Reflections on the Meaning and Measurement of Unobserved Economies: What do we really know about the "Shadow Economy"?[1]

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Abstract

This paper reviews the meaning and measurement of unobserved economies germane to tax evasion and macroeconomic information systems. These include unreported, non-observed, underground, illegal, informal and unrecorded economies. It reviews the progress and shortcomings of national and international agency efforts to measure these unobserved economies, noting what they have in common, what distinguishes one from another and their interconnections. It then examines the meaning of Professor Schneider's shadow economy (SSE), and the veracity of his claim to have accurately estimated its size and trend worldwide by employing a MIMIC model methodology. It concludes that SSE estimates suffer from conceptual flaws, apparent manipulation of results and insufficient documentation for replication, questioning their place in the academic, policy and popular literature.

INTRODUCTION

The past half century has seen an explosion of popular and professional literature referring to economies variously described as grey, black, subterranean, cash in hand, off the books, moonlight, undeclared, hidden, unofficial, concealed, parallel, invisible, occult, irregular, shadow, underground, non-observed, unreported, unrecorded, illegal, and informal. I propose that these economies comprise the activities of individuals, households and/or firms that evade, avoid, circumvent, elude, are excluded from, or not subject to the rules and conventions of established institutions. They all involve economic agents engaged in non-compliant behaviours that they seek to hide. This paper develops a broad conceptual framework, establishing what these various economies have in common, and what distinguishes one from another. It briefly recalls the discovery of non-compliant behaviours and reviews earlier empirical efforts to measure their magnitude. Its primary focus is on the meaning, measurement and consequences of non-compliance with fiscal codes, and violations of the rules and conventions of national income accounting.

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The paper employs a national accounting framework to specify the meaning and conceptual interrelationships between unreported, non-observed, underground, illegal, informal and unrecorded economies. The literature often uses these terms interchangeably, although they have quite different meanings. We review the efforts of national revenue agencies to estimate the magnitude of tax evasion and the contributions of national and international statistical organizations to obtain exhaustive estimates of national income and output by measuring the non-observed economy. The paper's final section analyzes the meaning of Professor Schneider's shadow economy (SSE) and examines the veracity of his claim to have estimated its size, trend, causes and consequences worldwide (see, for example, Schneider, Buehn, & Montenegro, 2010a, 2010b, 2010c, 2011; Buehn & Schneider, 2012a; Schneider & Williams, 2013; Schneider & Enste, 2013).

Non-compliance

Since society penalizes non-compliant behaviours, entities that benefit from rule violations have incentives to undertake deceptive behaviours designed to defy detection, making non-compliant behaviours difficult and costly to observe and measure. Thus, non-compliance and "unobservability" are common features of all behaviour in unobserved economies (UEs). What distinguishes one UE from another is the particular rule being violated, making each UE distinctive in character, composition and magnitude. The impact of a particular non-compliant behaviour on the economy, society and polity depends on the nature and importance of the rule violated or avoided, and the extent of the rule violation.

Normatively speaking, the better the rule, the more harmful the consequences of non-compliance. Conversely, the worse the rule, the more beneficial the consequences of violating it. "Bad" rules typically inhibit voluntary exchanges, except where there are demonstrable negative external effects. "Good" rules prohibit coercive behaviours unless there are demonstrable overriding positive externalities (Epstein, 1995). Non-compliance with a bad law may be Pareto-improving, while breaking good laws may make society worse off (Leitzel, 1997). Non-compliant behaviours have real resource costs, as actors attempt to conceal their behaviours and authorities try to detect them. As well as affecting efficiency, non-compliance also has distributive consequences, shifting resources from the compliant to the non-compliant.

The study of non-compliant behaviours begins with the recognition that there are as many UEs as there are institutional domains with specific rules to be broken. For example, circumvention of the fiscal code by tax evasion gives rise to an *unreported* economy. Violations of the rules and conventions of national income accounting generate *unrecorded* and *non-observed* economies. Contravention of rules governing the production and distribution of prohibited goods and services, such as drugs, prostitution and human trafficking, gives rise to an *illegal* economy. Circumvention of

labour market regulations specifying minimum wages, working conditions, social security, unemployment and disability benefits gives rise to an *informal* economy that deprives some workers of deserved benefits while conveying undeserved benefits to others. Violations of the former Soviet Union's Five Year Plans, its production quotas and price controls, permitted a quasi-market reallocation of goods and services in what became known as the *second* or *parallel* economy (see Grossman, 1977; Feldbrugge, 1989; Ericson, 1984). Circumvention of immigration laws gives rise to an *illegal alien* economy; circumvention of currency exchange regulations to a *black market* economy; circumvention of intellectual property rights to a *knock-off* economy; circumvention of environmental regulations to a *pollution* economy, and circumvention of rules governing public officials' ethical behaviour to a *corruption* economy.

Given the variety of UEs, we limit our attention to those involving tax evasion resulting from violations of fiscal rules, and those affecting the nation's information systems due to circumventions of the rules and conventions of national income accounting. What kinds of observable traces does non-compliant behaviour leave behind that permits the social scientist to detect its presence? A relatively inexpensive means of hiding non-compliant transactions is to use cash as the medium of exchange. Since its usage does not leave a paper trail, it provides anonymity to those seeking to hide evidence of non-compliant behaviour. Anomalies in cash usage provide clues to identify, quantify and track changes in non-compliance over time.

Philip Cagan was the first to notice an empirical anomaly in currency usage during World War II (Cagan, 1958). Economists had predicted, and continue to predict, the advent of a "cashless society", anticipating a secular decline in the ratio of currency to deposits (or income) due to financial innovations and economic growth. Cagan's contradictory finding of an increase in the currency ratio led him to conclude that it was due to cash being used as a means to conceal income from the tax authority. He developed a simple currency ratio model that estimated US "unreported income" to be between nine and ten per cent of GDP ($21-$25 billion) in 1945.[3]

A second unexpected rise in the currency ratio during the 1970s and '80s suggested that tax evasion and unreported income might again be increasing. To the extent that national income and product accounts (NIPA) relied on income tax data as a basis for estimating components of aggregate output, there was concern that the national accounts might be systematically biased downward due to misreported income tax data resulting from tax evasion. A number of studies employing variants of Cagan's currency ratio method and Feige's (1979) transaction approach suggested that a relatively large and growing portion of the nation's economy had shifted from the

[3] Unreported income (a measure of the extent of fiscal non-compliance) is defined as the amount of net income not properly reported to the government due to non-filing, under-reporting income and/or overstating deductions credits and exemptions.

observed to the unobserved sector.[4] The "unobserved income hypothesis" (Feige, 1980, 1989a) maintained that observed "stagflation" could be partially explained by misguided macroeconomic policy based on biased estimates of income growth and unemployment due to an unnoticed shift from the observed to the unobserved sector of the economy.[5]

These academic findings stimulated the Internal Revenue Service (IRS) to estimate the extent to which growing non-compliance impeded the government's ability to raise revenues, and led the Bureau of Economic Analysis (BEA) to respond to concerns that the nation's national accounting information system might be systematically biased. The institutions whose rules were being violated had the greatest responsibility, incentives, resources and knowledge base to investigate these issues. They responded to the challenge with their own more detailed attempts to measure the extent and consequences of non-compliance.

The IRS undertook studies (1979, 1983) to improve audit strategies and to estimate the extent and nature of non-compliance with the US tax code.[6] Slemrod (2004, p.84) concludes that the IRS' Taxpayer Compliance Measurement Program (TCMP) produced "the most comprehensive, and probably most accurate, data on tax compliance for any country at any time". The TCMP consisted of 45,000-50,000 intensive "audits from hell" of sample tax returns for the years 1973, 1976, 1979, 1982, 1985 and 1988. Thereafter, the IRS abandoned the TCMP in response to strenuous political opposition. In 2001, the IRS initiated a new National Research Program (NRP) relying on less intrusive audits to estimate unreported income and the gross and net "tax gap" for the years 2001 and 2006.[7]

Suspicions that the nation's information system was biased motivated the BEA to clarify the relationship between unreported income on tax returns and unrecorded income that might be missing from the NIPA (Carson, 1984; Parker 1984). The BEA, well aware of deficiencies in the tax data on which it relies for measuring components of the national accounts, accordingly included "misreporting adjustments" in its

[4] Gutmann (1979) estimated what he called the "subterranean" economy, Feige (1979, 1980) the "irregular economy" and the "unobserved sector", and Tanzi (1983) and Feige (1989a) the "underground economy".

[5] Blinder and Rudd (2012) present evidence for a competing hypothesis, namely that the stagflation experience was entirely explicable in terms of supply shocks to the economy.

[6] See Feige (1989a, pp.33-36) for an account of the methods employed by the IRS.

[7] See IRS (2012); *Black* et al. (2012); Gemmell and Hasseldine (2012). The "gross tax gap", defined as the difference between the tax that taxpayers should pay and what is actually paid on a timely basis, was estimated at $345 billion in 2001. It rose to $450 billion in 2006. The "net tax gap" represents the amount of tax liability that will never be collected, despite enforcement efforts. This amounted to $290 billion in 2001 and $385 billion in 2006.

estimates of income aggregates.[8] These considerable adjustments improve the accuracy of NIPA accounts in the US, avoiding a key potential source of distortion.[9] The United Nations' System of National Accounts (ISWGNA, 1993) acknowledged the existence of underground, illegal and informal economies, but it was not until 2002 that a team of national accounts experts, drawn from national and international statistical organizations, produced *Measuring the Non-Observed Economy: A Handbook* (OECD, 2002).

Measuring the non-observed economy (NOE)

Spurred on by media reports of academic estimates, obtained by macro-model methods, of an alarmingly large unobserved economy (OECD, 2002, p.11),[10] the community of national income accountants collaborated in a major effort to obtain exhaustive and internationally comparable estimates of national income and product. This effort was particularly timely, given the disintegration of the Soviet Union and the expansion of the European Union. The countries of the former Soviet Union (FSU) and of Central and Eastern Europe (CEE) were replacing the central planning material product system (MPS) of national accounting with the United Nations System of National Accounts (SNA). The European Union required member states to adhere strictly to SNA accounting conventions, since it employed the resulting estimates of GDP to distribute grants and levy contributions. An added impetus came from a shift in economic production toward the developing world and the globalization of trade, requiring that the national accounts of developing nations accurately and exhaustively measure the level and growth of their productive capacities.

Consistent and exhaustive measures of GDP also form the basis for key policy decisions of international agencies. These often depend on ratio indicators, among them per-capita GDP, government debt and deficits to GDP, research and development expenditures to GDP and CO2 emissions to GDP. Recent estimates of VAT tax evasion also depend on the exhaustiveness of GDP accounting.[11] Recognizing that the quality of national accounts depends on the extent to which their coverage is exhaustive, the OECD's *Handbook* sought a common nomenclature among national statistical agencies and consistent methodologies representing what statisticians and national accounts experts regarded as best practice for measuring the NOE.

[8] Adjustments are made for non-farm proprietor income, corporate profits, interest paid, and wages and salaries on employment tax returns and not covered by unemployment insurance.
[9] In 2011, the last year for which all misreporting adjustments were tabulated, they totalled $1.3 trillion.
[10] The entire final chapter of the *Handbook* is devoted to a critique of these "macro-model methods".
[11] New "top down" approaches to measuring VAT tax gaps rely on national accounts aggregates. See Reckon (2009); Center for Social and Economic Research (2013a, 2013b); European Commission (2015); IMF (2013, 2014).

The national income accounting framework

National income accounting seeks to provide an exhaustive measure of productive economic activity. Let Y_e = exhaustive income defined as the sum of observed income (Y_o) and the income produced in the non-observed economy (Y_{NOE}):

$$1) \qquad Y_e \equiv Y_o + Y_{NOE}$$

According to the *Handbook*, the NOE comprises productive activities "that are missing from the basic data used to compile the national accounts because they are underground, illegal, informal, household production for own final use, or due to deficiencies in the basic data collection system" (OECD, 2002, p.3). If we include household production for own final use as part of the informal economy,[12] and deficiencies in the basic data collection system as reasonably included under the agency's definition of the underground economy,[13] the NOE (Y_{NOE}) is defined as the sum of the underground economy (Y_u), the illegal economy (Y_{il}) and the informal economy Y_{in}, such that:

$$2) \qquad Y_{NOE} = Y_u + Y_{il} + Y_{in}$$

The definition of the underground economy (Y_u) comes directly from the 1993 United Nations SNA, according to which the underground economy includes legal production activities that are "deliberately concealed from public authorities for the following kinds of reasons:

- to avoid payment of income, value added or other taxes;
- to avoid payment of social security contributions;
- to avoid having to meet certain legal standards, such as minimum wages, maximum hours, safety or health standards, etc.;
- to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms" (ISWGNA, 1993, p.153; OECD, 2002, p.139).

[12] There is still considerable confusion concerning a precise definition of the informal economy, which varies depending on source. Household production for final use is not part of the informal economy according to the 15th ICLS Resolution (OECD, 2002, p.41); however, it is included in the Istat Analytical Framework (OECD, 2002, p.43).

[13] The *Handbook* refers to this as the "statistical" underground resulting from under-coverage, non-response or underreporting by enterprises (OECD, 2002, p.41).

The illegal economy (Y_{il}) "consists of the income produced by those productive economic activities pursued in violation of legal statutes defining the scope of legitimate forms of commerce" (Feige, 1990).[14] NIPA explicitly excludes illegal activities (Parker, 1984, p.19), since these are considered to be "bads" rather than "goods" and "because they are by their very nature conducted out of sight of public scrutiny and so data are not available to measure them" (BEA, 2009, Ch.2, p.2) However, both the SNA and the European System of National Accounts (ESA, 1996, p.61) require that all productive illegal activities be included in national accounts. Inclusion of the illegal economy is important to ensure that national accounts are consistent between countries and over time. Some activities, such as prostitution, may be legal in some countries and illegal in others. The legal status of some activities changes over time, for example the recent legalization of marijuana in some parts of the US. Only when national accounts are sufficiently exhaustive to include both legal and illegal production are they consistent between countries and over time (OECD, 2002, p.153).

Chapter 10 of the *Handbook* describes some of the complex definitional issues pertaining to informal sector production; however, there is no professional consensus concerning its definition. Charmes (2012, 2014) provides the most comprehensive coverage of the subject. For our purposes, it is sufficient to note that national accounts attempt to measure whatever non-observed production occurs in the informal sector.

Obtaining exhaustive measures of economic production requires measurement of the NOE (Y_{NOE}). Let β represent the fraction of the NOE that a statistical agency has succeeded in measuring and (Y^m_{NOE}) represent the amount of measured non-observed income. Then,

$$3) \qquad Y^m_{NOE} = \beta\, Y_{NOE.} = \beta(Y_u + Y_{il} + Y_{in})$$

Recorded income (Y_{rec}) – the published, official income aggregate – is the sum of observed income Y_o and measured non-observed income (Y^m_{NOE}). The "unrecorded" economy (Y_{urec}) is the difference between exhaustive income and recorded income[15]

[14] The SNA defines illegal production as the "production of goods and services whose sale, distribution or possession is forbidden by law" and "productive activities which are usually legal but which become illegal when carried out by unauthorized producers" (ISWGNA, 1993, p.152). The OECD (2002, p.38) employs the same definition.

[15] Some fraction of "unreported income" due to tax evasion is recorded in measurement of the underground component of non-observed income in the form of a "misreporting adjustment". However, one must be very careful not to equate the underground component of NOE with "tax evasion", since unreported income from various sources such as capital gains does not reflect productive activities.

$$4) \qquad Y_{urec} = Y_e - Y_{rec} = Y_e - (Y_o + Y^m_{NOE}) = Y_e - [Y_o + \beta\,(Y_u + Y_{il} + Y_{in})]$$

$$\text{and } Y_{urec} \rightarrow 0 \text{ as } \beta \rightarrow 1.$$

Size of the non-observed economy

The *Handbook*'s publication enabled various national statistical agencies to undertake measurements of NOE, striving to produce exhaustive measures of GDP. The *Handbook* acknowledged that it is

> incumbent on national accountants to inform users of the extent of the *non-observed economy* – i.e., how much economic activity escapes direct measurement – and the extent of *non-measured economy*[16] – i.e. how much of the non-observed economy may still be missing from GDP after making the various adjustments of the kind described in this Handbook (OECD, 2002, p.192).

In 2003, the United Nations Economic Commission for Europe inventoried the practices of the 29 countries that had attempted to measure their NOE.[17] By 2008, this inventory included rudimentary descriptions of the estimation procedures employed by 43 countries and a sparse assortment of point estimates of their Y^m_{NOE} (UN, 2008, p.10). However, the UN surveys did not indicate how measures of NOE changed over time, nor did the surveys include information concerning the amount of measured NOE (Y^m_{NOE}) that each nation regularly included in its published national accounts statements.

National accounts measurements of NOE require a variety of imputations employing diverse statistical inferential methods to model lacunae in the basic data sources available to national accountants. Direct surveys and commodity flow approaches that balance supplies and uses of individual products contribute to the accounts' accuracy. Complex imputation methods vary from country to country, activity to activity and over time, requiring intensive documentation, reporting transparency, estimation of confidence intervals, and extensive professional oversight.[18] Adherence to these

[16] We have called this the "unrecorded" economy.
[17] The UN (2003, p.13, Table 1) erroneously lists the NOE adjustment of GDP for Kyrgyzstan in 1999 as 48 per cent. The correct figure is 13 per cent.
[18] Manski (2015) emphasizes the importance of communicating uncertainty in official statistics. Particularly germane is the issue of permanent statistical uncertainty arising from "incompleteness or inadequacy of data collection that does not diminish with time" (p. 637).

standards is necessary to mitigate misinterpretation of official statistics and to address concerns regarding the reliability of these exhaustive measures of GDP. To date, despite major expenditures of time and resources by national and international agencies, regular, comprehensive country reporting of the major components of recorded income, namely observed and measured non-observed income, is still lacking.

In the absence of any official compilation of measures of non-observed income since the 2008 UN survey, Table 1 presents time-series estimates of the ratio of measured non-observed income (Y^m_{NOE}) to GDP, generously provided by 27 statistical agencies from the Former Soviet Union (FSU) and Central and Eastern Europe (CEE) in response to my request for information.[19] Entries in bold print in Table 1 are those included in the latest UN publication (UN, 2008, p.10).

Whereas the statistical agencies of the US, Sweden, Netherlands and Australia report that measured NOE accounts for roughly one per cent of recorded GDP, the CEE and FSU countries' estimates range from five to 35 per cent and display considerable variation over time. The rising temporal pattern of some of the estimates may reflect a steep learning curve and the availability of improved statistical resources over time. Other apparent anomalies, such as the observation that Estonia's measured NOE is half the size of that of Lithuania's and Latvia's, or that Kazakhstan's is twice the size of Kyrgyzstan's, may be the result of respondents' reporting estimates being derived from different approaches to measurement. In theory, output, income and expenditure approaches to measurement should produce the same result; however, in practice they may differ considerably because they are derived from largely independent and less than perfect data sources. The UN's (2008) survey reveals that measured NOE estimates derived from the output approach are often twice as large as those estimated from the expenditure approach.[20] These discrepant results are an indicator of the degree of uncertainty associated with the estimation procedure, and typically serve as a signal that further work is required to reconcile the results.

The estimates reported in Table 1 all employ methodologies proposed by the *Handbook*, but the respondents did not identify their specific measurement approach, nor assess the reliability of their reported estimates, nor did they specify which of their estimates were finally included in their reported GNP statistics.

Exhaustive measures of economic aggregates are increasingly important in light of the growing extent to which investors and policy makers rely on national accounts data to guide consequential resource allocation decisions. Recent "top down" methods to estimate the VAT "tax gap" (Reckon, 2009; European Commission, 2015) rely

[19] This is an updated version of Table 1 originally presented in Feige and Urban (2008, p.292).
[20] The UN (2008) reports that the Czech Republic, Latvia, Poland and Norway disclose both output- and expenditure-based estimates of measured NOE. The former are roughly twice the size of the latter.

critically on the exhaustiveness of the EU's national accounts to estimate the theoretical VAT tax liability which, when compared with actual VAT tax collections, yields the VAT tax gap estimate. The allocation of grants and levies similarly depends on the exhaustiveness of EU member countries' national accounts. These dependencies make the accounts susceptible to "Campbell's Law":

> The more any quantitative social indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor (Campbell, 1975, p.35).

The recent inclusion of estimates of the size of the illegal economy in the recorded GDP of some European countries has heightened public skepticism regarding the reliability of the accounts.[21] If we are to gain greater confidence in their reliability, it is incumbent on international statistical organizations to monitor, assess and report on the accuracy of measures of the NOE that national statistical agencies include in their reported national accounts. All statistical agencies should be required to provide complete and timely reporting of measured NOE components included in reported GDP estimates. Gyomai and Van de Ven (2014, p.9) suggest that:

> Officially publishing estimates of the size of the NOE and its components … may help limit the proliferation of alternative estimates based on macro-econometric models, with the risk that these alternative measures eventually shape policies instead of the official national accounts embedded measures.

[21] According to *The Economist* (2015), illegal drugs and prostitution boosted the UK's GDP between 1997 and 2009 by £7 billion to £11 billion, accounting for roughly 0.7 per cent of GDP (ONS, 2014, p.4). Eleven other OECD member nations added illegal income to their GDP estimates. These ranged from 0.1 per cent of GDP for Germany to 0.7, 0.9 and one per cent for Poland, Spain and Italy respectively (Van de Ven, 2015, p.11).

Table 1. Measured non-observed income (YmNOE/(GDP)*100), 1990-2008

	Period Avg.	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08
FSU																				
Armenia[1]	29.3					27.0	31.6	34.3	28.9	25.6	29.0	30.2	28.2	29.4	28.9	29.0	27.3	27.4		
Azerbaijan[2]	20.0											19.5	22.7	19.2	20.7	19.7	16.7	13.9		
Belarus[3]	10.4	5.7	6.0	10.7	11.0	10.1	11.9	13.2	10.9	11.0	11.7	11.1	10.6	11.1	10.7					
Estonia[4]	9.5				9.8	9.3	10.6	11.4	10.4	8.8	8.7	8.9	7.4	9.6	7.7					
Georgia[5]	30.7							26.9	27.4	30.3	30.3	33.7	33.4	33.2	33.1	28.3				
Kazakhstan[6]	25.2	12.2	13.0	21.7	23.0	24.3	32.9	37.1	37.9	30.3	27.4	24.7	23.9	22.6	21.6					
Kyrgyzstan[7]	12.7						8.4	9.4	10.3	11.9	13.2	13.1	14.4	16.5	17.0					
Latvia[8]	16.9								16.0	16.8		18.0	17.5	16.0	13.0	11.5	11.7	11.0		
Lithuania[9]	19.2			20.1	19.0	20.7	19.1	20.0	21.0	17.9	17.7	18.0	18.3	18.9		16.0	14.4	12.9		
Moldova[10]	30.5				33.0	29.6	26.2	24.2	31.4	30.1	34.4	34.6	31.6							
Russia[11]	13.6				5.3	8.5	10.4	11.7	11.9	11.9		24.8			24.3					
Tajikistan[25]	25.0														25.0					
Turkmenistan[25]	17.2													14.8			18.1			
Ukraine[12]	18.0											20.0	16.3	17.7	17.2	18.9				
Uzbekistan[13]	30.3									31.0			29.5							
CEE																				
Albania[14]	31.1							30.2	28.9	30.7	32.8	34.2	30.4	30.5	30.8					
Bulgaria[15]	18.3							27.8	31.2	12.3	12.0	16.3	10.2							
Croatia[16]	9.9						9.5	9.5	9.5	8.6	8.3	8.5	8.3	8.2	7.5	7.4	7.3			
Czech R.[17]	7.8									7.9	8.0	7.7	7.5	6.9	6.9	6.5	6.2	6.2	5.9	
Hungary[18]	15.6			16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	11.9	16.0							
Macedonia[19]	14.7								14.4	16.2	13.7	12.9	14.9	14.4	16.3					
Montenegro[20]	6.6													7.8			5.3			
Poland[21]	15.4					17.2	16.6	15.9	15.2	15.3	14.5	14.6	14.3	15.4	15.8	14.5	15.9	15.9		
Romania[22]	16.5			6.7	8.9	12.6	16.6	18.4	18.6	23.3	21.1	21.1		17.7						
Serbia[25]	14.6														14.6					
Slovakia[23]	14.1						11.8	14.2	13.4	14.5	14.9	14.9	15.2	14.6	14.9	13.6	13.8	13.9	13.8	13.6
Slovenia[24]	7.1						6.4	6.3	6.5	6.1	5.8	6.9	6.8	7.5	8.0	8.0	8.0	8.0	8.0	

Sources: [1]Personal Correspondence (PC), Anahit Safyan, National Statistical Service, Republic of Armenia; [2]PC, Rasim Mirayev-SNA Division, Azerbaijan; [3]PC, Ministry of Statistics, Belarus; [4]PC, Andres Lauba, Statistical Office of Estonia; [5]PC, Revaz Tsakadze, State Department for Statistics of Georgia; [6]PC, Zhanara Isakova, Statbase, Kazakhstan; [7]Kudabaev (2004) & PC, Akylbek Masydykov, National Bank of Kyrgyzstan; [8]PC, Elita Kalnina, National Accounts Section, Latvia; [9]PC, G. Juskiene & I. Tvarijonaviciute, National Accounts Division, Statistics Lithuania; [10]PC, V. Gidilica, National Accounts Moldova; [11]Masakova (2001); [12]Golovko (n.d.); [13]Rogoznikova (2004); [14]Personal interviews at INSTAT, Tirana, Albania; [15]PC, T.Yalamov, Center for the Study of Democracy, Bulgaria; [16]PC, Robert Jurak, Central Bureau of Statistics, Croatia; [17]PC, N. Holikova & Vladimir Kermiet, National Accounts Department, Czech Republic; [18]PC, I. Bedekovics & Peter Szabó, National Accounts Department, Hungary; [19]UN (2003, p.225 & 2008, p.300); [20]PC, Branka Susic, Statistical Office of Montenegro; [21]PC, R. Popiński, Central Statistical Office of Poland; [22]Ciupagea (2004); [23]PC, V. Cicmanec, P.Baláž, & Jaroslav Sedivy: Statistical Office, Slovakia; [24]PC, A. Flajs, Statistical Office of the Republic of Slovenia; [25]UN (2008, p.10).

Macro-model estimation methods

The national accounting community concludes that the "lack of transparency in describing the procedures used to compile the national accounts is the main reason why outsiders resort to macro-models and produce estimates that undermine the credibility of the national accounts" (OECD, 2002, p.192). The *Handbook* devotes an entire chapter (Chapter 12) to criticizing these macro-model estimates – specifically, monetary methods, global indicator methods and latent variable methods – calling into question their relevance for national income accounting, the validity of their assumptions, and their stability, reliability and precision.

The limitations of currency demand methods in estimating the size of unobserved activities are well-known and extensively documented (for example, Feige, 1986, 1989a; Thomas, 1992; Bajada & Schneider, 2005; Breusch, 2005c). Small changes in assumptions regarding velocity, hoarding, dollarization, financial innovation, and benchmarking radically alter the resulting estimates, rendering them subject to wide error margins. However, to the extent that cash remains the preferred medium of exchange for transactions that individuals seek to hide, its temporal path contains clues to the evolution of non-compliant activities. The stubborn up-trend in per-capita cash holdings in the face of dramatic increases in currency substitutes remains the most significant trace evidence of increased unobserved activity over time (Feige, 2012a, 2012b).

The transactions method has not been used for four decades (Feige, 1979), given the proliferation of financial transactions and the difficulty of obtaining the data required to estimate their volume. Global indicator methods (e.g. electric consumption methods) have fallen out of favour (see Dobozi & Pohl, 1995; Kaufmann & Kaliberda, 1996; Johnson, Kaufmann, & Schleifer, 1997; Johnson, Kaufmann, & Zoido-Lobaton, 1998; Friedman, Johnson, Kaufmann, & Zoido-Lobaton, 2000; Eilat & Zinnes, 2002). Their simple assumptions are typically violated and the methodology produces anomalous results (Feige & Urban, 2003, 2008). However, latent variable methods have experienced a surprising resurgence since Frey and Weck-Hannemann (1984) introduced the innovation of treating the "hidden" economy as a latent variable.

Frey and Weck-Hannemann defined the hidden economy as "that part of the economy that escapes official measurement" and employed a multiple indicator multiple cause (MIMIC) model to estimate its size and trend in 17 OECD countries for the period 1960-1978.[22] They provided sufficient data and documentation to enable Helberger and

[22] In the interest of full disclosure, Bruno Frey presented the original paper at the Netherlands Institute for Advanced Study 1982 International Conference on the Unobserved Economy. As editor of the conference volume, I rejected the paper (Feige, 1989a) because it was implausible to believe that the model's latent variable was measuring the "hidden" economy and because the most significant variable

Knepel (1988) to readily replicate the results and examine their robustness. While finding the methodology "basically meaningful and intellectually fascinating" (Helberger & Knepel, 1988, p.975), Helberger and Knepel concluded:

> A re-analysis of the data shows that the results of Frey and Weck-Hannemann's model are extremely unstable and cannot be regarded as reliable statements about the shadow economy of these 17 countries. Even minor variations in the number of countries included in the analysis, in the period under investigation or in the index which is defined, lead to a pronounced instability. A critical look at the observational variables used in the model lead to the conclusion that the authors cannot even be sure that what they have investigated is indeed the shadow economy. The latent variable could equally well be interpreted in other ways. It could be, for instance, that they have measured the development of the welfare state (Helberger and Knepel, 1988, p.965).

Giles (1999) and Giles and Tedds (2002) subsequently employed the MIMIC methodology to estimate the hidden economies of New Zealand and Canada. Their careful studies acknowledge the difficulty of interpreting the latent variable and the uncertainty associated with their resulting estimates. Hill (2000) and Smith (2002) criticized the complexity of Giles and Tedds' MIMIC methodology and, like Helberger and Knepel, found fault with the specification of causes and indicators. Breusch (2005a, p.388) severely criticized their MIMIC application, while commending the authors for documenting their calculations and providing their data in sufficient detail to permit replication and analysis of their results. Breusch's analysis finds that "radically different estimates are obtained when minor changes are made to the starting values of the estimation algorithm" (p.372) and that the temporal results were essentially derived from a single variable, interpretation of which could not be sustained as an index of underground activity relative to observed GDP. Moreover, the size of the underground economy was established using a benchmark from a separate, unidentified currency demand model, so the "estimates" of its key parameters are "merely numerical accidents without connection to the data" (Breusch, 2005a, p.387). Breusch concludes "that the overall level of the series estimated by Giles and Tedds is a mirage". Tedds and Giles' (2005) response to Breusch's critique acknowledges these shortcomings, admitting that they render "the specific results regarding the size and

in the analysis (tax morale) had been arbitrarily constructed from a source found to be completely unreliable (see Strümpel, 1966). The paper was subsequently published as Frey and Weck-Hannemann (1984).

form of the underground economy reported in the book ineffectual" (Tedds & Giles, 2005, p.394).

Schneider's shadow economy (SSE)

Despite these critiques of MIMIC model applications, Friedrich Schneider and several co-authors subsequently employed the methodology to estimate what he calls the "shadow" economy.[23] Schneider's most recent claim – to have estimated the size and trend of the shadow economy for 162 countries to the accuracy of one decimal place[24] – has been widely cited in the academic literature and popular press, gaining visibility and influence through publication as a World Bank working paper (Schneider, Buehn, & Montenegro, 2010a, 2010b). What distinguishes Schneider's work from earlier MIMIC model applications (in addition to its ambitious scope) is the difficulty of obtaining documentation on his data, methods and sources to replicate his results and check their robustness and reliability.[25] Breusch's (2006a) review of Schneider and Bajada's (2005) study purporting to estimate the size of the shadow economy for 145 countries states the problem explicitly: "It is impossible to reconstruct these results from the documentation that is provided here or in other Schneider papers on which this chapter is based. Neither the data nor the model details were forthcoming from Schneider when I asked for them" (Breusch, 2006a, p.493).[26]

The problem of definition

The term "shadow economy" was originally introduced into the literature as the English translation of "Schattenwirtschaft", and is most often associated with the work of Professor Schneider, whose early papers used the term without defining it (Schneider

[23] Schneider's MIMIC model specification for the OECD countries is virtually identical to the original Frey and Weck-Hannemann specification critiqued by Helberger and Knepel, except that it employs a more controversial "benchmarking" procedure. Compare Schneider and Williams (2013, p.47) with Frey and Weck-Hannemann (1984, p.40).

[24] The first mention of an error margin of MIMIC results appears *ex nihilo* in Schneider and Williams (2013, pp.30, 50): "Estimates of the size of the shadow economy by the MIMIC method are generally thought to have a margin of error of +/- 15 per cent". No explanation is offered as to how or where this error margin was derived.

[25] Breusch (2005b) succeeded in replicating Dell'Anno and Schneider's (2003) earlier Italian study and Bajada and Schneider's (2005) 17-country Asian-Pacific study.

[26] Over the past decade, I have encountered similar problems in attempting to obtain sufficient data and documentation to replicate Schneider's work (see Feige & Urban, 2008, p.288). Buehn and Montenegro have now provided the raw data for the Schneider, Buehn, and Montenegro (2010a, 2010b) study. However, requests for further documentation required for replication, concerning data sources, data inconsistencies, transformations and calibration specifications, have not been forthcoming.

& Neck, 1993). Schneider and Enste's (2000b) widely-cited survey paper on "shadow economies" mentions several possible definitions, but concludes: "In general, a precise definition seems quite difficult if not impossible" (Schneider & Enste, 2000b, pp.78-79). Among the *Handbook*'s key criticisms of "macro model results" is that:

> the activities that the models aim to measure are not precisely defined; it is often unclear whether the models are estimating non-observed or non-measured production, or whether they include informal or illegal activities as well as underground activities (OECD, 2002, p.187).

Possibly responding to this critique, Schneider subsequently adopted the SNA's 1993 definition of the "underground economy", Y_u (ISWGNA, 1993, p.153; OECD, 2002, p.139) as his own definition of the "shadow economy" (see, for example, Schneider, 2005, p.600, 2007, p.5, 2009, p.1081, 2010, p.443; Schneider & Buehn, 2009, p.2; Schneider, Buehn, & Montenegro, 2010a, p.5, 2010b, p.5, 2010c, p.444, 2011, p.55; Buehn & Schneider, 2012a, p.141, 2012b, p.175; Torgler, Schneider, & Schaltegger, 2010, p.305; Schneider & Williams, 2013, p.25). He explicitly excludes the illegal economy and the informal economy from his definition of the shadow economy. Schneider's shadow economy (SSE) therefore represents a single component of the NOE, namely the "underground economy" (Y_u), as defined by the SNA.

$$5) \qquad SSE \equiv Y_u$$

How, then, do MIMIC model estimates of SSE compare with estimates of measured non-observed income (Y^m_{NOE}) computed by national statistical agencies for comparable periods? Since SSE is defined to be only the underground component of non-observed income, it follows that, if β is close to unity, $SSE/Y^m_{NOE} < 1$. Table 2 reveals that, contrary to expectation, SSE (as a percentage of GDP) is on average two and a half times larger than the national accounting measures of the NOE for FSU and CEE countries. For the OECD countries for which we have comparable estimates, it averages eight times larger.

These discrepancies document why the national accounting community is so critical of macro-model estimates. The OECD's *Handbook* discusses macro-model estimates, "not because they are considered useful in obtaining exhaustive estimates of GDP or in estimating underground production, but because they tend to produce spectacularly high measures, which attract much attention from politicians and newspapers" (OECD, 2002, p.187). If Schneider's results were accurate estimates of the "underground" component of NOE, one would have to conclude that national accounting information systems have grossly failed to obtain exhaustive measures of national income, product and expenditure.

Table 2. Comparison of SSE with Y^m_{NOE} as a percentage of GDP

Country	SSE[1]	Y^m_{NOE}**	SSE/Y^m_{NOE}		Country	SSE*	Y^m_{NOE}[2]	SSE/ Y^m_{NOE}
FSU					**Other**			
Armenia	49.9	28.9	1.7		Australia	14.3	1.3	11.0
Azerbaijan	61.6	19.8	3.1		Austria	9.7	7.9	1.2
Belarus	50.2	11.0	4.5		Belgium	22.0	3.5	6.3
Estonia	39.3	8.7	4.5		Brazil	39.6	12.8	3.1
Georgia	68.1	32.0	2.1		Italy	27.0	15.8	1.7
Kazakhstan	45.2	24.0	1.9		Ireland	16.1	4.0	4.0
Kyrgyzstan	41.2	14.8	2.8		Mexico	30.5	12.1	2.5
Latvia	39.6	14.6	2.7		Netherlands[3]	13.7	1.0	13.7
Lithuania	30.5	17.2	1.8		Norway[3]	18.2	1.7	10.7
Moldova	47.3	33.5	1.4		Spain	22.7	11.2	2.0
Russia	48.9	24.6	2.0		Sweden	19.2	1.3	14.8
Ukraine	55.9	18.0	3.1		Turkey	31.0	1.7	18.7
Uzbekistan	37.2	29.5	1.3		United States	8.8	0.8	11.0
CEE								
Albania	35.1	31.7	1.1					
Bulgaria	37.4	12.8	2.9					
Croatia	35.7	8.6	4.1					
Czech R.	19.4	7.1	2.7					
Hungary	25.7	14.6	1.8					
Macedonia	38.3	16.3	2.3					
Poland	28.0	15.0	1.9					
Romania	36.5	20.0	1.8					
Serbia	41.1	14.6	2.8					
Slovakia	19.0	14.6	1.3					
Slovenia	28.0	7.3	3.8					

Sources: [1]Schneider & Williams (2013, pp.149-154); [2]Average values from Table 1 & UN (2008, p.12); [3]Schneider (2005, p.611).

Since the allocation of both public and private resources is heavily dependent on the accuracy of these national information systems, we must further examine the reliability and robustness of SSE estimates based on currency demand MIMIC model methods. To anticipate our conclusions, once the curtain of complexity surrounding the MIMIC procedure is lifted, we find that Schneider's estimates are so arbitrary, fragile and poorly documented that they cannot be taken seriously as estimates of the NOE, nor of

tax evasion, as is sometimes erroneously claimed to be the case (see Schneider, 2012; Murphy, 2012, pp.11-12; Schneider, Raczkowski, & Mróz, 2015).

Examining the veracity of Schneider's mimic model estimates

Breusch's (2005a, 2005b) exemplary efforts to replicate and analyze the reliability of MIMIC methods sets a high professional standard rarely surpassed. In his detailed examination of studies by Giles and Tedds (2002), Dell'Anno and Schneider (2003), and Bajada and Schneider (2005), Breusch explains that "understanding their results requires peeling away the layers of econometric complication, which include MIMIC modeling, prediction, and benchmarking" (Breusch, 2005a, p.387). He carefully attempts to replicate the empirical results of each study, noting data transformations, calibration procedures and their consequences. He expresses particular concern about the "control that the researchers exercise over their methods to ensure that the results are interesting, and reasonable (meaning challenging but not too outlandish)" (Breusch, 2005a, p.388), demonstrates how key assumptions of the MIMIC model are violated (Breusch, 2005b, p.28), and skillfully demonstrates the arbitrary nature of the calibration procedures. He discovers:

> transformations of the data … are not documented … and as a result of these ancillary treatments, it is not always clear to the reader how, and by how much, the results of the MIMIC model are stretched and squeezed to fit some outside evidence. … The upshot is a method that lacks objectivity because it is open to manipulation and misrepresentation (Breusch, 2005b, p.3).

As we shall see, arbitrary choices made by the investigator determine the signs of the causal variables, the time path of the "shadow economy" and its size.

In order to assign a scale to the latent variable, the MIMIC model requires the choice of an indicator variable for normalization, typically given a unit coefficient (Bollen, 1989, Ch.6). Bajada and Schneider (2005) choose currency holdings as their normalizing indicator with a unit coefficient, while Dell'Anno and Schneider (2003) choose real GDP as their normalizing indicator, but specify that it must have a coefficient of *negative* one. The coefficient specification is highly consequential, since the signs of the coefficients of the structural causal variables of the model depend on the sign of the coefficient assigned to the normalizing indicator. Breusch points out that their conclusions – that increases in the tax burden, the size of government and the

extent of self-employment all increase the size of the shadow economy – are a direct result of their arbitrary choice of a negative one coefficient for their normalizing indicator variable, real GDP.[27] Dell'Anno and Schneider (2006) confirm these findings and proceed to justify their arbitrary choices of the signs of the normalizing coefficients by appealing to "reductio ad absurdum" (Dell'Anno & Schneider, 2006, p.5; Dell'Anno, 2007, p.262). They state:

> When the "sign" of the coefficient of scale is changed from positive to negative, all the structural parameters of the causes change from positive to negative and vice versa (keeping the same absolute values), e.g. if a positive value is assigned to λ_1 [the scale coefficient] the relationship between tax burden and SE it becomes than negative [sic]. In our view, these results completely diverge from well-known theories and empirical results that assert a "positive" link between the underground economy and these variables (Dell'Anno & Schneider, 2006, p.5).

All of Schneider's MIMIC model papers conclude that higher tax rates increase the size of the shadow economy. However, tax evasion theory predicts that this relationship is either ambiguous (Allingham & Sandmo, 1972) or negative (Yitzhaki, 1974). Similarly, Schneider's arbitrary parametric choices force the conclusion that increased regulation unambiguously increases non-compliance. However, audit studies find that stricter income reporting regulations invariably improve compliance. Therefore, the results obtained by employing the conventional unit value as the normalizing coefficient are neither absurd, nor inconsequential. Schneider achieves consistent substantive results conforming to his prior beliefs by selecting indicator variables and normalization coefficients that vary from study to study. Table 3 lists the various indicator variables chosen for normalization in different papers, and their chosen coefficient.

Breusch (2005b, p.18) initially called attention to the fact that "the assignment of a negative coefficient to the normalizing indicator variable will reverse the sign of the latent variable. Since the latent variable is interpreted as a series of changes, that decision will *invert* the time path of the final result".[28]

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[27] Dell'Anno's earlier working paper (Dell'Anno, 2003, p. 24) acknowledges the "strong dependence of outcomes by the choice of the coefficient of scale" and that "the signs of the determinants of the hidden economy … are a function of the researcher's choice". Unfortunately, these key admissions no longer appear in the published version of the paper (Dell'Anno & Schneider, 2003).

[28] Dell'Anno's (2003, p.24) working paper hints at this inversion by stating that "if the parameter of scale is chosen to equal +1 (instead of -1) the estimated shadow economy became specular to time series

One of the most bizarre, albeit largely unnoticed, changes to empirical results occurred when Schneider reversed his conclusions regarding the trend of the worldwide shadow economy. Schneider, Buehn, and Montenegro (2010a) initially reported estimates of the size of SSE as a percentage of GDP for 162 countries, concluding that, between 1999 and 2007, virtually all of the world's shadow economies *increased* in size.

Table 3 MIMIC Indicator Variables and Normalization Coefficients

Paper	Page	Indicator Variable for Normalization	Coefficient
Dell'Anno & Schneider (2003)	102	Real GDP	-1
Bajada & Schneider(2005)	394	Currency holdings	1
Schneider (2005)	604	Annual rate of GDP change	-1
Schneider (2005)	605	Average working time (per week)	-1
Schneider (2007)	11	Annual rate of GDP	-1
Schneider (2007)	12	Average working time	-1
Buehn & Schneider (2008)	15	GDP	1
Buehn & Schneider (2008)	15	GDP	-1
Herwartz, Schneider, & Tafenau (2015)	1580	GDP per capita	-1
Schneider & Buehn (2009)	8	Growth rate of GDP	-1
Schneider & Buehn (2009)	10	GDP per capita	-1
Schneider & Buehn (2009)	11	GDP per capita	-1
Tafenau, Herwartz, & Schneider (2010)	632	GPD per capita	-1
Feld & Schneider (2010)	130	Average working time (per week)	-1
Schneider (2010)	450	Annual rate of GDP	1
Schneider. Buehn, & Montenegro (2010)	449	Currency	1

Note: The various models also include different additional indicator variables, some of which occasionally appear as causal variables, thereby violating the MIMIC specification requirement that the indicators are conditionally independent of the causes, given the latent variable.

Shortly thereafter, they produced a revised version of the paper, with the same title, models and parameter estimates (Schneider, Buehn, & Montenegro, 2010b), claiming that virtually all of the world's shadow economies had *decreased* in size during the same period.[29] This remarkable inversion of the time path results is mysteriously

displayed". However, Dell'Anno and Schneider's published version omits this observation, giving the impression that the negative relationship between the growth rate of GDP and the hidden economy is a result of the empirical findings rather than their arbitrary choice of a -1 normalizing coefficient (Dell'Anno & Schneider, 2003, pp.106, 112).

[29] All estimated parameters for each of the seven MIMIC model specifications reported in Version 1 (Schneider, Buehn, & Montenegro, 2010a) are identical to those of Version 2 (Schneider, Buehn, & Montenegro, 2010b); only the labels of the model specifications have changed. Nevertheless, the reported size of the shadow economy and its trend has changed for every one of the 162 countries.

attributed to "a serious calibration error (sign switch)."[30] No further explanation is offered. The only clue as to what may have occurred appears as an inconspicuous addition of the following words to footnote 24 in the revised version of the paper: "The MIMIC index has been adjusted to the positive range by adding a positive constant."[31] My correspondence with the authors of the paper failed to provide any further clarification.

Subsequent versions of the Schneider, Buehn, and Montenegro results only confuse the matter further. Schneider and Enste (2013, Ch.4, p.37, Table 4.2) report the size and trend of the shadow economy in the 151 countries taken from the *original* version of Schneider, Buehn, and Montenegro (2010a, Table 3.3.6) as mostly increasing between 1999 and 2007. The same chapter (Schneider and Enste, 2013, Ch.4, p. 43, Table 4.3) includes results of the size and trend for 88 countries taken from the *revised* (Schneider, Buehn, & Montenegro, 2010b, Table 3.3.1) paper, showing a downward trend for the shadow economy.[32] Neither these nor other published versions of the same Schneider, Buehn, and Montenegro estimates (Buehn & Schneider, 2012a; Schneider & Williams, 2013) make mention of the "calibration error". These subsequent versions also omit mention of the mysterious addition of the positive constant required to make the MIMIC index positive.[33]

Another major point of contention regarding Schneider's MIMIC model estimates is their size. It is important to recognize that the MIMIC model produces only an index of SSE. Its size is determined by a separate "benchmarking" calibration procedure. Following Schneider, Buehn, and Montenegro (2010a, 2010b), the size of SSE (N^*_t) at time *t* is given as:

$$N^*_t = \tilde{N}_t / \tilde{N}_{2000} \times N^*_{2000}$$

where $\tilde{N}_t$ denotes the value of the MIMIC index at time t, $\tilde{N}_{2000}$ is the value of the index in the base year 2000, and N^*_{2000} is an exogenous estimate of SSE in the year 2000. The "exogenous" estimates for each of the 162 countries come from unspecified currency demand models. No documentation is given concerning the source or specification of each country's currency demand model required to produce the necessary N^*_{2000} "benchmark". This makes it impossible to determine either what each

[30] The lead footnote of the "revised" version (Schneider, Buehn, & Montenegro, 2010b) reads, "Unfortunately the estimates of the original version (WPS 5356) needed to be revised due to a serious calibration error (sign switch). We apologize for this, especially as we now have in this version a negative trend for the size and development of the shadow economies over 1999-2007, which we did not have in the original version."

[31] Schneider, Buehn, and Montenegro (2010c) make no mention of the "calibration error" but, in footnote 8, p.453, include reference to the adjustment required to make the MIMIC index positive.

[32] Both tables, taken from different versions of the paper, reference their source simply as Schneider, Buehn, and Montenegro (2010).

[33] Note its absence from footnote 17 in Buehn and Schneider (2012a, p.159).

currency model was designed to measure, or the interval of uncertainty of the estimate.[34] Slemrod and Weber's (2012) critique of Schneider's benchmarking approach concludes that it "makes the estimates nearly impossible to interpret, since the estimates for each country are a function of other estimates, where the exact model used (by other researchers) to obtain these estimates are often directly violated in MIMIC" (Slemrod & Weber, 2012, p.49).

Breusch concludes his trenchant critique with a stern warning to the profession:

> The literature applying this model to the underground economy abounds with alarming Procrustean tendencies. Various kinds of sliding and scaling of the results are carried out in the name of "benchmarking", although these operations are not always clearly documented. The data are typically transformed in ways that are not only undeclared but have the unfortunate effect of making the results of the study sensitive to the units in which the variables are measured. The complexity of the estimation procedure, together with its deficient documentation, leave the reader unaware of how these results have been shortened to fit the bed of prior belief. There are many other results in circulation for various countries, for which the data cannot be identified and which are given no more documentation than "own calculations by the MIMIC method". Readers are advised to adjust their valuation of these estimates accordingly (Breusch, 2005b, pp.28-29).

Despite these explicit and powerful warnings concerning the veracity of Schneider's MIMIC model results, his estimates have been repeatedly and inappropriately used as "the dependent variable in regression analyses in order to determine what causes noncompliance" (Slemrod & Weber, 2012, p.49). SSE estimates have now been regressed on virtually every conceivable variable for which comparable temporal cross-country data exist. These include: *tax morale* (Torgler & Schneider, 2009); *direct democracy* (Teobaldelli & Schneider, 2013); *unemployment* (Bajada & Schneider, 2009); *regulation* (Enste, 2010a, 2010b); *the quality of institutions* (Torgler & Schneider, 2009; Dreher, Kotsogiannis, & McCorriston, 2009; Dreher, Méon, & Schneider, 2014); *the influence of public institutions* (Schneider, 2010a); *corruption* (Schneider, 2007; Schneider & Buehn, 2009; Bovi & Dell'Anno, 2010; Buehn &

[34] Breusch (2005b, p.28) and Slemrod and Weber (2012, pp.49-50) also demonstrate that, when currency is also used as an indicator along with a measure of income, the strict assumptions required of the correlation structure of the MIMIC model are violated. Ahumada, Alvaredo, and Canavese (2007) demonstrate how income elasticity estimates greater than or less than one in currency demand models will further bias these shadow economy estimates.

Schneider, 2012b); *the official economy* (Dell'Anno, 2008); *enforcement* (Buehn & Schneider, 2012a); *voice, accountability and corruption (*Torgler, Schneider, & Macintyre, 2011); *work in the shadows* (Schneider, 2014); *energy prices* (Suslov & Ageeva, 2009); *decentralization* (Buehn, Lessmann, & Markwardt, 2013; Dell'Anno & Teobaldelli, 2015); *trust* (D'Hernoncourt & Méon, 2012); *education* (Buehn & Farzanegan, 2013); *pollution* (Elgin & Oztunali, 2014); *intelligence* (Salahodjaev, 2015*); inequality* (Dell'Anno, 2015); *religion* (Schneider, Linsbauer, & Heinemann, 2015); *internet usage* (Elgin, 2013); *quality of life* (Kireenko & Nevzorova, 2015) and *electronic payments* (Schneider, 2010b, 2013).

Commenting on such studies, Slemrod and Weber (2012, p.50) note:

> While estimates obtained from such an analysis may appear reasonable ex-post, they are not interpretable as estimates of any causal effect. They are useful neither for confirming ex-ante hypotheses nor for learning additional information about what factors cause the size of the informal economy to differ across countries (Slemrod & Weber, 2012, p.50).

A decade has passed since Breusch's critical evaluations of Schneider's earlier MIMIC model estimates. None of Schneider's subsequent studies using this methodology has been, or can be, tested for robustness because, to date, he has not provided sufficient documentation for replication. What we have learned of Professor Schneider's work can be summarized as follows:

1) The ambiguous meaning of the latent variable estimated by the MIMIC model suggests that Schneider has not measured the entity he has defined; he has simply defined the entity he has measured.
2) His substantive conclusions concerning the effects of the causal variables on the size of the shadow economy are not determined by the data, but rather by his arbitrary choices of indicators and normalizing coefficients.
3) The downward trend he now reports for the world's shadow economies, between 1999 and 2007, results from an arbitrary and unexplained addition of a constant to the MIMIC index he originally calculated.
4) The magnitude of his shadow economy estimates are the result of his benchmarking the MIMIC index against currency demand model estimates of undocumented provenance, specifications of which typically violate the assumptions of the MIMIC model.
5) The proliferation of published studies regressing his unreliable shadow economy MIMIC estimates on virtually every other available temporal cross-country variable cast no light on the causes of the shadow economy, nor are they useful for testing any other ex-ante hypotheses.

The MIMIC model's complexity, the arbitrary procedures employed in its applications, the absence of information concerning the range of uncertainty associated with its estimates, and the lack of appropriate documentation required for replication lead one to the inescapable conclusion that Schneider's reported results are not credible estimates of any unobserved economy.

CONCLUSIONS

Every effort to observe and measure non-compliant behaviours confronts the social scientist with the analogue of the "observer effect" in physics, namely that the very act of observation affects the phenomenon being observed. The presence of any observer, be it a tax authority, a government agency charged with enforcing regulations, a statistical agency, or an experimental researcher (Milgram, 1963), leads individuals, households and firms to change their behaviour. Agents' attempts to avoid detection distort observation and make measurement difficult and costly. Nevertheless, measurement is essential if we are to understand the causes and the efficiency, equity and stabilization consequences of non-compliant behaviours. The distinguishing feature of each non-compliant behaviour is determined by the particular rule it violates, and its social, economic and political impact depends on the importance of the rule violated and the extent of the violation.

Early, crude attempts to estimate non-compliant economic activity suggested the existence of a growing unobserved economy sufficiently large to be of concern to both tax authorities and the custodians of the nation's information systems. In response, fiscal agencies set themselves the task of measuring the amount of revenue lost due to unreported income. Their studies confirm that substantial amounts of revenue are not collectable, but that the income categories subject to the strongest reporting regulations have the highest rates of compliance (IRS, 1973, 1983, 2005a, 2005b, 2005c, 2006, 2012). The theory of tax evasion predicts that improving compliance requires penalizing evaders and increasing probabilities of detection, while also refining the design of optimal tax systems to reduce the costs of compliance. Rule simplification, improved information and service provision, and enhancements in the efficiency and equity of public goods delivery systems all serve to enhance voluntary compliance (Slemrod, 1990; Alm, 1996; IRS, 2011; Sandmo, 2012). Recent efforts to assess the extent of revenue losses due to tax evasion involve both "bottom-up" tax gap estimates based on audits, surveys and data matching, and "top-down" estimates, the reliability of which depends critically on the exhaustiveness of the NIPA aggregates required for their construction (HM Revenue and Customs, 2014a, 2014b; European Commission, 2015).

In response to academic challenges, national and international agencies responsible for the collection and dissemination of macro-economic information now employ a coherent nomenclature describing the components of the NOE they seek to measure, as well as prescribed best practice methods for obtaining exhaustive measures of national income and product. Misreporting adjustments, accounting for unreported income missing from the tax return data used to construct components of the accounts, are included in measures of NOE. The statistical agencies of many countries now produce measures of the three major components of NOE, namely the underground, illegal and informal sectors. The complex inferential methods employed to estimate these non-observed components include modelling, surveys, and reconciliation of the supplies and uses of commodity flows.

Decisions concerning the allocation of private and public resources rely increasingly on the exhaustiveness, compatibility and accuracy of national information systems. In order to improve confidence in these information systems, as well as the outcomes of decisions based on them, recorded national accounts must be published on a timely basis, along with detailed estimates of both the observed and measured non-observed components of the accounts. Where possible, reporting should include estimates of error ranges to reflect associated uncertainty. The methods used to construct measures of the non-observed sector need to be transparent and strictly monitored for reliability and compatibility across countries and over time. To date, these confidence-building requirements have yet to be met for many countries, as we still lack consistent reports that document the manner and extent to which measures of NOE affect published national estimates of key macroeconomic aggregates. The United Nations Economic Commission for Europe could rectify this situation by collecting and systematically publishing this information in an expanded and updated edition of its *Survey of Country Practices* (see UN, 2003, 2008).

MIMIC model applications treating the "shadow economy" as a latent variable purport to measure the underground component of NOE. Analyses of these applications reveal that the statistical and economic assumptions of the MIMIC model are typically violated, and that the resulting latent variable has little relationship with any unobserved economy. The methodology has been shown to be so malleable that it can be readily manipulated to obtain virtually any desired result; however, the complexity of the procedure often obscures these manipulations.

The major proponent of this arcane methodology is Professor Friedrich Schneider, who claims to have estimated the size and trend of the shadow economy worldwide (Schneider, 2005, 2007; Schneider & Buehn, 2009; Schneider, Buehn, & Montenegro, 2010a, 2010b, 2010c, 2011). If the veracity of his results were substantiated, they

would represent an important contribution to the field. To date, insufficient and inaccurate documentation concerning key data sources and procedures has precluded replication of his results. However, we know that his estimates critically depend on his choice of indicator variables and the sign of their normalizing coefficients, on which theory provides little guidance. The size and trend of his latent variable is arbitrary and fragile, its meaning is obscure, and his estimates bear no relation to existing national accounting measurements of the NOE component he claims to estimate. It is time to acknowledge that both the conceptual and empirical basis of Schneider's shadow economy are insubstantial. The repeated use of his flawed MIMIC estimates as dependent variables in subsequent studies is empirically unjustified. These fundamental defects of the MIMIC applications documented by various researchers are increasingly acknowledged and cited by Schneider, but he chooses to ignore the implication of these critiques,[35] namely that the estimates he continues to present are untenable and do not contribute to our stock of useful knowledge.

It does not speak well for our profession that these conceptually faulty, highly manipulated, and largely undocumented estimates continue to be published in our academic journals. This practice would be curtailed if all journal editors were to adopt and enforce the submission guidelines and data availability policies required by the American Economics Association. It is also unfortunate that our literature continues to confound various unobserved economies, without carefully distinguishing which set of institutional rules are being violated by the behaviour of concern. Tax evasion, the NOE, the illegal economy, the corruption economy and the illegal alien economy may overlap to some extent; however, their nature, measurement, consequences and policy implications are quite different. Policy makers are cautioned neither to blur these distinctions nor to be influenced by unsubstantiated estimates of the so-called "shadow economy". The popular press must become more circumspect about citing them uncritically. It is time to bring greater credibility to the study of unobserved economies by acknowledging that, to date; distinctions between them have too often been ignored, and that the results obtained by prevailing applications of the MIMIC methodology are unworthy of a place in the academic, policy and popular literature. Further research must begin with a greater willingness to acknowledge the critical limitations of what we too often claim to know.

Future research must continue the quest to understand the nature, causes, consequences and extent of non-compliant behaviors. Extensions of the theory of tax evasion demonstrate how individual decisions regarding tax compliance may affect the

[35] Responding to Breusch's (2005b) critique, Dell'Anno and Schneider (2006, p.17) conclude that "the MIMIC model is still one of the best approaches to this purpose".

performance of the entire economic system (Sandmo, 2012). Reliable empirical estimates of the extent, trend and costs of non-compliance are required to mobilize the public resources necessary to deal with its consequences. Greater creativity and inventiveness is necessary to develop unobtrusive measures of non-compliant behaviours and a deeper understanding of the traces that these behaviours leave behind.[36] Cash and, more recently, virtual currencies, being preferred media of exchange for suspect transactions, provide promising clues to trends in non-compliant activities.[37]

If MIMIC applications are to be employed, their cause/indicator structure must be consistent with both the statistical assumptions of the latent variable specification and with relevant economic theory pertaining to the particular non-compliant behaviour being estimated. Calibration methods must only employ exogenous estimates, such as point estimates of tax gaps independently derived from audit studies, or exogenous national accounts estimates of measured NOE. Above all, macro approaches to measurement must adhere to stricter standards of transparency through full provision of data, sources, transformations, statistical assumptions, estimation methods, pre-testing biases and error margins of results. All publishable studies must be readily replicable in order to test the reliability and robustness of the findings.

Ultimately, a preeminent goal of social policy is the achievement of greater voluntary compliance with good rules. Creative approaches are needed to reduce compliance and administrative costs, target appropriate deterrence measures, improve the perceived equity of institutional rules, enhance the efficiency and quality of public goods delivery, and innovatively restructure choice architecture through increased reliance on "nudges" (Thaler & Sunstein, 2008). Non-compliance research is not limited to violations of fiscal rules and conventions of national income accounting. The profession faces major challenges in its efforts to observe, measure and understand the causes and consequences of non-compliant behaviours involving undocumented workers, illegal immigrants, human, drugs and arms traffickers, and planetary polluters. These issues will continue to test the theoretical, observational and measurement skills of the social science community for many years to come.

[36] For example, Pissarides and Weber (1989) and Feldman and Slemrod (2007) rely on anomalies in food expenditure and charitable contribution patterns, respectively, as traces of misreported income.
[37] Unexplained changes in per-capita cash holdings and changes in the velocity of cash, as evidenced by changes in the average lifetimes of note denominations, yield potential traces of non-compliant activities (Feige, 1989b).

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