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9434
2021

November 2021

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CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editor: Clemens Fuest
https://www.cesifo.org/en/wp
An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
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CESifo *Working Paper No. 9434*

Do Different Estimation Methods Lead to Implausible Differences in the Size of the Non-Observed or Shadow Economies? A Preliminary Answer

Abstract

In this paper, first, six micro (4) and macro (2) estimation approaches are briefly described; they are the National Accounts Statistics discrepancy method and two new micro survey methods, a third one using a combination of company manager surveys and their knowledge to calibrate the size of the shadow economy in firms, and the consumption-income-gap of households method. The two macro methods are the MIMIC method and a structured hybrid method of the Currency demand and MIMIC models. Second, a detailed comparison of the results of four micro estimation methods with the macro MIMIC method are presented. One major result is that the estimated size of the shadow economy using the MIMIC method comes close to the size of the shadow economy of various types of recently developed micro survey methods. Third, using behavioral economics, some remarks are made about the reasons that individuals work in the shadow economy, and which estimation methods are best suited to apply this approach.

JEL-Codes: E260, E010, H260, H320, K420, P240, O170.

Keywords: MIMIC estimation methods, macro and adjusted, micro survey method asking company managers, micro survey method using household data, using the consumption-income-gap, comparison of results of size of shadow economy of mostly OECD countries, shadow economies.

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November 24, 2021

1. Introduction

All over the world the estimation of the size and development of shadow economies (se) is a hot and controversial scientific topic. Numerous review articles tackle this problem, and there is ongoing debate about the plausibility of the size of the shadow economy under the various methods[1]. At the same time, some new and promising micro and macro approaches have been developed, widening the spectrum of estimation methods[2]. The goal of this paper is threefold, first to present the results of four micro methods, and second to compare these micro-based results with MIMIC-macro and MIMIC-macro-adjusted results, as we see from them the, by far, biggest differences in the size of various countries' shadow economies. Finally, some remarks are made about applying the behavioral economics (be) approach, why individuals work in the shadow economy, and which estimation methods should be used when using the be method.

In chapter 2 some brief remarks are made about the underlying economic theories, why people are engaged in se or non-observed activities, and then six micro and macro approaches are presented including the MIMIC and a widened hybrid MIMIC approach. In chapter 3 a detailed comparison of the results for the size of the shadow economy of mostly highly developed countries is undertaken to see how large the difference is between these macro (MIMIC) and micro approaches and what we can learn when making these comparisons. Chapter 4 provides a summary and draws some conclusions.

2. Micro and other approaches to estimate a shadow economy

2.1 The underlying theories of shadow economy activities

The oldest and most commonly used theoretical approach is that developed by Allingham and Sandmo (1972) for the case of tax evasion. As in most cases shadow economy activities are linked with evading taxes, this approach is also used to theoretically model se activities. This approach assumes that individuals are rational utility maximizing actors who weigh up costs and benefits when considering breaking the law. Their decision to partially or completely participate in shadow economy activities is a choice under uncertainty, as it involves a trade-off between gains, if their activities are not discovered, and losses, if they are discovered and penalized. Shadow economic activities thus negatively depend on the probability of detection p and potential fines f, and positively on the opportunity costs of remaining formal, denoted as B. The opportunity costs are positively determined by the burden of taxation T and high labor costs W – individual income generated in the shadow economy is usually categorized as labor income rather than capital income – due to labor market regulations. Hence, the higher the tax burden and labor costs, the more

[1] For recent surveys compare Feld and Schneider (2010), Medina and Schneider (2021), Williams and Schneider (2016). For debates and controversies compare Kirchgaessner (2016) and Feld and Schneider (2016), Breusch (2016), Feige (2016a, 2016b), Schneider (2016) and Hashimzade and Heady (2016).

[2] Compare for the micro level Putnins and Sauka (2021 and 2017) and for the macro level Dybka et al. (2019, 2020).

incentives individuals have to avoid these costs by working in the shadow economy. The probability of detection p itself depends on enforcement actions A taken by the tax authority and on facilitating activities F accomplished by individuals to reduce the detection of shadow economic activities. This discussion suggests the following structural equation:

$$SE = SE\left[\overset{-}{p}\left(\overset{+}{A}, \overset{-}{F} \right); \overset{-}{f}; \overset{+}{B}\left(\overset{+}{T}, \overset{+}{W} \right) \right]$$

Hence, shadow economic activities may be defined as those economic activities and income earned that circumvent government regulation, taxation or observation. More narrowly, the shadow economy includes monetary and non-monetary transactions of a legal nature; hence all productive economic activities that would generally be taxable were they reported to the state (tax) authorities.

However, this traditional approach has been criticized by many public finance and economic scholars who argue that on the one hand, individuals do not act rationally (or maximize utility) all the time, and on the other hand their decision depends, besides the above-mentioned factors, on social norms, institutions (e.g., direct democracy) and attitudes (such as e.g. religion)[3].

Two pioneers of this approach were Simon (1959) and Schmölders (1960, 1975), who developed behavioral science (be) which tries to explain why individuals frequently make irrational choices, from a traditional economics standpoint, or why their behavior does not match the patterns predicted by neoclassical models (Diacon, Donici and Maha, 2013, p. 29). Especially in the research area of taxation and tax behavior, the behavioral economic approach is one of the most used methods to explain tax behavior and to try to shed light on the question "Why do people pay taxes" and what are the main motives for this behavior[4]. Here, micro-sociological and psychological approaches can provide interesting additional insights into the decision process of individuals choosing to work in the underground economy (for references see footnotes 3 and 4). In an interdisciplinary approach (as undertaken in Economic Psychology) variables such as tax morale, which was first discussed by Günter Schmölders (1960, 1975), and other factors such as acceptance and perceived fairness of the tax system are considered.

In this paper there will be no extensive discussion about the strengths and weaknesses of the behavioral economic approach (for references see footnote 3), as here the research question is put forward, whether or not the different estimation methods provide the possibility to econometrically test the neoclassical and be

[3] Compare Simon (1959), Alm et al. (1992), Schmölders (1970), Smith (2005), Kirchler (2007), Torgler (2016, 2021), to mention just a few.
[4] Compare here Alm (2012, 2019), Torgler (2002, 2007, 2021), Torgler and Schneider (2007, 2009).

approaches. The best possibilities involve micro estimation procedures because they mostly use individual data, and variables such as tax morale, religion, and other social norms can be included. As it is much more difficult or sometimes impossible to include such independent/causal variables (e.g. tax morale or religion) in macro estimation models and as the macro estimation models often provide quite large sizes of the shadow economy, the question of the plausibility of the results of both the micro and macro estimation methods is crucial and is the main focus of this paper.

Finally, a short remark is made about which causal variables are most important for the shadow economy. The increase in the shadow economy has been caused by many different factors but those most important and most often cited are[5]:

(i) the rise of the burden of taxes and social security contributions combined with the increase in the density and intensity of regulations in the official economy, especially on labor markets,
(ii) the (forced) reduction of weekly working time, earlier retirement and the increasing unemployment rate, and
(iii) the (long-term) decline of civic virtues and loyalty toward public institutions combined with a declining tax morale.

In the following subchapters, the following six methods of measuring the shadow economy[6] are briefly presented[7] and critically evaluated.

(i) Measurement by the system of National Accounts Statistics – Discrepancy method;
(ii) Micro approach (survey technique);
(iii) Micro method: use of surveys of company managers;
(iv) Micro method: estimation of the consumption-income-gap of households;
(v) MIMIC method (macro and adjusted); and
(vi) Currency demand and MIMIC models: A structured hybrid method.

[5] Compare here Schneider and Enste (2000), Torgler and Schneider (2007, 2009), Feld and Schneider (2010).
[6] The term *shadow economy* here means measuring the non-observed economy. This will be explained in detail in describing the first method of the National Accounts Statistics (Discrepancy method). Compare here Gyomai and van de Ven (2014), Feld and Schneider (2010), Williams and Schneider (2016) and Medina and Schneider (2021).
[7] A critical evaluation is not undertaken here, because this is covered in various other studies, including Feld and Schneider (2010), Gërxhani (2004), and Medina and Schneider (2021).

2.2 System of National Accounts Statistics – Discrepancy method

This method is described in detail in the paper by Gyomai and van de Ven (2014). The authors start with a classification for measuring the non-observed economy as follows (Gyomai and van de Ven, p. 1):

(i) Underground hidden production: Activities that are productive and legal, but deliberately concealed from public authorities.
(ii) Illegal production: Productive activities that generate goods and services forbidden by law or that are unlawful when carried out by unauthorized procedures.
(iii) Informal sector production: Productive activities conducted by incorporated enterprises in the household sector or other units that are registered and/or less than specified size in terms of employment and have some market production.
(iv) Production of households for own final use: Productive activities that result in goods or services consumed or capitalized by the households that produced them.
(v) Statistical "underground": All productive activities that should be accounted for in basic data collection programs but are missed due to deficiencies in the statistical system.

Gyomai and van de Ven (2014) provide a precise definition in order to reach the goal of exhaustive estimates, as follows:

(1) Hidden activities (System of National Accounts):

SNA 2008, § 6.40: Certain activities may clearly fall in the production boundary of the SNA and also be quite legal, but are deliberately concealed from public authorities for the following kinds of reasons:

(i) to avoid the payment of income, value added or other taxes;
(ii) to avoid the payment of social security contributions;
(iii) to avoid having to meet certain legal standards such as minimum wages, maximum hours, safety or health standards, etc.;
(iv) to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

(2) Illegal activities:

SNA 2008, § 6.43: There are two kinds of illegal production:

(i) The production of goods or services whose sale, distribution or possession is forbidden by law;
(ii) Production activities that are usually legal but become illegal when carried out by unauthorized producers; for example, unlicensed medical practitioners.

In SNA 2008, § 6.45 it is written that both kinds of illegal production are included within the production boundary of the SNA provided they are genuine production processes whose outputs consist of goods or services for which there is an effective market demand.

With this classification, the authors provide a comprehensive and useful categorization of the various shadow economy/underground activities. This estimation method is applied by National Statistical Offices and is explained in detail in the Handbook for Measuring the Non-Observed Economy, OECD (2010). The authors argue that non-observed economy estimates take place at various stages of the integrated production process of national accounts:

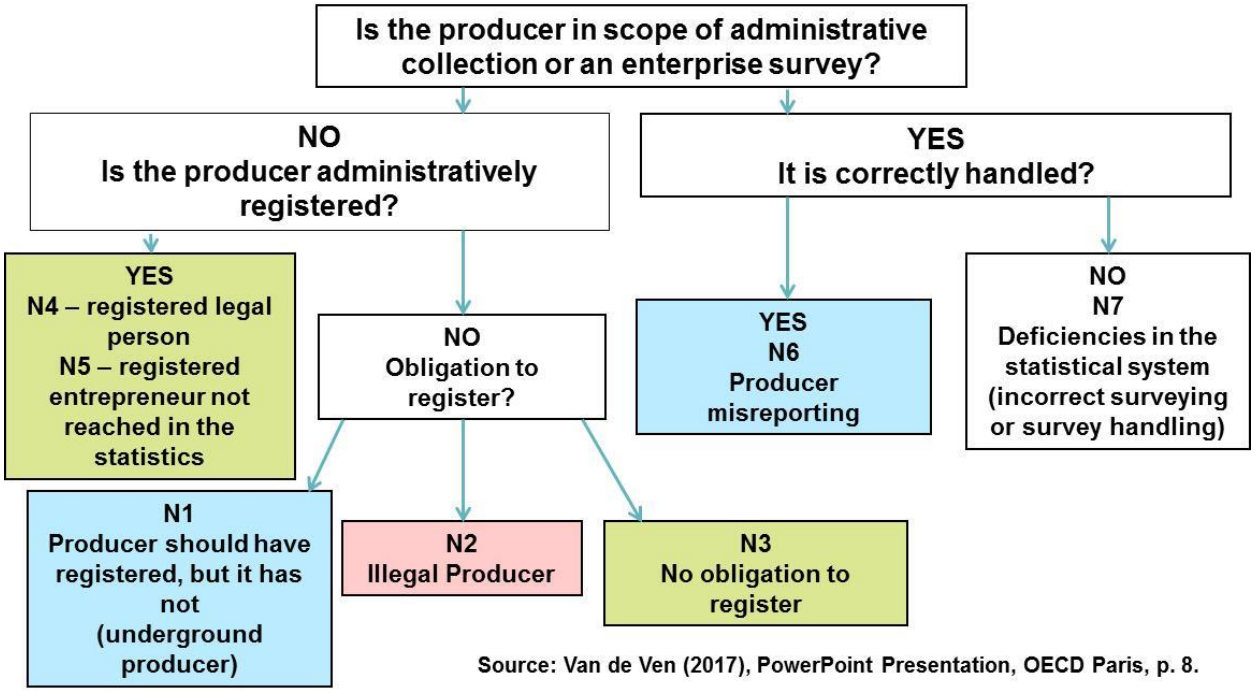
First, data sources with identifying biases on reporting on scope are corrected via imputations.

Second, upper-bounded estimates are used to access the maximum possible amount of non-observed economy (NOE) activity for a given industrial activity or product group based on a wide array of available data.

Third, special purpose surveys are carried out for areas where regular surveys provide little guidance and small-scale models are built to indirectly estimate areas where direct observation and measurement is not feasible.

In Figure 2.1 the classification of the NOE (non-observed economy) in order to reach estimates with the national accounts method (NAM) is shown.

Figure 2.1: Classification of NOE (Non-Observed Economy)



This is a careful procedure which takes all possible situations into account to finally provide an exhaustive estimation. The concept of the national account method (NAM) to capture all non-observed economic activities is described below.

It includes the following non-observed economy categories:

- Economic underground: N1+N6
- Informal, i.e. not registered or observed (and own account production): N3+N4+N5
- Statistical deficiencies (or underground): N7
- Illegal production of legal and illegal products and services: N2.

Much work has been done on the first three categories, less so on illegal activities. However, in the European Union there is currently increased interest in illegal activities, since their inclusion has become mandatory with the introduction of ESA 2010.

In general, the discrepancy analysis is performed at a disaggregated level and the nature of adjustment has the effect that various NOE categories can be at least partly identified. The methodological descriptions provided by countries reveal that country practices in many areas of adjusting for NOE are often somewhat similar.

Still, substantial differences show up between the various countries. Table 2.1 presents NOE adjustments by informality type of 16 developed OECD countries over the years 2011 to 2012. It shows that the total non-observed economies vary considerably between the countries[8]. For example, Austria and Israel have the largest statistical deficiencies with 46.8 and 46.8% of the total NOE! Also, the adjustments in the different categories are quite considerable. Using this method, some countries such as Italy have relatively large non-observed economies (NOE) with 17.5%, followed by Slovak Republic with 15.6% and Poland with 15.4% of official GDP. The smallest is Norway with 1%.

Table 2.1: NOE adjustments by informality type – percentage of GDP (share of adjustment type within total NOE); 2011–2012

	Underground N1 + N6	Illegal N2	Informal sector N3 + N4 + N5	Statistical deficiencies N7	Total NOE
Austria	**2.4 (31.7%)**	**0.2 (2.1%)**	**1.5 (19.4%)**	**3.5 (46.8%)**	**7.5 (100%)**
Belgium	**3.8 (83.8%)**	**-**	**-**	**0.7 (16.2%)**	**4.6 (100%)**
Canada	**1.9 (88.2%)**	**0.2 (8.2%)**	**-**	**0.1 (3.6%)**	**2.2 (100%)**
Czech Rep.	**6.3 (77.6%)**	**0.4 (4.5%)**	**1.3 (15.6%)**	**0.2 (2.3%)**	**8.1 (100%)**
France	**3.7 (54.7%)**	**-**	**2.9 (42.7%)**	**0.2 (2.7%)**	**6.7 (100%)**
Hungary	**3.1 (27.9%)**	**0.8 (7.5%)**	**3.1 (28.6%)**	**3.9 (36%)**	**10.9 (100%)**
Israel	**2.2 (32.6%)**	**-**	**1.4 (21.8%)**	**3 (45.6%)**	**6.6 (100%)**
Italy	**16.2 (92.8%)**	**-**	**-**	**1.2 (7.2%)**	**17.5 (100%)**
Mexico	**5.5 (34.7%)**	**-**	**10.4 (65.3%)**	**-**	**15.9 (100%)**
Netherlands	**0.8 (36.6%)**	**0.5 (20.1%)**	**0.5 (20%)**	**0.5 (23.2%)**	**2.3 (100%)**
Norway	**0.5 (51.5%)**	**0 (0.3%)**	**0.5 (43.8%)**	**0 (4.4%)**	**1 (100%)**
Poland	**12.7 (82.6%)**	**0.9 (6%)**	**0 (0%)**	**1.8 (11.4%)**	**15.4 (100%)**
Slovak Rep.	**12.1 (77.3%)**	**0.5 (3%)**	**2.9 (18.7%)**	**0.2 (1%)**	**15.6 (100%)**
Slovenia	**3.9 (38.2%)**	**0.3 (3.2%)**	**2.8 (27.7%)**	**3.1 (30.9%)**	**10.2 (100%)**
Sweden	**3 (100%)**	**-**	**-**	**-**	**3 (100%)**
U.K.	**1.5 (65.6%)**	**-**	**0.5 (22.9%)**	**0.3 (11.4%)**	**2.3 (100%)**

Source: Gyomai and van de Ven (2014, p. 6).

2.3 Micro Approach: Representative surveys

Representative surveys[9] are often used to obtain micro knowledge about the size of the shadow economy and shadow labor markets. This method is based on representative surveys designed to investigate public perceptions of the shadow economy, actual participation in shadow economy activities, and opinions about shadow practices. As an example, we present some results of such surveys which were designed by the Lithuanian Free Market Institute and its partner organizations for Belarus, Estonia, Latvia, Lithuania, Poland and Sweden. The surveys took place from May 22 until June 15, 2015. The target audience included local residents aged 18–75. The total sample size comprised 6,000 respondents across the six countries.

[8] A comparison to other methods will be done in chapter 3.
[9] Compare e.g. Feld and Larsen (2005, 2008, 2009), and Zukauskas and Schneider (2016).

Approximately two thirds of the survey participants were 36 years old or older. Some results of the surveys are presented in Tables 2.2 and 2.3[10]. Table 2.2 contains undeclared working hours as a proportion of normal working hours from the year 2015. Undeclared hours, as a share of normal working hours based on a weekly calculation, vary between 4.2% in Sweden and 20.7% in Poland, which is a huge range. This is not unexpected, because the shadow economy in Sweden is much smaller than that in Poland. If one considers the average weekly undeclared hours worked by respondents with shadow experience, the range is much narrower. The work ranges between 25.5 hours in Poland and 16.8 hours in Lithuania. In Table 2.3 the extent of aggregated shadow wages as a proportion of GDP is shown. Obviously, Sweden has by far the lowest with 1.7% of GDP as shadow employment, Belarus is the largest with 32.8%, followed by Poland with 24%. One also sees quite considerable variance here.

Table 2.2: Undeclared working hours as a proportion of normal working hours; year 2015

Country	Friends/ relatives in shadow labor market	Average weekly undeclared hours worked by respondents with shadow experience	Average weekly undeclared hours worked for the whole population	Normal average weekly working hours	Undeclared hours as a share of normal hours
	1	2	3=1x2	4	5=3/4
	Proportion	Hours per week	Hours per week	Hours per week	Proportion
Belarus	29%	23.5	6.82	39.8	17.1%
Estonia	26 %	22.4	5.82	38.9	15.0 %
Latvia	36 %	20.3	7.31	39.1	18.7 %
Lithuania	29 %	16.8	4.87	38.1	12.8 %
Poland	33%	25.5	8.42	40.7	20.7%
Sweden	8%	18.9	1.51	36.3	4.2%

Note: Figures for the experience of friends or relatives in the shadow labor market and average weekly undeclared hours are taken from the survey, while normal average weekly working hours come from the Eurostat Database for the year 2014. In the absence of such data for Belarus, it was estimated as an average of normal working hours for Central and Eastern European countries that belong to the European Union.
Source: Zukauskas and Schneider (2016, p. 128).

[10] Here, we do not concentrate on various results about attitudes, which can be seen in detail in the paper by Zukauskas and Schneider (2016).

Table 2.3 Extent of aggregated shadow wages as a proportion of GDP; year 2015

Country	Undeclared hours worked per year	Average undeclared hourly wage	Extent of shadow market	GDP	Extent of shadow employment of GDP
	1	2	3=1x2	4	5=3/4
	Million hours	Euro	Million Euros	Million Euros	Proportion
Belarus	2,504	7.51	18,816	57,300	32.8%
Estonia	289	10.37	2,993	19,963	15.0 %
Latvia	549	5.03	2,760	23,581	11.7 %
Lithuania	540	6.62	3,570	36,444	9.8 %
Poland	11,954	8.24	98,554	410,845	24.0%
Sweden	541	13.32	7,212	430,635	1.7%

Note: Undeclared hours worked per year are calculated as Shadow frequency/100 x average weekly undeclared hours worked by persons who carried out shadow activities x 52 x total population aged 18–74. Figures for shadow frequency, average undeclared weekly hours, and average undeclared hourly wage are taken from the survey, while the population aged 18–74 and GDP at current prices are taken from the Eurostat Database for the year 2014.
Source: Zukauskas and Schneider, 2016.

2.4 Micro method: Measuring the shadow economy with the use of surveys of company managers

Putnins and Sauka (2015) use surveys of company managers to measure the size of the shadow economy. They combine misreported business income and misreported wages as a percentage of GDP. The method produces detailed information on the structure of the shadow economy, especially in the service and manufacturing sectors. It is based on the premise that company managers are most likely to know how much business income and wages go unreported due to their unique position in dealing with both types of income. They use a range of survey-designed features to maximize the truthfulness of responses. Their method combines estimations of misreported business income, unregistered or hidden employees and unreported wages in order to calculate a total estimate of the size of the shadow economy as a percentage of GDP. In their opinion, their approach differs from most other studies of the shadow economy, which largely focus either on macroeconomic indicators or on surveys about households. They have developed first results for Estonia, Latvia and Lithuania. Results are shown in Table 2.4 for the period 2009 to 2020. For Estonia and Latvia there is a decline of the shadow economies over the period 2009 to 2020 and the highest shadow economy is Latvia with an average value of 25.9% over 2009 to 2020, followed by Estonia with 16.7%. In

Lithuania one observes a decrease from 17.7 (2009) to 12.5% (2014) and an increase from 15.0% (2015) to 20.4% in 2020; a higher value than in 2009.

Table 2.4: A comparison of the size of the shadow economy (in % of GDP) in the Baltic countries 2009 – 2015 by Putnins and Sauka with Schneider

Year	Estonia	Latvia	Lithuania
2009	20.2%	36.6%	17.7%
2010	19.4%	38.1%	18.8%
2011	18.9%	30.2%	17.1%
2012	19.2%	21.1%	18.2%
2013	15.7%	23.8%	15.3%
2014	13.2%	23.5%	12.5%
2015 2016 2017 2018 2019 2020	14.9% 15.4% 18.2% 16.7% 14.3% 16.5%	21.3% 20.7% 22.0% 24.2% 23.9% 25,5%	15.0% 16.5% 18.2% 18.7% 18.2% 20.4%
Average 2009–2020	16.9%	25.9%	17.2%

Source: Putnins and Sauka (2015, Table 1, p. 12) and Putnins and Sauka (2021, page 12).

2.5 Micro method: The use of household data based on the consumption-income-gap

The size of the shadow economy of the Czech and Slovak Republic is estimated by Lichard, Hanousek and Filer (2014, 2016, 2021) based on microeconomic data. They avoid making the unrealistic assumption that leads to underestimating the size of the shadow economy by excluding underreporting among those who unjustifiably are assumed to have fully reported their income. Their explanation is that employees being paid under the table or having a secondary undeclared source of income while not being officially classified as self-employed constitute a major source of unreported income; this is included in their approach. Lichard, Hanousek and Filer correctly criticize that most approaches continue to rely on the basic and critical assumption that researchers must specify in advance a sub-set of the population who always fully report their incomes and another group of self-employed individuals who may underreport. These simplifying assumptions are, however, weak, both theoretically and empirically. Hence, their goal is to bypass the problem of arbitrary a priori assignment of individuals to evading and non-evading groups by using an endogenous switching regression with an unknown sample separation rule, to estimate the probability of

underreporting and its potential extent. Such a technique is, to the authors' knowledge, first used by them and they apply a new method for the year 2008 for the Czech and Slovak Republics. The size of the shadow economy for 2008 for the Czech Republic was 17.6% and for the Slovak Republic 22.9%. These are quite high values for the shadow economies of these two countries, higher than the shadow economy calculated by other micro and macro methods[11].

2.6 Macro Method: The MIMIC and an extended hybrid approach

2.6.1 The MIMIC Method

Using this macro approach, the size of the shadow economy (se) is based on a combination of the cash (currency/demand) approach and of the Multiple Indicators Multiple Causes (MIMIC) method. The basic idea behind the currency demand approach is that goods and services sold in the shadow economy are paid for in cash and that, using a cash demand function, it is possible to estimate such goods and services performed in return for cash and thus to calculate the volume (value added) of the shadow economy. The MIMIC approach is based on the idea that the shadow economy is not a directly observable figure, but that it is possible to approximate it using quantitatively measurable causes of working in the underground economy (such as the tax burden and amount of regulation), and using indicators (such as cash, official labor force participation rate, etc.), in which shadow economic activities are reflected. As the MIMIC method only enables relative orders of magnitude of the underground economy of individual countries to be calculated, some se values calculated with the help of the cash approach are necessary to convert/calibrate the se values into absolute ones (in percentage of official GDP or in billions of Euros).

In the following, the MIMIC estimation procedure (compare also Figure 2.2) is briefly explained[12]:

(1) Modeling the shadow economy as an unobservable (latent) variable;

(2) Description of the relationships between the latent variable and its causes in a structural model: $\eta = \Gamma x + \zeta$; and

(3) The link between the latent variable and its indicators is represented in the measurement model: $y = \Lambda_y \eta + \varepsilon$.

where:

[11] Compare chapter 3 for detailed results.

[12] As many papers exist, which extensively present the MIMIC-method with all its strengths and weaknesses, a detailed presentation is not done here. Compare e.g. Dell'Anno (2021a, 2021b), Medina and Schneider (2021), and Dybka et al. (2019).

η: latent variable (shadow economy);

X: (q×1) vector of causes in the structural model;

Y: (p×1) vector of indicators in the measurement model;

Γ: (1×q) coefficient matrix of the causes in the structural equation;

Λy: (p×1) coefficient matrix in the measurement model;

ζ: error term in the structural model and ε is a (p×1) vector of measurement error in y.

The specification of the structural equation is:

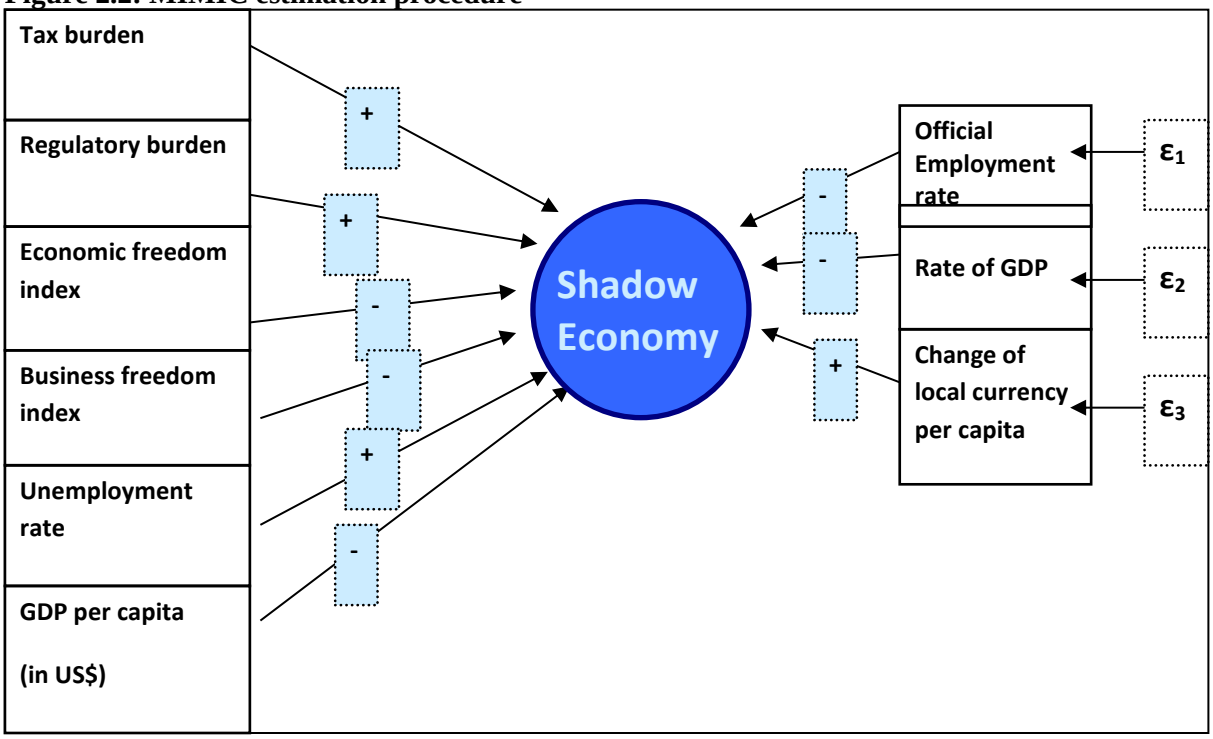
$$[\text{shadow economy}] = [\,\gamma1, \gamma2, \gamma3, \gamma4, \gamma5, \gamma6, \gamma7, \gamma8] \times \begin{matrix}[\text{Share of direct taxation}]\\ [\text{Share of indirect taxation}]\\ [\text{Share of social security burden}]\\ [\text{Burden of state regulation}]\\ [\text{Quality of state institutions}]\\ [\text{Tax morale}]\\ [\text{Unemployment quota}]\\ [\text{GDP per capita}]\end{matrix} + [\zeta]$$

The specification of the measurement equation is:

Employment Quota		λ1				ε1
Change of local currency	=	λ2	**x**	**Shadow Economy**	+	ε2
Average working time		λ3				ε3

where γi and λi are coefficients to be estimated.

Figure 2.2: MIMIC estimation procedure



Source: Schneider, Buehn and Montenegro (2010).

How does one proceed to get the absolute figures? Schneider, Buehn and Montenegro (2010) use the following two steps:

1. The first step is that the shadow economy remains an unobserved phenomenon (latent variable) which is estimated using causes of illicit behavior, e.g. tax burden and regulation intensity, and indicators reflecting illicit activities, e.g. currency demand and official work time. This procedure "produces" only relative estimates of the size of the shadow economy.
2. In the second step the currency demand method is used to calibrate the relative se estimates into absolute figures by using two or three values of the absolute size of the shadow economy from CDA estimations.

2.6.2 A structured hybrid CDA and MIMIC Model

Dybka et al.'s (2019) novel hybrid procedure takes into consideration the previous critique of the CDA and MIMIC models produced by Feige (1996) and Breusch (2016). They successfully overcome the misspecification in the CDA equations and "vague" transformation of the latent variable obtained through the MIMIC model into interpretable levels and paths of the shadow economy. Dybka et al.'s (2019) proposal is based on a new identification method for the MIMIC model, referred to as "reverse

standardization." Reverse standardization supplies the MIMIC model with panel-structured information on the latent variable's mean and variance obtained from the CDA estimates, treating this information as given in the restricted full-information maximum likelihood function. This approach does not require the choice of an externally estimated reference point for benchmarking or adopting other ad hoc identifying assumptions (such as unity restriction on a selected parameter in the measurement equation). Furthermore, the proposed estimation procedure directly addresses the numerical problem of negative variances in the MIMIC estimation, largely disregarded in much off-the-shelf software. The non-negativity restriction on variances within the MIMIC framework can materially affect the significance, specification decisions, and measurement results. Paying due respect to the (intuitive) constraint on the non-negativity of variances may lead to a surprising result of flattening the trajectory of the shadow economy. Also, the analysis of variance decomposition of SE estimated by their hybrid strategy confirms findings from the previous literature by showing that as much as 97.2 to 98.2% of SE variance in the panel is due to the CDA component (between cross-sections), whereas only the small remaining fraction is due to MIMIC's fine tuning.

First, Dybka et al. (2019) estimate and extend a panel version of the CDA equation using both frequent and neglected variables (describing the development of an electronic payment system) and abandon the controversial assumption that the share of the shadow economy in the total economy is zero. Second, they estimate a MIMIC model by maximizing a (full-information) likelihood function reformulated in two ways: (i) instead of anchoring the index of an arbitrary time period and using arbitrary normalizations or other discretionary corrections, they use the means and variance estimated in the CDA model; and (ii) they constrain the parameter vector to explicitly assume away the negative variances of structural errors and measurement errors. Their hybrid model proposes a solution to the long-standing problem of identification in the MIMIC model, which, in many ways, outperforms previous approaches to just-identification. Their approach clearly implies a scale and unit of measurement, avoids obscure ad hoc corrections, and paves the way to the construction of a sensible confidence interval. This new method is a promising approach to overcoming the usual critiques of the CDA and the MIMIC model.

2.6.3 The problem of "double counting"

With macro approaches such as the MIMIC or Currency Demand approaches another big problem is that they use causal factors such as tax burden, unemployment, self-employment and regulation, which are also responsible for people undertaking do-it-yourself activities or asking friends and neighbors to "help" them. Hence, do-it-yourself activities, neighbors' or friends help, and legally bought material for the shadow economy, but also to some extent illegal activities, are included in these macro approaches. This has the consequence of estimating a "total" shadow economy which certainly is an upper bound estimate.

In Table 2.5 a decomposition of shadow economy activities is undertaken for the countries Estonia and Germany. Table 2.5 starts with line (1) of the macro MIMIC estimates of 28% in Estonia as an average value for 2009 to 2015 and 16.2% for Germany for an average over 2009 to 2015. Legally bought material for shadow economy or do-it-yourself activities and friends' help are deducted. Then illegal activities such as smuggling are deducted. Furthermore, do-it-yourself activities and neighbors' help are deducted. Due to these factors from lines (2) to (4) one gets a corrected shadow economy which is roughly two thirds of the macro size of the shadow economy. It is 65% for Estonia and 64.2% for Germany. In the following, this correction factor is used to calculate an adjusted size of the shadow economy using the MIMIC method. The results for 31 European countries for 2017 are presented in Figure 2.3. The shadow economy appears considerably smaller and this might be a more realistic value of the true size of the shadow economy using a macro method.

Table 2.5: Decomposition of shadow economy activities in Estonia and Germany

No.	Kinds of shadow economy activities (rough estimates!)	Estonia		Germany	
		Size in % of official GDP average 2009–2015	Proportion of total shadow economy	Size in % of official GDP average 2009–2015	Proportion of total shadow economy
1	Total shadow economy (estimated by the MIMIC and calibrated by the currency demand procedures)	28.0	100%	16.2	100%
2	Legally bought material for shadow economy and DIY activities	6.0	21%	3.1	19.1%
3	Illegal activities (smuggling etc.)	2.0	7%	1.2	7.4%
4	Do-it-yourself activities and neighbors' help[1)]	2.0	7%	1.5	9.2%
5	Sum (2) and (4)	10.0	35%	5.8	35.7%
6	"Corrected" shadow economy, but legal activities (position (1) minus position (5))	18.0	65%	10.4	64.2%
	[1)] Without legally bought material which is included in (2)				

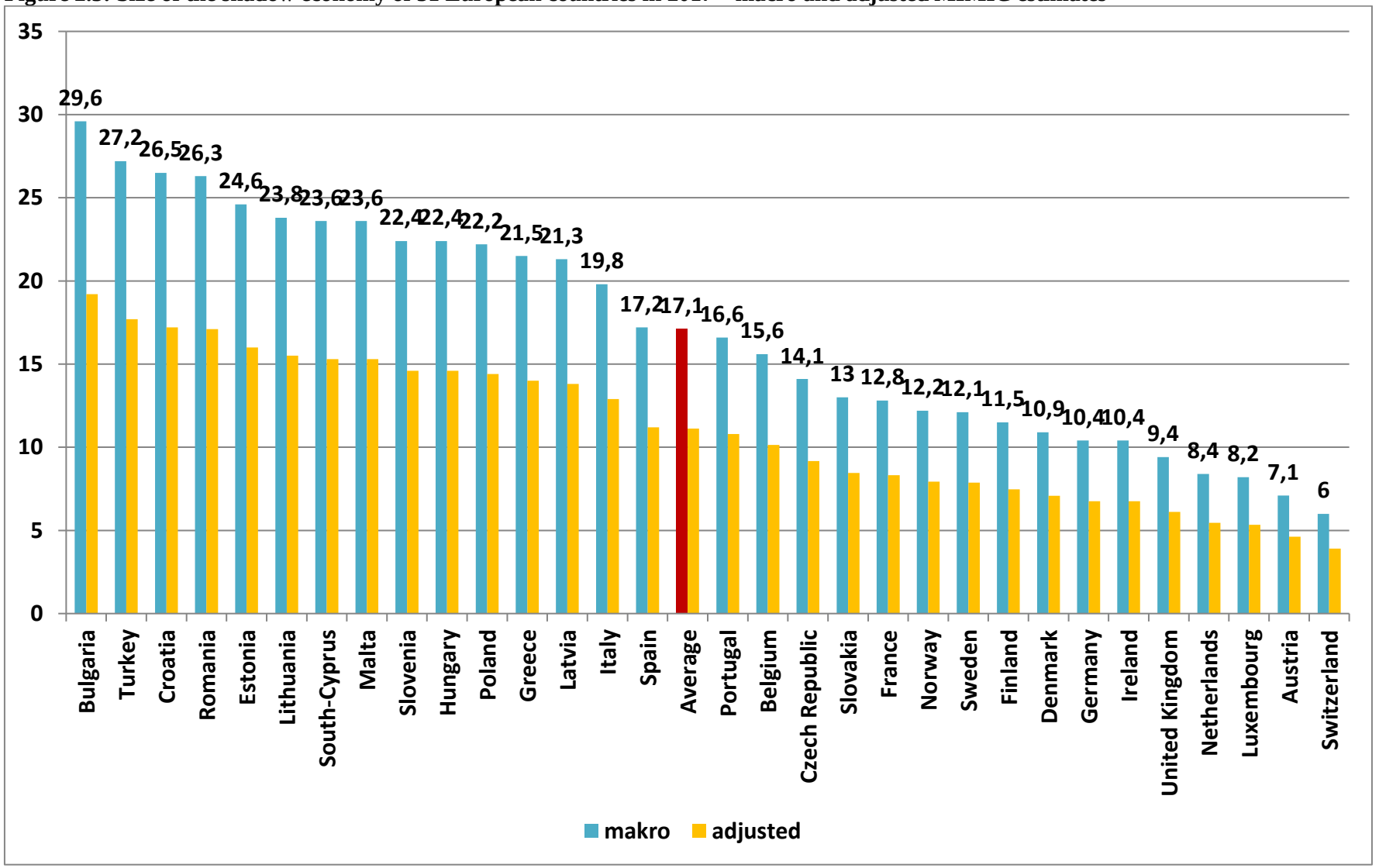
Source: Own calculations, Linz, September 2016.

2.7 Concluding remarks

The presentation of these six methods has the sole purpose of briefly explaining them. Detailed criticism is provided in Schneider (2017, 2021), Feld and Schneider (2010), Dybka et al. (2019), and Medina and

Schneider (2021). Hence, it is not repeated here. In chapter 3, some detailed comparison will be undertaken. The first four methods will be used as a benchmark against the MIMIC macro and adjusted results.

Figure 2.3: Size of the shadow economy of 31 European countries in 2017 – macro and adjusted MIMIC estimates



Source: Own calculations.

3. A comparison of the MIMIC results with the micro survey and National Accounts Discrepancy methods

3.1. MIMIC results versus National Accounts – Discrepancy method results

The first comparison will be made between the calculations of the size of the shadow or non-observed economy (NOE) applying the system of National Accounts (discrepancy method) and those using the MIMIC method (macro and adjusted). The results are shown in Table 3.1, which contains 16 OECD countries for the years 2011–2012 (averages). For most countries the MIMIC results are considerably larger, especially in the cases of Belgium, Czech Republic, Hungary, Norway and Poland. Amazingly, some MIMIC estimates, macro and even more adjusted ones, come very close to the National Accounts Discrepancy method. For example, in Austria the non-observed economy is 7.5% by the National Accounts Discrepancy method and 7.6% using the macro MIMIC estimation, while the adjusted figure is only 4.9%, hence, considerably lower than the National Accounts Discrepancy method. Also somewhat close are the results for the Slovak Republic and for Israel, but one clearly sees that the MIMIC macro and adjusted results are considerably higher than those achieved with the National Accounts Discrepancy method. If one makes a comparison between the MIMIC adjusted values and the National Accounts Discrepancy method, the differences shrink considerably. While we have large differences for Norway at 8.4 percentage points, Sweden with 6.4 and Belgium with 6.4, for a number of countries the differences are less than three to four percentage points.

What can we conclude from Table 3.1? There are still considerable differences between the macro MIMIC approach and the National Accounts Discrepancy method, however, the variance is quite large, especially in the National Accounts Discrepancy method, and the MIMIC results, at least for two or three countries, come quite close to this calculation of the shadow economy. Hence, the statement of Gyomai and van de Ven (2014) that the estimates by Schneider would be on average three times as large as the estimates for the non-observed economy in the system of National Accounts and 6.7 times larger than the relevant underground economy estimates should be reconsidered. Also, their statement that macroeconomic MIMIC models produce a large size for the shadow economy and the differences are likely to be in great part caused by unrealistic model assumptions and calibration decisions, at least with the adjusted MIMIC results, should be reconsidered.

Table 3.1: Comparison of the MIMIC (macro and adjusted) results with National Accounts Discrepancy Method (NADM); 16 OECD Countries, year 2011/2012 (av.)

No.	Country	NADM (1)	MIMIC (% of GDP)		Difference (MIMIC-NOE)	
		% of GDP	Macro (2)	Adj. (3)	(2)–(1)	(3)–(1)
1	*Slovenia*	*10.2*	*23.9*	*15.5*	*13.7*	*5.3*
2	*Norway*	*1*	*14.5*	*9.4*	*13.5*	*8.4*
3	*Israel*	*6.6*	*19.7*	*12.8*	*13.1*	*6.2*
4	*Belgium*	*4.6*	*17*	*11*	*12.4*	*6.4*
5	Mexico	15.9	27.9	18.1	12	2.2
6	Hungary	10.9	22.6	14.7	11.7	3.8
7	Sweden	3	14.5	9.4	11.5	6.4
8	Canada	2.2	11.7	7.6	9.5	5.4
9	Poland	15.4	24.7	16	9.3	0.6
10	Czech Rep.	8.1	16.2	10.5	8.1	2.4
11	UK	2.3	10.3	6.7	8	4.4
12	Netherlands	2.3	9.6	6.2	7.3	3.9
13	France	6.7	10.9	7.1	4.2	0.4
14	*Italy*	*17.5*	*21.4*	*13.9*	*3.9*	*–3.6*
15	*Slovak Rep.*	*15.6*	*15.7*	*10.2*	*0.1*	*–5.4*
16	*Austria*	*7.5*	*7.6*	*4.9*	*0.1*	*–2.6*

Source: Gyomai and van de Ven (2014, p. 6) and own calculations.

Table 3.2 shows a comparison between the National Accounts Statistics Discrepancy method and the MIMIC results for eight Sub-Saharan African countries over 2010 to 2014. Here we have exactly the opposite result compared to Table 3.1. For most countries, results calculated by the discrepancy method NOE are considerably higher than the MIMIC results; also compared to the MIMIC adjusted results. We have, at least for Africa, the opposite picture, i.e. that the National Accounts Statistics Discrepancy method indicates considerably higher sizes of the shadow economy than the MIMIC results. Hence, again, the criticism that MIMIC estimates are unrealistically large and high may be not true, at least not for Sub-Saharan African countries. In seven out of the eight Sub-Saharan African countries the MIMIC estimation is considerably lower than that obtained using the discrepancy method. For example, in Guinea-Bissau the National Accounts Statistics Discrepancy method estimate is 53.4% and the MIMIC result is 38%, a difference of 15.4 percentage points.

Table 3.2: Comparison between National Accounts Statistics and MIMIC results for eight Sub-Saharan African countries over 2010–2014

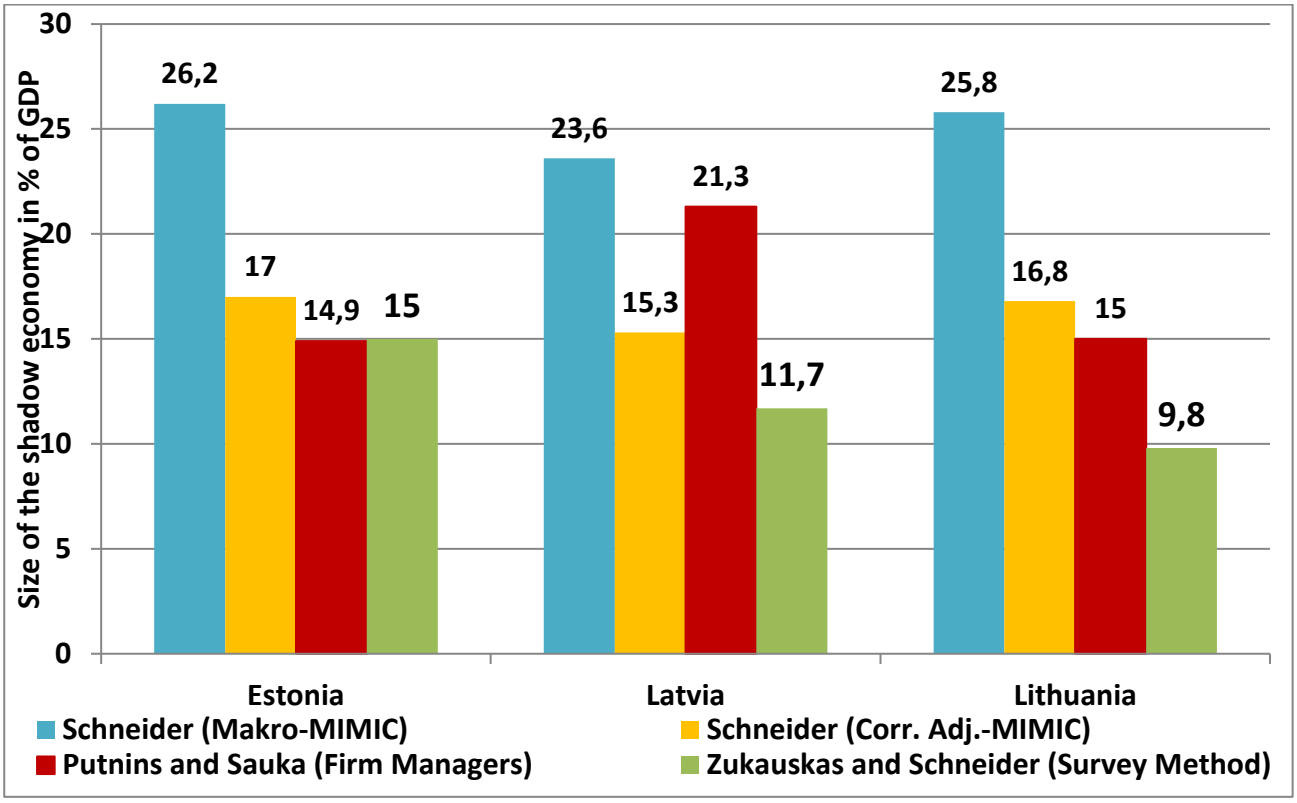
Country	Methods (averages over 2010–2014)			Differences	
	(1) National Accounts Statistics[1)]	(2) MIMIC	(3) MIMIC Adjusted	(2)–(1)	(3)–(1)
Guinea-Bissau	**53.4**	**38**	**31.8**	**–15.4**	**–21.6**
Mali	**55**	**40.4**	**26.3**	**–14.6**	**–28.7**
Togo	**40.1**	**28**	**24.7**	**–12.1**	**–15.4**
Guinea	**48.1**	**37**	**24.1**	**–11.1**	**–24**
Burkina Faso	**43.1**	**32**	**26**	**–11.1**	**–17.1**
Senegal	**47.5**	**40**	**20.8**	**–7.5**	**–26.7**
Benin	**55.6**	**49**	**18.2**	**–6.6**	**–37.4**
Cote d'Ivoire	**34**	**35**	**22.8**	**1**	**–37.4**
Correlation: 0.73 **Spearman's Rank Correlation: 0.857**					

1) **Mostly the Discrepancy method is used.**
Source: Medina et al. (2017), p. 28.

3.2. MIMIC versus micro survey method results

In Figure 3.1 a comparison of the size of the shadow economy as a percentage of GDP of the Baltic countries for the year 2015 is shown, using three different estimation procedures. The survey of firm managers by Putnins and Sauka (2016) and the classical survey results of Zukauskas and Schneider (2016) are compared with the MIMIC macro and adjusted results by Schneider. If one compares the adjusted MIMIC macro results from Schneider with the other two approaches for the case of Estonia, they are quite close. The MIMIC adjusted value is 17% of GDP, the survey method of firm managers is 14.9% and the pure survey method by Zukauskas and Schneider is 15%. Somewhat different results are achieved for Latvia, where the macro MIMIC estimates with 23.6% come quite close to the 21.3% of the survey method of firm managers and the adjusted MIMIC results are, at 15.3%, much lower, as is the pure survey method of Zukauskas and Schneider with 11.7%. In the case of Lithuania, the results of the adjusted MIMIC estimates and those of Putnins and Sauka are quite close with 16.8% and 15% and the pure survey results of Zukauskas are considerably lower with 9.8%. But again, one clearly sees, applying two different survey methods and comparing them with the MIMIC estimations, the results show that the adjusted MIMIC estimations are quite close to the other estimations. Only the pure macro MIMIC estimations are considerably higher.

Figure 3.1: A comparison of the size of the shadow economy (in % of GDP) of the Baltic countries in 2015 applying three different estimation methods



Source: Putnins and Sauka (2015), Zukauskas and Schneider (2016) and own calculations.

3.3. Macro versus micro methods – a comparison of 8/9 different methods

Finally, the view is widened and this subchapter presents results comparing all se/NOE results of the different macro and micro methods first for two countries. Additionally, a further micro method, a modified consumption-income method by Lichard et al. (2021), is included[13]. The results are shown in Table 3.3, where the widest comparison is undertaken comparing nine different methods for the case of the Czech and Slovak Republics, mostly for the year 2008 and three results for 2000. Table 3.3 is ranked according to the size of the shadow economy for the Slovak Republic. The Currency Demand Deposit Ratio by Alm and Embaye (2013) provides the largest results with 23.2% and 25.1% for the Czech and Slovak Republics, respectively. But in place number two is the Consumption-Income-Gap method by Lichard et al. (2014), calculating sizes of 17.6% and 22.6%. They are considerably lower than the Currency Demand approach from Alm and Embaye, but considerably higher than the Deterministic Dynamic Simulation approach by Elgin and Öztunali (2012) with 16.8% and 16.6% for the Czech and Slovak Republics, respectively. They are also considerably higher than the MIMIC macro approach from Buehn and Schneider for the year 2008 with 15.2% and 16.0%. The other results from the Statistical Office Discrepancy Method, Currency Deposit

[13] Lichard et al. (2021, page 1, direct quote) develop an estimator of unreported income that relies on more flexible identifying assumptions than those that have been used previously. Assuming only that evaders have a higher consumption-income-gap than non-evaders in surveys, our model enables the estimation of both the probability of hiding income and the amount of unreported income for each household. The authors illustrate their "new" method using Czech and Slovak household budget surveys. Their results are robust to alternative specifications. Furthermore, they show that since the underreported share decreases with reported income, income inequality in these countries may be lower than suggested by the reported income.

Ratio and another Structural MIMIC model are considerably lower compared to the four first results. Table 3.2 shows that even using similar approaches, the MIMIC or structural model is used in this table three times; the size of the shadow economy can vary considerably, which again leads to the question how these results can be evaluated with respect to their plausibility. Table 3.3 demonstrates that the micro approach household survey Consumption-Income-Gap leads to as high results as have been achieved with most macro Currency Demand or MIMIC approaches. Hence, the question remains open why the macro results are so unreliably high.

Table 3.3: Nine Alternative estimates of the shadow economy as percentage of GDP for Czech and Slovak Republics

Estimation method	Source	Year	Czech Rep.	Slovak Rep.
(1) Currency Demand Deposit Ratio (panel GMM difference)	*Alm and Embaye (2013)*	*2006*	*23.2%*	*25.1%*
(2) Consumption-Income Gap Method (switching reg.)	*Lichard et al. (2014)*	*2008*	*17.6%*	*22.9%*
(3) Deterministic Dynamic General Equilibrium Model	*Elgin and Öztunali (2012)*	*2008*	*16.8%*	*16.6%*
(4) MIMIC	**Buehn and Schneider (2013)**	**2008**	**15.2%**	**16.0%**
(5) Statistical Office: Discrepancy Method	**Calculated from Quintano and Mazzocchi (2010)**	**2008**	**5.4%**	**13.6%**
(6) Currency Deposit Ratio	**Embaye (2007)**	**2000–2005**	**8.0%**	**12.6%**
(7) Structural Model (calibrated to M1)	**Ruge (2010)**	**2001**	**8.2%**	**8.1%**
(8) Cons.-Income Method: Using Food Engel Curves (self-employed excl.)	**Lichard (2012)**	**2008**	**4.0%**	**6.8%**
(9) Structural Model (calibrated to M2)	**Ruge (2010)**	**2001**	**3.3%**	**3.3%**

Source: Lichard et al. (2021, Table 4). See this paper for precise description of the authors' methods.

Similar results to those for the Czech and Slovak Republics are shown for Germany in Table 3.4, where eight different approaches have been applied for Germany over the period 1970 to 2005. The comparison starts with the survey approach (IfD Allensbach, 1975; Feld and Larsen, 2005), then Discrepancy between expenditure and income, Discrepancy between official and actual employment, Physical Input method, Transactions approach, Currency Demand approach, MIMIC approach and Soft Modelling approach. For the year 1980, values for seven out of the eight approaches are available; only the survey approach is

missing. If we take the value of 3.6% from the year of 1975 as a crude proxy for 1980, it is obvious that the survey method has by far the lowest value. The highest values are from the Discrepancy method between official and actual employment with a se of 34%, followed by the Transaction approach developed by E. Feige with 29.3%, then the Discrepancy method between expenditure and income with 13.4%, followed by the Currency Demand approach with 12.6%, the MIMIC approach with 9% and a somewhat lower value from Soft Modelling with 8.3% (year used 1975). Table 3.4 shows the huge variations in estimating the size of the shadow economy in the case of Germany when applying the different estimation methods. But, as in the other tables, the CDA and MIMIC approaches do not "produce" the highest values.

Table 3.4: The size of the shadow economy in Germany according to different methods (in % of official GDP)

Method/Source	Shadow economy (in % of official GDP) in:							
	1970	1975	*1980*	1985	1990	1995	2000	2005
Survey (IfD Allensbach, 1975) (Feld and Larsen, 2005)	-	3.6[1)]	-	-	-	-	-	-
	-	-	-	-	-	-	4.1[2)]	3.1[2)]
	-	-	-	-	-	-	1.3[3)]	1.0[3)]
Discrepancy between expenditure and income (Lippert and Walker, 1997)	11.0	10.2	*13.4*	-	-	-	-	-
Discrepancy between official and actual employment (Langfeldt, 1984)	23.0	38.5	*34.0*	-	-	-	-	-
Physical input method (Feld and Larsen, 2005)	-	-	*13.5*	14.5	14.6	-	-	-
Transactions approach	17.2	22.3	*29.3*	31.4	-	-	-	-
Currency demand approach (Kirchgässner 1983; Langfeldt, 1984; Schneider and Enste, 2000)	3.1	6.0	*10.3*	-	-	-	-	-
	12.1	11.8	*12.6*	-	-	-	-	-
	4.5	7.8	*9.2*	11.3	11.8	12.5	14.7	-
Latent (MIMIC) approach (Frey and Weck, 1983; Pickardt and Sarda, 2006; Schneider 2005, 2007)	5.8	6.1	*8.2*	-	-	-	-	-
	-	-	*9.4*	10.1	11.4	15.1	16.3	-
	4.2	5.8	*10.8*	11.2	12.2	13.9	16.0	15.4
Soft modelling (Weck-Hannemann, 1983)	-	8.3	*8.3*	-	-	-	-	-

1) 1974.
2) 2001 and 2004; calculated using wages in the official economy.
3) 2001 and 2004; calculated using actual "black" hourly wage paid.

Finally, in Table 3.5, comparison of the results of the shadow economy estimations for five OECD countries, Canada, Germany, Great Britain, Italy, and the United States is made using nine different methods over the period 1970 to 1990. Table 3.5 will not be interpreted here in detail, but it shows that

surveys of households and tax auditing (except for the United States) lead to considerably lower results compared with the discrepancy methods, physical input methods and especially the transaction approach. Again, the se results of the CDA and/or MIMIC approaches do not have the highest values.

Table 3.5: A comparison of the results of the shadow economy estimations of five OECD countries using nine different methods over the period 1970–1990

No.	Method	Size of the shadow economy (in % of GDP) in:																			
		CANADA av. over				GERMANY av. over				U.K. av. over				ITALY av. over				U.S. av. over			
	Year	70–75	76–80	81–85	86–90	70–75	76–80	81–85	86–90	70–75	76–80	81–85	86–90	70–75	76–80	81–85	86–90	70–75	76–80	81–85	86–90
1	Surveys of households	-	1.3	1.3	1.4	3.6	3.6	-	-	1.5	-	-	-	-	-	-	-	3.7	4.5	5.6	-
2	Tax auditing	-	2.9	2.9	-	-	-	-	-	-	-	-	-	3.0	3.9	-	10.0	4.9	6.3	8.2	10.0
3	Discrepancy between expenditure and income	-	-	-	-	11.0	10.2	13.4	-	2.5	3.6	4.2	-	3.2	4.3	-	9.3	3.2	4.9	6.1	10.2
4	Discrepancy between official and actual employment	-	-	-	-	23.0	38.5	34.0	-	-	-	-	-	-	18.4	-	-	-	-	-	-
5	Physical input (electricity) method	-	8.8	-	11.2	-	14.4	-	14.5	-	10.3	-	13.2	-	15.2	-	19.3	-	7.8	7.8	9.9
6	Currency demand (Tanzi)	5.1	6.3	8.8	12.0	4.5	7.8	9.2	11.3	4.3	7.9	8.5	9.7	11.3	13.2	17.5	23.1	3.5	4.6	5.3	6.2
7	Cash deposit ratio (Gutmann)	13.8	15.9	11.2	18.4	-	-	-	-	14.0	7.2	6.2	-	23.4	27.2	29.3	-	8.8	11.2	14.6	-
8	Transactions approach (Feige)	-	26.5	15.4	21.2	17.2	22.3	29.3	31.4	17.2	12.6	15.9	-	19.5	26.4	34.3	-	17.3	24.9	21.1	19.4
9	Model approach (Frey/Weck-H.)	-	8.7	-	-	5.8	6.1	8.2	-	-	8.0	-	-	-	10.5	-	-	-	8.2	-	-
	Number of used methods	2	7	5	5	6	7	5	3	5	5	4	2	5	8	3	4	6	8	7	5

Source: Schneider in Petersen and Gallagher (2000, p. 333).

4. Summary and conclusions

In this paper, we describe two conventional and two new micro methods that measure the size of the shadow economy. The two new ones are the survey method using the expertise of managers and their detailed knowledge about firms' shadow economy, and a modified version estimating the consumption-income-gap, relaxing the assumption that one has to solve how many people are working in the shadow economy and especially assuming that the self-employed have a higher shadow economy share. The statistical discrepancy method is briefly described and all four are used as a benchmark for the MIMIC macro and adjusted methods, which are also briefly described. Then a detailed comparison of these se results is undertaken showing that the macro MIMIC estimates are, in some cases, much higher than the Statistical Discrepancy methods. However, in the case of eight Sub-Saharan African countries we observe the opposite, finding that the National Accounts Discrepancy method leads to considerably higher results than the MIMIC procedures. For a number of countries, the MIMIC approaches (especially when the MIMIC procedure is adjusted due to a double counting problem) provide similar results to the other four approaches, so claims that they are unrealistically high and rely on unrealistic assumptions, either in calibration or estimation, need to be reconsidered.

What conclusions can be drawn?

(i) The traditional surveys mostly consider only households and may contain non-responses and/or incorrect responses. Quite often, results of the financial volume of black hours worked and not of value added are calculated. The new methods described in this paper are promising and overcome these weaknesses.

(ii) The Discrepancy method which is used mostly by statistical offices is quite often a combination of estimation procedures, which are different from country to country, and detailed questionnaires. The precise calculation method is often not clearly documented.

(iii) The macro approaches lead to quite high estimations and provide "only" one "macro" figure of the size of the se. Additionally they have a double counting problem including do-it-yourself activities, legally bought material, and neighbors' help.

(iv) Using the MIMIC model one gets only relative coefficients and not absolute ones. One has to use a calibration procedure, and select starting values, which have a great influence on the size and development of the shadow economy. The new hybrid estimation procedure combining the CDA and MIMIC method from Dybka et al. (2019) can help to overcome this weakness. Additionally, the se estimates of all macro approaches, including the MIMIC approach, lead to

high numerical values because a double counting problem exists. By applying the adjustment procedure suggested in this paper, at least part of this double counting problem can be solved.

(v) If applying the behavioral economic method, the micro approaches are best suited for empirical verification.

What open research questions remain?

(1) We have no superior method. All still have serious problems and weaknesses. If possible, one should use several methods.

(2) Satisfactory validation of the size of the se should be developed, so that it is easier to judge empirical results with respect to their plausibility. An attempt has been made in chapter 3 of this paper.

(3) An internationally accepted definition of the shadow economy is missing. Such a definition is needed in order to make comparisons easier between countries and methods, and also to avoid the double counting problem.

(4) The link between theory and empirical estimation of the shadow economy is still unsatisfactory. In the best case, theory provides us with derived signs of the causal and indicator variables. However, which are the core causal and core indicator variables is theoretically open.

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