assumes that if these estimates are 'correct', then some traces of the implied values of the shadow economy should also be visible in the National Accounts. The basic idea is then that the shadow economy appears disproportionally in different National Accounts measures. As is well known, all transactions in the National Accounts are shown in production, income and in the use of income/production accounts. There is convincing evidence that it is the income measures that distort the shadow economy more than other National Accounts measures. As a result, the total income in most cases is likely to exceed the total use of income (i.e. the sum of the demand components). This way of measuring the scope of the shadow economy is mentioned in almost all literature surveys (e.g. Gyomai & van de Ven, 2014; UNECE, 2008) and yet relatively little serious effort has been put thus far to examining whether the idea can be applied to actual data.[3]

It seems, however, that a proper analysis cannot be done at the level of Gross National Product (GDP) nor Gross National Income (GNI), as many income transfer components and consolidations of income between different (sub)sectors (including the rest of the world) and industries are involved; additionally, discrepancies are often considered as an indication of the low quality of a statistical compilation.[4] Therefore, this paper will concentrate on one sector only – households. In this case, the income and expenditure approaches produce (by definition) different outcomes and thus statisticians have no incentive to manipulate the

[2] There are some other interesting data sets like Elgin's (2020) data on European metropolises, but they do not facilitate considerably the comparison with the data of the National Accounts.

[3] There are also some other pitfalls in the measuring of the shadow economy, e.g. a part of the shadow income could be transferred abroad. Nevertheless, most of it would likely be done via the banking system and therefore would show in the current account and further in income accounts. Some income could be hoarded but that would probably be a temporary behavioral pattern not lasting for as long as 27 years, which is the period that the data used here covers.

[4] Schneider and Buehn (2016) argue that since national accounts statisticians are anxious to minimise this discrepancy, the initial discrepancy or the first estimate should be employed as an estimate of the shadow economy rather than the published discrepancy. If all the components on the expenditure side were to be measured without error, this approach would indeed yield a good estimate of the size of the shadow economy. Unfortunately, this is not the case. Instead, the discrepancy reflects all the omissions and errors in the national accounts statistics and the shadow economy. These estimates may therefore be crude and of a questionable reliability.

discrepancies between these two. Household consumption and income are also frequently surveyed for different statistical purposes (such as income distribution indicators and the consumer price index). In practical terms, we will be comparing household income and household consumption. The basic idea is that there is a shadow income component in household (disposable) income that is not included in the National Accounts values of household income. As regards household consumption, there can also be a shadow income component, but we believe that this component is much smaller than the corresponding income component, as all income is either consumed or invested over time. Income from the shadow economy is consumed much in the same way as the income from the non-shadow economy. In fact, this idea is often utilised in practical anti-corruption and anti-tax-evasion procedures in a very simple way: individuals' consumption level is compared with their official income. In practice this entails surveying the housing space, the number and price of cars, etc.[5] Of course, the real household consumption includes some items that are not present in the National Accounts statistics. Most notably this is true in the case of such 'illegal' components as prostitution and drugs. Although the volume of these components varies both across countries and over time, the average value might still be rather low and not significant from the point of view of our empirical results.[6]

The problem here is that at the theoretical and behavioural level, we do not have the identity of $consumption = income$ that would hold every period, nor do we have a simple degenerated equation for consumption being equal to $b * income$, where the propensity to consume b would be universally constant over time and households/countries. Nevertheless, it could temporarily be assumed that the relationship between $income$ and $consumption$ – at least in the long run – would be relatively constant. Then, other things being equal, we could expect that in households, and thus in countries where the shadow economy reaches high levels, the share of b tends to be large. In fact, b could be well above 1 and, consequently, the savings rate would be negative. Therefore, we intend to scrutinise the correspondence between the (long-run) measures of the shadow economy and the level of the savings rate. We attempt to answer the question whether the savings rate is small or negative in countries with a large shadow economy, and if the opposite is true for economies with a small shadow economy. Alternatively, we will focus on the dependence of (the growth of) consumption on the measures of the shadow economy. As far as the consumption growth is concerned, we expect its positive dependence on the size of the shadow economy, conditional on the measured National Accounts income growth and other control variables.

[5] See Enikolopov and Mityakov (2019) for a practical research application.
[6] For instance, Statistics Finland's estimate of the size of these items is only 0.2% of the Finnish GDP.

Our approach is to some extent related to an old study by Pissarides and Weber (1989), where the household (food) consumption – income relationship is analysed from the point of view of the grey economy. Pissarides and Weber use the UK Family Expenditure Survey data to find out whether the self-employed underreport their income. The authors adopt some comparatively strong assumptions on the permanent income consumption model on the basis of which they develop an equation where the measured income and the indicator of self-employment (jointly with a set of controls for household characteristics) appear on the right-hand side of the equation. The estimation results indicate that a substantial underreporting of income is indeed related to self-employment. A more comprehensive study was performed by Lyssiotou et al. (2004), who based it on an expenditure system of six main (non-durable) commodity groups and information on the main sources of income. From our perspective, the interesting point in these studies is the assumption that consumption expenditure – unlike disposable income – is assumed to be correctly measured (see Adair (2018) for some critical comments on other features of this study).

In the subsequent parts of the paper, we review both the Medina and Schneider (2019) and the National Accounts data or the data for different controls. Then, in Section 3 we present the estimates using cross-country panel data, while Section 4 contains the concluding remarks.

2. The data

We begin with an analysis of the shadow economy data. In the Medina and Schneider (2019) study, there are 158 countries and in the majority of the cases the data cover the period 1991–2017, whereas here we consider 34 European countries. Most of them are European Union (EU) countries, but the sample also includes Iceland, Norway, Switzerland, the United Kingdom, Ukraine, Belarus and Russia. Mexico and Colombia (Organisation for Economic Co-operation and Development [OECD] countries) are also included into the sample to examine the dynamics of the results.

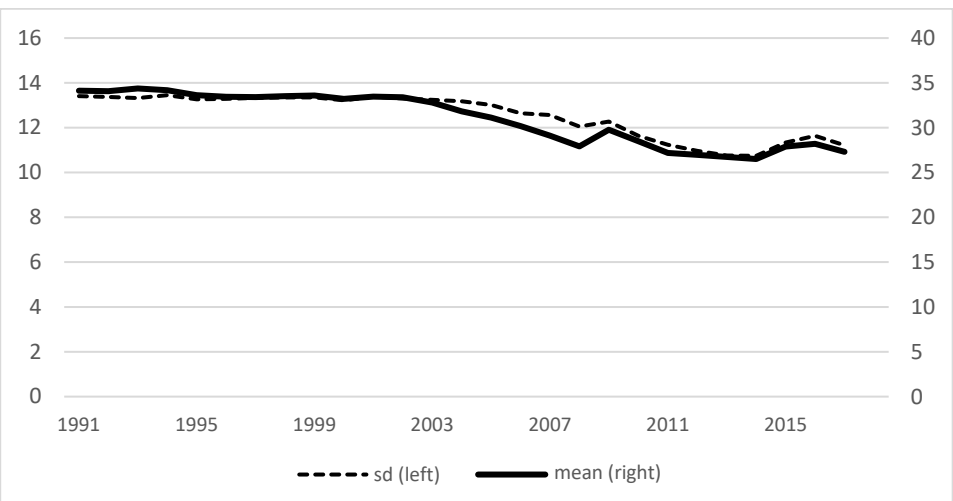
As regards the National Accounts data, the key variables are private consumption, household disposable income, and the savings rate. We consider both gross and net income (and, accordingly, gross and net savings), but since the measures do not make any noticeable difference in the results, we concentrate on the net values. The coefficient of correlation between the two series is 0.97, which mainly reflects the level differences. The details of the data are explained in the data appendix.

As for the controls, we have GDP (both in national currencies and in US dollars), the respective deflators (including the consumption prices), the (real) income *per capita* in euros and real GDP *per capita* in US dollars, the share of agriculture, the share of self-employment, the real (long-term) interest rate and, finally, the amount of remittances sent to and from the country. We use the total population numbers for scaling purposes.

Although the control variables could cover longer periods, we decided to restrict the sample to the same years as the Medina and Schneider shadow economy sample, i.e. to 1991–2017. Altogether we could have 972 data points, but the final sample is smaller because of the differencing and lags and since the savings/income data cover a shorter period of time (1995–2017). For these reasons, the final sample size consists of about 600 data points.

Before proceeding to the proper analysis, let us briefly examine the Medina and Schneider (2019) shadow economy data. Some of the typical features of the data are presented in Figure 1, which shows the cross-section means and standard deviations of 158 time series.

Figure 1. Cross-section means and standard deviations of the shadow economy series, expressed in %



Note. sd – standard deviation. The values have been computed from all 158 series.
Source: authors' work based on Medina and Schneider (2019).

The above indicates that the size and country dispersion of the shadow economy has decreased over time. The 2008/2009 financial crisis is shown in the mean values as a small, temporary peak, but otherwise it is difficult to find any cyclical features in the data. This is also reflected in the autocorrelation function of the shadow

economy series, where the AR(1) coefficient is 0.955. For the sake of comparison, the corresponding values of the net savings rate and the growth rate of (real) private consumption expenditure are 0.871 and 0.221, respectively.[7]

The trend-like features of the shadow economy time series also appear in a principal component (PC) analysis. Thus, if the analysis is based on the whole of the data, including 158 countries, the first PC explains 76% of the total variation of the data, 3 PCs – 89% and 10 PCs – 97% of the data. It would take 20 PCs to explain 100% (in practical terms) of the total variation. In other words, the role of country-specific features in the data is relatively small, which makes the identification of the shadow economy in the panel data more difficult. This similarity clearly reflects the way in which the data are constructed (the same model, the same forcing variables and similar trends in these variables across countries).

3. Analysis

3.1. Derivation of the model and the hypotheses

The estimating equation for the savings rate takes the following form:

$$s_{it} = \alpha_{0it} + \alpha_1 s_{it-1} + \alpha_2 h_{it} + \alpha_3 \Delta y_{it} + \alpha_4 \pi_{it} + \alpha' \mathbf{X}_{it} + \mu_{it}, \quad (1)$$

where s denotes the savings rate, h is the shadow economy measure, Δy signifies the growth of real income, π indicates the rate of inflation, $\mathbf{X}$ represents the set (vector) of the control variables, and μ is the error term. Subscript i denotes country, and t time (year). All variables are expressed in real terms, meaning that if they were originally nominal, their values would be deflated by consumer prices. Thus, e.g. $\Delta y = \Delta log(Y/P)$. At this stage, the basic hypothesis is that α_2 is negative, therefore an increase in the shadow economy appears in a larger negative difference between National Accounts measures of income and consumption.

In the same way, we specify the equation for consumption growth as

$$\Delta c_{it} = \beta_{0it} + \beta_1 \Delta c_{it-1} + \beta_2 h_{it} + \beta_3 \Delta y_{it} + \beta_4 \pi_{it} + \beta' \mathbf{X}_{it} + \mu_{it}, \quad (2)$$

where Δc denotes the growth rate (log difference) of real private consumption growth. Real income refers to the real current income here; following e.g. Pissarides and Weber (1989), we can assume that current income Y is related to permanent income Y^P by the expression $Y = \rho Y^P$, where ρ is a random variable which depends

[7] Some recent comparative analyses on the shadow economy size estimates are reported in e.g. Almenar et al. (2019) and Dybka et al. (2019).

on certain aggregate events. Since we cannot really identify ρ for the shadow and non-shadow economy, we refer to the current income only. Moreover, we cannot see that the shadow economy would affect current and permanent income genuinely differently. As far as Equation (2) is concerned, the basic hypothesis is that β_2 is positive, i.e. an increase in the shadow economy share facilitates higher consumption, given that the National Accounts' measure of real disposable income is the control variable.

When we introduce income growth variable Δy into these two equations, we must assume that there is a difference between the 'true' income and the measured income. Suppose that the true income is Y^*, while the measured income is Y. As regards consumption, however, true consumption C^* is supposed to equal the National Accounts measure of C. Ratio h is assumed to be the share of the shadow economy in the measured income (although it is not completely clear how the Medina and Schneider values should be interpreted). As a result, h is now $\frac{(Y^*-Y)}{Y} = \frac{Y^*}{Y} - 1$, and thus $Y^* = (1+h)Y$. In our estimating equations, we have the (real) income growth on the right-hand side of the equation, but ideally it should read $\Delta log(Y^*)$. Using the previous notation, $\Delta log(Y^*)$ equals $\Delta log(1+h) + + \Delta log(Y) \approx \Delta h + \Delta y$. Thus, instead of using (the level of) h as the right-hand side variable, we should use its difference (but the signs of both Δh and Δy should be positive). That is clearly true only if we assume that the shadow economy share affects the economy solely via the income variable.

We have an additional problem with the savings rate equation due to the fact that the savings rate also contains a measurement error. The 'correct' savings rate would be $(Y^* - C)/Y^*$ instead of $(Y - C)/Y$. Moreover, the savings rate is highly persistent, as pointed out above, so that the AR(1) coefficient of the lagged value of the savings rate is close to 0.9, which is also visible in the subsequent empirical results. To simplify the matter, let us assume that the left-hand side variable is Δs instead of s (in fact, Deaton (1977) uses Δs as the dependent variable). Then the skeleton form of the savings rate equation, where (a difference in) the savings rate depends only on real income growth, can be written as $\frac{\Delta((1+h)Y-C)}{(1+h)Y} = \beta\Delta h + \beta\Delta y$, where β is the coefficient of $\Delta log(Y^*/P)$ in the savings rate equation. Now the left-hand side of this equation is simply $\Delta(1 - \{(1-s)/(1+h)\})$, which may be approximated by $(\Delta h + \Delta s)/(1+h)$.[8] Thus, the equation takes the form of $\Delta s = (\beta(1+h) - 1)\Delta h + \beta(1+h)\Delta y$, implying that the share of the shadow

[8] $\Delta\big(1 - (1-s)/(1+h)\big)$ is equal to $\frac{(\Delta s + \Delta h)}{(1+h)} - \Delta h(h+s)/(1+h)^2$ and we disregard the latter term.

economy has a negative effect on the change of the savings rate at reasonable values of h and β, while the National Accounts income growth still has a positive effect. Therefore, in fact, estimating Equation (1) would take the following form:

$$\Delta s_{it} = \alpha_{0it} + \alpha_1 s_{it-1} + \alpha_2 \Delta h_{it} + \alpha_{31} h_{it} \Delta y_{it} + \alpha_{32} \Delta y_{it} + \alpha_4 \pi_{it} + \alpha' \mathbf{X}_{it} + \mu_{it}. \quad (1)$$

Now we would expect the sign of α_2 to be negative and the sign of both α_{31} and α_{32} to be positive. In the empirical application, however, it is difficult to obtain precise estimates for α_{31} and α_{32}; we must therefore rely more on specification (1). Regardless, we use either the level of h or the first difference of h as the dependent variable.

As regards other control variables, we use the rate of inflation and the real interest rate. Applying the rate of inflation as a control variable can be motivated by the Deaton (1977) savings equation, where the inflation rate affects savings due to the following mismeasurement effect: when inflation grows, consumers (sampling individual prices) interpret increases of individual prices as changes of the relative prices of respective commodities and decrease the demand for those commodities. When we aggregate consumers and households, a positive relationship occurs between the savings rate and inflation. Obviously, we would expect inflation to have an inverse effect on consumption growth. That is because (roughly) $\Delta s = \Delta y - \Delta c$.

In addition to the income growth and the share of the shadow economy, we have some other structural variables: the share of self-employment (emp), the share of agriculture (agr), the *per capita* income level ($gdpc$; GDP *per capita* in constant US dollars), the growth rate of population (Δpop), the rate of inflation (inf), the real interest rate (rr) and the amount of remittance income – both inflow (rem) and outflow (rex). The remittance income variables are expressed in US dollars, so they are divided by the respective GDP in US dollars. Household indebtedness ($debt$) is another variable, but not included in the final specification, since not all data were available for each of the studied countries and thus its explanatory power was rather low. A detailed list of the variables and data sources as well as their descriptive statistics are included in the Appendix.

3.2. Empirical results

We start by reporting a set of cross-section results for sample means of the main variables. These are presented in Table 1.

Table 1. Estimation results with mean values of the country data

Dependent Variable→	$Shadow$	sn	Δc
Constant	19.747	2.868	0.028
	(36.16)	(3.11)	(11.74)
$self\text{-}emp$	0.137	0.290	–0.046
	(5.48)	(12.57)	(7.79)
$gdp\ pc$	–0.018	0.049	–0.025
	(20.02)	(4.56)	(091)
rem	0.291	.	0.555
	(7.13)		(5.43)
rex	.	–0.017	.
		(6.71)	
agr	–0.031	1.022	0.096
	(0.47)	(25.99)	(9.28)
inf	0.816	0.735	–0.073
	(20.45)	(17.63)	(6.50)
sn	0.018	.	.
	(0.49)		
$shadow$	.	0.046	–0.005
		(1.36)	(5.02)
R^2	0.818	0.570	0.275
SEE	4.199	4.523	0.012

Note. Number of observations: 36. The numbers in parentheses are the t-values. $self\text{-}emp$ – self-employment, $gdp\ pc$ – GDP *per capita*, rem – remittance income inflow, rex – remittance income outflow, agr – agriculture, inf – rate of inflation, sn – net saving rate, $shadow$ – shadow economy measure, Δc – growth rate (log difference) of real private consumption growth.

Source: authors' calculations.

It is quite clear that the measure of the shadow economy does not seem to be related either to the savings rate or to the growth rate of consumption. On the other hand, the figures demonstrate that the size of the shadow economy is negatively related to the income level of the country and positively related to the level of self-employment and the rate of inflation. These results are not very surprising, as this type of variables drive the MIMIC model predictions for the shadow economy share.

Subsequently, we proceed to the ordinary panel data and estimate equations for the net savings rate and consumption growth. The respective results are presented in Table 2.

Table 2. Panel estimates of consumption and savings rate equations

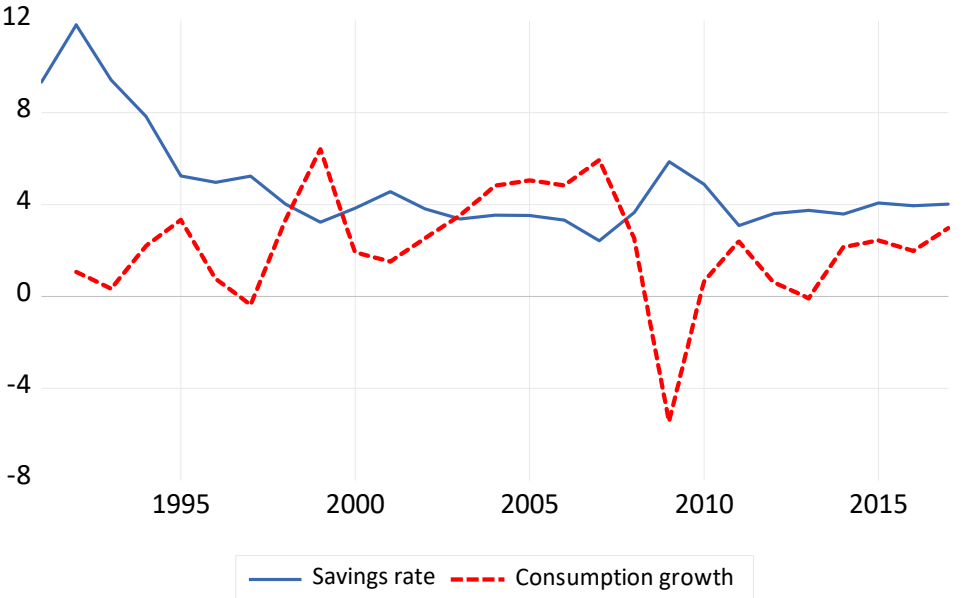
Dependent Variable→	Δc	Δc	Δc	Δc	sn	sn	sn	Δsn	sn
Constant	0.021	0.045	0.015	.	–0.434	4.395	–0.472	–0.616	.
	(1.79)	(2.08)	(2.89)		(0.64)	(2.25)	(1.08)	(1.04)	
Lag of Dep. Var.	0.159	–0.095	0.189	–0.009	0.866	0.706	0.866	–0.137	0.739
	(2.96)	(1.79)	(3.44)	(0.33)	(45.53)	(20.34)	(50.17)	(6.31)	(17.41)
$shadow$	0.001	–0.179	.	.	–0.036	0.142	.	0.422[a)]	.
	(0.28)	(1.42)			(1.56)	(1.49)		(1.46)	
$\Delta(shadow)$	.	.	–0.900	–0.006	.	.	0.747	0.763	0.657
			(5.67)	(2.45)			(6.54)	(5.32)	(5.31)
Δy	0.281	0.228	0.427	0.414	0.146	0.149	0.183	0.088	0.228
	(7.30)	(6.45)	(6.18)	(31.77)	(7.03)	(6.89)	(8.75)	(1.44)	(18.36)
$inflation$	–0.189	–0.401	–0.214	.	0.217	0.281	0.218	0.248	0.445
	(2.31)	(6.34)	(2.62)		(3.69)	(2.66)	(7.26)	(4.34)	(16.07)
$self\text{-}emp$	–0.049	–0.240	–0.059	–0.002	0.014	0.204	0.024	0.025	0.439
	(2.11)	(3.22)	(2.62)	(0.80)	(0.67)	(2.66)	(1.18)	(1.33)	(4.91)
agr	0.315	1.198	0.313	0.007	–0.147	–0.430	–0.153	–0.158	–448
	(5.87)	(7.63)	(5.86)	(2.07)	(4.33)	(3.84)	(4.89)	(3.63)	(16.07)
rr	–0.384	–0.663	–0.324	–0.477	0.150	0.202	0.092	0.101	0.151
	(5.50)	(8.83)	(4.74)	(16.79)	(3.90)	(4.73)	(2.42)	(1.71)	(4.74)
$gdp\ pc$	0.022	–0.296	–0.004	–0.001	0.002	0.002	0.014	0.017	–0.011
	(0.31)	(1.94)	(0.66)	(2.56)	(0.25)	(1.07)	(2.19)	(2.32)	(0.65)
Δpop	0.282	–0.450	0.467	–1.393	0.267	0.487	0.459	0.282	–0.091
	(1.41)	1.72)	(1.68)	(2.36)	(1.41)	(2.11)	(0.21)	(0.13)	(0.91)
Net remittances/Y	–0.024	0.668	–0.021	–0.020	–0.002	–0.005	–0.003	–0.003	0.002
	(1.91)	(2.76)	(1.77)	(1.32)	(0.16)	(0.96)	(0.18)	(0.15)	(0.26)
Fixed effects	no	cs fixed	no	dif	no	cs fixed	no	no	dif
Estimator	OLS	OLS	OLS	GMM	OLS	OLS	OLS	OLS	GMM
R^2	0.551	0.679	0.586	.	0.886	0.900	0.894	0.248	.
SEE	0.0280	0.0250	0.0280	0.0236	2.580	2.496	2.501	2.495	2.244
DW/J	1.50	1.62	1.52	0.243[J]	2.03	1.91	1.98	1.98	0.222[J]
Observations	584	584	584	536	580	580	580	580	536

Note. The numbers inside the parentheses are robust t-values. $cs\ fixed$ denotes fixed country effects. Superscript J denotes the p-value of the J-test. Dif indicates that the data are differenced. In the second to last column, the dependent variable is differenced. In this column, variable indicated by [a)] is $h * \Delta y$ according to Equation (1′). Given that the sample mean value of the shadow economy is 21%, the elasticities of Δy are roughly the same in Equations (7) and (8) in Table 2. $shadow$ – shadow economy measure, $\Delta(shadow)$ is a difference of it, Δy – growth of real income, inf – rate of inflation, $self\text{-}emp$ – self-employment, agr – agriculture, rr – real interest rate, $gdp\ pc$ – GDP *per capita*, and Δpop – growth rate of population.

Source: authors' calculations.

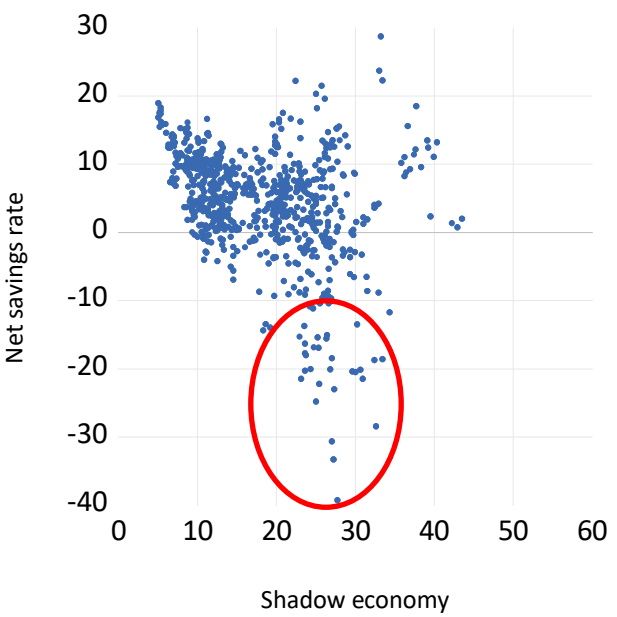
The data for the time series of the savings rate and the consumption growth rate are shown in Figure 2 and the scatter plots for the data of the sn, Δc and the shadow economy measure h are shown in Figures 3 and 4. The scatter plot between the shadow economy measure and household indebtedness is shown in Figure 5. It seems that in the 'shadow economy countries' indebtedness is typically low, but it is difficult to state at this point whether the relationship has any deeper meaning.

Figure 2. Mean savings and consumption growth rates in the data, expressed in %



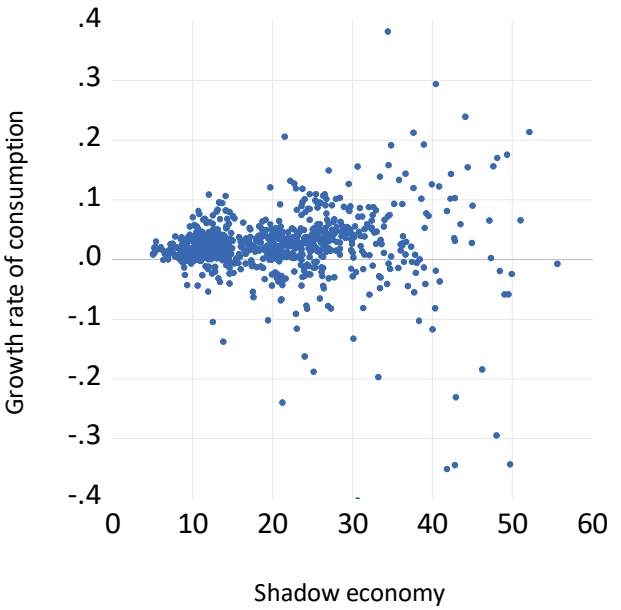
Source: based on authors' calculations.

Figure 3. Shadow economy share and the net savings rate



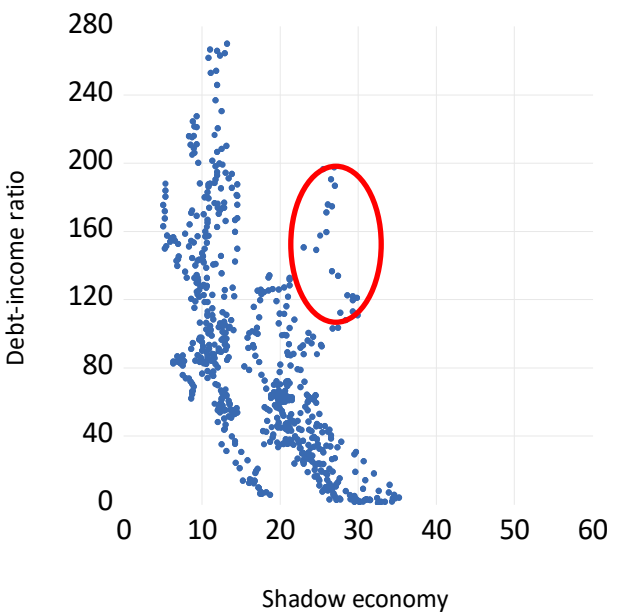
Note. Observations in the circled area come from Greece, Cyprus, Latvia and Romania.
Source: based on authors' calculations.

Figure 4. Shadow economy and consumption growth



Source: based on authors' calculations.

Figure 5. Shadow economy and household indebtedness



Note. The North-East set of observations come from Cyprus.
Source: based on authors' calculations.

When estimating (1) and (2), we face the problem of reverse causality between savings or consumption growth on the one hand, and the shadow economy variable, on the other. In our opinion, however, the nature of shadow economy is such that it is most likely not affected by changes in the savings rate or the growth rate of consumption. Thus, the shadow economy is close to the concept of a 'deep' variable. Even so, when we use the (Arellano-Bond) GMM estimator, we assume that the shadow economy variable is endogenous in estimating Equations (1) and (2). The use of GMM is obviously required also due to the panel setting of the data.

The mean savings rate for the 34 countries is remarkably stable over time, while consumption growth (more) clearly reacts to cyclical variations of real income. As opposed to the shadow economy measures, savings and consumption growth rates show no visible trends. As regards the relationship between the shadow economy on the one hand and savings and consumption on the other, we see from Figure 3 that the savings rate seems to be inversely related to the shadow economy. This, however, results from certain extreme observations: Romania has a very high negative savings rate and a very high value for the shadow economy,[9] while Switzerland is characterised by a very low value of the shadow economy, but a very high savings rate. On the other hand, all other observations do not follow any clearly defined pattern. The very high negative savings rates of some countries are puzzling, which is particularly true for Romania, where the negative rate does not seem to be a temporary phenomenon and it differs from that of its neighbouring countries. When comparing the Romanian savings rate with the household indebtedness variable, some correspondence can be detected as the indebtedness had increased from practically zero to 30% in the sample period; that, however, does not match the magnitude of the cumulative sum of the negative savings rates.[10]

As far as consumption growth is concerned, it is very difficult to distinguish any kind of relationship with respect to the size of the shadow economy. If our basic assumption that income is more distorted by the shadow economy than consumption is true, we might expect a positive relationship between the shadow economy and consumption growth, and yet this kind of pattern does not seem to exist. Obviously, the identification of the shadow economy effect becomes more difficult if the relative size of the shadow economy remains constant.

Now let us refer to the cross-country analysis of the time-series data. As previously mentioned, all results are presented in a conventional panel data setting.

[9] The case of Romania is discussed in more detail in Rocher and Stierle (2015). It is suspected that a part of the country's consumption is in fact investment and the distinction between households and firms is made incorrectly.

[10] Within the whole data set, we found the following correspondence between indebtedness and the savings rate: $\Delta dept = -0.19s$, which is obviously far from the identity of $\Delta dept = s$. However, it must be kept in mind that debt refers to the gross (not net) debt ratio.

This kind of data requires considering the issue of fixed and random effects first, and therefore we ought to treat the fixed effect with caution. This is because the shadow economy variables, as well as most of the control variables, are enormously persistent, coming close to linear trends. If we had fixed country effects, they could absorb most of the impact of the shadow economy. Nonetheless, we do also use the fixed effects specification as an alternative. Regarding the random effects, we found that this specification is not appropriate, as the Hausman test indicated. In the case of the GMM, we use the first differences of the data. When checking the robustness of the results, we also apply robust estimators to eliminate the potential effect of any outliers.

The results in Table 2 confirm the initial impression that the shadow economy measures do not help predicting either the level of savings or the growth rate of consumption. If the level form of the shadow variable is used in the estimating equation, the signs of the coefficients are either 'wrong', or insignificant, according to the standard levels of significance. Alternatively, if we use the first differences of the shadow economy variable, the t-values are very high, but the signs of the coefficients do not make sense from the point of view of the analysed notion assuming that the shadow economy reveals itself in income but not in consumption. Thus, the estimates imply that an increase in the (change of) the size of the shadow economy decreases consumption growth (given income growth and other controls) and, accordingly, an increase in the (change of) the shadow economy increases the National Accounts savings rate. When the equation was estimated by the GMM estimator, the results remained practically unchanged in relation to the key variables. It only involved the change of some of the control variables' (such as the population growth and GDP *per capita*) coefficients along with the estimator and the differencing of the data.[11]

Otherwise, the estimated equations perform reasonably well following the lines of the earlier research. In conclusion, both consumption growth and the savings rate are sensitive to income growth, the real interest rate and the rate of inflation. The savings rate equation works perfectly according to Deaton's (1977) 'involuntary saving hypothesis', i.e. inflation indeed increases savings in the same way as real income growth does. The real interest rate also changes in accordance with the life-cycle permanent income hypothesis. The coefficients of the self-employment variable are negative in the consumption equation(s) and positive in the savings rate

[11] The equations were also estimated by robust and quantile estimators but that did not change the overall pattern of results in terms of the shadow economy variable. Also including the Non-European countries (Colombia & Mexico) into the sample does not mark any noticeable difference in the results.

equation(s) even if we exclude the shadow economy variable from the estimating equations.[12] Clearly, this result is at variance with the idea utilised by e.g. Pissarides and Weber (1989), assuming that the self-employed underreport their income. If the size of the self-employed population increases, we would expect it to show in positive consumption (and negative savings rate) effects, but that does not seem to be the case. As regards the other control variables, in most cases they follow the intuitive lines, although at times the coefficients are quite sensitive to the fixed effects specification. One reason for that is that these variables (income level, self-employment, share of agriculture) are highly autocorrelated and also highly correlated with each other, which makes individual coefficients less reliable.

4. Concluding remarks

Our analyses show that the most commonly used measure of the shadow economy is inconsistent with the idea that this kind of economy biases household income more than household consumption. Although it is true that in several countries the shadow economy measures correspond to the differences between income and consumption, for most countries the differences between disposable income and consumption expenditure do not correspond to the shadow economy data in the panel setting. This obviously does not mean that the National Accounts consumption and income data are equally prone to the shadow economy, nor that they are free from any impact of the shadow economy.

There are several caveats relating to this outcome. First of all, we focused only on the household sector. Even more importantly, there are differences in the measures of the shadow economy. The data that we used deviate quite significantly from various national measures of the shadow economy. The values used are generally much higher than the national measures, but since they do not follow a uniform conceptual and measurement pattern, it is difficult to say anything about the country and/or period by period differences. Hopefully, more alternative datasets will become available for both analytical and descriptive purposes.

References

Adair, P. (2018). *Non-Observed Economy vs. the Shadow Economy in the EU: The Accuracy of Measurements Methods and Estimates revisited*. 4th OBEGEF International Conference Interdisciplinary Insights Fraud and Corruption, Porto. https://hal-upec-upem.archives-ouvertes.fr

[12] The share of self-employment and shadow variables are positively correlated with $r = 0.30$, but multicollinearity is not the reason for the 'wrong' coefficient signs.

/hal-01683929/file/Adair_2017_Non-Observed%20Economy%20vs.%20Shadow%20Economy%20_European_Union.pdf.

Almenar, V., Sánchez, J. L., & Sapena, J. (2019). Measuring the shadow economy and its drivers: the case of peripheral EMU countries. *Economic Research / Ekonomska Istraživanja*, *33*(1), 2904–2918. https://doi.org/10.1080/1331677X.2019.1706601.

Deaton, A. (1977). Involuntary Saving through Unanticipated Inflation. *American Economic Review*, *67*(5), 899–910.

Dybka, P., Kowalczuk, M., Olesiński, B., Torój, A., & Rozkrut, M. (2019). Currency demand and MIMIC models: towards a structured hybrid method of measuring the shadow economy. *International Tax and Public Finance*, *26*(1), 4–40. https://doi.org/10.1007/s10797-018-9504-5.

Elgin, C. (2020). Shadow Economies Around the World: Evidence from Metropolitan Areas. *Eastern Economic Journal*, *46*(2), 301–322. https://doi.org/10.1057/s41302-019-00161-4.

Enikolopov, R., & Mityakov, S. (2019). *Tax Evasion of Politically Connected Firms: Labor Mobility Channel*. Conference On Corruption And Anti-Corruption Policies, Kyiv.

Grech, O. (2013). *Forty-Sixth Annual Report and Statement of Accounts*. Valletta: Central Bank of Malta.

Gyomai, G., & van de Ven, P. (2014). The Non-Observed Economy in the System of National Accounts. *OECD Statistics Brief*, (18), 1–12. http://www.oecd.org/sdd/na/Statistics%20Brief%2018.pdf.

Kirchgässner, G. (2017). On Estimating the Size of the Shadow Economy. *German Economic Review*, *18*(1), 99–111. https://doi.org/10.1111/geer.12094.

Lyssiotou, P., Pashardes, P., & Stengos, T. (2004). Estimates of the black economy based on consumer demand approaches. *The Economic Journal*, *114*(497), 622–640. https://doi.org/10.1111/j.1468-0297.2004.00234.x.

Medina, L., & Schneider, F. (2019). *Shedding Light on the Shadow Economy: A Global Database and the Interaction with the Official One* (CESifo Working Paper No. 7981). https://ideas.repec.org/p/ces/ceswps/_7981.html.

Pissarides, C. A., & Weber, G. (1989). An expenditure-based estimate of Britain's black economy. *Journal of Public Economics*, *39*(1), 17–32. https://doi.org/10.1016/0047-2727(89)90052-2.

Rocher, S., & Stierle, M. H. (2015). *Household saving rates in the EU: Why do they differ so much?* (European Economy Discussion Paper No. 005). https://ec.europa.eu/info/sites/info/files/dp005_en.pdf.

Schneider, F., & Buehn, A. (2016). *Estimating the Size of the Shadow Economy: Methods, Problems and Open Questions* (IZA Discussion Paper No. 9820). http://ftp.iza.org/dp9820.pdf.

Takala, K., & Virén, M. (2010). Is Cash Used Only in the Shadow Economy?. *International Economic Journal*, *24*(4), 525–540. https://doi.org/10.1080/10168737.2010.525992.

United Nations Economic Commission for Europe. (2008). *Non-observed economy in National Accounts: Survey of Country Practices*. New York, Geneva. https://unece.org/fileadmin/DAM/stats/publications/NOE2008.pdf.

Appendix

Table A1. The definitions and data sources

Variable name	Definition	Source
agr	share of agriculture	World Bank
CPI	consumer price index	AMECO & World Bank data banks
CV	private consumption expenditure	AMECO & IMF data banks
$debt$	household indebtedness	Eurostat
emp	share of self-employment	World Bank
$GDPus$	GDP in USD	World Bank
h	share of shadow economy	Medina and Schneider (2019)
pop	population	IMF
rem	iflow of remittances in USD (scaled by $GDPus$)	World Bank
rex	outflow of remittances in USD (scaled by $GDPus$)	World Bank
rr	real interest rate	World Bank
sb	gross household savings rate	AMECO data bank
sn	net household savings rate	AMECO data bank
YD	household disposable income (net & gross)	AMECO data bank

Source: authors' work.

Table A2. Descriptive statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
agr, %	9.01	6.25	45.21	1.00	7.55
$\pi = \Delta log(CPI)$	0.0511	0.0245	1.3705	–0.1864	0.1083
$\Delta c = \Delta log(CV/CPI)$	0.0226	0.0236	0.9263	–0.7507	0.0716
$debt$, %	86.32	77.35	269.77	0.27	59.98
emp, %	17.80	15.08	53.61	0.86	10.24
$GDPus$, USD	497558	197483	3893959	3788	753910
h, %	21.09	20.20	55.70	5.10	10.21
$\Delta pop = \Delta log(pop)$	0.0029	0.0029	0.0304	–0.0565	0.0089
rem, USD	0.0237	0.0061	0.2795	0.0000	0.0422
rex, USD	0.0328	0.0022	1.0948	0.0000	0.1095
rr, %	2.12	2.72	139.81	–91.72	11.44
sb; %	9.87	10.49	25.74	–19.80	6.76
sn, %	4.34	5.28	28.66	–39.35	7.94
$\Delta y = \Delta log(YD/CPI)$	0.0132	0.0174	0.2504	–0.8462	0.0771

Source: authors' work.

The household income, savings and consumption data of the following countries: Belarus, Bulgaria, Ukraine and Russia came from the respective national statistical offices. The data for Malta came from Grech (2013, pp. 42–48). In the above cases, the time-series cover much shorter time periods than the other data that, with a few exceptions, cover 1991–2017.

The set of countries consists of the following:
Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, Belarus, Russia, Ukraine; Mexico, Colombia.