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THE SHADOW ECONOMY IN PORTUGAL: AN ANALYSIS WITH THE MIMIC APPROACH

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The paper estimates the Portuguese Shadow Economy (SE) from 1977 to 2004 and tests the statistical relationships between the SE and other economic variables. In order to carry out the econometric analysis, a multiple indicators multiple causes (MIMIC) model with means and intercepts is applied. The main causes of the Portuguese SE are analyzed and economic policies to reduce it are suggested. An appraisal on the reliability of estimates and an alternative benchmark strategy for the MIMIC approach are proposed.

JEL classification codes: O17, H10, H26, C39
Key words: shadow economy, MIMIC model, Portugal

I. Introduction

An ample literature analyses the causes and consequences of the hidden economy on citizens, firms and government.[1] The Shadow Economy (SE) has relevant repercussions on many aspects of the economic and social life of a country. On one hand, the SE is one of the causes of the inefficient functioning of the goods and labour markets. It introduces a distortion of competition within countries and among States. A growing SE attracts workers away from the official economy and creates competition for official firms; it harms involved workers by depriving them of their rights and guarantees; and the decision by entrepreneurs to work outside the fiscal regulatory framework produces a vicious circle, as their exit from the formal economy reduces State revenues and consequently decreases public expenditures (e.g., on infrastructure, education, research, etc.). Moreover, hidden activities favour corruption and links between criminal and illegal activities; the SE

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[1] For an overall survey, see Schneider and Enste (2002).

hampers policy making as it questions the reliability of the national account aggregates;[2] and the SE increases lack of trust in institutions and feeds resentment among citizens.

On the other hand, the SE creates an extra added value that can be spent in the official economy. Schneider and Enste (2000) for instance state that at least two-thirds of the income earned in the SE is immediately spent in the official economy, thus having a positive effect on the latter. As Smith (2002) points out, in a world of minimum wages, high payroll taxes and limits on hours worked, the underground economy may enable some individuals to be employed who would otherwise be unemployed, enable other individuals to increase their incomes by holding second jobs, and provide services that would otherwise be unavailable. Irregular activities may add a dynamic element to an economy and increase competition in some sectors. Underground production may improve the distribution of income in society.

Hence, it is clear that the SE not only has negative effects on the economic system but also generates positive ones. These potentially positive aspects of SE should be considered in the planning of policies, as the main aim of the policy maker should be to adopt economic policies which drive the shadow activities towards the regular economy rather than easily fight them. The knowledge of the size, sector distribution, dynamics and determination of the main causes of the SE are necessary conditions for adopting a coherent plan of economic policies.

In this paper, we attempt to find some plausible answers to the following questions: What are the dynamics and size of the Portuguese SE (as percentage of the official GDP) in the last thirty years?, what are the main causes of SE?, and what kind of economic policies could be effective in reducing SE? To find answers to these queries, we apply an "*ad hoc*" econometric model, namely a Multiple Indicators Multiple Causes (MIMIC) model which is a special specification of a more general approach called Structural Equation Modelling (SEM).

The outline of the paper is as follows. The section below provides an overview of the definition of the SE. Section III describes the empirical approach and data. The estimates and econometric strategy are discussed in Section IV. Section V presents the conclusions.

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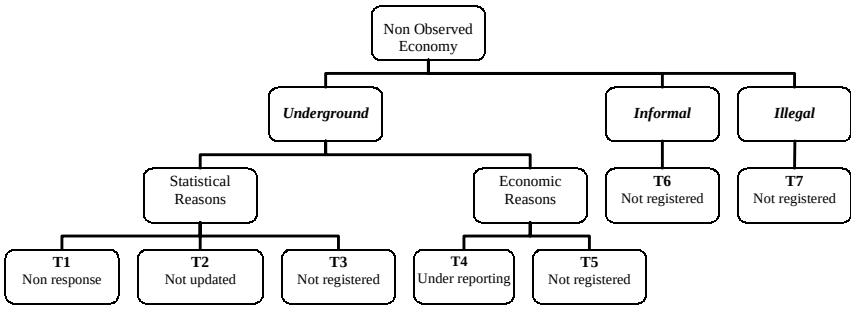
[2] The national accounts are an integrated system, which requires related flows to be recorded consistently. Recording one part of a certain activity (expenditure on goods and services from household production) but excluding the other part of the activity (production of goods and services) introduces inconsistencies in the accounts and errors in the balancing items (Bloem and Shrestha 2000).

II. Definition of the shadow economy

The nature of SE appears to mean very different things to macroeconomists, labor economists, criminologists, fiscal experts and national income accountants. No single definition of the underground economy serves all the diverse scientific aims. Alternative definitions therefore have to be fashioned in light of the relevance that particular underground activities have to different areas of economic inquiry (Feige 1989). Several attempts are presented in the literature to summarize the wide range of proposed definitions of SE (see, *inter alia*, Schneider and Enste 2000, Dell'Anno 2003). Although it is impossible to select the best general definition, for the empirical orientation of this research, we adopted a nomenclature proposed by the System of National Accounts (SNA93) and the European System of National Accounts (ESA95). These classifications introduce in national accounts a statistical aggregate called "non-observed economy" (NOE). In particular, the analytical ISTAT (Italian National Statistical Institute) framework described in OECD (2002), is used to show the different components of the NOE (see Figure 1). The NOE comprises all product activities that can be classified into the following three areas: Underground production, informal production and illegal production.

Figure 1. ISTAT framework of NOE



Underground production represents the area of production activities that are not directly observed due to: economic reasons as activities carried out with the deliberate desire to avoid taxes and social contributions in favour of employees or, also, to avoid observing law provisions concerning minimum wages, the number of work hours, job safety, etc.; and, statistical reasons as production activities that are not registered due to failure to fill out administrative forms or statistics questionnaires because of a lack of sensitivity to statistics and/or shortcomings in

the statistics system, difficulty in grasping the changes of a rapidly evolving productive system characterised by small productive activities that are often not detectable with the traditional survey techniques.

Informal production refers to productive institutional units characterised by a low level of organisation, little or no division between work and capital, and work relations based on occasional jobs, kinship, or personal relations (this includes craftsmen, peddlers without licences, farm workers, home workers, and unregistered activities of small merchants).

Finally, illegal production includes the activities involved in the production of goods and services whose sale, distribution or possession is prohibited by law. Included in this area are also productive activities carried out by unauthorised operators.[3] Due to the difficulty of estimation, which could limit international comparability, illegal activities are often excluded from national accounts.

In accordance with the SNA93 and ESA95 classifications, the use of the terms non-observed, underground, informal, illegal economy is not just a question of nomenclature. They clearly measure different aggregates and therefore require diverse theoretical and empirical methodologies.

Although the proposed structure of NOE is functional to achieve the exhaustiveness of national accounts, there is no available aggregate that could be considered consistent with the wider (economic) notion of the SE. For this reason, in this research, the NOE is aggregated in three categories: the Shadow Economy or "economical part" of NOE is defined as the non-observed economy caused by economic reasons (T4, T5, T6); the Illegal Activities correspond to T7; the "Statistical part" includes T1, T2, T3 and imputed rentals. By this grouping, only the first category is considered to be the SE.

III. Empirical strategy and data

Structural Equation Models (SEM) are statistical relationships among latent (unobserved) and manifest (observed) variables.[4] A special case of SEM is the

[3] SNA (1993) states explicitly that illegal activities should be included in the system of national accounts, noting that "despite the obvious practical difficulties in obtaining data on illegal production, it is included within the production boundary of the System" (SNA 1993: 6.30), and that: "All illegal actions that fit the characteristics of transactions – notably the characteristic that there is mutual agreement between the parties – are treated the same way as legal actions" (SNA 1993: 3.54). The 1993 SNA suggests that illegal actions for which there is no mutual agreement can be construed as an extreme form of externality for which, in general, no values are imputed in the national accounts. Therefore, it is absence of consent rather than illegality that is actually the criterion for exclusion from the production boundary (OECD 2002, p. 38).

[4] Hence an alternative name for this field is "analysis of covariance structures".

Multiple Indicators and Multiple Causes model. It allows to consider the SE as a "latent" variable linked, on the one hand, to a number of observable indicators (reflecting changes in the size of the SE) and on the other, to a set of observed causal variables, which are regarded as some of the most important determinants of the unreported economic activity.

The MIMIC Model received its name from Jöreskog and Goldberger (1975), although it had previously been discussed by Zellner (1970), Hauser and Goldberger (1971) and Jöreskog (1973). In particular, regarding the applications of MIMIC models to estimate the SE, the first economists to consider the size of the hidden economy as an 'unobservable variable' were Frey and Weck-Hannemann (1984). Following Frey and Weck-Hannemann's example, other economists used this approach for their statistical analysis of the SE: Loayza (1996) for Latin America countries, Giles (1995, 1999) for New Zealand, Giles and Tedds (2002) for Canada, Dell'Anno (2003) for Italy, Bajada and Schneider (2005) for Asia-Pacific countries, Schneider (2005) for 110 countries, Chaudhuri, Schneider and Chattopadhyay (2006) for India, Dell'Anno, Gomez and Alañón Pardo (2007) for France, Greece and Spain.

An analytical representation of the most general specification (MIMIC 6-1-2: six determinants, one latent variable and two indicators) is utilized in this research to measure the development of the Portuguese SE. This model framework is fundamental to qualify how correctly and comprehensively the MIMIC model is able to evaluate the SE because the model specification starts from the most general specification and continues omitting the variables, which do not have statistically significant structural parameters. In other words, the MIMIC 6-1-2 is the starting specification for subsequent model modification (see Appendix A for methodological details).

According to the SEM classification, the equation with the relationships between the latent variable [η: shadow economy index] and the causes [X_q: government employment in labour force (X_1), tax burden (X_2), subsidies (X_3), social benefits paid by government (X_4), self-employment (X_5), unemployment rate (X_6)] is called the Structural Model:

$$\eta = \alpha + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \gamma_4 X_4 + \gamma_5 X_5 + \gamma_6 X_6 + \zeta \quad (1)$$

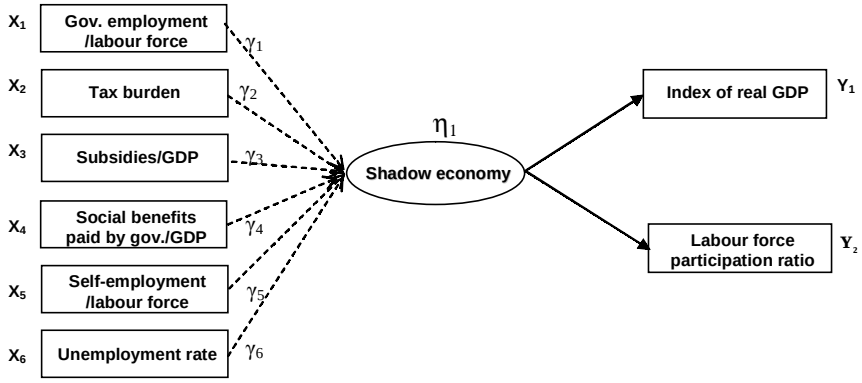
The equations system that links the indicators [Y_p: real gross domestic product index (Y_1), labour force participation rate (Y_2)] and the unobservable variable (η) is the Measurement Model:

$$Y_1 = \delta_1 + \lambda_1 \eta + \varepsilon_1. \quad (2)$$

$$Y_2 = \delta_2 + \lambda_2 \eta + \varepsilon_2 . \quad (3)$$

An intuitive description to show the economic theory underlying this method is using a path diagram (Figure 2) where the potential causes of the SE are shown on the left and the indicators on the right.[5] Appendix B reports the data sources for each variable in the empirical model.

Figure 2. MIMIC model



A. Determinants of the SE

Government employment in labour force (X_1). This explanatory variable is introduced in order to take into account both the degree of economic freedom and an index of over-burden of the public sector in the economy. Consistent with the Heritage Foundation/Wall Street Journal that publish the annual Index of Economic Freedom, the SE is the reaction of citizens against restrictions to economic freedom. These limitations consist of government constraints, coercions on production, distribution, or consumption of goods and services beyond the extent necessary for citizens to protect and maintain liberty itself (O'Driscoll, Feulner and O'Grady 2003, p. 50). The ample literature on the relationship between the SE and regulation is contrasting. The large majority of researchers support a decreasing role of the

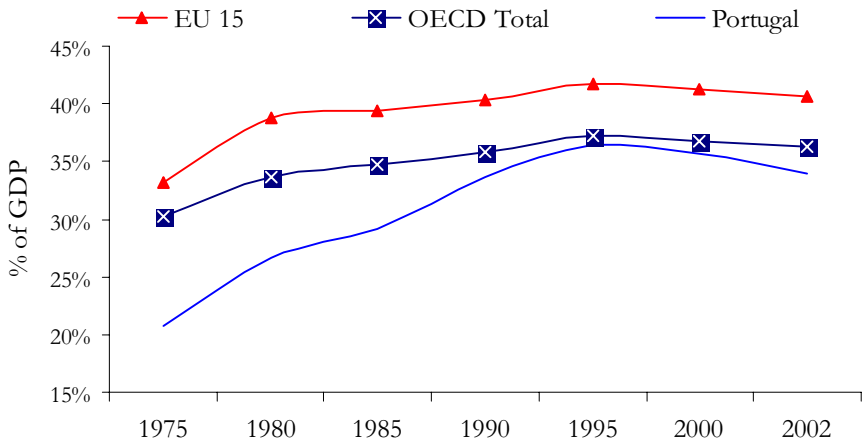
[5] In order to eliminate the non-stationarity in the time series, according to the ADF and PP unit root tests, all variables are converted to first differences.

public sector in the economy. According with this view, there is: (a) An over-bureaucratisation in the economy. And, the more regulated the economy is, the more incentive firms find to develop their activities in the underground economy (Belev 2003); (b) A high relative size of the public sector implies bureaucrats' have more power for decisions and obviously the level of corruption rises. Briberies and dishonesty of civil servants is another potential determinant of the hidden economy (Schneider and Enste 2002); (c) A large presence of the public sector in the market needs to be financed by a complex system of taxes. That introduces distortions in the allocation of resources between private businesses (more efficient), and public institutions and firms. Other researchers (a minority) argue that, in some industries, the presence of the State could provide a disincentive for people to join the shadow economy. From this outlook, the larger the State intervention in the economy is, then the greater is the intensification of the attack upon the irregular economy, consequently, we would expect a negative sign in the relationship between the SE and the index of "rule of law". Unfortunately, there is no data available regarding the struggle to reduce shadow economy activities and this effect is probably overlooked by our empirical analysis.

Tax burden (X_2). In the literature, the most popular determinants of SE are tax rates. The common hypothesis is that an increase of the tax burden is a strong incentive to work in the unofficial economy. Tax burden is measured by the total share of direct taxes, indirect taxes and social contributions as a percentage of (official) gross domestic product. In terms of burden, the Portuguese total tax revenue/GDP is significantly below the EU average (Figure 3). With reference to the structure of the tax system, a distinctive feature of Portugal is the relatively high reliance on consumption taxes: These account in 1998, for 42 per cent of total tax revenue, compared with 30 per cent on average in the OECD and EU.

Subsidies (X_3). They are current unrequited payments that government units make to enterprises on the basis of their level of production or the quantities or values of the goods or services which they produce, sell or import (SNA 1993). The subsidies have conflicting effects on the SE. On one hand, an increase in subsidies raises the costs to be irregular - this is because only formal activities have access to subsidies. But, on the other hand, it introduces distortions to competition and, by altering the net tax burden of enterprises, could encourage enterprises towards the irregular sector - this is because the criteria of subsidy allocation, rather than market efficiency targets, could discriminate between firms depending on their membership of different lobby capacities, geographical locations, etc.

Figure 3. Tax revenue as percentage of GDP

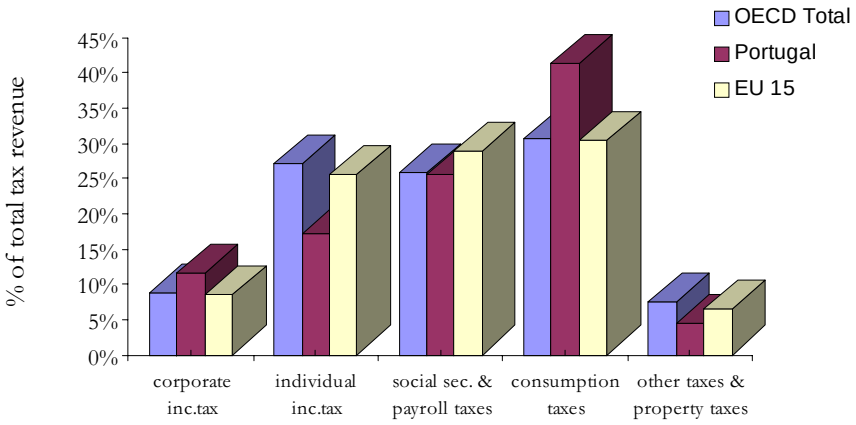


Social benefits paid by government (X_4): This variable includes all current transfers received by households intended to provide for needs arising from certain events or circumstances. For example, unemployment, retirement, sickness, housing, education or family circumstances (SNA 1993). Social benefits, like subsidies, could have uncertain effects on the SE. They increase the cost of being irregular, because informal workers do not have access to unemployment allowances, financial help, etc. At the same time, they are an incentive to participate and remain in the irregular market, by reducing the willingness of the unemployed to work and providing incentives to under-declare official income in order to receive undue social benefits.

Self-employment (X_5). The rate of self-employment as a percentage of the labour force is considered as a determinant of the SE. A significant diffusion of professionals and self-employed, compared to the total workforce, increases the potential number of opportunities to hide income from the authorities. Pissarides and Weber (1989) found that in the United Kingdom those with a significant amount of self-employment income did not report 35 percent of their total income. Mirus and Smith (1997), found that in Canada from 11 to 16 percent of income from self-employment went unreported. Schuetze (2002) support that finding and estimates that between 12 and 24 percent of self-employment income went unreported in Canada in 1990. Apel (1994) found that in Sweden 26 percent of self-employed income went unreported. Bordignon and Zanardi (1997, p. 172) in their work for Italy remark that "a large proportion of professionals and self-employed implies

greater possibilities for transferring expenses from consumption to production (to be deducted from taxes), simplified accounting, and easier path collusion with customers". In other research on European countries, Dell'Anno (2003) and Dell'Anno, Gomez and Alañón (2007), find a significant (positive) correlation between self-employment and the SE. As Bronchi and Gomes-Santos (2001) state there is a bias in the Portuguese tax burden (including social contributions) in favour of the self-employed. This factor compounded by relatively tight employment-protection legislation explains why the share of self-employed in total employment is one of the highest in the OECD area (see Figure 4).[6] They can evade taxes by deducting some of their private consumption as business expenses, as well as benefit from most of the tax allowance granted to incorporated companies. Moreover, tax legislation makes evasion easy for these workers: subject to certain turnover limits (20 times the national minimum wage), book-keeping is not compulsory for the self-employed, and they are not required to keep separate bank accounts for private and professional activity.

Figure 4. The structure of taxation by type of tax (1998)



[6] Estimates of the Instituto de Gestão Financeira da Seguranca Social (IGFSS), which manages the general system of social security contributions in Portugal, show that the self-employed tend to pay the highest legal rate - to benefit from the broad coverage of the social security system - but choose the lower base allowed by the system (i.e. the minimum national remuneration) in order to minimise taxes without losing the associated benefits. Bronchi and Gomes-Santos (2001, p. 28).

Unemployment rate (X_6). The labour force of the hidden economy is composed of very heterogeneous workers; one part is classified as unemployed because they are components of the official labour force, the other part of 'hidden' workers is composed of retired people, minors and housewives who are not part of the official workforce. Furthermore, there are people who have both an official and unofficial job at the same time (Tanzi 1999, p. 343). In this sense, the official unemployment rate could be weakly correlated with the SE.

B. Indicators

Two variables are used as indicators of the latent variable: the real (official) gross domestic product index (1995=100) and the labour force participation rate, to measure the development of the SE.

Real gross domestic product index (base year 1995=100) (Y_1). The discussion about this indicator is crucial to the problem of identification as well as for the theoretical consequences it implies, mainly because it is chosen as a *variable of scale* (or *reference variable*). Since the latent variable is unmeasured, the researcher must set its unit of measurement. We fix the coefficient $\lambda_1$equal to a nonzero value. The choice of this value can be restricted between two alternatives (+1 or -1) because, by using a unitary base for normalization, the estimated coefficients are more easily comparable.[7] Following Dell'Anno (2003), we use a strategy that determines the sign of coefficient of scale through a *reductio ad absurdum*. As in the MIMIC model the vector of structural coefficients is proportional to the coefficient of scale, when the sign of $\lambda_1$is changed, the structural parameters γ_q of the causes change from positive to negative (and viceversa) keeping the same absolute values. According with this property, if the signs of the estimated coefficients that link the underground economy and its causes are completely divergent from well-known theories and empirical studies in one case (e.g., $\lambda_1 = +1$), then the hypothesis supporting the opposite sign for the relationships between shadow economy and reference variable should be accepted as more rational.[8] Unfortunately, in the literature there is no common view about what is the sign of the relationship between official and unofficial

[7] For details about the effects of normalization on structural coefficients, see Dell'Anno, Gomez and Alañón (2007).

[8] This approach is not very different from the calibration procedure. It means taking parameters that have been estimated for a similar model into one's own model.

economy. Can a downturn in the economic official activities lead to a loss of jobs and thus drive more individuals into the hidden economy or, on the contrary, can a contraction in the GDP reduce the demand for underground products and thus offset the first effect? Empirical answers to these questions are contrasting. Adam and Ginsburgh (1985) for Belgium, Giles and Tedds (2002) for Canada, Chatterjee, Chaudhuri and Schneider (2003) for Asian countries, find a positive relation between SE and official GDP, while Frey and Weck-Hannemann (1984) for 17 OECD countries, Loayza (1996) for 14 Latin America countries, Kaufmann and Kaliberda (1996) for Transition countries, Eilat and Zinnes (2000) for transition countries, Schneider and Enste (2000) for 76 Countries, Ott (2002) for Croatia, Dell'Anno (2003) for Italy, Dell'Anno, Gomez and Alañón (2007) for France, Greece and Spain, find a negative relationship. Moreover, Schneider (2005) shows a negative sign for transition and developing countries and a positive relationship for developed ones.

Labour force participation rate (Y_2). The labour force participation rate is calculated as the ratio of the total labour force (LF) and the population of working age (15-64 years old). Some authors (e.g., Fuà 1976, Contini 1981) estimated the size of the hidden economy from changes in the labour force participation rate. According to Giles (1998) a decline in this rate over time or a low rate relative to those in comparable economies may reflect a movement of the workforce from the measured economy into hidden activities. By including this variable as an indicator, it is possible to determine empirically if there is a flow of resources between official and underground economy. The fact that changes in participation reflect variations in the SE, or vice versa, is uncertain and conflicting hypothesis must be considered. Numerous empirical evidence shows that unrecorded economic activity is only partially undertaken by members of the measured workforce. For Bajada and Schneider (2005), it is possible that the participation rate may be unaffected by SE activity if such activities are undertaken after hours or on weekends when individuals are not working in the regular economy. In our opinion there is a further warning, in the last forty years the structural composition of the labour force has strongly changed. In particular, the effect that changes in the black labour market have on the participation ratio could be biased by the growing female participation in the workforce. In general, however, there is a tendency to conclude that people do not withdraw from the measured labour market in order to participate in the SE. According with the previous arguments, we suggest to cautiously consider the MIMIC output for this indicator.

IV. Estimates and benchmarking strategy

A. Results of the MIMIC model

The maximum likelihood estimatated coefficients are shown in Table 1. Since causes are measured with the same unit of measurement (percentage points), the coefficients of Table 1 are directly comparable in order to evaluate relative weight to explain the dynamics of SE. In particular, estimation outputs reveal that the main causes of SE, among those included in the MIMIC model, are (in decreasing order): social benefits/GDP, the proxy of (lack) economic freedom, the unemployment rate and self-employment/labor force. Starting from MIMIC 6-1-2, and deleting nonsignificant paths, we consider MIMIC 4-1-2 as the best model.

Table 1. Estimated coefficients of the MIMIC models and global goodness of fit statistics

Models	Empl.gov. /Lab. force	Tax burden	Subsidies /GDP	Social benef. /GDP	Self-empl. /Lab. force	Unempl. rate	Particip. lab. force
MIMIC 6-1-2	0.70 *	0.03	0.20	0.91 *	0.50 *	0.62 *	0.37 *
	(2.12)	(0.19)	(0.49)	(2.52)	(3.99)	(3.90)	(2.69)
MIMIC 5-1-2	0.73 *	—	0.20	0.94 *	0.49 *	0.62 *	0.36 *
	(2.36)		(0.49)	(2.75)	(4.49)	(4.06)	(2.68)
MIMIC 4-1-2	0.75 *	—	—	0.93 *	0.48 *	0.62 *	0.38 *
	(2.52)			(2.75)	(4.46)	(4.11)	(2.71)

Global Goodness of Fit Statistics	Chi-square[2] (p-value)	RMSEA[3] (p-value)	Degrees of freedom[4]	Intercept (α)
MIMIC 6-1-2	12.41+	0.055+	10	- 0.14
	(0.258)	(0.41)		(-0.79)
MIMIC 5-1-2	9.81+	0.09+	6	- 0.15
	(0.133)	(0.22)		(-0.79)
MIMIC 4-1-2	6.86+	0.069+	5	- 0.14
	(0.231)	(0.33)		(-0.79)

Notes: z-statistics are given in parentheses. * Means |z-statistic|>1.96; + Means good fitting (p-value > 0.05). [2] If the structural equation model is correct and the population parameters are known, then the matrix S (sample covariance matrix) will equal $\Sigma(\theta)$ (model-implied covariance matrix) therefore the perfect fitting correspond to p-value=1. This test has a statistical validity if there are large sample and multinormal distributions. [3] p-value for Test of Close Fit (RMSEA < 0.05). [4] The degrees of freedom are determined by $0.5(p+q)(p+q+1)+m-t$, where "p" is the number of indicators, "q" the number of causes, "m" the number of means and intercepts and "t" is the number of free parameters.

B. Benchmarking procedure and estimates of the Portuguese SE

The SE as a percentage of GDP is calculated by converting the index of SE estimated by the structural model (equation 1). As Breusch (2005) highlights, several benchmarking procedures exist that estimate the size of the SE by MIMIC outputs. Unfortunately, at this stage of research on the Model approach, which benchmark method should be applied is not definite yet. In the following, we apply an alternative two-step procedure.[9]

Step I

According to the previously applied identification rule, the latent variable has the same scale as the reference indicator. In order to preserve the proportional relationship between the indicator and the latent variable, we divide the first difference in the biannual official GDP by a base value. According with the scaling operation applied to official GDP, we deduce that the latent variable (index of SE) is measured as changes compared to the same base year. In the Portuguese analysis, the base is the first semester of 1995 because for this period there is an exogenous estimate of SE/GDP extracted by Schneider (2005).[10] It is equal to 22.1% and corresponds to the average between the years 1994 and 1995. By substituting the two chains of indexes (index of changes in real GDP respect to 1995 and index of changes in SE/GDP respect to 1995) in equation (2), we have:

$$\text{Measurement equation: } \frac{GDP_t - GDP_{t-1}}{GDP_{1995}} = \delta_1 - \frac{\tilde{\eta}_t - \tilde{\eta}_{t-1}}{GDP_{1995}} \qquad (4)$$

[9] For a fuller treatment of this subject, we refer the reader to Dell'Anno and Schneider (2006).

[10] In order to evaluate the dependence of results on the choice of base year and the exogenous estimation of SE/GDP, we re-estimate the MIMIC model by adopting the SE estimate for 2001 (22.5%) extracted by Schneider (2005). Statistical significance and proportionality among structural coefficients are preserved in the outputs. The rebasing choice affects the absolute level of the series without significant differences in the rates of growth. In particular, the absolute values of the SE/GDP estimates translate upward six percentage points (on average) to satisfy the condition that estimated SE as percentage of GDP in 2001 is equal to 22.5%; the differences among annual growth rates of SE when the base year is 2001 instead of 1995 is 0.15% (on average).

Where the index of changes in SE/GDP is estimated according with the following equation:[11]

$$\text{Structural equation: } \frac{\tilde{\eta}_t}{GDP_{1995}} = 0.75X_{1t} + 0.93X_{4t} + 0.48X_{5t} + 0.62X_{6t} \qquad (5)$$

Step II

Finally, the index is scaled to take up to a value of 22.1 percent in 1995 and further transformed from changes compared to 1995 into a time series of SE/current GDP. These operations are shown in the following benchmark equation:

$$\frac{\tilde{\eta}_t}{GDP_{1995}} \frac{\eta^*_{1995}}{GDP_{1995}} \frac{GDP_{1995}}{\tilde{\eta}_{1995}} \frac{GDP_{1995}}{GDP_t} = \frac{\hat{\eta}_t}{GDP_t} \qquad (6)$$

where $\left(\tilde{\eta}_t / GDP_{1995}\right)$ is calculated by equation(5); $\left(\eta^*_{1995} / GDP_{1995} = 22.1\%\right)$ is the exogenous estimate of SE; $\left(\tilde{\eta}_{1995} / GDP_{1995}\right)$ is the value of index estimated by equation (5) in 1995; $\left(GDP_{1995} / GDP_t\right)$ is to convert the index of changes respect to the GDP in base year in a time series of SE/current GDP; $\left(\hat{\eta}_t / GDP_t\right)$ is the estimated shadow economy as a percentage of official GDP.

Equation (6) can be simplified to:

$$\frac{\tilde{\eta}_t}{\tilde{\eta}_{1995}} \frac{\eta^*_{1995}}{GDP_t} = \frac{\hat{\eta}_t}{GDP_t} \qquad (7)$$

In Table 2, numerical values are presented for the period 1977 to 2004.

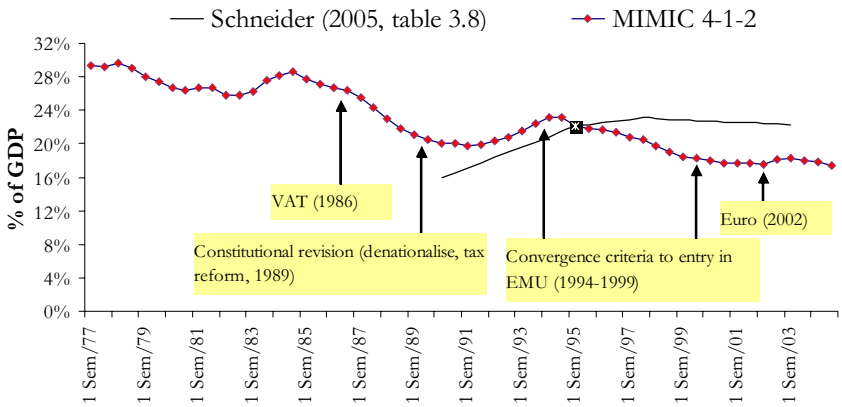
[11] The intercept is not included because it is not statistically significant, see Table 1. Moreover, as the variables are all differenced to the same degree, to calculate the levels of the latent variable multiplying the structural coefficients for raw (unfiltered) data, it is equivalent to compute the changes in the index by multiplying coefficients for the differenced causes and then to integrate them.

Table 2. Shadow Economy estimated by MIMIC model

Years	1977/79	1980/82	1983/85	1986/88	1989/91	1992/94	1995/97	1998/00	2001/03	2004
Shadow Economy	28.8%	26.4%	27.6%	24.6%	20.2%	21.9%	21.4%	18.5%	17.9%	17.6%

In Figure 5, the outcomes of MIMIC 4-1-2 are shown together with some of the most relevant economic events and an alternative estimate of SE provided by Schneider (2005).[12]

Figure 5. Shadow economy as percentage of official GDP



As can be seen in Figure 5, in what concerns the size of the SE with respect to GDP, the dimension of SE ranges from around 30 %, in 1978, to around 17% in 2004, and the SE slightly decreases except for two periods, from 1983 to 1984 and from 1992 to 1994. The first five years of the nineties show a temporary change in the decreasing dynamics of the size of SE. The growth of the SE stops at the end of 1994, and decreases until 2004.

The MIMIC analysis reveals that social benefits/GDP, the proxy of (lack) economic freedom, the unemployment rate and self-employment/labor force are the main causes of the SE dynamics. We calculate (and report in Table 3) the five-year averages of annual growth rates for these variables to see if they help us understand the reasons behind the SE dynamics in Potugal.

[12] The line for Schneider's estimates is calculated by linear interpolation of the six biennial estimates.

Table 3. Five-year average of annual growth rates

Years	Empl. gov./ Lab. force	Soc. benef./ GDP	Self-empl.	Unempl. rate	Shadow Economy /GDP
1985-1989	+2.8%	+0.1%	-1.1%	-9.3%	-6.0%
1990-1994	+2.8%	+7.2%	+1.9%	+7.2%	+2.3%
1995-1999	+1.5%	-1.2%	+0.1%	-7.8%	-4.5%
2000-2004	-0.3%	+2.4%	-1.3%	+8.6%	-0.8%

The decreasing trend in the SE from 1985 to 1989 (-6.0%) and from 1995 to 1999 (-4.5%) was simultaneous with large reductions in the unemployment rate. For the period 1990 to 1994, we observe a growth in the SE and a simultaneous increase in all four causal variables. Finally, for the 2000 to 2004 period, there are increasing and decreasing growth rates. There seems to be a compensation among causal variables.

V. Conclusions

This paper attempts to estimate the Portuguese SE from 1977 to 2004 and economic recommendations for policy makers are provided. Concerning the econometric analysis, we followed Giles' (1995) suggestion to detect unit roots and applied the subsequent corrections. Moreover, an alternative benchmark strategy is proposed in the attempt to improve the reliability of SE estimates.

In what concerns the size of the SE with respect to GDP, we found that the dimension of SE ranges from 29.6 percent, in 1978, to 17.6 percent of official GDP in 2004. The SE slightly decreases except for two periods, from 1983 to 1984 and from 1992 to 1994.

An economic explanation for this result is challenging. The two main reforms carried out at the end of the 1980's, i.e., reform of the tax system and reform of the Constitution, seem to be associated to an increase of the SE. The reform of the tax system was approved in 1989 and consisted in broadening the tax bases (e.g., the introduction of VAT in 1986) and lowering rates. As Bronchi and Gomes-Santos (2001) affirm, the complexity of tax laws, exacerbated by the frequent revisions and amendments that followed the 1989 tax reform, together with leniency of the laws against tax evasion, could provide a reasonable justification for the increase of the SE in the period 1990-1995. The revision of the Constitution also took place in 1989. It reduced the role of the State in economy and social affairs. It abolished the communist-inspired «agrarian reform» which permitted the denationalisation of the State-owned banks and other public enterprises. We could suppose that

structural reforms (e.g., denationalisation, reduction of the State's role in economy, agrarian reform) are a much more complex and lengthy process that requires several years. According with this view, while the tax reform is usually effective in the same year it is introduced, the delayed effects of the constitutional revision passed in 1989 and the tax reforms contributed in reducing SE only after a transition period, probably after 1994.

From 1994 to 1999, like the other European member countries, Portugal had to coordinate its economic policies in order to abide by the convergence criteria of the Treaty of Maastricht. This included reduction of inflation and interest rates, control of the government deficit and debt and respect of normal fluctuation margins provided by the exchange-rate mechanism of the European monetary system. According to MIMIC outcomes, these constraints on policies, together with the delayed effects of the constitutional revision and reduction in the unemployment rate (from 7.2% in 1995 to 4.4% in 1999) had a positive consequence for the dynamics of SE.

Given our empirical results, the policy recommendations to reduce the Portuguese SE are based on three pillars: (a) To reform the social benefits system, especially for unemployed people; (b) To improve the efficiency of public sector together with an increase of economic freedom; (c) To reform tax regulation for the self-employed.

Devising strategies to target social benefits, especially for the unemployed, could have advantageous effects in reducing the Portuguense SE. Social welfare measures should be differentiated according to the dissimilar possibilities of being involved in an irregular market among sectors, and the different probabilities of accepting an irregular job depending on personal situations and skills. Given the aim of SE control, a labour market policy that cuts social contribution rates paid by employers is more effective than one that gives subsidiary income directly to unemployed persons.

Estimates show that reductions of the proxy of bureaucracy decrease the size of SE. Unfortunately, the difficulty in obtaining reliable data on variables such as economic freedom, regulation burden, and corruption weaken the policy implications of this result. Anyway, by admitting government employment in the labour force as a proxy of this type of variables, the estimated positive correlation supports measures to increase the efficiency of bureaucracy together with actions to reduce corruption. In general terms, the overburden of regulation is worse, the more competitive the market economy. A good organization of bureaucratic machinery is one of the most pressing issues with increasing international

competition and the enlargement of the European Union. Finally, increasing efficiency of tax auditing jointly with tax system simplification can improve the citizens' attitude toward the State and tax morality.

Regarding reform of tax regulation for self-employed, Bronchi and Gomes-Santos (2001, p. 29) state that in 1998, "dependent workers and pensioners, who account for three-quarters of taxpayers, contributed 90 per cent of personal income tax revenues. Almost all independent workers (99.6 per cent) were able to keep simplified accounting books for their transactions and operations and 18 per cent of the total presented negative returns".[13] These figures reveal a bias in the tax system that favours activities undertaken by the self-employed. Besides, the forgone revenue creates a sense of unfairness among taxpayers that may lower the degree of social acceptance of the tax system and encourage non-compliance. In agreement with Bronchi and Gomes-Santos (2001), we believe that an effective improvement for the Portuguese tax system could be to impose separate bank accounts for individual companies (one for private and one for business purposes), together with making effective use of the new possibility to access bank information for tax purposes.

To conclude, there are some open questions as to the reliability of MIMIC estimates. First, other variables are potentially correlated with SE, such as complexity of the tax system, tax enforcement and socio-cultural factors, but data availability dictated some serious limitations. Second, the model does not permit to resolve the endogeneity issue for this kind of phenomenon: Do high levels of taxation, unemployment, etc., cause a large SE or vice versa? Third, there is a criticism related to the "real meaning" of the estimated latent variable being "SE" instead of another concept. Fourth, several difficulties arise for undertaking a time-series analysis with the MIMIC model (e.g., tests to exhaustively check property of residuals, methods to perform co-integration analysis in the context of SEM). Finally, the MIMIC model can reproduce the dynamics of SE but the exact estimates used for the benchmarking procedure depend on an exogenous estimate (e.g., Portuguese SE/GDP in 1995 is equated to 22.1%). This is out of the researcher's control and, as any quantification of SE, it is a rough measure. Although these

[13] The situation of VAT collection is very similar. According with Bronchi and Gomes-Santos' (2001) estimates for the 1998: around 91 per cent of tax revenues were paid by 6.3 per cent of all taxpayers who submitted periodical tax returns. The large majority of taxable small retailers (93.7 per cent of the total) declared a turnover below 12,500 euro and paid only 8.8 per cent of tax. These figures make clear that a great part of self-employers and small activities under-report a relevant part of their value added.

problems dramatically reduce the descriptive power of the results, if we consider the econometric alternatives of measuring SE, then the MIMIC approach could be considered a helpful methodology in this field for at least for two reasons. From a methodological viewpoint, it is based on a "structural approach" more appropriate than others given the nature of the SE. From a normative perspective, in addition to the estimated SE time series, the MIMIC approach provides supplementary knowledge to understand the economic phenomenon of "shadow activities". Though there is space for discussion about the absolute values of SE, there exists wider academic consensus about the reliability of the coefficients estimated by the MIMIC model.

Appendix

A. Identification of MIMIC and fit function with means and intercepts

In the Portuguese analysis, a multiple indicators multiple causes model with means and intercepts is applied. In general, allowing the means and intercepts to be nonzero could be considered an advance for applications in this field. As Hayduk (1987, p. 321) states, with the inclusion of means both the model is consistent with a wider range of evidence than if mere covariances were used, and the structural coefficients are better because they must now be consistent with broader empirical evidence.

The main difference from the standard MIMIC model consists in considering a diverse covariance matrix (precisely a moment matrix) in the fit function used by a maximum likelihood estimator to compute estimates. For a fuller treatment of the subject we refer the reader to Hayduk (1987) where the wider context of Structural Equation Modelling is considered, including means and intercepts. Below, we limit our attention to show the differences in (model-implied and data-based) covariance matrices, when means and intercepts are taken into account.

Analogously to the standard MIMIC approach, the SE (η) is linearly determined, subject to a disturbance ϖ, by a set of observable exogenous causes $x_{1,}\, x_{2,\ldots,}\, x_q$:

$$\eta = \alpha + \sum \gamma_q x_q + \zeta \qquad \text{(A1)}$$

The latent variable (η) determines, linearly, subject to disturbances $\varepsilon_{1,}\, \varepsilon_{2,\ldots,}\, \varepsilon_p$, a set of observable endogenous indicators $y_{1,}\, y_{2,\ldots,}\, y_{\mathrm{p}}$:

$$y_p = \delta_p + \lambda_p \eta + \varepsilon_p \qquad \text{(A2)}$$

The structural disturbance ζ and measurement errors ε all display normal distribution and are mutually independent.[14] From equations (A1) and (A2), the model can be presented for the reduced form as a function of observable variables. As anticipated, compared to the "standard" MIMIC model without means, the covariance matrix (model-implied) Σ is substituted by (model-implied) moment matrix Ω. It follows that the discrepancy function (F^{means}) considered in the maximum likelihood in order to estimate parameters is:[15]

$$F^{means} = \ln|\Omega| + \mathrm{tr}\left(M\Omega^{-1}\right) - \ln|M| - (p+q+1) \tag{A3}$$

where M is the observed moment matrix, p is the number of observed endogenous indicators (*Y*), q is the number of observed exogenous causes (*X*), "1" compensates for the fact that the (augmented) moment matrix has one more row and column than the S and Σ matrices in the standard fit function of SEM.

In particular, the (model-implied) moment matrix is:

$$\Omega = \begin{pmatrix} \Sigma + \mu\mu' & \mu \\ \mu' & 1 \end{pmatrix} \tag{A4}$$

where

$$\Sigma = \begin{pmatrix} \Sigma_{yy} & \Sigma'_{xy} \\ \Sigma_{xy} & \Sigma_{xx} \end{pmatrix} \tag{A5}$$

with $\underset{(pxp)}{\Sigma_{yy}}$, $\underset{(qxq)}{\Sigma_{xx}}$, $\underset{(pxq)}{\Sigma_{yx}}$ the covariance matrices among indicators, causes, and indicators and causes, while μ is the vector of estimated means of indicators (*Y*) followed by the means of estimated causes (*X*).

Analogously, the observed matrix M, which has replaced the original S matrix, is:

$$M = \begin{pmatrix} S + z\bar{z} & \bar{z} \\ \bar{z}' & 1 \end{pmatrix} \tag{A6}$$

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[14] The assumption of independence between the structural disturbance *æ*, and the measurement errors *å* is crucial for the reliability of estimates. Unfortunately, the SEM packages do not perform this kind of test. Hayduk (1987, p.193) explains that it "…is purely a matter of arbitrary convention" and it is possible to test this assumption using a model re-parameterisation. An attempt to test the hypothesis of independence between structural and measurement errors is presented in Dell'Anno (2003).

[15] The standard fit function is: $F = \ln|\Sigma| + \mathrm{tr}\left(S\Sigma^{-1}\right) - \ln|S| - (p+q)$.

where *z* is the vector of the means of observed indicators (*Y*) followed by the means of the observed causes (*X*).

According with model MIMIC 6-1-2, in the matrix Σ the following vectors are estimated:

Structural parameters (measurement model): $\Lambda' = (-1, \lambda_2)$ (A7)
Structural parameters (structural model): $\Gamma = (\gamma_1, \gamma_2, \gamma_3, \gamma_4, \gamma_5, \gamma_6)$ (A8)
Intercepts of measurement model: $T_y = (\delta_1 = \bar{y}_1 = 0.24, \delta_2)$ (A9)
Intercept of structural model: $A = (\alpha_1)$ (A10)
Means of causes: $K = (k_1, k_2, k_3, k_4, k_5, k_6)$ (A11)
Measurement errors: $\Theta = (\varepsilon_1, \varepsilon_2, \varepsilon_{12})$ (A12)
Structural disturbance: $\Psi = (\zeta_{11})$ (A13)
Variance and covariances among causes:
$\Phi = (\phi_1, \phi_2, \phi_3, \phi_4, \phi_5, \phi_6, \phi_{24}, \phi_{34}, \phi_{56})$ (A14)

These are the 28 free parameters estimated by the ML estimator in the Portuguese MIMIC model with six causes and two indicators.

B. Data sources

In the econometric exercise, half-yearly observations extracted by the OECD Statistical Compendium database are used. These data come from the Economic Outlook Statistics and Projections, OECD Standardised National Accounts and OECD Labour Force Statistics. Variables are expressed as percentage points.

Table A1. Data description

Variable	Symbol	Unit root	Transf.	Sources	Note
Government employment in labour force	X_1	I(1)	$\Delta(X_1)$	OECD – Statistical Compendium	Employment, government /Total labour force [1°sem.1965-2°sem.2004]
Tax burden	X_2	I(1)	$\Delta(X_2)$	OECD – Statistical Compendium contributions	(Total direct taxes + indirect taxes +social security received by government)/Gross domestic product (market prices). [1°sem.1977-2°sem.2004]
Subsidies	X_3	I(1)	$\Delta(X_3)$	OECD – Statistical Compendium	Subsidies/Gross domestic product (market prices) [1°sem.1977-2°sem.2004]
Social benefits paid by government	X_4	I(1)	$\Delta(X_4)$	OECD – Statistical Compendium	Social benefits paid by government /Gross domestic product (market prices) [1°sem.1977-2°sem.2004]
Self-employment rate	X_5	I(1)	$\Delta(X_5)$	OECD – Statistical Compendium	Self employed/Total labour force [1°sem.1965-2°sem.2004]
Unemployment rate	X_6	I(1)	$\Delta(X_6)$	OECD – Statistical Compendium	Unemployment rate [1°sem.1965-2°sem.2004]
Real gross domestic product index	Y_1	I(1)	$\Delta(Y_1)$	OECD – Statistical Compendium	(Real GDP_t)/(Real $GDP_{1°sem1995}$) [1°sem.1965-2°sem.2004]
Labour force participation rate	Y_2	I(1)	$\Delta(Y_2)$	OECD – Statistical Compendium	Labour force, participation ratio [1°sem.1965-2°sem.2004]

References

Adam, Markus C., and Victor Ginsburgh (1985), "The effects of irregular markets on macroeconomic policy: Some estimates for Belgium", *European Economic Review* **29**: 15-33.

Apel, Mikael (1994), "An expenditure-based estimate of tax evasion in Sweden", Working Paper 1994:1, Uppsala, Department of Economics, Uppsala University.

Bajada, Christopher, and Friederich Schneider (2005), "The shadow economies of the Asia-Pacific", *Pacific Economic Review* **10**: 379-401.

Belev, Boyan (2003), *The Informal Economy in the EU Accession Countries: Size, Scope, Trends and Challenges to the Process of EU Enlargement*. Center for the Study of Democracy, Sofia.

Bloem, Adriaan M., and Manik L. Shrestha (2000), "Comprehensive measures of GDP and the unrecorded economy", WP/00/204, IMF.

Bordignon, Massimo, and Alberto Zanardi (1997), "Tax evasion in Italy", *Giornale degli Economisti e Annali di Economia* **56**: 169-210.

Breusch, Trevor (2005), "Estimating the underground economy using MIMIC models", Econometrics 0507003, Economics Working Paper Archive at WUSTL.

Bronchi, Chiara, and Josè C. Gomes-Santos (2001), "Reforming the tax system in Portugal", Working Paper 302, OECD Economics Department.

Chatterjee, Sumana, Kausik Chaudhuri, and Friederich Schneider (2003), "The size and development of the Indian shadow economy and a comparison with other 18 Asian countries: An empirical investigation", Discussion Paper 2003-02, Department of Economics, Johannes Kepler University of Linz.

Chaudhuri, Kausik, Friederich Schneider, and Sumana Chattopadhyay (2006), "The size and development of the shadow economy: An empirical investigation from states of India", *Journal of Development Economics* **80**: 428-443.

Contini, Bruno (1981), "The second economy of Italy", *Taxing and Spending* **3**: 17–24.

Dell'Anno, Roberto (2003), "Estimating the shadow economy in Italy: A structural equation approach", Working Paper 2003-7, Department of Economics, University of Aarhus.

Dell'Anno, Roberto, Miguel Gomez, and Angel Alañón Pardo (2007), "Shadow economy in three different Mediterranean countries: France, Spain and Greece. A MIMIC approach", *Empirical Economics* **33**: 51-84.

Dell'Anno, Roberto, and Friederich Schneider (2006), "Estimating the underground economy: A response to T. Breusch's critique", Working Paper 06/07, Department of Economics, Johannes Kepler University of Linz.

Eilat, Yair, and Clifford Zinnes (2000), "The evolution of the shadow economy in transition countries: Consequences for economic growth and donor assistance", CAER II Discussion Paper 83, Harvard Institute for International Development.

Feige, Edgar L. (1989), *The Underground Economies, Tax Evasion and Information Distortion*, Cambridge, Cambridge University Press.

Frey, Bruno S. and Hannelore Weck-Hannemann (1984), "The hidden economy as an "unobservable" variable", *European Economic Review* **26**: 33–53.

Fuà, Giorgio (1976), *Occupazione e Capacità Produttiva: La Realtà Italiana*, Bologna, Il Mulino.

Giles, David E.A. (1995), "Measuring the size of the hidden economy and the tax gap in New Zealand: An econometric analysis", Working Paper on Monitoring the Health of the Tax System 5a, Wellington, Inland Revenue Department.

Giles, David E.A. (1998), "The underground economy: Minimizing the size of government", Econometrics Working Papers 9801, Department of Economics, University of Victoria.

Giles, David E.A. (1999), "Measuring the hidden economy: Implications for econometric modeling", *Economic Journal* **109**: 370-380.

Giles, David E.A., and Lindsay M. Tedds (2002), *Taxes and the Canadian Underground Economy*, Canadian Tax paper 106, Toronto, Canadian Tax Foundation.

Hauser, Robert M., and Arthur S. Goldberger (1971), "The treatment of unobservable variable in path analysis", in H. L. Costner, ed., *Sociological Methodology*, San Francisco, Jossey-Bass.

Hayduk, Leslie A. (1987), *Structural Equation Modelling with LISREL. Essential and Advances*, London, Johns Hopkins University Press.

Jöreskog, Karl G. (1973), "A general method for estimating a linear structural equation system", in A.S. Goldberger and O.D. Duncan, eds., *Structural Equation Models in the Social Sciences*, New York, Seminal Press.

Jöreskog, Karl G., and Arthur S. Goldberger (1975), "Estimation of a model with multiple indicators and multiple causes of a single latent variable", *Journal of the American Statistical Association* **70**: 631-639.

Kaufmann, Daniel and Aleksander Kaliberda (1996), "Integrating the unofficial economy into the dynamics of Post-Socialist economies: A framework of analysis and evidence", in B. Kaminski, ed., *Economic Transition in the Newly Independent States*, Armonk, NY, M.E. Sharpe Press.

Loayza, Norman V. (1996), "The economics of the informal sector: A simple model and some empirical evidence from Latin America". *Carnegie-Rochester Conference Series on Public Policy* **45**: 129-162.

Mirus, Rolf, and Roger S. Smith (1997), "Self-employment, tax evasion, and the underground economy: Micro-based estimates for Canada", Working Paper 1002, Cambridge, MA, Harvard Law School, International Tax Program.

O'Driscoll, Gerald P., Edwin J. Feulner, and Mary A. O'Grady (2003), *Index of Economic Freedom*, Washington, DC, The Heritage Foundation and Dow Jones & Company, Inc.

OECD (2002), *Handbook for measurement of the non observed economy*, Paris, OECD Publishing.

Ott, Katarina (2002), "The underground economy in Croatia", Occasional Paper 12, Zagreb, Institute of Public Finance.

Pissarides, Christopher, and Guglielmo Weber (1989), "An expenditure-based estimate of Britain's black economy", *Journal of Public Economics* **39**: 17-32.

Schneider, Friederich (2005), "Shadow economies around the world: What do we really know", *European Journal of Political Economy* **21**: 598-642.

Schneider, Friederich, and Dominik H. Enste (2000), "Shadow economies: size, causes and consequences", *Journal of Economic Literature* **38**: 77-114.

Schneider, Friederich, and Dominik H. Enste (2002), *The Shadow Economy. An International Survey*, Cambridge, Cambridge University Press.

Schuetze, Herbert J. (2002), "Profiles of tax non-compliance among the self-employed in Canada: 1969 to 1992", *Canadian Public Policy* **28**: 220-223.

Smith, Roger S. (2002), "The underground economy: Guidance for policy makers?", *Canadian Tax Journal /RevueFiscale Canadienne* **50**: 1655-1661.

SNA (1993), System of National Accounts, United Nations, Statistics Division.

Tanzi, Vito (1999), "Uses and abuses of estimates of the underground economy", *Economic Journal* **109**: 338–347.

Zellner, Arnold (1970), "Estimation of regression relationships containing unobservable variables", *International Economic Review* **11**: 441-454.