CESifo Working Papers

Estimating the Size of the Shadow Economy: Methods, Problems and Open Questions

Friedrich Schneider
Andreas Buehn

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Abstract

This paper presents the various methods to estimate the size of the shadow economy, their strengths and weaknesses. The purpose of the paper is twofold. Firstly, it demonstrates that no ideal method to estimate the size and development of the shadow economy exists. Because of its flexibility, the MIMIC method used to get macro-estimates of the size of the shadow economy is discussed in greater detail. Secondly, the paper focuses on the definition and causal factors of the shadow economy as well as on a comparison of the size of the shadow economy using different estimation methods.

JEL-Code: D780, E260, H200, H110, H260, K420, O500, O170.

Keywords: shadow economy estimates, MIMIC approach, methods to estimate the shadow economy, advantages and disadvantages of the measurement methods.

Friedrich Schneider
Department of Economics
Johannes Kepler University of Linz
Altenbergerstraße 69
Austria – 4040 Linz
friedrich.schneider@jku.at

Andreas Buehn
Institute for Advanced Sustainability Studies
(IASS) Potsdam e. V. / Platform Enabling
Technologies for Sustainability (ETS)
Berliner Straße 130
Germany – 14467 Potsdam
Andreas.Buehn@iass-potsdam.de

1. INTRODUCTION

Empirical research about the size and development of the shadow economy all over the world has strongly increased.[1] There are nowadays so many studies, which use different methods in order to estimate the size and development of the shadow economy, that it is quite difficult to judge the reliability of various methods. Hence, the goal of this paper is to critically review the various methods estimating the size of the shadow economy and to discuss their strengths and weaknesses. This shall enable an interested reader to realize what advantages and disadvantages the different methods have.

The paper is structured as follows: In the next section very shortly some theoretical considerations are made, starting with a definition of the shadow economy and a brief discussion of its main causes. In section 3 the various measurement methods as well as their strengths and weaknesses are presented. This section also presents estimates of the size of the shadow economy in Germany using different estimation methods. Finally, section 4 presents a summary and some concluding remarks.

2. THEORETICAL CONSIDERATIONS

2.1. Defining the shadow economy

Researchers attempting to measure the size of shadow economy face the question of the definition.[2] One commonly used working definition is all currently unregistered economic activities that would contribute to the officially calculated (or observed) Gross National Product if observed.[3] Smith (1994, p. 18) uses the definition "market-based production of goods and

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[1] See e.g. Feld and Schneider (2010), Gerxhani (2003), Schneider (2011), and Schneider and Williams (2013).

[2] See Frey and Pommerehne (1984), Thomas (1992), Loayza (1996), Pozo (1996), Lippert and Walker (1997), Schneider (1994a, 1994b, 1997, 1998a, 2003, 2005, 2011), Johnson, Kaufmann, and Shleifer (1997), Johnson, Kaufmann and Zoido-Lobatón (1998a), Belev (2003), Gerxhani (2003), and Pedersen (2003). For newer surveys, see Schneider and Enste (2000, 2002), Schneider and Williams (2013), Alm, et al. (2004) and Feld and Schneider (2010).

[3] This definition is used, for example, by Feige (1989, 1994), Schneider (1994a, 2003, 2005, 2011), and Frey and Pommerehne (1984). Do-it-yourself activities are not included. For estimates of the shadow economy and do-it-yourself activities for Germany, see Buehn, Karmann and Schneider (2009). This definition is taken from Del'Anno (2003), Del'Anno and Schneider (2004) and Feige (1989). See also Thomas (1999), Fleming, Roman and Farrell (2000).

services, whether legal or illegal, that escapes detection in the official estimates of GDP." One of the broadest definitions includes "those economic activities and the income derived from them that circumvent government regulation, taxation or observation".[4] As these definitions still leave a lot of questions open, table 2.1 is helpful for developing a feeling for what could be a reasonable consensus definition of the underground (or shadow) economy. From table 2.1, it is clear that a broad definition of the shadow economy includes unreported income from the production of legal goods and services, either from monetary or barter transactions – and so includes all economic activities that would generally be taxable were they reported to the tax authorities.

Table 2.1: A taxonomy of types of underground economic activities

Type of activity	Monetary transactions		Non-monetary transactions	
Illegal Activities	Trade with stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling; fraud; etc.		Barter of drugs, stolen goods, smuggling etc. Produce or growing drugs for own use. Theft for own use.	
	Tax Evasion	**Tax Avoidance**	**Tax Evasion**	**Tax Avoidance**
Legal Activities	Unreported income from self-employment; Wages, salaries and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits	Barter of legal services and goods	All do-it-yourself work and neighbor help

Structure of the table is taken from Lippert and Walker (1997, p. 5) with additional remarks

This paper uses the following more narrow definition of the shadow economy.[5] The shadow economy includes all market-based legal production of goods and services that are deliberately concealed from public authorities for the following reasons:

(1)   to avoid payment of taxes, e.g. income taxes or value added taxes,

(2)   to avoid payment of social security contributions,

(3)   to avoid certain legal labor market standards, such as minimum wages, maximum working hours, safety standards, etc., and

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[4] This definition is taken from Del'Anno (2003), Del'Anno and Schneider (2004) and Feige (1989). See also Thomas (1999), Fleming, Roman and Farrell (2000).

[5] Compare also the excellent discussion of the definition of the shadow economy in Pedersen (2003, pp.13-19), who uses a similar definition.

(4)   to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

2.2. Theorizing about the Shadow Economy

A useful starting point for a theoretical discussion of the shadow economy is the paper by Allingham and Sandmo (1972) on income tax evasion. While the shadow economy and tax evasion are not congruent, activities in the shadow economy in most cases imply the evasion of direct or indirect taxes, such that the factors determining tax evasion will most certainly also affect the shadow economy. According to Allingham and Sandmo tax compliance depends on its expected costs and benefits. The benefits of tax non-compliance result from the individual marginal tax rate and the true individual income. In the case of the shadow economy the individual marginal tax rate is often roughly calculated using the overall tax burden from indirect and direct taxes including social security contributions. The expected costs of non-compliance derive from deterrence enacted by the state, i.e., the state's auditing activities raising the probability of detection and the fines individuals face when they are caught. Individual morality also plays a role for compliance and additional costs could pertain beyond the tax administration's pure punishment in the form of psychic costs like shame or regret, but also additional pecuniary costs if, for example, a reputation loss results.

Individuals are rational calculators who weight the costs and benefits a legal status entails. Their decision to partially or completely participate in the shadow economy is a choice under uncertainty facing a trade-off between the gains if their activities are not discovered and a loss if discovered and penalized. Shadow economic activities SE 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 labour costs W – the individual income generated in the shadow economy is usually categorized as labor income rather than capital income – due to labour market regulations. Hence, the higher the tax burden and labor costs, the more incentives individuals have to avoid those 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 detection of shadow economic activities. This discussion suggests the following structural equation:

$$SE = SE\left[\overset{-}{p}\left(\overset{+}{A}, \overset{-}{F}\right); \overset{-}{f}; \overset{+}{B}\left(\overset{+}{T}, \overset{+}{W}\right)\right]. \tag{1}$$

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 transaction of legal nature, hence all productive economic activities that would generally be taxable were they reported to the state (tax) authorities. Those activities are deliberately concealed from public authorities to avoid payment of income, value added or other taxes and social security contributions, to avoid compliance with certain legal labor market standards, such as minimum wages, maximum working hours, or safety standards and administrative procedures. The shadow economy thus focuses on productive economic activities that would normally be included in the national accounts but which remain underground due to tax or regulatory burdens.[6] Although such legal activities would contribute to the country's value added, they are not captured in the national accounts because they are produced in illicit ways. Informal household economic activities such as do-it-yourself activities and neighborly help are typically excluded in the analysis of the shadow economy.[7]

Kanniainen, Pääkönen and Schneider (2004) incorporate many of these insights in their model of the shadow economy. They hypothesize that tax hikes unambiguously increase the shadow economy, while the availability of public goods financed by taxes moderates participation in the shadow economy. The latter effect however depends on the ability to access those public goods. A shortcoming of this analysis is the neglected endogeneity of tax morale and good governance, which is addressed by Feld and Frey (2007) who argue that tax compliance is the result of a complicated interaction between tax morale and deterrence measures. It must be clear to taxpayers what the rules of the game are and as deterrence measures serve as signals for the level of tax morale a society wants to elicit (Posner, 2000), deterrence may also crowd out the intrinsic motivation to pay taxes. Tax morale does not only increase if taxpayers perceive the public goods received in exchange for their tax payments. It may also decrease if

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[6] Although classical crime activities such as drug dealing are independent of increasing taxes and the causal variables included in the empirical models are only imperfectly linked (or causal) to classical crime activities, the footprints used to indicate shadow economic activities such as currency in circulation also apply for the classic crime. Hence, macroeconomic shadow economy estimates do typically not distinguish legal from illegal underground activities; rather they represent the whole informal economy spectrum.

[7] From a social perspective, may even from an economic one, soft forms of illicit employment, such as moonlighting (e.g. construction work in private homes) and its contribution to aggregate value added may be assessed positively. For a discussion of these issues see Thomas (1992) and Buehn, Karmann and Schneider (2009).

individuals perceive political decisions for public activities or the treatment of taxpayers by the tax authorities to be unfair. Tax morale is thus not exogenously given but influenced by deterrence and the quality of state institutions. Table 2.2 presents an overview of the most important determinants influencing the shadow economy.

Table 2.2: The main causes determining the shadow economy

Causal variable	Theoretical reasoning	References
Tax and Social Security Contribution Burdens	The distortion of the overall tax burden affects labor-leisure choices and may stimulate labor supply in the shadow economy. The bigger the difference between the total labor cost in the official economy and after-tax earnings (from work), the greater is the incentive to reduce the tax wedge and to work in the shadow economy. This tax wedge depends on social security burden/payments and the overall tax burden, making them to key determinants for the existence of the shadow economy.	E.g. Thomas (1992), Johnson, Kaufmann, and Zoido-Lobatón (1998a,b), Giles (1999), Tanzi (1999), (2003, 2005), Dell'Anno (2007), Dell'Anno, Gomez-Antonio and Alanon Pardo (2007), Buehn and Schneider (2012)
Quality of Institutions	The quality of public institutions is another key factor for the development of the informal sector. Especially the efficient and discretionary application of the tax code and regulations by the government plays a crucial role in the decision to work underground, even more important than the actual burden of taxes and regulations. In particular, a bureaucracy with highly corrupt government officials seems to be associated with larger unofficial activity, while a good rule of law by securing property rights and contract enforceability increases the benefits of being formal. A certain level of taxation, mostly spent in productive public services, characterizes efficient policies. In fact, the production in the formal sector benefits from a higher provision of productive public services and is negatively affected by taxation, while the shadow economy reacts in the opposite way. An informal sector developing as a consequence of the failure of political institutions in promoting an efficient market economy, and entrepreneurs going underground, as there is an inefficient public goods provision, may reduce if institutions can be strengthened and fiscal policy gets closer to the median voter's preferences.	E.g. Johnson et al. (1998a,b), Friedman, Johnson, Kaufmann, and Zoido-Lobaton (2000), Dreher and Schneider (2009), Dreher, Kotsogiannis and Macorriston (2009), Schneider (2010), Buehn and Schneider (2012), Teobaldelli (2011), Teobaldelli and Schneider (2012)
Regulations	Regulations, for example labor market regulations or trade barriers, are another important factor that reduces the freedom (of choice) for individuals in the official economy. They lead to a substantial increase in labor costs in the official economy and thus provide another incentive to work in the shadow economy: countries that are more heavily regulated tend to have a higher share of the shadow economy in total GDP. Especially the enforcement and not the overall extent of regulation – mostly not enforced – is the key factor for the burden levied on firms and individuals, making them operate in the shadow economy.	E.g. Johnson, Kaufmann, and Shleifer (1997), Johnson, Kaufmann, and Zoido-Lobatón (1998b), Friedman, Johnson, Kaufmann, and Zoido-Lobaton (2000), Kucera and Roncolato (2008). Compare also Williams (2005, 2007) and Williams and Renooy (2007, 2009).

Causal variable	Theoretical reasoning	References
Public Sector Services	An increase of the shadow economy may lead to fewer state revenues, which in turn reduce the quality and quantity of publicly provided goods and services. Ultimately, this may lead to increasing tax rates for firms and individuals, although the deterioration in the quality of the public goods (such as the public infrastructure) and of the administration continues. The consequence is an even stronger incentive to participate in the shadow economy. Countries with higher tax revenues achieved by lower tax rates, fewer laws and regulations, a better rule of law and lower corruption levels, should thus have smaller shadow economies.	E.g. Johnson, Kaufmann, and Zoido-Lobatón (1998a,b)
Tax Morale	The efficiency of the public sector also has an indirect effect on the size of the shadow economy because it affects tax morale. Tax compliance is driven by a psychological tax contract that entails rights and obligations from taxpayers and citizens on the one hand, but also from the state and its tax authorities on the other hand. Taxpayers are more heavily inclined to pay their taxes honestly if they get valuable public services in exchange. However, taxpayers are honest even in cases when the benefit principle of taxation does not hold, i.e. for redistributive policies, if such political decisions follow fair procedures. The treatment of taxpayers by the tax authority also plays a role. If taxpayers are treated like partners in a (tax) contract instead of subordinates in a hierarchical relationship, taxpayers will stick to their obligations of the psychological tax contract more easily. Hence, (better) tax morale and (stronger) social norms may reduce the probability of individuals to work underground.	E.g. Feld and Frey (2007), Kirchler (2007), Torgler and Schneider (2009), Feld and Larsen (2005, 2009)
Deterrence	Despite the strong focus on deterrence in policies fighting the shadow economy and the unambiguous insights of the traditional economic theory of tax non-compliance, surprisingly little is known about the effects of deterrence from empirical studies. This is due to the fact that data on the legal background and the frequency of audits are not available on an international basis; even for OECD countries such data is difficult to collect. Either is the legal background quite complicated differentiating fines and punishment according to the severity of the offense and the true income of the non-complier, or tax authorities do not reveal how intensively auditing is taking place. The little empirical survey evidence available demonstrates that fines and punishment do not exert a negative influence on the shadow economy, while the subjectively perceived risk of detection does. However, the results are often weak and Granger causality tests show that the size of the shadow economy can impact deterrence instead of deterrence reducing the shadow economy.	E.g. Andreoni, Erard and Feinstein (1998), Pedersen (2003), Feld and Larsen (2005, 2009)

3. METHODS TO ESTIMATE THE SIZE OF THE SHADOW ECONOMY

Estimating the size of a shadow economy is a difficult and challenging task. In this chapter we give a short but comprehensive overview on the various procedures for estimating the size of a shadow economy. Three different categories of methods are most widely used, and each is briefly discussed.

3.1. Direct approaches

These are microeconomic approaches that employ either well designed surveys and samples based on voluntary replies or tax auditing and other compliance methods. Sample surveys designed to estimate the shadow economy are widely used in a number of countries[8]. The main disadvantages of this method are the flaws of all surveys. For example, the average precision and results depend greatly on the respondent's willingness to cooperate, it is difficult to assess the amount of undeclared work from a direct questionnaire, most interviewers hesitate to confess to fraudulent behavior, and responses are of uncertain reliability, which makes it difficult to calculate a true estimate (in monetary terms) of the extend of undeclared work. The main advantage of this method lies in the detailed information about the structure of the shadow economy but the results from these kinds of surveys are very sensitive to the way the questionnaire is formulated[9].

Estimates of the shadow economy can also be based on the discrepancy between income declared for tax purposes and that measured by selective checks. Fiscal auditing programs have been particularly effective in this regard. Since these programs are designed to measure the amount of undeclared taxable income, they may also be used to calculate the size of the shad-

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[8]The direct method of voluntary sample surveys has been extensively used for Norway by Isachsen et al. (1982), and Isachsen and Strom (1985). For Denmark this method is used by Mogensen et. al. (1995) in which they report „estimates" of the shadow economy of 2.7% of GDP for 1989, of 4.2% of GDP for 1991, of 3.0% of GDP for 1993 and of 3.1% of GDP for 1994. In Pedersen (2003) estimates of the Danish shadow economy contain the years 1995 with 3.1% up to 2001 with 3.8%. See also newer studies like Feld and Larsen (2005, 2008, 2009) which reach similar sizes of the shadow economy for Germany.

[9]The advantages and disadvantages of this method are extensively dealt by Pedersen (2003), Mogensen (1985) and Mogensen et. al (1995) in their excellent and very carefully done investigations.

ow economy.[10] However, a number of difficulties beset this approach. First, using tax compliance data is equivalent to using a (possibly biased) sample of the population. In general, the selection of taxpayers for tax audits is not random but based on properties of submitted (tax) returns that indicate a certain likelihood of tax fraud. Consequently, such a sample is not a random one of the whole population, and estimates of the shadow economy based upon a biased sample may not be accurate. Second, estimates based on tax audits reflect only that portion of the shadow economy income authorities discover, and this is likely to be only a fraction of all hidden income.

To summarize:

Survey methods are likely to underestimate the shadow economy because people are likely to under-declare in surveys what they are trying to hide from authorities. In order to minimize the number of respondents dishonestly replying or totally declining answers to sensitive questions, structured interviews are undertaken (usually face to face), in which respondents slowly become accustomed to the main purpose of the survey. The first part of the questionnaire aims at shaping respondents' perceptions of the issue's intended. The second part asks questions about the respondents' activities in the shadow economy. A third part contains the usual socio-demographic questions. Nevertheless, the results of the shadow economy estimates from survey methods are clearly lower-bound estimated compared to other approaches.

Survey results can also be inconsistent internationally. In addition to the studies by Feld and Larsen (2005, 2008, 2009), Haigner et al. (2011), and Enste and Schneider (2006) for Germany, survey methods have been applied in the Northern countries and Great Britain (Isachsen and Strøm (1985), Pedersen (2003)) as well as in the Netherlands (Van Eck and Kazemier (1988), Kazemier (2006). The questionnaires underlying these studies are broadly comparable in design; however, recent attempts by the European Union to provide survey results for all member states have run into great difficulties of comparability (Renooy et al. (2004), European Commission (2007)). The wording of the questionnaires becomes more and more cumbersome, depending on the culture of different countries with respect to the underground economy.

A further disadvantage of these two direct methods (surveys and tax auditing) is the point estimate character. While they capture shadow economic activities only partially and may be

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[10]In the United States, IRS (1979, 1983), Simon and Witte (1982), Witte (1987), Clotefelter (1983), and Feige (1986). For a more detailed discussion, see Dallago (1990) and Thomas (1992).

seen as lower bound estimates, they have one considerable advantage: they provide detailed information about shadow economy activities, the structure and composition of the activities as well as the socio-economic characteristics and motives of those who work in the shadow economy.

3.2. Indirect approaches

These approaches, which are also called indicator approaches, are mostly macroeconomic and use various economic and other indicators that contain information about the development of the shadow economy (over time). Currently there are five indicators that leave some traces of the shadow economy.

3.2.1 *The discrepancy between national expenditure and income statistics*

This approach is based on discrepancies between income and expenditure statistics. In national accounting the income measure of GNP should be equal to the expenditure measure of GNP. Thus, if an independent estimate of the expenditure site of the national accounts is available, the gap between the expenditure measure and the income measure can be used as an indicator of the extent of the shadow economy.[11] Since national accounts statisticians are anxious to minimize this discrepancy, the initial discrepancy or first estimate, rather than the published discrepancy, should be employed as an estimate of the shadow economy. If all the components of the expenditure side are measured without error, then this approach would indeed yield a good estimate of the size of the shadow economy. Unfortunately, however, this is not the case. Instead, the discrepancy reflects all omissions and errors everywhere in the national accounts statistics as well as shadow economy. These estimates may therefore be crude and of questionable reliability.[12]

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[11] See, e.g., Franz (1983) for Austria; MacAfee (1980) O'Higgins (1989) and Smith (1985), for Great Britain; Petersen (1982) and Del Boca (1981) for Germany; Park (1979) for the United States. For a critical survey, see Thomas (1992).

[12] A related approach is pursued by Pissarides and Weber (1988), who use micro data from household budget surveys to estimate the extent of income understatement by self-employed.

3.2.2 *The discrepancy between the official and actual labor force*

A decline in participation of the labor force in the official economy can be seen as an indication of increased activity in the shadow economy. If total labor force participation is assumed to be constant, then a decreasing official rate of participation can be seen as an indicator of an increase of shadow economic activities, ceteris paribus.[13] One weakness of this method is that differences in the rate of participation may also have other causes. Also, people can work in the shadow economy and have a job in the official economy. Therefore such estimates may be viewed as weak indicators of the size and development of the shadow economy.

3.2.3 *The transactions approach*

This approach has been fully developed by Feige.[14] It is based upon the assumption that there is a constant relation over time between the volume of transaction and official GNP, as summarized by the well-known Fisherian quantity equation, or $M*V = p*T$ (with M money, V velocity, p prices, and T total transactions). Assumptions also have to be made about the velocity of money and about the relationships between the value of total transactions $p*T$ and total (official + unofficial) nominal GNP. Relating total nominal GNP to total transactions, the GNP of the shadow economy can be calculated by subtracting the official GNP from total nominal GNP. However, to derive figures for the shadow economy, one must also assume a base year in which there is no shadow economy and therefore the ratio of $p*T$ to total nominal (official = total) GNP was "normal" and would have been constant over time if there had been no shadow economy. To obtain reliable shadow economy estimates, precise figures of the total volume of transactions should be available, which might be especially difficult for cash transactions, because they depend, among other factors, on the durability of bank notes in terms of the quality of the papers on which they are printed.[15] Also, the assumption is made that all variations in the ratio between the total value of transaction and the officially measured GNP are due to the shadow economy. This means that a considerable amount of data is required in order to eliminate financial transactions from "pure" cross payments, which are legal and have nothing to do with the shadow economy. In general, although this approach is

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[13] Such studies have been made for Italy, see e.g., Contini (1981) and Del Boca (1981); for the United States, see O'Neill (1983), for a critical survey, see again Thomas (1992).

[14] For an extended description of this approach, see Feige (1996); for a further application for the Netherlands, Boeschoten and Fase (1984), and for Germany, Langfeldt (1984).

[15] For a detailed criticism of the transaction approach see Boeschoten and Fase (1984), Frey and Pommerehne (1984), Kirchgaessner (1984), Tanzi (1982a,b, 1986), Dallago (1990), Thomas (1986, 1992, 1999) and Giles (1999a).

theoretically attractive, the empirical requirements necessary to obtain reliable estimates are so difficult to fulfill that its application can lead to doubtful results.

3.2.4 The currency demand approach

The currency demand approach was first used by Cagan (1958), who considered the correlation between currency demand and tax pressure (as one cause of the shadow economy) for the United States over the period 1919 to 1955. 20 years later, Gutmann (1977) used the same approach but without any statistical procedures. Cagan's approach was further developed by Tanzi (1980, 1983), who estimated a currency demand function for the United States for the period 1929 to 1980 in order to calculate the size of the shadow economy. His approach assumes that shadow (or hidden) transactions are undertaken in the form of cash payments, so as to leave no observable traces for the authorities. An increase in the size of the shadow economy will therefore increase the demand for currency. To isolate the resulting excess demand for currency, an equation for currency demand is estimated over time. All conventional possible factors, such as the development of income, payment habits, interest rates, credit and other debt cards as a substitute for cash and so on, are controlled for. Additionally, such variables as the direct and indirect tax burden, government regulation, state institutions and tax morale, which are assumed to be the major factors causing people to work in the shadow economy, are included in the estimation equation. The basic regression equation for the currency demand, proposed by Tanzi (1983), is the following:

$$ln \, (C \, / \, M_2)_t = \beta_O + \beta_1 \, ln \, (1 + TW)_t + \beta_2 \, ln \, (WS \, / \, Y)_t + \beta_3 \, ln \, R_t + \beta_4 \, ln \, (Y \, / \, N)_t + u_t,$$

with $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 < 0$, $\beta_4 > 0$, where ln denotes natural logarithms, C/M_2 is the ratio of cash holdings to current and deposit accounts, TW is a weighted average tax rate (to proxy changes in the size of the shadow economy), WS/Y is a proportion of wages and salaries in national income (to capture changing payment and money holding patterns), R is the interest paid on savings deposits (to capture the opportunity cost of holding cash) and Y/N is the per capita income.[16] Any "excess" increase in currency, or the amount unexplained by conventional or normal factors is then attributed to the rising tax burden and other reasons leading

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[16] The estimation of such a currency demand equation has been criticized by Thomas (1999) but part of this criticism has been considered by the work of Giles (1999a,b) and Bhattacharyya (1999), who both use the latest econometric technics.

people to work in the shadow economy. Figures for the size and development of the shadow economy can be calculated in a first step by comparing the difference between the development of currency when the direct and indirect tax burden and government regulation are held at lowest values, and the development of currency with the current (higher) burden of taxation and government regulation. Assuming in a second step the same income velocity for currency used in the shadow economy as for legal *M1* in the official economy, the size of the shadow can be computed and compared to the official GDP.

This is one of the most commonly used approaches. It has been applied to many countries[17] all over the world but has nevertheless been criticized on various grounds.[18] The most commonly raised objections to this method are:

(1) Not all transactions in the shadow economy are paid in cash. Isachsen and Strom (1985) used the survey method to find out that in Norway, in 1980, roughly 80 percent of all transactions in the hidden sector were paid in cash. The size of the total shadow economy (including barter) may thus be even larger than previously estimated.

(2) Most studies consider only one particular factor, the tax burden, as a cause of the shadow economy. But others (such as the impact of regulation, taxpayers' attitudes toward the state, tax morality and so on) are not considered, because for most countries reliable data is not available. If, as seems likely, these other factors also have an impact on the extent of the hidden economy, it might again be higher than reported in most studies.[19]

(3) As discussed by Garcia (1978), Park (1979), and Feige (1996), increases in currency demand deposits are largely due to a slowdown in demand deposits rather than to an increase in currency caused by activities in the shadow economy, at least in the case of the United States.

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[17] See Karmann (1986, 1990), Schneider (1997, 1998a), Johnson et al. (1998a) and Williams and Windebank (1995).

[18] See Thomas (1992, 1999), Feige (1986), Pozo (1996), Pedersen (2003) and Ahumada et al. (2004).

[19] One (weak) justification for the only use of the tax variable is that this variable has by far the strongest impact on the size of the shadow economy in the studies known to the authors. The only exception is the study by Frey and Weck-Hannemann (1984) where the variable "tax immorality" has a quantitatively larger and statistically stronger influence than the direct tax share in the model approach. In the study of Pommerehne and Schneider (1985), for the U.S., besides various tax measures, data for regulation, tax immorality, minimum wage rates are available, the tax variable has a dominating influence and contributes roughly 60-70% to the size of the shadow economy. See also Zilberfarb (1986).

(4) Blades (1982) and Feige (1986, 1996) criticize Tanzi's studies on the grounds that the US dollar is used as an international currency so that Tanzi should have considered (and controlled for) the presence of US dollars, which are used as an international currency and held in cash abroad.[20] Frey and Pommerehne (1984) and Thomas (1986, 1992, 1999) claim that Tanzi's parameter estimates are not very stable.[21]

(5) Most studies assume the same velocity of money in official and shadow economies. As argued by Hill and Kabir (1996) for Canada and by Klovland (1984) for the Scandinavian countries, there is considerable uncertainty about the velocity of money in the official economy, and the velocity of money in the hidden sector is even more difficult to estimate. Without knowledge about the velocity of currency in the shadow economy, one has to accept the assumption of an equal velocity of money in both sectors.

(6) Ahumada, Alvaredo, Canavese, and Canavese (2004) show that the currency approach together with the assumption of equal income velocity of money in the reported and the hidden transaction is only correct if the income elasticity is 1.

(7) Finally, the assumption of no shadow economy in a base year is open to criticism. Relaxing this assumption would again imply an upward adjustment of the size of the shadow economy.

3.2.5 The physical input (electricity consumption) method

3.2.5.1 The Kaufmann - Kaliberda Method[22]

To measure overall (official and unofficial) economic activity in an economy, Kaufmann and Kaliberda (1996) assume that electric-power consumption is regarded as the single best phys-

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[20] Another study by Tanzi (1982, esp. pp. 110-113) explicitly deals with this criticism. A very careful investigation of the amount of US dollars used abroad and US currency used in the shadow economy and for "classical" crime activities has been undertaken by Rogoff (1998), who concludes that large denomination bills are major driving force for the growth of the shadow economy and classical crime activities, due largely to reduced transactions costs.

[21] However in studies for European countries Kirchgässner (1983, 1984) and Schneider (1986) conclude that the estimation results for Germany, Denmark, Norway and Sweden are quite robust when using the currency demand method. Hill and Kabir (1996) find for Canada that the rise of the shadow economy varies with respect to the tax variable used; they conclude "when the theoretically best tax rates are selected and a range of plausible velocity values is used, this method estimates underground economic growth between 1964 and 1995 at between 3% and 11% of GDP." (p.1553).

[22] This method was used earlier by Lizzeri (1979), Del Boca and Forte (1982), and then was used much later by Portes (1996), Kaufmann and Kaliberda (1996), Johnson et al. (1997). For a critique see Lackó (1998).

ical indicator of overall (or official plus unofficial) economic activity. Overall economic activity and electricity consumption have been empirically observed throughout the world to move in lockstep with an electricity to GDP elasticity usually close to one. This means that the growth of total electricity consumption is an indicator for growth of overall (official and unofficial) GDP. By having this proxy measurement for the overall economy and then subtracting from this overall measure the estimates of official GDP, Kaufmann and Kaliberda (1996) derive an estimate of unofficial GDP. This method is very simple and appealing. However, it can also be criticized on various grounds:

(1) Not all shadow economy activities require a considerable amount of electricity (e.g. personal services), and other energy sources can be used (gas, oil, coal, etc.). Only a part of the shadow economy will be indicated.

(2) Over time, there has been considerable technical progress so that both the production and use of electricity are more efficient than in the past, and this will apply in both official and unofficial uses.

(3) There may be considerable differences or changes in the elasticity of electricity/GDP across countries and over time.[23]

3.2.5.2 *The Lackó method*

Lackó (1998, 1999, 2000a,b) assumes that a certain part of the shadow economy is associated with the household consumption of electricity. This part comprises the so-called household production, do-it-yourself activities, and other non-registered production and services. Lackó further assumes that in countries where the portion of the shadow economy associated with the household electricity consumption is high, the rest of the hidden economy (or the part Lackó cannot measure) will also be high. Lackó (1996, pp.19 ff.) assumes that in each country a part of the household consumption of electricity is used in the shadow economy. Lackó's approach (1998, p.133) can be described by the following two equations:

$$ln\ E_i = \alpha_1\ ln\ C_i + \alpha_2\ ln\ PR_i + \alpha_3\ G_i + \alpha_4\ Q_i + \alpha_5\ H_i + u_i, \text{ with } \alpha_1 > 0,\ \alpha_2 < 0,\ \alpha_3 > 0,\ \alpha_4 < 0,\ \alpha_5 > 0 \text{ and}$$

$$H_i = \beta_1\ T_i + \beta_2\ (S_i - T_i) + \beta_3\ D_i \text{ with } \beta_1 > 0,\ \beta_2 < 0,\ \beta_3 > 0$$

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[23] Johnson et al. (1997) make an attempt to adjust for changes in the elasticity of electricity/GDP.

where i indicates the number assigned to the country,

E_i is per capita household electricity consumption in country i,

C_i is per capita real consumption of households without the consumption of electricity in country i in US dollars (at purchasing power parity),

PR_i is the real price of consumption of 1 kWh of residential electricity in US dollars (at purchasing power parity),

G_i is the relative frequency of months with the need of heating in houses in country i,

Q_i is the ratio of energy sources other than electricity energy to all energy sources in household energy consumption,

H_i is the per capita output of the hidden economy,

T_i is the ratio of the sum of paid personal income, corporate profit and taxes on goods and services to GDP,

S_i is the ratio of public social welfare expenditures to GDP, and

D_i is the sum on number of dependants over 14 years and of inactive earners, both per 100 active earners.

In a cross country study, she estimates the first equation substituting for H_i with the second equation. For the calculation of the actual size (value added) of the shadow economy, Lackó further must know how much GDP is produced by one unit of electricity in the shadow economy of each country. Since these data are not known, she takes the result of one of the known shadow economy estimates calculated for a market economy with another approach for the early 1990s, and applies this to the other countries. Lackó used the shadow economy of the United States as such a base (the shadow economy value of 10.5% of GDP taken from Morris (1993)) and calculated the size of the shadow economy for other countries. Lackó's method is also open to criticism:

(1) Not all shadow economy activities require a considerable amount of electricity and other energy sources can be used.

(2) Shadow economy activities do not take place only in the household sector.

(3) It is doubtful whether the ratio of social welfare expenditures can be used as the explanatory factor for the shadow economy, especially in transition and developing countries.

(4) It is questionable, which is the most reliable base value of the shadow economy in order to calculate the size of the shadow economy for all other countries, especially for the

transition and developing countries.

3.2.6 The model approach[24]

All methods described so far consider just one indicator that to capture all effects of the shadow economy. However, shadow economy effects show up simultaneously in the production, labor, and money markets. An even more important critique is that the causes that determine the size of the shadow economy are taken into account only in some of the monetary approach studies that usually consider one cause, the burden of taxation. The model approach explicitly considers multiple causes of the existence and growth of the shadow economy[25], as well as the multiple effects of the shadow economy over time. The empirical method used is quite different from those used so far. It is based on the statistical theory of unobserved variables, which considers multiple causes and multiple indicators of the phenomenon to be measured.

As the size of the shadow economy is an unknown (hidden) figure, a latent estimator approach using the MIMIC (i.e. multiple indicators, multiple causes estimation) procedure is applied. This method is based on the statistical theory of unobserved variables. The statistical idea behind such a model is to compare a sample covariance matrix, that is, a covariance matrix of observable variables, with the parametric structure imposed on this matrix by a hypothesized model.[26] Using covariance information among the observable variables, the unobservable variable is in the first step linked to observable variables in a factor analytical model also called measurement model. Second, the relationships between the unobservable variable and observable variables are specified through a structural model. Therefore, a MIMIC model is the simultaneous specification of a factor and a structural model. In this sense, the MIMIC model tests the consistency of a 'structural' theory through data and is thus a confirmatory, rather than an exploratory technique. An economic theory is thus tested examining the consistency of actual data with the hypothesized relationships between the unobservable (latent)

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[24] See also Aigner et al. (1988, p. 303), applying this approach for the United States over time; for Germany this approach has been applied by Karmann (1986, 1990). The pioneers of this approach are Weck (1983), Frey and Weck-Hannemann (1984), who applied this approach to cross-section data from the 24 OECD countries for various years. Before turning to this approach they developed the concept of „soft modeling" (Frey et al. (1982), Frey and Weck (1983a,b)), an approach which has been used to provide a ranking of the relative size of the shadow economy in different countries. One paper dealing extensively with the MIMIC approach, its development and its weaknesses is from Del'Anno (2003) as well as the excellent study by Giles and Tedds (2002).

[25] Thomas (1992); Schneider (2003, 2005, 2011); Pozo (1996); Johnson et al. (1998a,b); Giles (1997a,b, 1999a,b,c); Giles and Tedds (2002), Giles et al. (2002), Del'Anno (2003) and Del'Anno and Schneider (2004).

[26] Estimation of a MIMIC model with a latent variable can be done by means of a computer program for the analysis of covariance structures, such as LISREL (Linear Structural Relations). A useful overview of the LISREL software package in an economics journal is Cziraky (2004).

variable or factor and the observable (measurable) variables.[27] In general, a confirmatory factor analysis has two goals: (i) to estimate parameters such as coefficients and variances; and (ii) to assess the fit of the model. For the analysis of shadow economy activities these two goals mean (i) to estimate the relationships between a set of observable variables, divided into causes and indicators, and the shadow economy activity (unobservable variable); and (ii) to test if the researcher's theory or the derived hypotheses as a whole fit the data. MIMIC models are, compared to regression models, a rarely used method by economists, which might be due to an under-evaluation of their capabilities with respect to their potential contribution to economic research.

The idea of the MIMIC model application is to examine the relationships between the latent variable size of shadow economy activities and observable variables in terms of the relationships among a set of observable variables by using their covariance information. The observable variables are divided into causes and indicators of the latent variable (see figure 3.1). The key benefits of the MIMIC model are that it allows modelling shadow economy activities as an unobservable (latent) variable and that it takes into account its multiple determinants (causes) and multiple effects (indicators). A factor- analytic approach is used to measure the size of shadow economy activities as an unobserved variable over time. The unknown coefficients are estimated in a set of structural equations, as the 'unobserved' variable, that is, the size of the shadow economy cannot be measured directly. Formally, the MIMIC model consists of two parts: the structural equation model and the measurement model.

Figure 3.1: The MIMIC model

| CAUSES | | INDICATORS |

$Z_{1t} \longrightarrow$ **Development of the shadow economy** $\longrightarrow Y_{1t}$

$Z_{2t} \longrightarrow$ $\longrightarrow Y_{2t}$

... ...

$Z_{kt} \nearrow$ $\searrow Y_{pt}$

---
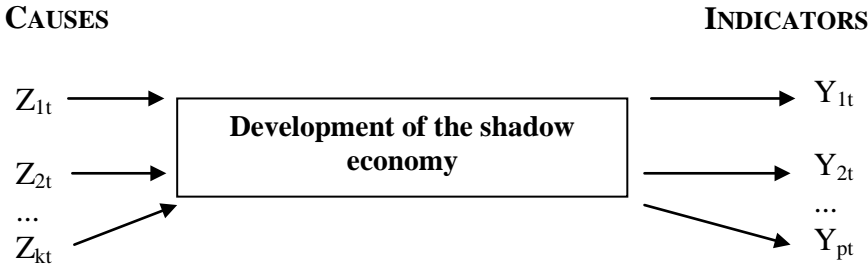
[27] On the contrary, in an exploratory factor analysis a model is not specified in advance, i.e., beyond the specification of the number of latent variables (factors) and observed variables the researcher does not specify any structure of the model. This means that one assumes that all factors are correlated, all observable variables are directly influenced by all factors, and all measurement errors are uncorrelated with each other. In practice, however, the distinction between a confirmatory and an exploratory factor analysis is less strong. Facing poorly fitting models, researchers using the MIMIC model often modify their models in an exploratory way in order to improve the fit. Thus, most applications fall between the two extreme cases of exploratory (non- specified model structure) and confirmatory (ex- ante specified model structure) factor analysis (Long 1983a, pp. 11–17).

In the measurement model, the unobservable variable η_t determines a p vector $y'_t = (y_{1t}, y_{2t}, ..., y_{pt})'$ of indicators, that is, observable variables that reflect the shadow economy activities, subject to a p vector of random error terms $\varepsilon'_t = (\varepsilon_{1t}, \varepsilon_{2t}, ..., \varepsilon_{pt})'$. The unobservable variable η_t is a scalar and λ is a p column vector of parameters that relates y_t to η_t. The measurement equation is given by:

$$y_t = \lambda \eta_t + \varepsilon_t \qquad (2)$$

The structural model determines the unobservable variable η_t by a set of exogenous causes $x'_t = (x_{1t}, x_{2t}, ..., x_{qt})'$ that may be useful in predicting its movement and size, subject to a structural disturbance error term ς_t. The structural equation is given by:

$$\eta_t = \gamma' x_t + \varsigma_t \qquad (3)$$

where γ' is a q row vector of structural parameters.[28] In equations (2) and (3) it is assumed that ς_t and the elements of ε_t are normally, independently and identically distributed, the variance of the structural disturbance term ς_t is denoted by ψ, and $\boldsymbol{\Theta}_\varepsilon = \mathrm{E}\left(\varepsilon_t \varepsilon_t'\right)$ is the $(p \times p)$ covariance matrix of the measurement errors.[29] Figure 3.1 shows the path diagram of the MIMIC model.

The MIMIC model of shadow economy activities estimated in this paper uses three indicators and nine causes. Hence, within this model, equations (2) and (3) are specified as follows:

$$\begin{bmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{bmatrix} = \begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \end{bmatrix} \cdot \eta_t + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} \qquad (4)$$

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[28] Without loss of generality, all variables are taken as standardized deviations from their means.
[29] In the standard MIMIC model the measurement errors are assumed to be independent of each other, but this restriction could be relaxed (Stapleton 1978, p. 53).

$$\eta_t = \begin{bmatrix} \gamma_1 & \gamma_2 & \gamma_3 & \gamma_4 & \gamma_5 & \gamma_6 & \gamma_7 & \gamma_8 & \gamma_9 \end{bmatrix} \cdot \begin{bmatrix} x_{1t} \\ x_{2t} \\ x_{3t} \\ x_{4t} \\ x_{5t} \\ x_{6t} \\ x_{7t} \\ x_{8t} \\ x_{9t} \end{bmatrix} + \varsigma_t \tag{5}$$

Substituting (2) into (3) yields a reduced form equation which expresses the relationships between the observed causes and indicators, that is, between x_t and y_t. This is shown in equation (6):

$$y_t = \Pi x_t + z_t \tag{6}$$

where: $\Pi = \lambda \gamma'$ is a (3×9) reduced form coefficient matrix and $z_t = \lambda \varsigma_t + \varepsilon_t$ is a reduced form vector of a linear transformation of disturbances that has a (3×3) reduced form covariance matrix Ω given as:

$$\Omega = \mathrm{Cov}(z_t) = \mathrm{E}[(\lambda \varsigma_t + \varepsilon_t)(\lambda \varsigma_t + \varepsilon_t)'] = \lambda \psi \lambda' + \Theta_\varepsilon \tag{7}$$

In equation (7), $\psi = \mathrm{Var}(\varsigma_t)$ and $\Theta_\varepsilon = \mathrm{E}\left(\varepsilon_t \varepsilon_t'\right)$ is the measurement error's covariance matrix.

In general, estimation of a MIMIC model uses covariance information of sample data to derive estimates of population parameters. Instead of minimizing the distance between observed and predicted individual values, as in standard econometrics, the MIMIC model minimizes the distance between an observed (sample) covariance matrix and the covariance matrix predicted by the model the researcher imposes on the data. The idea behind that approach is that the covariance matrix of the observed variables is a function of a set of model parameters:

$$\Sigma = \Sigma(\theta) \tag{8}$$

where Σ is the population covariance matrix of the observed variables, θ is a vector that contains the parameters of the model and $\Sigma(\theta)$ is the covariance matrix as a function of θ,

implying that each element of the covariance matrix is a function of one or more model parameters. If the hypothesized model is correct and the parameters are known, the population covariance matrix would be exactly reproduced, that is, Σ will equal $\Sigma(\theta)$. In practice, however, one does not know either the population variances and covariances or the parameters, but instead uses the sample covariance matrix and sample estimates of the unknown parameters for estimation (Bollen 1989, p. 256).

Estimation is thus performed by finding values for $\hat{\theta} = f\left(\hat{\lambda}, \hat{\gamma}, \hat{\psi}, \hat{\boldsymbol{\Phi}}, \hat{\boldsymbol{\Theta}}_{\varepsilon}\right)$ producing an estimate of the models covariance matrix $\hat{\Sigma}$ that most closely corresponds to the sample covariance matrix S. During this estimation procedure, all possible matrices that meet the imposed restrictions are considered. If an estimate Σ^* of $\hat{\Sigma}$ is close to S, one might conclude that θ^* is a reasonable estimate of the model's parameters. Hence, estimation of a MIMIC model is reduced to the problem of measuring how close Σ^* is to S and if this estimate is the most accurate, that is, if it is the best estimate given the set of all possible estimates that meet the imposed restrictions (Long 1983b, pp. 42–5). The covariance equation of the MIMIC model can be derived and has the following functional form:

$$\hat{\Sigma} = \left[\begin{array}{c|c} \hat{\lambda}\left(\hat{\gamma}'\hat{\boldsymbol{\Phi}}\hat{\gamma} + \hat{\psi}\right)\hat{\lambda}' + \hat{\boldsymbol{\Theta}}_{\varepsilon} & \hat{\lambda}\hat{\gamma}'\hat{\boldsymbol{\Phi}} \\ \hline \hat{\boldsymbol{\Phi}}\hat{\gamma}\hat{\lambda}' & \hat{\boldsymbol{\Phi}} \end{array} \right] \quad (9)$$

The function measuring how close a given Σ^* is to the sample covariance matrix S is called the fitting function $\mathrm{F}\left(S; \Sigma^*\right)$. The θ^* of all possible θ^* that meets the imposed constraints on λ, γ, $\boldsymbol{\Phi}$, ψ, and $\boldsymbol{\Theta}_{\varepsilon}$ and minimizes the fitting function, given the sample covariance matrix S, is the sample estimate $\hat{\theta}$ of the population parameters. This means that if one set of estimates θ_1^* produces the matrix Σ_1^* and a second set θ_2^* produces the matrix Σ_2^* and if $\mathrm{F}\left(S; \Sigma_1^*\right) < \mathrm{F}\left(S; \Sigma_2^*\right)$, Σ_1^* is then considered to be closer to S than Σ_2^* (Long 1983a, p. 56).

The most widely used fitting function is the Maximum Likelihood (ML) function.[30] Under the assumption that $\Sigma(\theta)$ and S are positive definite, that is, nonsingular, and S has a Wishart distribution, the following fitting function is minimized:

$$F_{ML} = \log|\Sigma(\theta)| + tr\left[S\Sigma^{-1}(\theta)\right] - \log|S| - (p+q) \tag{10}$$

where $\log|\ |$ is the log of the determinant of the respective matrix and $(p+q)$ is the number of observed variables. In general, no closed form or explicit solution for the structural parameters that minimize F_{ML} exists. Hence, the values of λ, γ, Φ, ψ and Θ_ε that minimize the fitting function are estimated applying iterative numerical procedures.[31] The ML estimator is widely used because of its desirable properties:[32]

First, the ML estimator is asymptotically unbiased.

Second, the ML estimator is consistent, that is $\text{plim}\,\hat{\theta} = \theta$ ($\hat{\theta}$ is the ML estimator and θ is the population parameter).

Third, the ML estimator is asymptotically efficient, that is, among all consistent estimators no other has a smaller asymptotic variance.

Fourth, the ML estimator is asymptotically normally distributed, meaning that the ratio of the estimated parameter and its standard error approximate a z- distribution in large samples.

Fifth, a final important characteristic of the ML estimator is scale invariance (Swaminathan and Algina 1978). The scale invariance property implies that changes in the measurement unit of one or more of the observed variables do not change the value of the fitting function. This means that $\hat{\lambda}$, $\hat{\gamma}$, $\hat{\Phi}$, $\hat{\psi}$ and $\hat{\Theta}_\varepsilon$ are the same for any change of scale.

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[30] Other estimation procedures such as Unweighted Least Squares (ULS) and Generalized Least Squares (GLS) are also available. ULS has the advantage that it is easier to compute and leads to a consistent estimator without the assumption that the observed variables have a particular distribution. Important disadvantages of ULS are, however, that ULS does not lead to the asymptotically most efficient estimator of θ and that F_{ULS} is not scale invariant. The GLS estimator has similar statistical properties like the ML estimator but the significance tests are no longer accurate if the distribution of the observed variables has very 'fat' or 'thin' tails. Moreover, F_{GLS} accepts the wrong model more often than ML and parameter estimates tend to suffer when using F_{GLS}. Thus, ML seems to be superior (see, e.g. Bollen 1989, pp. 111–15; Ollsson et al. 1999, 2000; Jöreskog and Sörbom 2001, pp. 20–4).

[31] See Appendix 4C in Bollen (1989) for details.

[32] The properties are only briefly reviewed. For a detailed discussion see Bollen (1989, pp. 107–23).

It is widely accepted by most scholars who estimate the size and development of shadow economic activities using the MIMIC model or more general Structural Equation Models (SEMs) with more than one unobservable variable, that such an empirical exercise is a 'minefield', regardless of which method is used. For example, in evaluating the currently available shadow economy estimates of different scholars, one should keep in mind that there is no best or commonly accepted method. Each approach has its strengths and weaknesses and can provide specific insights and results. Although SEM/MIMIC model applications in economics are 'accompanied' by criticisms, they are increasingly used for estimating the shadow economy and other informal economic activities.

In comparison to other statistical methods, SEMs/MIMIC models offer several advantages for the estimation of shadow economic activities. According to Giles and Tedds (2002), the MIMIC approach is a wider approach than most other competing methods, since it allows one to take multiple indicator and causal variables into consideration at the same time. Moreover, it is quite flexible, allowing one to vary the choice of causal and indicator variables according to the particular features of the shadow economic activity studied, the period in question, and the availability of data. SEMs/MIMIC models lead to a formal estimation and to testing procedures, such as those based on the method of maximum likelihood. These procedures are well known and are generally 'optimal', if the sample is sufficiently large (Giles and Tedds 2002). Schneider and Enste (2000) emphasize that these models lead to some progress in estimation techniques for the size and development of the shadow economy, because this methodology allows a wide flexibility in its application. Therefore, they consider it potentially superior to other estimation methods. Cassar (2001) argues that, when compared to other methods, SEMs/MIMIC models do not need restrictive assumptions to operate. Analogously, Thomas (1992, p. 168) argues that the only real constraint of this approach is not in its conceptual structure, but the choice of variables. These positive aspects of the SEM approach in general and the MIMIC model in particular do not only apply in its application to the shadow economy, but to all informal economic activities.

Of course this method has its disadvantages or limitations, too, which are identified in the literature. The three most important points of criticism focus on the model's implementations, the sample used, and the reliability of the estimates:

(1) The most common objection estimating shadow economic activities using SEMs concerns the meaning of the latent variable (e.g. Helberger and Knepel 1988; Dell'Anno

2003). The confirmatory rather than exploratory nature of this approach means that one is more likely to determine whether a certain model is valid than to 'find' a suitable model. Therefore, it is possible that the specified model includes potential definitions or informal economic activities other than the one studied. For example, it is difficult for a researcher to ensure that traditional crime activities such as drug dealing are completely excluded from the analysis of the shadow economy. This criticism, which is probably the most common in the literature remains difficult to overcome as it goes back to the theoretical assumptions behind the choice of variables and empirical limitations on data availability.

(2) Helberger and Knepel (1988) argue that SEM/MIMIC model estimations lead to unstable coefficients with respect to changes of the sample size and alternative model specifications. Dell'Anno (2003) shows, however, that instability disappears asymptotically as the sample size increases. Another issue is the application of SEMs to time series data because only simple analytical tools such as q- and stemleaf plots are available to analyse the properties of the residuals (Dell'Anno 2003).[33]

(3) Criticism is also related to the benchmarking procedure used to derive 'real world' figures of shadow economic activities (Breusch 2005a, 2005b). As the latent variable and its unit of measurement are not observed, SEMs just provide a set of estimated coefficients from which one can calculate an index that shows the dynamics of the unobservable variable. Application of the so- called calibration or benchmarking procedure, regardless which one is used, requires experimentation, and a comparison of the calibrated values in a wide academic debate. Unfortunately, at this stage of research on the application of the SEM/MIMIC approach in economics it is not clear which benchmarking method is the best or the most reliable.[34]

The economic literature using SEMs is well aware of these limitations. Consequently, it acknowledges that it is not an easy task to apply this methodology to an economic dataset, but also argues that this does not mean one should abandon the SEM approach. On the contrary, following an interdisciplinary approach to economics, SEMs are valuable tools for economic analysis, particularly when studying the shadow economy. However, the mentioned objec-

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[33] Particularly critical are the assumptions $\mathrm{E}\left(\varsigma_{ik}^2\right) = \mathrm{Var}\left(\varsigma_i\right)$ for all k (homoscedasticity assumption) and $\mathrm{Cov}\left(\varsigma_{ik}, \varsigma_{il}\right) = 0$ for all $k \neq l$ no autocorrelation in the error terms). Unfortunately, corrections for autocorrelated and heteroscedastic error terms have not yet received sufficient attention in models with unobservable variables (Bollen 1989, p. 58). An interesting exception is Folmer and Karmann (1992).

[34] See Dell'Anno and Schneider (2009) for a detailed discussion on different benchmarking procedures.

tions should be considered as an incentive for further (economic) research in this field rather than as a suggestion to abandon this method.

3.3. Results of the Size of the German Shadow Economy Using the Various Estimation Methods

Finally, so that the interested reader sees how big the variance of the different estimations of the size of the shadow economy is, the results for the case of Germany are shown. A significant amount of empirical work has been done on the shadow economy in Germany, and this makes it an interesting case study. The results are shown in table 3.1. The oldest estimate uses the survey method of the Institut für Demoskopie (IfD) in Allensbach (Germany) and shows that the shadow economy was 3.6% of official GDP in 1974. In a much later study Feld and Larsen (2005, 2009) undertook an extensive research project using the survey method to estimate shadow economy activities in the years 2001 to 2006. Using the officially paid wage rate, they concluded that the shadow economy activities reached from 4.1% in 2001, 3.1% in 2004, 3.6% in 2005 and 2.5% in 2006. Using the much lower shadow economy wage rate, these estimates shrink, however, to 1.3% in 2001 and 1.0% in 2004, respectively.

As discussed, we know that the survey method underestimates the size of the shadow economy. Using the discrepancy method and applying national income statistics, Lippert and Walker (1997) estimate a size of the German shadow economy from 1970 to 1980 between 11.0% and 13.4% of official GDP. Using the discrepancy method applying official and actual employment, Langfeldt (1983) gets much higher estimates for 1970 to 1980, ranging from 23.0% to 34.0%. Applying the physical input method (electricity approach), Feld and Larsen (2005) get results of 14.5% for the year 1985 and 14.6% for 1990. The monetary transaction method developed by Feige calculates the shadow economy to be of about 30% between 1980 and 1985. These are the highest estimates for the case of Germany. Switching to the currency demand approach, first used by Kirchgässner (1983, 1984), his study provides values of 3.1% in 1970 and 10.3% in 1980. Kirchgässner's values are quite similar to those obtained by Schneider and Enste (2000, 2002), who also use the currency demand approach to estimate the size of the shadow economy, which are 4.5% in 1970 and 14.7% in 2000. Using the MIMIC estimation procedure, which was first applied by Frey and Weck (1983), the results are quite sim-

ilar to those from the currency demand approach.[35] Frey and Weck (1983) calculate a shadow economy in Germany in 1970 of 5.8% which increases to 8.2% in 1980. Pickardt and Sarda (2006), whose sample used for the MIMIC estimations started a bit later, get a value of 9.4% in 1980, which increases to 16.3% in the year 2000. These are quite similar values to Schneider (2005, 2007). Finally, using the soft modeling variant of the MIMIC approach, Weck-Hannemann (1983) gets a value of 8.3% of GDP in 1975.

Considering table 3.1, one can see that different estimation procedures produce different results. It is safe to say that the figures produced by the transactions and discrepancy approaches are unrealistically large. A size of the shadow economy of almost one third of official GDP in the mid-eighties is most likely to be an overestimate. The figures obtained using the currency demand and the hidden (latent, MIMIC) approaches are, on the other hand, relatively close together and much lower than those produced by the discrepancy or transactions approach. The estimates from the MIMIC approach can be regarded as the most reasonable estimates of the size of the shadow economy and the survey model is likely to produce too low estimates for the reasons already discussed.

Finally, in table 3.2 a comparison of the size of the German shadow economy using the survey and the MIMIC method for the year 2006 is undertaken. As we see, the difference between the estimates of the macro-method (here the MIMIC estimation procedure) and the results from the survey method is quite large. In table 3.2 an attempt is undertaken to demonstrate the major difference between these two estimation methods. The first line of table 3.2 clearly shows shadow economy activities from labor (hours worked, survey results). They range from 5.0%–6.0% in the year 2006. If one adds to this used material, illegal activities and those which are already included in the official GDP, one gets a value between 13.0% and 17.0% of GDP, which comes very close to the 15.0% of the MIMIC estimation results. Hence, one realizes that the macro-results of course include the used materials and illegal activities, so that it is not amazing to find much larger results.

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[35] This is not astonishing as quite often the calibration start-values have been used from the currency demand approach in order to transform the relative estimates of the MIMIC approach.

Table 3.1: The Size of the Shadow Economy in Germany According to Different Methods (in percentage of official GDP)

Method/Source	Shadow economy (in percentage of official GDP) in:							
	1970	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**
Survey (IfD Allensbach, 1975)	-	3.6 [1]	-	-	-	-	-	-
(Feld and Larsen, 2005)	-	-	-	-	-	-	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, 1983)	23.0	38.5	34.0	-	-	-	-	-
Physical input method (Feld and Larsen, 2005)	-	-	-	14.5	14.6	-	-	-
Transactions approach	17.2	22.3	29.3	31.4	-	-	-	-
Currency demand approach (Kirchgäss-ner, 1983)	3.1	6.0	10.3	-	-	-	-	-
(Langfeldt, 1983, 1984)	12.1	11.8	12.6	-	-	-	-	-
Schneider and Enste (2000)	4.5	7.8	9.2	11.3	11.8	12.5	14.7	-
Latent ((DY)MIMIC) approach Frey and Weck (1983)	5.8	6.1	8.2	-	-	-	-	-
Pickardt and Sarda (2006)	-	-	9.4	10.1	11.4	15.1	16.3	-
Schneider (2005, 2007)	4.2	5.8	10.8	11.2	12.2	13.9	16.0	15.4
Soft modellingWeck-Hannemann (1983)	-	8.3	-	-	-	-	-	-

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

Table 3.2: A comparison of the Size of the German Shadow Economy using the survey and the MIMIC-method, year 2006

Various kinds of shadow economy activities/values	Shadow Economy in % of official GDP	Shadow Economy in bill. Euro	% share of the overall shadow economy
Shadow economy activities from labour (hours worked, *survey results*) + Material (used) + Illegal activities (goods and services) + already in the official GDP included illegal activities	5.0 – 6.0 3.0 – 4.0 4.0 – 5.0 1.0 – 2.0	117 – 140 70 – 90 90 – 117 23 – 45	33 – 40 20 – 25 25 – 33 7 - 13
Sum (1) to (4)	13.0 – 17.0	300 – 392	85 – 111
Overall (total) shadow economy (estimated by the MIMIC and calibrated by the currency demand procedure)	15.0	340	100
Source: Enste/Schneider (2006) and own calculations.			

4. SUMMARY AND CONCLUDING REMARKS: PROBLEMS AND OPEN QUESTIONS

If we summarize our findings about the methods to estimate the size and development of the shadow economy, we come to the following findings:

4.1. Surveys

(i)   Quite often only households are considered and firms are, at least partly, left out.

(ii)   Non-responses and/or incorrect responses are given.

(iii)   Results of the financial volume of "black" hours worked and not of value added are obtained.

4.2. Estimations from the discrepancy method

(i)   Quite often here a combination of "rough" estimations and unclear assumptions about them is used.

(ii)   The calculation method is often not clear.

(iii)   The documentation and procedure is often not made public.

4.3. Monetary and/or electricity methods

(i)   Some estimates are very high and only macro-estimates are available.

(ii)   A breakdown by sector or industry is not possible.

(iii)   Great differences to convert millions of KWh into a value added figure, when using the electricity method.

4.4. MIMIC (latent) method

(i)   Only relative coefficients, no absolute values, are obtained.

(ii)   The estimations are quite often highly sensitive with respect to changes in the data and specifications.

(iii)   Difficulties to differentiate between the selection of causes and indicators.

(iv)   The calibration procedure and starting values which are used have a great influence on the results.

What type of conclusions can we draw or what have we learnt during 35 years of shadow economy research?

(1)   There is no ideal or dominating method to estimate the size and development of the shadow economy. All methods have serious problems and weaknesses.

(2)   If possible, researchers should use several methods to come somewhat closer to the actual value of the size and development of the shadow economy.

(3)   Much more research is needed with respect to the estimation methodology and the empirical results for different countries and periods.

(4)   The focus should be now on micro-shadow economy research, and to undertake experiments in order to reach two goals:

(i)   a better micro-foundation and

(ii)   a better knowledge why people work in the shadow economy, what their motivation is and what they earn.

What questions remained open?

(1)   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 factors, but which are the "core" causal factors is still open and also in which indicators shadow economy activities are reflected.

(2)   A satisfactory validation of the empirical results should be developed so that it is easier to judge the empirical results with respect to their plausibility.

(3)   A common and internationally accepted definition of the shadow economy is still missing. Such a definition or convention is needed in order to make comparisons between countries possible.

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