Shadow Economy in Portugal: computation by different approaches

by

Sónia Cristina Leite Sousa

Master in Economy and Business Administration

Advisers: Óscar Afonso and Paulo Vasconcelos

Porto, September of 2014

Biographical note

Sónia Cristina Leite Sousa, was born on September 27, 1988, in Oporto.

She began her studies in the academic year 2007/2008 at the School of Economics and Management, University of Porto, having completed the first degree in Management in 2011. On the same year, she joined the Economics and Business Administration Master's degree in the same institution.

Chose to join this project given the multidisciplinary nature of the course which enabled her to get a solid background knowledge in management. Allowed her also to obtain the necessary skills to face the many challenges of the labour market.

Started working in management areas since September 2011, giving at the same time, mathematics and economics explanations classes.

Acknowledgments

I would like to express my gratitude to the Professors Óscar Afonso and Paulo Vasconcelos, for the valuable help and guidance I received throughout the preparation of this study. I also thank all my teachers by broadening my horizons of knowledge.

I could not forget to express my gratitude to my family, specially my parents, Carlos and Cristina, thank you for having me brought to the world.

To Frederico Oliveira, I appreciate the patience and support you have always given me, especially in difficult times which allowed me to proceed with this project.

To my friend Daniela Silva, thank you for all the help and good advice that motivated me to move on.

To my colleague Manuel Nogueira, a special thanks for the collaboration and all aid that you have given.

Moreover, I want to mention all friends and colleagues who directly or indirectly contributed to make this study a reality.

Abstract

In a period of financial and economic turmoil, it is of paramount interesting to quantify the Shadow Economy (SE). It is a phenomenon present in all countries, regardless of their level of development. In Portugal, the latest data reveals that its share reached 25.40% of the observed GDP in 2011 (Afonso and Gonçalves, 2012).

For the determination of SE the author used the Electricity Consumption Method (ECM) and the Structural Model of Multiple Indicators and Multiple Causes, the MIMIC model, which is an econometric analysis, firstly proposed by Jöreskog, and Goldberg (1975). Several other methods can alternatively be used.

The purpose of this dissertation is to analyse different approaches and to comprehend the evolution of the Shadow Economy in Portugal until 2011, through the perspective of several authors. Furthermore, it is also intended to estimate its Portuguese value in 2012 and 2013, through the use of ECM and the MIMIC model. The electricity consumption is regarded as the single best physical indicator of overall (both official and unofficial) economic activity moving in sync with GDP. MIMIC model is based on structural modelling using the Shadow Economy as a latent variable considering several causes and indicators of the SE.

According to the results, the relative size of the SE in Portugal has increased over the last decades (1970-2013). According to the ECM, it increased from 9.31% of GDP in 1970 to 19.23% of GDP in 2013, while the MIMIC approach shows increase of the shadow economy from 8.18% of GDP in 1970 to 25.62% of GDP in 2013. In the final phase is developed a new method to estimate the size of SE based on the combination of the two previous methods.

Keywords: Shadow Economy, GDP, Methods to Estimate the Shadow Economy, ECM, MIMIC Model, Portugal

Resumo

Num período de turbulência financeira e económica é deveras interessante quantificar a Economia Não Registada (ENR). Esta é um fenómeno presente em todos os países, independentemente do seu nível de desenvolvimento. Em Portugal, os últimos dados revelam que o seu peso atingiu 25.40% do PIB observado em 2011 (Afonso e Gonçalves, 2012). Para a determinação deste indicador, a autora utilizou o Método do Consumo de Electricidade (MCE) e o Modelo Estrutural de Múltiplos Indicadores e as Causas Múltiplas, o modelo MIMIC, que consiste numa análise econométrica, em primeiro lugar proposto por Jöreskog e Goldberg (1975). Vários outros métodos podem ainda ser usados.

O objetivo desta dissertação é analisar as diferentes abordagens e compreender a evolução da ENR em Portugal até 2011, através da perspectiva de vários autores. Além disso, também tem como objetivo estimar o seu valor para Portugal em 2012 e 2013, através do MCE e do modelo MIMIC. O consumo de energia elétrica é considerado o melhor indicador físico da totalidade da atividade económica (tanto oficial e não oficial) que se movimenta em sincronia com o PIB. O modelo MIMIC é baseado em modelos estruturais que usa a ENR como uma variável latente, considerando várias causas e indicadores da ENR.

De acordo com os resultados apresentados neste trabalho, o tamanho relativo da ENR em Portugal tem aumentado ao longo das últimas décadas (1970-2013). De acordo com o MCE, passou de 9.31% do PIB em 1970 para 19.23% do PIB em 2013, enquanto que a abordagem MIMIC mostra aumento da Economia Não Registada de 8.18 % do PIB em 1970 para 25.62 % do PIB em 2013. Na fase final é desenvolvido um novo método de estimativa para o tamanho da ENR com base na combinação dos dois métodos anteriores.

Palavras Chave: Economia Não Registada, PIB, Métodos para Estimar a Economia Não Registada, MCE, Modelo MIMIC, Portugal

Contents

List of Figures

List of Tables

1. Introduction

The growth of the underground, informal, illegal economy or any other name that will be used is a global phenomenon. Recent studies indicate that the size of this part of the economy, that does not pay tax or is not measured, regulated or even not operate within the law, is higher than many economists thought and presents a high growth.

The shadow economy did not attract the attention of economists until the sixties when it became the subject of study. In 1972, from a study of the International Labour Organization (ILO), the subject gains prominence and its study momentum.

In fact, Dixon (1999) states that the shadow economy drew little attention until recently. This attitude changed after the first estimates of SE. They showed just how large it might be. From there, the population in general and the government have become concerned with the phenomenon due mainly to its effect on tax evasion. The shadow economy reduces the credibility of official statistics, makes it difficult to choose public policies and produces unequal competition with companies of the official sector.

Nowadays, the Shadow Economy evaluation is still quite controversial as there are disagreements about the definition of the concept of shadow economic activities and about their estimation procedures. Several meaningful outcomes have already been written by Schneider and Enste (2000), and Feld and Schneider (2010), yet a widely definition has not been adopted. The theoretical studies have advanced several reasons why pointing people to operate in the shadow economy. The most often mentioned factors are the high taxes, high labour costs and the strong regulation of economy. Empirical studies, in turn, face a big problem that resides in fact of trying to measure something that is not observable (by its nature), which in itself is an arduous task.

The present study attempts to arrange the development of literature, including its theoretical and empirical aspects of their disputes, with a view to developing a index to measure the evolution of the shadow economy in Portugal.

This present dissertation is organized as follows: chapter 2 defines the concept of SE and explores its main causes and consequences in the official economy. Chapter 3

examines the existing measurement methods of SE. In chapter 4, the development of the empirical models are executed, taking into account the introduced theoretical concepts and specific econometric techniques, to measure the size of SE in Portugal. Chapter 5 concludes the study with the presentation of the main findings.

2. Shadow Economy: definition, causes and consequences

The purpose if this chapter is to revise some important aspects of Shadow Economy. First of all, it is imperative to overlook a few well known definitions, then the study of the main causes and consequences are vital to understand the impact that Shadow Economy has in the economic, social and political spheres.

2.1. Definition of Shadow Economy

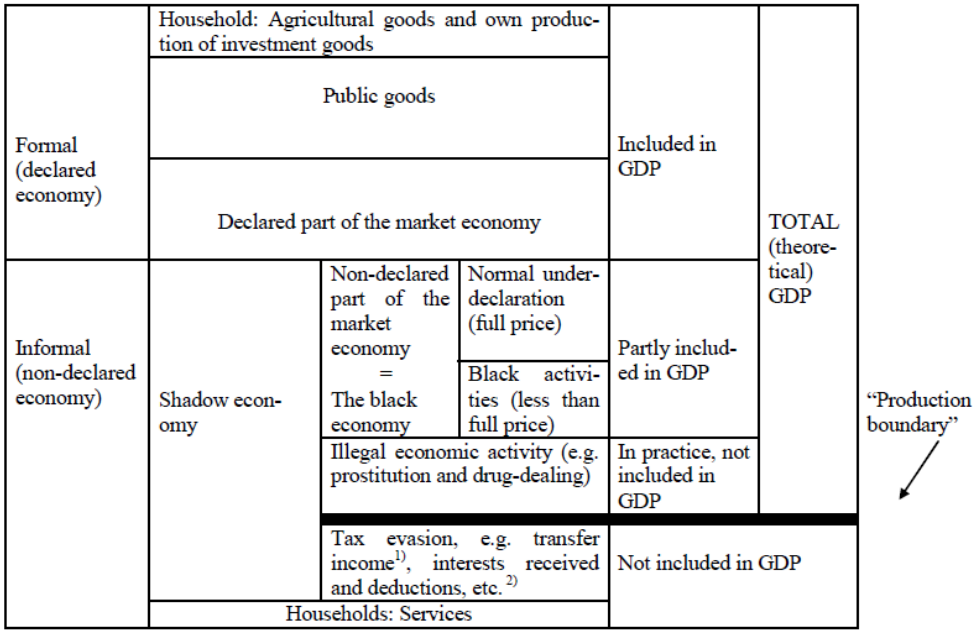
It would be easy to estimate the Shadow Economy if a commonly used definition was set-up. Unfortunately, this is not the case and no consensus has yet been achieved. Innumerable definitions for SE are deployed, according to Schneider and Enste (2000), being the one proposed by Schneider and Enste (2000, pp. 78) – "all economic activities that contribute to the officially calculated (or observed) gross national product but are currently unregistered" – one of the most used.

Pesut (1992, pp. 3) defines Shadow Economy as "that part of the domestic product which is not measured by official statistics", whereas for Smith (1994, pp. 18) it includes the "market based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP".

For the OCDE (2002, pp. 12) the Shadow Economy includes "the groups of activities most likely to be non-observed are those that are underground, illegal, informal sector, or undertaken by households for their own final use. Activities may also be missed because of deficiencies in the basic data collection programme."

For Pedenser (2003) SE combines the total sum of "the black economy"– which lies within the so-called "production boundary" of the GDP – and all other ("non-productive") under declaration (of, for example, transfer income, interest and tax deductions); it also includes illegal production (e.g., drug-dealing and prostitution, etc.). These definitions are shown in Figure 1.

Figure 1. Definition of "Shadow Economy", "Black Economy" and "Black Activities"



Source: Pedenser (2003)

Moreover, Feige (1990) distinguishes four specific underground economies:

1) Illegal economy: consists of the income produced by those economic activities pursued in violation of legal statutes defining the scope of legitimate forms of commerce.

2) Unreported economy: consists of those economic activities that circumvent or evade the institutionally established fiscal rules as codified in the tax code. A summary measure of the unreported economy is the amount of income that should be reported to the tax authority, but is not so reported.

3) Unrecorded economy: consists of those economic activities that circumvent the institutional rules that define the reporting requirements of government statistical agencies. A summary measure of the unrecorded economy is the amount of unrecorded income, namely the amount of income that should be recorded in national accounting systems, but is not recorded.

4) Informal economy: comprises those economic activities that circumvent the costs and are excluded from the benefits and rights incorporated in the laws and administrative

rules covering property relationships, commercial licensing, labour contracts, torts, financial credit and social security systems.

From Table 1, it is clear that a wider definition of the Shadow Economy comprises unreported revenue from the production of legal goods and services, altogether it includes economic activities that would be taxable if they were stated to the fiscal authorities (Schneider and Buehn, 2013).

Table 1. 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 neighbour help

Source: Lippert and Walker (1997, p. 5) with additional own remarks.

Schneider and Williams (2013) provide in their research some examples of Shadow Economy activities, such as: Child-minding with income not declared; Paying builder cash, income not declared; Purchase of cigarettes smuggled from EU country; Counterfeit production of an otherwise legal product such as cigarettes. And activities

not included in SE: Selling drugs (because it is an illegal activity); Building work done by homeowner (because it is a do-it-yourself activity not subject to tax or regulation).

Schneider (2012) states that there are four reasons for the occurrence of events that are intentionally covered from public authorities:

(1) To avoid payment of income, value added or other taxes,
(2) To avoid payment of social security contributions,
(3) To avoid having to meet certain legal labour market standards, such as minimum wages, maximum working hours, safety standards, etc.,
(4) To avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

2.2. Causes of Shadow Economy

The growth of the SE is caused by many diverse factors. More than a few authors have mentioned and studied the causes of the SE (e.g., Schneider, 2005, 2013; Schneider and Enste, 2000). As it is shown in their research, the leading cause for the appearance of shadow economy activities, is government's inability to answer to crucial challenges, in the fields of employment, health and education. Such inefficiency may as well turned out to be the origin and expansion of the informal sector.

According to Sim et al. (2011), the causes can be summarised in the following:

Government

- Efficiency of the bureaucracy;
- Trust crisis of the people and governments;
- Few or low quality of Public Sector service;
- Education expenditure;
- Government Transparency;
- Social transfer;
- Government budget;
- Bribery of government servant.

Regulation

- Intensity or corrupted regulation;
- Slow and closed legislative system;
- Equality under the law;
- Labour market regulation.

Taxation

- Tax burden and social insurance (security) contributions;
- Tax morale.

Economy Issues

- Recession;
- Unemployment;
- High public debt;
- Inadequate and slow economic growth.

Social ethos

- Break in market tradition;
- Cultures characteristics;
- Survival strategies;
- Public attitude;
- Bribery;
- Urbanisation;
- Growth in self-employment.

Figure 2 shows that according to Schneider (2012) tax and social security contribution burden is the leading cause for the growth of SE, followed by variables tax morale and quality of state institutions. These three have the main accountability in the increasing of SE. According to the same author, a rising burden of taxation provides a strong incentive to work in the Shadow Economy. It is also assumed that increases in the burden of regulation gives a strong incentive to enter the SE. A declining in tax morale

(citizens' attitudes toward the state), which describes the readiness of individuals (at least partly) to leave their official occupations and enter the SE, tends to increase the size of the SE.

In the market labour, the unemployment rate and the self-employment are also considered causes of the SE. In literature is assumed that an unemployed individual has more incentives to work in SE activities, however this assumption depends on the educational and cultural aspects. There are people who prefer working in the official economy because of the social benefits and labour protections, to increase their income, they can also add to their official activity a shadow activity. At the same time, increased activities in the informal sector may be expected to be reflected in shorter working hours in the official economy. Concerning self-employment, it is well known that self-employers understate their incomes to authorities (Dell'Anno, 2007). So, it is expected that an increase in this variable will positively influence the size of SE.

Figure 2. Main Causes of the Increase of the Shadow Economy

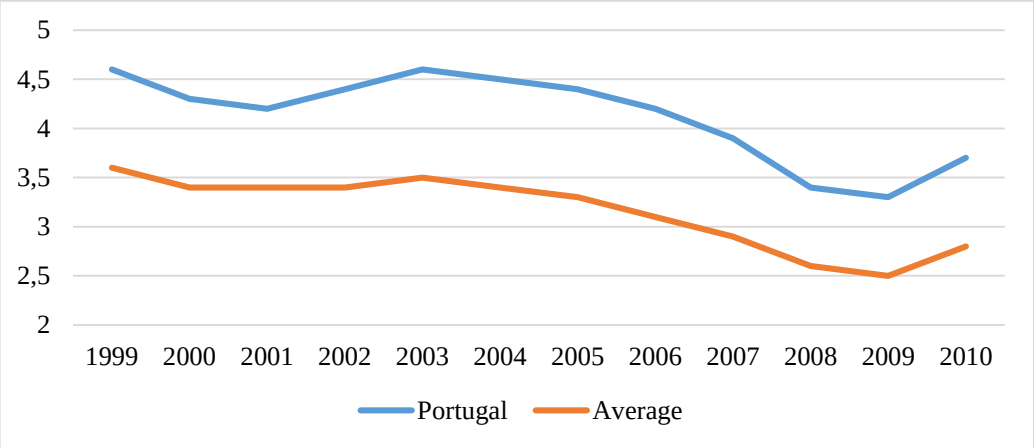
Factors influencing the shadow economy	Influence on the shadow economy (in %)	
	(a)	(b)
(1) Increase of the Tax and Social Security Contribution Burdens	35-38	45-52
(2) Quality of State Institutions	10-12	12-17
(3) Transfers	5-7	7-9
(4) Specific Labor Market Regulations	7-9	7-9
(5) Public Sector Services	5-7	7-9
(6) Tax Morale	22-25	-
Influence of all Factors	84-98	78-96

(a) Average values of 12 studies.
(b) Average values of empirical results of 22 studies.
Source: Schneider (2009)

The size of tax evasion (Figure 3) has decreased from 1999 to 2001 and from 2004 to 2009. After 2001, this indicator increased until 2003, a possible explanation for such development maybe the 9/11 and all negative consequences derivate from it. In 2010 it is also notice an increase, possibly due to the economic and financial world crises that

broke down in 2008. It is notorious that Portugal and the 38 OECD countries average have a similar trend, although Portugal displays a differential, about +1%, which is a remarkable difference.

Figure 3. Size and development of tax evasion (in % of GDP) in Portugal and in 38 OECD countries average accounting for indirect taxation and self-employment as driving forces



Source: Schneider and Buehn (2012)

Another worrying cause is bribery. Corruption is a symptom of over-regulation, as well as Shadow Economy. Governments must have economic freedom in all conceivable areas, so that bribery and SE can diminish through time. Economic freedom with a strong rule of law will foster a culture of investment, job creation and institutional respect (Eiras, 2003).

There is a negative relationship between economic freedom and Shadow Economy, that is, as economic freedom is reduced the Shadow Economy assumes a greater share of the GDP. In repressed countries in their economic freedom the Shadow Economy weighs 40.25% in the GDP, while in countries with high economic freedom the weight drops to 16.37% (Barbosa *et al*., 2013).

Table 2. Portugal's Corruption Perceptions Index from 1995 to 2013

Year	Index	Rank	Total Countries	Rank/Total Countries
1995	5,56	22	41	54%
1996	6,53	22	54	41%
1997	6,97	19	52	37%
1998	6,5	22	85	26%
1999	6,7	21	99	21%
2000	6,4	23	90	26%
2001	6,3	25	91	27%
2002	6,3	25	102	25%
2003	6,6	25	133	19%
2004	6,3	27	146	18%
2005	6,5	26	159	16%
2006	6,6	26	163	16%
2007	6,5	28	180	16%
2008	6,1	32	180	18%
2009	5,8	35	180	19%
2010	6	32	178	18%
2011	6,1	32	183	17%
2012	6,3	33	176	19%
2013	6,2	33	177	19%

Source: Transparency International

The Corruption level within a country is another factor that increases SE activities.The Corruption Perceptions Index[1] (Table 2) shows that corruption has been decreasing in Portugal between edge years. In 2013, Portugal belongs to the 19% cleanest countries of the sample, however it is important to notice that the worst years were in 1995 with 5.56 and in 2009 with 5.8.

There is no consensual and unique study perspective of the impact of these factors in the development of Shadow Economy. These causes, either major or minor, change for different countries. Nevertheless, as small or insignificant a cause can be, its influence in the evolution of Shadow Economy should be taken into account by researchers to avoid mistakes. Only through meticulous study is possible to aid politicians in the fight for decreasing the size of Shadow Economy.

[1] The Corruption Perceptions Index ranks countries and territories based on how corrupt their public sector is perceived to be. A country or territory's score indicates the perceived level of public sector corruption on a scale of 0 - 10, where 0 means that a country is perceived as highly corrupt and 10 means it is perceived as very clean. A country's rank indicates its position relative to the other countries and territories included in the index.

2.3. Consequences of Shadow Economy

The development of SE has different outcomes in the official economy. Inequality and unfairness of the economic system is one of them, as there are individuals who seek the same products cheaper in the SE by not paying taxes.

One hypothesis for the negative correlation between the formal and informal sector may be due to an increase in the SE that leads to a reduction in tax revenue and, therefore, a smaller quantity and quality of public goods and services made available to society. Thus, it could occur a reduction of economic growth, under the premise of a tax burden higher than the optimum, and a weak compliance with state institutions (Loayza, 1996). This proposition becomes true, to the extent that a public infrastructure is a key to economic growth.

Another form submitted for negative explanation of this correlation is through a model, prepared by Asea (1996), which is based on the fact that the production technology depends of public services funded by taxes. Adding to the fact that the SE does not pay taxes, but fines and fees, which, in most cases, are not used to finance public services required to impulse economic growth.

If a SE is growing faster than the official and the resources are moving up to informality, as a result of a likely high taxation, increase regulation or another previously pointed cause, it is clear that official statistics of economic growth will be undervaluing the real growth of the entire economy. Therefore, it can be deduced that a fast growth of SE contributes to a decrease in observed economic growth (Feige, 1979).

The observed economic growth may be being taken into account by the governments when they set their economic policies and it also could be observed in official unemployment statistics, presenting in this case a likely overestimation regarding the real situation (Gutmann, 1979).

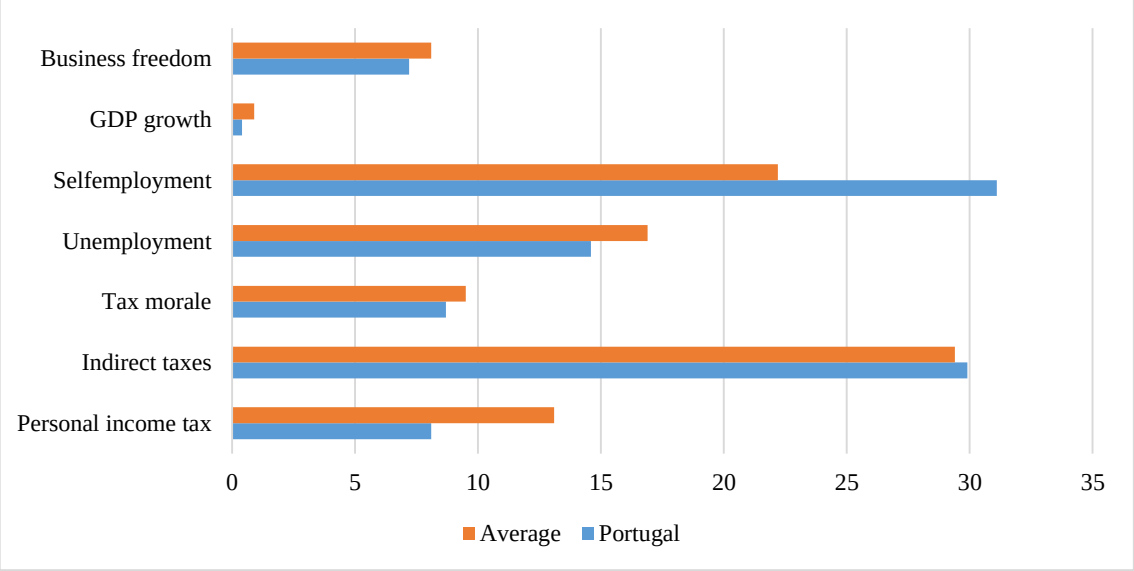
Another negative consequence of SE is disincentive for foreign investment. Since foreign investments are usually more regulated, their produced goods can potentially be uncompetitive in comparison with the domestic competitors who are functioning in the SE.

Nevertheless, according to Asea (1996), the SE may lead to more competitiveness, greater efficiency and can limit governmental activities through an environment of urban demand and small scale production, adding dynamism and entrepreneurship to the economy. The SE can, therefore, contribute to the creation of markets, increase financial resources, printing a positive correlation between economic growth and informality.

Through some studies, Schneider and Enste (2000) present that around 66% of income generated by the SE, is immediately spent in the official sector, with positive effects on economic growth and revenues with indirect taxes, for instance VAT (value added tax).

A study by Schneider and Buehn (2012) revealed the impact of SE in different areas, from 1999 to 2010, in which the size of SE in Portugal was 22.7% of GDP, and the average of 38 OECD countries was 20.3% of GDP. The results are shown in the figure below.

Figure 4. Average relative impact (in %) of the Shadow Economy determinant's in Portugal and the average of 38 OECD countries (1999-2010)



Source: Schneider and Buehn (2012)

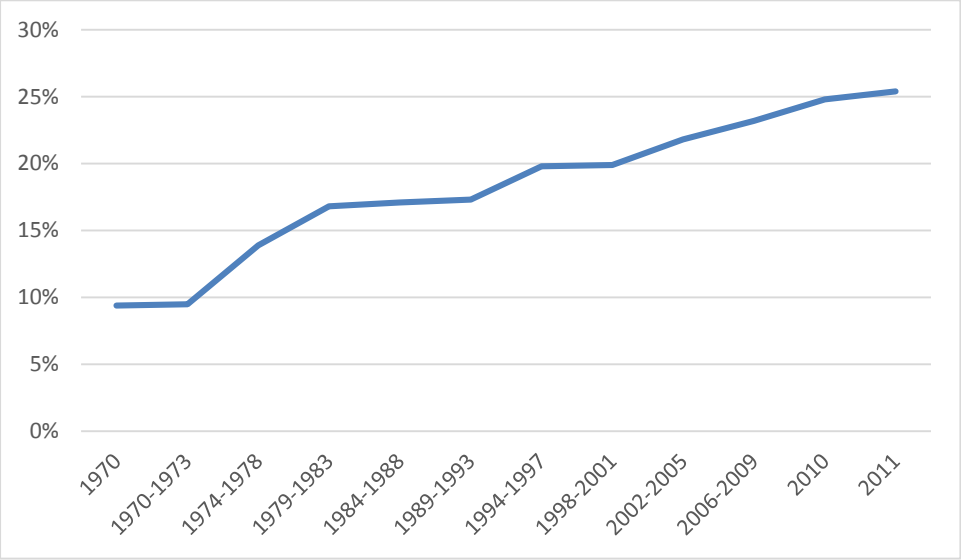
Figure 4 reveals that the main impact of SE in Portugal is in self-employment and indirect taxes, with approximately 30% each. This is also true for the average of 38 OECD countries, but with more featured for the indirect taxes. The third is

unemployment, whether for Portugal and for the average of 38 OECD countries, followed by tax morale in Portugal's case and personal income tax for the average of 38 OECD countries. The main difference between the two cases is self-employment, where Portugal has more or less 10% than the average of the 38 OECD countries. The opposite occurs for personal income tax, where the last has about 5% more than Portugal.

2.4. The Shadow Economy in Portugal

In recent years there have been appearing some studies about the Shadow Economy in Portugal, namely of the recent studies by Barbosa *et al.* (2013), Schneider (2010, 2013), and Afonso and Gonçalves (2010, 2012).

Figure 5. The Shadow Economy in GDP (%) in Portugal 1970-2011

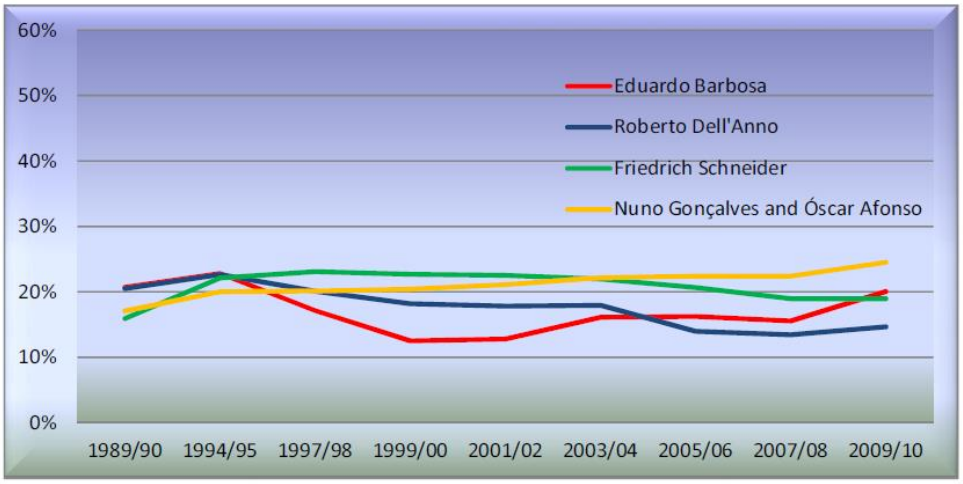


Source: Afonso and Gonçalves (2012)

Based on the continuous study developed by Afonso and Gonçalves in 2010, updated in 2011 and 2012, "A Economia Registada em Portugal", the author prepared Figure 5, according to the data displayed by the source. The model used was the MIMIC 6-1-3 (six causes, one latent variable and three indicators). As it is shown, the percentage of the Shadow Economy in Portugal is increasing from 9.4% in 1970 to 24.8% in 2010. In three decades, according with this estimation, the size has grown about 264%.

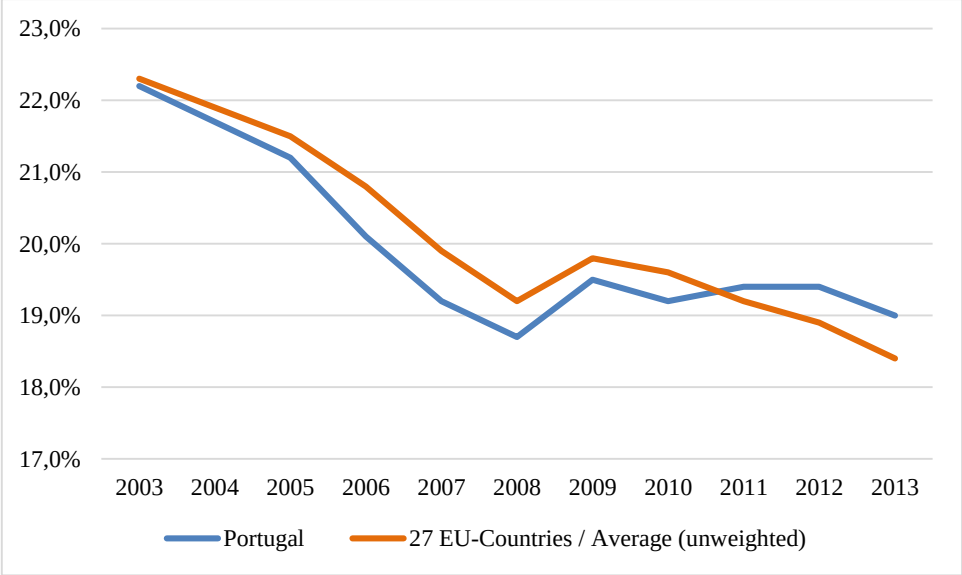
From the results shown in Figure 6 it is possible to see a guide line between all perspectives. Every author used the MIMIC Model for the estimation of the size and development of Shadow Economy. The majority of the approaches illustrate that after 2007/08 the size of the Shadow Economy has increased.

Figure 6. The Shadow Economy according to the different authors (1989/90 – 2009/10)



Source: Barbosa *et al*. (2013)

Figure 7. Size of the Shadow Economy of Portugal and 27 EU - Countries average over 2003–2013 (in % of GDP)



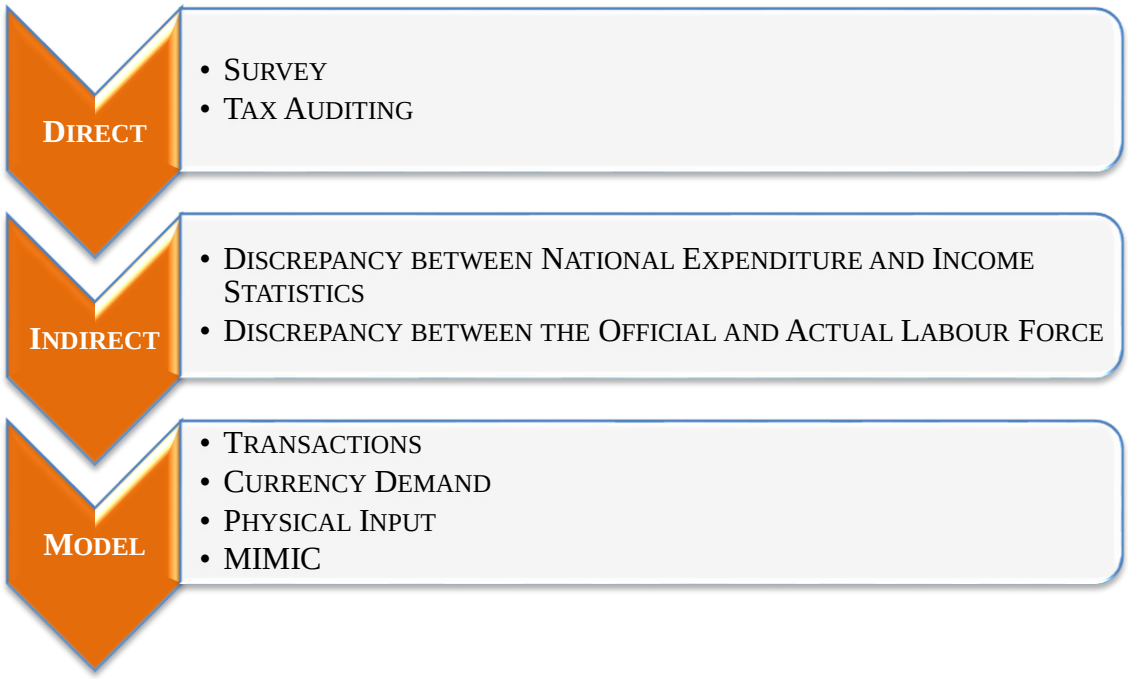
Source: Schneider (2013c)

Figure 7 was prepared by the author, according to the information in "Size and Development of the Shadow Economies of Portugal and 35 other OECD Countries from 2003 to 2013: Some New Facts" by Schneider (2013). Through it is possible to comprehend, that from 2003 to 2013, these 27 highly developed countries show a further decline of the shadow economies. The main reason for this development is the recovery of the official economy in most countries (Schneider, 2013). In that decade, in Portugal's case, the deceleration is also noticed. It is important to emphasise the growth of the Shadow Economy due to the world economic crisis, between 2008 and 2009, both in Portugal and the 27 EU - Countries Average.

3. Methods to Estimate the Size of the Shadow Economy

As mentioned in the previous chapter, estimating the size of a Shadow Economy is a tough and demanding task. Three different types of methods (Figure 8) are most regularly implemented: the direct, the indirect and the model approach (Schneider, 2005).

Figure 8. Quantification methods of the Shadow Economy



3.1. Direct Approaches: the Survey and Tax Auditing Method

Direct methods, as the name suggests, attempt to measure Shadow Economy directly, among economic agents who carry it out.

Survey methods consists on making inquiries of voluntary response, usually along the households, including questions about participation in Shadow Economy activities or on income earned in activities of this nature. Sample surveys designed to estimate the shadow economy are widely used in a number of countries. This approach has the advantage of allowing to obtain detailed information about the structure of the Shadow

Economy, but the results are very sensitive to the way the questionnaire is formulated (Schneider, 2005). Moreover, it has the disadvantages of any inquiry procedure: the credibility of the results depends greatly on the respondent's willingness to cooperate, on the ability to inquiry a representative sample and on the achievement of true answers to the questions.

Audit methods use personal tax returns for income groups and audits them to identify those who are misreporting or hiding their actual income.

The model considers cases in which individuals choose the fraction of income they report to the IRS, while facing stochastic probabilities of being audited. If individuals are caught evading taxes this year the IRS examines their tax returns for the previous year as well. In this simple, specification of the model, unreported income is either discovered by an IRS audit in the year that follows the tax filing, or is discovered when the taxpayer is audited and caught evading the following year, or else is never discovered (Engel and Hines, 1999).

The fiscal auditing programs can find discrepancies between income declared for tax purposes and that measured by selective checks. This kind of software is created to estimate the amount of undeclared taxable income, in that perspective, they may also be used to calculate the Shadow Economy.

For Schneider (2005) this approach shows many difficulties. First of all, using tax compliance information is equivalent to using a (possibly biased) sample of the population. The selection of tax payers for tax audit is not usually 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 based upon a biased sample may not be accurate. Secondly, estimates based on tax audits reflect only that portion of shadow economy income that the authorities succeed in discovering, and this is likely to be only a fraction of hidden income.

This method drastically understates the underground economy as it only measures tax evasion and does not include production of illegal goods and services.

3.2. Indirect Approaches

This type of methods seeks to deduce the importance of the Shadow Economy from the evidence that it leaves in certain macroeconomic variables.

3.2.1. The Discrepancy between National Expenditure and Income Statistics

There are three different methods to measure Gross Domestic Product (GDP). The expenditure, the income and the production approach. These should reach the same results. However, in reality they do not report the same value. The production approach measures GDP as the difference between value of output less the value of goods and services used in producing these outputs. The income approach is the sum of the total payments the individuals receive, while the expenditure approach is the sum of total expenditures in goods and services by all individuals of a country (Easton, 2001).

This method analyses the discrepancies between income and expenditure statistics. Several authors tried to study this issue, such as, Bajada (2001) and Weale (1992). The last one presented a maximum likelihood procedure to verify whether income or expenditure measures of GDP contribute most to the size of the statistical discrepancy. The gap between income and expenditure measures can be used as an indicator of the extent of the Shadow Economy (Schneider and Buehn, 2014). A positive difference indicates that purchases have been made in the underground economy and a negative difference indicates that income may have been produced in the underground economy (Bajada, 2001). People who work in Shadow Economy activities can spend more than their officially recorded income. This would be a reliable approach if it was measured without error, the discrepancy reflects all defaults and errors everywhere in the national accounts statistics as well as Shadow Economy. Hence, according to Schneider and Buehn (2014), these estimates may be crude and of questionable reliability.

3.2.2. The Discrepancy between the Official and Actual Labour Force

The Labour Force is composed by people who are available for work, as a result it includes the employed and the unemployed individuals. Every activity in the Shadow

Economy involves a "shadow labour market" to some extent (Schneider 2012). The participation in the workforce is stable and, therefore, fluctuations in the activity rate are, in fact, transitions between the formal and informal labour market. The result of applying this type of method is an estimate of the labour force engaged in the Shadow Economy and not directly of the economic value of shadow activities. The method does not take into account that besides the transitions between formal and informal economy, there are several other phenomena that affect the activity rate. Furthermore, it does not regard that many workers simultaneously participate in official and unofficial activities (Schneider and Buehn, 2014).

3.3. The Models Approach

Several models are used to determine the size of the SE. The most common are: the transactions approach, the currency demand approach, the physical input approach and the MIMIC model.

3.3.1. The Transactions Approach

The transactions approach, initially proposed by Feige (1979), belongs to a third approach. This method is based on the well-known Fisher's equation of exchange:

$$M * V = p * T \tag{3.1}$$

where

- *M*: is the volume of means of payment;
- *V*: the velocity of money circulation;
- *p*: is the price level;
- *T*: the number of transactions.

The discrepancies between the estimated payments and transactions value is, according to this method, the estimation of the Shadow Economy. If, however, *p*T* (which includes both formal and informal transactions) cannot be estimated, then estimates of *M*V* can still be used to determine the size of the SE.

This method is very demanding, as the information necessary for its implementation is very difficult to obtain, so rarely has been applied outside the more developed countries.

3.3.2. The Currency Demand Approach

The currency demand is one of the most used approaches, first used by Cagan (1958). In this publication, the author studied the correlation between currency demand and tax pressure. This method assumes that the transactions occurred at the Shadow Economy are in cash, with the objective to reduce detectable evidence by the authorities. Therefore, variations in the size of Shadow Economy will be reflected in variations of the currency demand (Tanzi, 1983). This approach is easily applicable because the amount of currency is well documented.

Econometric models are used to estimate the demand that would be expected in the absence of Shadow Economy and its comparison to the demand actually recorded provides an estimate of the value that this method assumes. 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:

$$\ln\left(\frac{C}{M2}\right)t = \beta 0 + \beta 1 \ln(1+TW)t + \beta 2 \ln\left(\frac{WS}{Y}\right)t + \beta 3 \ln Rt + \beta 4 \ln\left(\frac{Y}{N}\right)t + ut \quad (3.2)$$

with $\beta_{1,2,4} > 0$, $\beta_3 < 0$;

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);
- *Y/N*: is the per capita income.

The assumption that the Shadow Economy represents cash transactions is, however, limited; certain transactions, although informal, use banking means of payment, while others are done by direct exchange. Another difficulty is that the use of the method requires the estimation of parameters for a base year where Shadow Economy was inexistent: the choice of the base year can have a strong impact on the estimates. Most applications of the method assume that the velocity of money circulation is equal in both the official and unofficial economies, a fact about which there is no evidence and that is doubtful. Finally, it should be noted that in open economies, payments do not necessarily occur in the currency of the country where the informal transaction occurred, reducing the reliability of the method.

3.3.3. The Physical Input (Electricity Consumption) Method

The method of physical inputs, of which there are several versions, is also one of the most frequently applied. It is based on the notion that there are certain production factors, including electricity, which are used both in the formal and informal economy. In its simplest version, the method assumes that the electricity consumption grows so strictly proportional to the total formal and informal production. Consequently, the differences between the change rates of officially recorded production and consumption of electricity measure the change rate in the Shadow Economy (Feige and Urban 2003). While this method is empirically appealing, especially for countries whose data collection lags behind the rest of the world, it can lead to both under and over estimation depending on the development of the economy in question (Easton, 2001).

To convert these growth rates into estimated value of Shadow Economy it is necessary, as in the previous method, to assume that in a given base year Shadow Economy did not exist, which is a problem. Other drawbacks of the method are that it does not takes into account that certain informal activities use little or no electricity and the efficient energy use has varied over time and it is not uniform from country to country. It also does not take into account that, particularly in developing countries, the increase in electricity consumption is largely explained by the urbanization process.

The Kaufmann – Kaliberda Method

Kaufmann and Kaliberda (1996) assumed that electricity consumption is seen as the single best physical indicator of the overall economic activity. Throughout many countries, global economic activity and electricity consumption have been empirically observed, where the electricity to GDP elasticity is normally near one (Kaufmann and Kaliberda, 1996, pp. 10). Therefore, the growth of total electricity consumption is an indicator for growth of overall GDP, both recorded and unrecorded. Kaufmann and Kaliberda (1996) derived an estimate of unofficial GDP by subtracting the annual growth rate of GDP to annual growth rate of electricity power consumption.

The formula used by this approach to compute the size of Shadow Economy is given bellow.

$$S_t = S_t - 1\left(1 + \frac{1}{\mu} gEt - gYt\right) = S_0 \prod_{i=1}^{t} * (1 + \frac{1}{\mu} gEi - gYi) \quad (3.3)$$

Where

- $\boldsymbol{S_t}$: is the shadow economy in year *t*
- $\boldsymbol{S_0}$: is the output in the shadow economy in base year
- $\boldsymbol{g}$Et: is the annual growth rate of electricity power consumption
- $\boldsymbol{g}$Yt: is the annual growth rate of GDP
- μ*:* is the output elasticity of electricity consumption

The Lackó Method

This approach states that a particular portion of the SE is related with the domestic consumption of electricity. For Lackó (1998) it includes the household production, do-it-yourself activities and other non-registered production. Furthermore, Lackó undertakes that if the domestic electricity consumption regarding the SE is elevated, then the rest of the SE will also be high.

Lackó's method (1998) is based on the subsequent equations:

$$ln\,Ei = \alpha 1\,ln\,Ci + \alpha 2\,ln\,PRi + \alpha 3\,Gi + \alpha 4\,Qi + \alpha 5\,Hi + ui \quad (3.4)$$

with $\alpha_{1,3,5} > 0$ and $\alpha_{2,4} < 0$

$$Hi = \beta 1\,Ti + \beta 2\,(Si - Ti) + \beta 3\,Di \quad (3.5)$$

with $\beta_{1,3} > 0$ and $\beta_2 < 0$

Where

- *i*: the number assigned to the country
- *Ei*: per capita household electricity consumption in country i in Mtoe;
- *Ci*: per capita real consumption of households without the consumption of electricity in country i in US dollars (at purchasing power parity);
- *PRi*: the real price of consumption of 1 kWh of residential electricity in US dollars (at purchasing power parity);
- *Gi*: the relative frequency of months with the need of heating houses in country i;
- *Qi*: the ratio of energy sources other than electricity energy to all energy sources in household energy consumption;
- *Hi*: the per capita output of the hidden economy;
- *Ti*: the ratio of the sum of paid personal income, corporate profit and taxes on goods and services to GDP;
- *Si*: the ratio of public social welfare expenditures to GDP;
- *Di*: the sum on number of dependants over 14 years and of inactive earners, both per 100 active earners.

3.3.4. The MIMIC Model

The previous methods are designed to calculate the size and development of the SE. However, they consider just one indicator (Schneider, 2005). It is notorious that SE effects show up simultaneously in the production, labour, and monetary markets. An even more important critique is that the causes that determine the size of the SE are taken into account only in some of the monetary approach studies that usually consider one cause, the burden of taxation.

The Structural Model of Multiple Indicators and Multiple Causes, MIMIC model, due originally to Frey and Pommerehne (1984), is a special case of the models of structural equations (SEM – Structural Equation Models), which explicitly considers multiple causes leading to the existence and growth of the Shadow Economy, as well as the multiple effects over time. It has the particularity that the latent variables are formative and reflective items at the same time.

The MIMIC Model treats the Shadow Economy as a latent variable and estimates parameters that relate the latent variable to the causes and indicators respectively, as illustrated in Figure 9. Applying this model to Shadow Economy measurement has become increasingly popular in recent years with applications across many developed and developing countries (e.g., Loayza, 1996; Bajada and Schneider, 2005; Schneider, 2007). However, as Breusch (2005) indicates, the estimated parameters in such model can only recognise the relative size of the Shadow Economy in each year.

For Schneider (2013), the MIMIC estimation procedure can be described in three steps.

1. Modelling the Shadow Economy as an unobservable (latent) variable;
2. Description of the relationships between the latent variable and its causes in a structural model;
3. The link between the latent variable and its indicators is represented in the measurement model.

The structural equation model, according to Buehn and Schneider (2008), is given by:

$$\eta_t = \gamma' x_t + \varsigma_t \tag{3.6}$$

Where

- η_t represents the latent variable, the value of SE in year t;
- $\gamma' = (\gamma_1, \gamma_2,...,\gamma_q)$ a (1 × q) vector of coefficients in the structural model describing the "causal" relationships between the SE and its causes;
- $x'_t = (x_{1t}, x_{2t},\ldots,x_{qt})$ is a (1 × q) vector of time series variables as indicated by the subscript t. Each time series x_{it}, i = 1,…,q is a potential cause of the latent variable η_t;
- ς_t represents the unexplained component;

The MIMIC model assumes that the variables are measured as deviations from their means and that the error term does not correlate to the causes, i.e. $E(\eta_t) = E(x_t) = E(\varsigma_t) = 0$ and $E(x_t \varsigma'_t) = E(\varsigma_t x'_t) = 0$. The variance of ς_t is abbreviated by ψ and Φ is the (q × q) covariance matrix of the causes x_t.

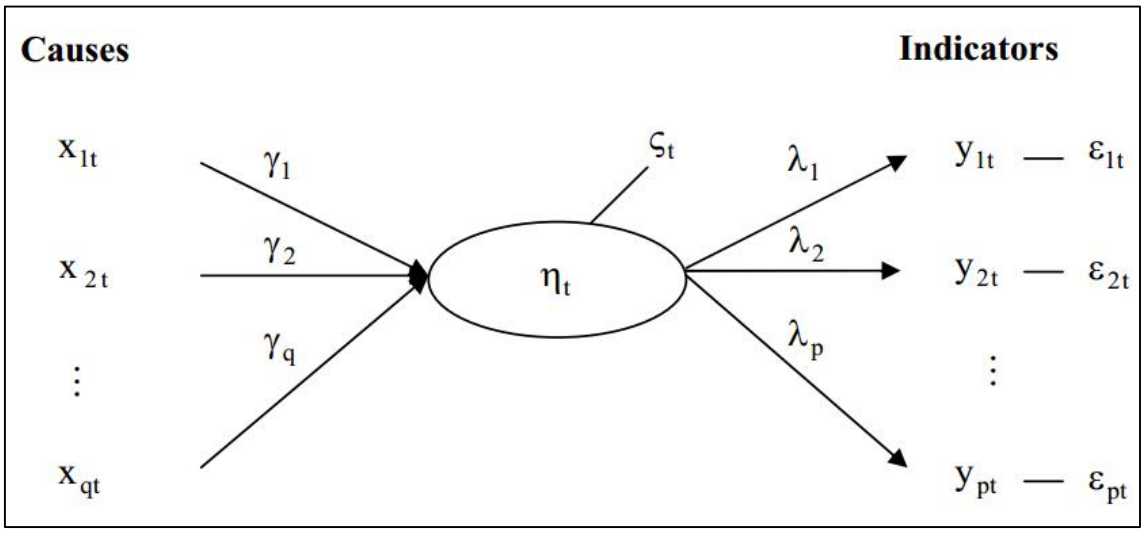
The measurement model represents the link between the latent variable and its indicators, i.e. the latent unobservable variable is expressed in terms of observable variables. It is specified by:

$$y_t = \lambda\eta_t + \varepsilon_t\,, \tag{3.7}$$

Where

- $y'_t = (y_{1t}, y_{2t},\ldots,y_{pt})$ is a (1 × p) vector of individual time series variables y_{jt} j = 1,…,p;
- $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t},\ldots, \varepsilon_{pt})$ is a (1 × p) vector of disturbances where every ε_{jt} , j = 1,…,p is a white noise error term. Their (p × p) covariance matrix is given by $\Theta\varepsilon$.
- The single λ_j, j = 1,…,p in the (1 × p) vector of regression coefficients λ, represents the magnitude of the expected change of the respective indicator for a unit change in the latent variable.

Figure 9. General Structure of a MIMIC Model



Source: Buehn and Schneider (2008)

Like the MIMIC model's causes, the indicators are directly measurable and expressed as deviations from their means, that is, $E(y_t) = E(\varepsilon_t) = 0$. Moreover, it is assumed that the error terms in the measurement model do not correlate either to the causes x_t or to the latent variable η_t, hence, $E(x_t \varepsilon'_t) = E(\varepsilon_t x'_t) = 0$ and $E(\eta_t \varepsilon'_t) = E(\varepsilon_t \eta'_t) = 0$. A final assumption is that the ε_t does not correlate to ς_t, i.e. $E(\varepsilon_t \varsigma'_t) = E(\varsigma_t \varepsilon'_t) = 0$. Figure 9 displays the common structure of the MIMIC model.

4. Estimation of the size of Shadow Economy in Portugal

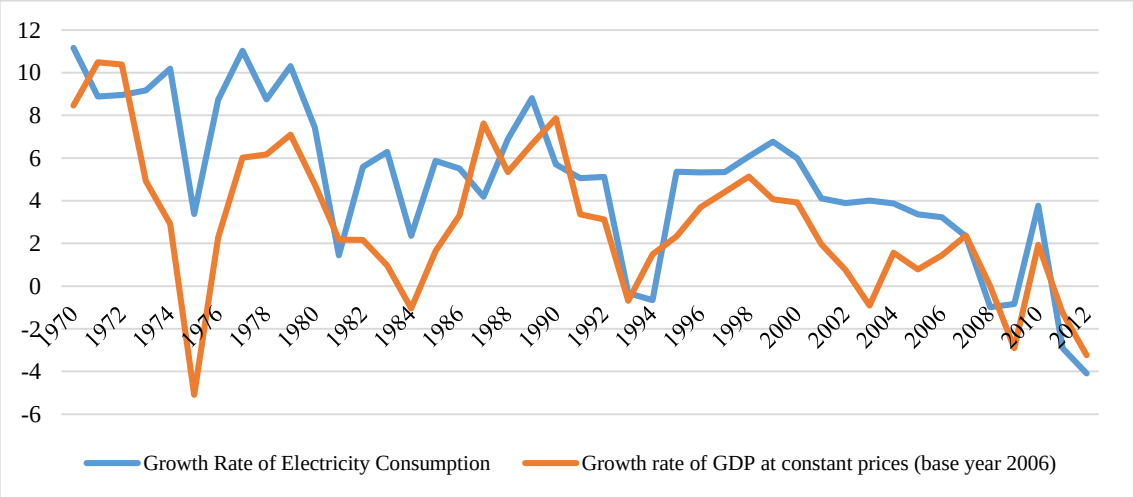
As seen in the previous sections, there are several researchers that calculate the size and growth of SE. In this chapter the author estimates the size of SE according to the Physical Input Method for the period of 1970 to 2012 and the MIMIC Model between 1970 and 2013. Then a combination of the achieved results will be presented as the compute of SE for that period of time.

4.1. Computation of the Shadow Economy by Physical Input Method

In this section the Kaufmann and Kaliberda electricity consumption method will be applied to estimate the size of SE in Portugal. The following stages are involved in estimating the SE for Portugal through this approach.

First, it is needed to gather data for the electricity consumption and GDP at constant prices growth rates. The electricity consumption data was obtained from World Bank for the period of 1970 to 1993 and from Pordata between 1994 and 2012. And the growth rate of GDP at constant prices (base year 2006) was acquired through Pordata for the period of 1970 and 2012. From Figure 10 it is possible to see that the two variables present a similar behaviour between 1970 and 2012.

Figure 10. Evolution of Electricity Consumption and of GDP in Portugal from 1970 to 2012

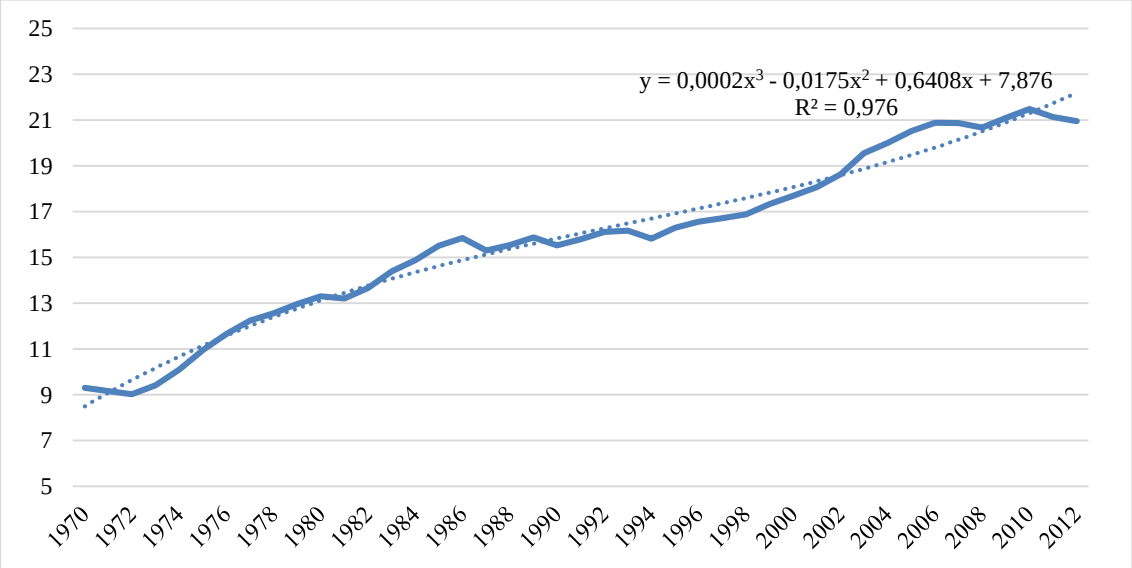


Source: World Bank and Pordata

According to Kaufmann and Kaliberda (1996), the output elasticity of electricity consumption is taken as one. After having the growth rates, an initial value of the SE is needed to derive the estimated results for the period of 1970 and 2012. For this purpose, it was assumed the size of SE in 1970, which was, according to Afonso and Gonçalves (2012), 9.31% of the GDP.

The formula used to compute the size of SE by this approach is (3.3), which is exhibited in the previous chapter. Figure 11 presents the outputs of the SE in Portugal for the period between the years 1970 and 2012. Even though the relative size of the SE within the GDP is strongly dependent on the SE base year and can be misleading, it is nuclear to mention that the dynamic trend of SE in GDP is not affected, regardless the initial base value.

Figure 11. Size of SE in Portugal (% of GDP) by Electricity Consumption Method



Source: Own calculations

The output indicates that the SE general trend as a percentage of the GDP between 1970 and 2012 in Portugal is increasing, from 9.31% to 20.95%, respectively. The value size of SE in year 2013 was estimated through the equation shown in figure above, the outcome was 19.23% of GDP (consult annual results in Table C.2 Appendix C).

Table 3. Size of SE in Portugal (% of GDP) by Electricity Consumption Method

Years	1970-73	1974-77	1978-81	1982-85	1986-89	1990-93	1994-97	1998-01	2002-05	2006-09	2010-13
ECM	9.23	11.24	13.01	14.61	15.64	15.90	16.35	17.50	19.68	20.89	20.70

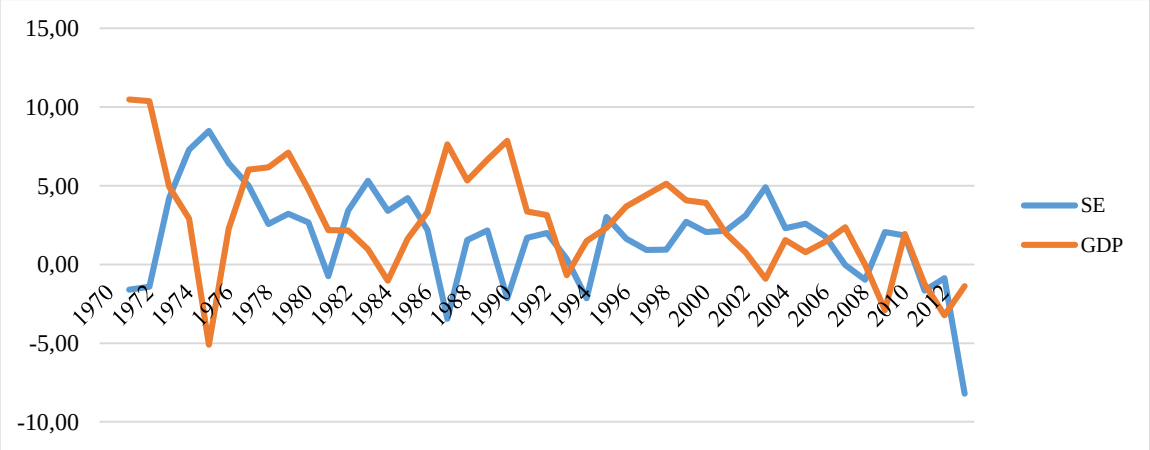
Source: Own calculations

In Table 3 are shown the average results for the size of SE. Starting from 1970 until 1989 the SE is increasing quickly, by one to two percent per year, it starts with 9.23% in 1970-1973 and finishes with 15.64% in 1986-1989. Between 1990 and 2009 it also rises but not so fast. The 2010-2013 SE estimation is an exception, it decreases to 20.70%.

During the years 1973-1977, the annual growth rate of the Electricity Consumption is much greater than the annual growth rate of the GDP for the same period. The annual difference is between four to nine percent, that why the SE is fast growing. According to the Kaufmann/Kaliberda method, this leads to the conclusion that the total economic activity (including the industry and the households) are using more electricity to produce goods and services that are not captured by the recorded official GDP.

From Figure 12 it is possible to realize that in 1970-2013, SE and GDP growth rates display symmetric behaviour, with the exception of the years 2010 and 2011, where the trend is the same. This means that when the official economy grew, the SE decreased.

Figure 12. SE annual growth by ECM vs GDP annual growth, 1970 to 2013



Source: Own calculations and Pordata

It is important to mention some problems with this approach. Not all shadow activities require a lot of electricity power, which allows measurement of only a part the SE. Overtime there is technical progress and the consumption of electricity, per unit product, is reduced. Finally, the electricity consumption is different across sectors, the tertiary sector does not employ as much electricity as the secondary.

4.2. Computation of the Shadow Economy by MIMIC Model

In this section, the MIMIC Model is used to estimate the size of Shadow Economy between 1970 and 2013. The causes and indicators of SE used in this work are based on the associated literature (Schneider and Enste, 2000; Dell'Anno, 2008; Enste, 2010) and the available data for Portugal. Are cited as potential causes:

- the weight of direct taxes and social security contributions[2] in the Gross Domestic Product (GDP), DTSSC;
- the weight of indirect taxes in GDP, IT;
- the weight of subsidies and social transfers[3] in GDP, SUBSSC;
- the weight of real government consumption in GDP, GE - variable used as a proxy for the burden of regulation;
- the percentage of self-employment, SEMP;
- the unemployment rate, UR.

The relationship between these variables and the SE is supposed to be given by the following structural formula:

$$\eta_t = \beta_1 \mathrm{DTSSC}_t + \beta_2 \mathrm{IT}_t + \beta_3 \mathrm{SUBSSC}_t + \beta_4 \mathrm{GE}_t + \beta_5 \mathrm{SEMP}_t + \beta_6 \mathrm{UR}_t + \varsigma_t \qquad (4.1)$$

It is expected that a variation in size of SE is given by the following:

[2] The value for this variable in 2013 was estimated, see Figure B.1. in Appendix B.
[3] The value for this variable in 2013 was estimated, see Figure B.2. in Appendix B.

- the amount of currency in circulation outside the banking system (per capita), CURR;
- the percentage of participation in the workforce, LFPR;
- real GDP per capita, GDP - this latter variable is used as the scale variable, the value of the associated coefficient is fixed to +1 or -1 to establish the relative magnitude of other indicators.

Considering Schneider (2005), the scale coefficient is set to be as +1 and, in line with Dell'Anno et al. (2007), the sign of the coefficient is adjusted (if necessary) according to the methodology *reductio ad absurdum*. The measurement equations are used:

$$\mathrm{CURR_t} = \lambda_1 \eta_t + \varepsilon_1 \tag{4.2}$$

$$\mathrm{LFPR_t} = \lambda_2 \eta_t + \varepsilon_2 \tag{4.3}$$

$$\mathrm{GDP_t} = +1.\eta_t + \varepsilon_3 \tag{4.4}$$

The data sources and the concrete specification of the variables are displayed in Table A.1 of Appendix. The MIMIC model base used was a 6-1-3 model (six causes, a latent variable and three indicators), shown in Figure 13, which has been progressively modified by omitting some of its non-statistically significant variables, in order to try to optimize the model. As Duncan (1975, pp.149) mentions: "The meaning of the latent variable depends completely on how correctly, precisely and comprehensively the causal and indicator variables correspond to the intended semantic content of the latent variable."

Following the theoretical considerations in chapter 2, eight hypotheses were developed below (all ceteris paribus), which will be empirically tested by using the MIMIC model:

1. An increase in direct and social security contributions increases SE.

2. An increase in indirect taxation increases the SE.

3. An increase in government expenditure rises the SE.

4. An increase in subsidies and social security contributions, leads to a decrease in SE.

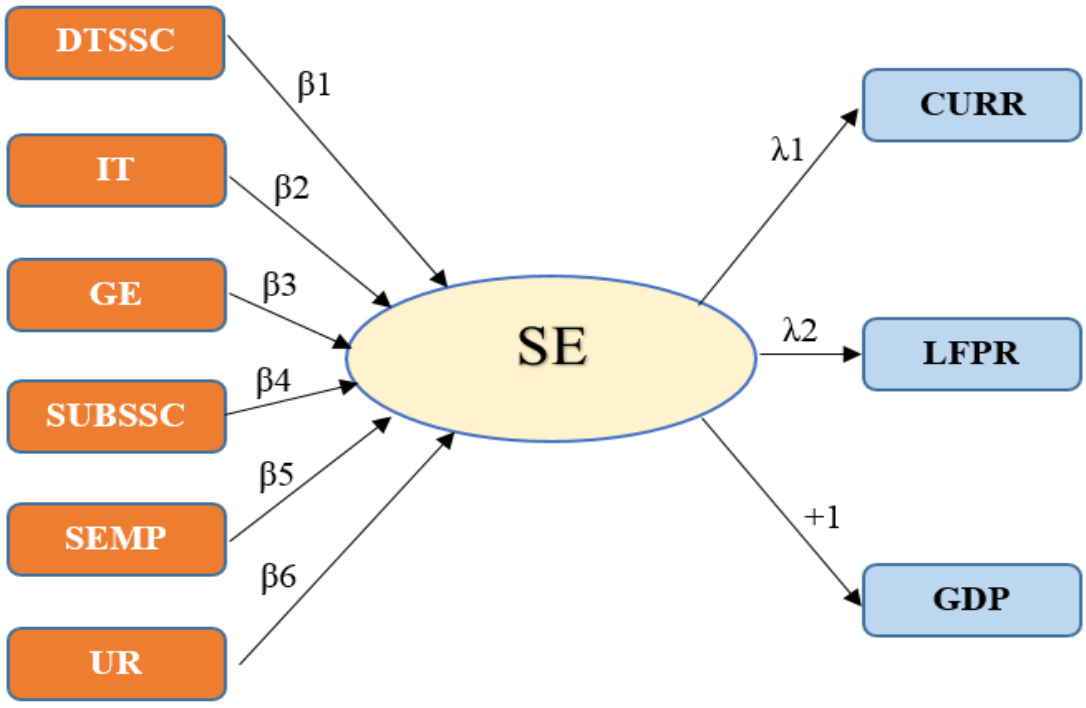
5. The higher self-employment, the more people work in SE activities.

6. The higher unemployment, the more people work in SE activities. However, the theory suggests that the coefficient of unemployment can have a positive or negative sign. The development of the SE can occur alongside the development of the formal economy, or it can occur in moments of crisis in the formal economy.

7. An increase in monetary transactions, implies a rise in shadow economy activities.

8. The lower labour force participation rate, the more people work in SE activities. However, the expected coefficient sign of this variable is ambiguous, since there is no consensus in the literature on the effects of SE in LFPR.

Figure 13. MIMIC Model 6-1-3



The statistical processing of data begins with the preparation of two tests for non-stationary of all variables in the model. It was used the econometric software Gretl, version 1.9.90, which was released in May 2014.

The first test performed was the Augmented Dickey-Fuller (ADF) test. The second test made was the Kwiatkowski Phillips-Schmidt-Shin (KPSS) test. The results are shown in Table A.2 in Appendix A, therefore it may be concluded that a large number of variables are I (1), since the ADF test does not reject the null hypothesis of the series not be stationary and KPSS test did not reject the alternative hypothesis of the series not to be stationary. The KPSS test appeared to decrease the uncertainty that often the ADF and Phillips-Peron (PP) tests evidenced. According to Kwiatkowski-Phillips-Schmidt-Shin, this test complements the analysis of traditional unit root tests (ADF and PP).

Then the Engle-Granger two-step Approach (1987) was prepared, to verify if all cause variables are co-integrated with each of the indicator variables. The results obtained from the estimations are shown in Table A.3 in Appendix A. The residuals of the co-integration relationship of each regression are analysed using the ADF test.

If the causes are co-integrated with the indicators, then it is expected the rejection of the null hypothesis of a unit root in the regression residuals of each equation, using the ADF test.

Table A.3 in Appendix A shows that, to the usual significance levels, the null hypothesis in all residuals can be rejected, which means the causes are co-integrated with each indicator. According to Dell' Anno et al. (2007), the detection of multivariate normality is vital to preserve the statistical properties of estimators. The "chi-square" test is used to evaluate if the models fit with the dataset. If the variables are not (multivariate) normally distributed, the maximum likelihood estimators may produce biased standard errors and an ill-behaved "chi-square" test of the overall model fit. The tests made displayed that the variables do not reject the null hypothesis of following a normal distribution.

The cause and indicator variables will be used without any differentiation treatment to estimate the long-term equilibrium of MIMIC model translated in equations (4.1; 4.2; 4.3; 4.4), Breusch (2005). The estimated coefficients for maximum likelihood method are shown in Table 3. The cause variables are all expressed in percentage, which allows the direct comparison of their coefficients in order to evaluate the importance of these variables in the formation of SE.

Starting with a 6-1-3 MIMIC model, some variables whose coefficients showed no statistical significance were iterated. Therefore in the total eleven MIMIC models were estimated (Table 4) and, based on the statistical significance of the coefficients in the Chi-square statistic (which indicates the explanatory power of the model), the statistical RMSEA (Root Mean Squared Error of Approximation) and statistical PGFI (Parsimonious Goodness of Fit Index). It was decided to use the MIMIC 6-1-3, 5-1-3b and 5-1-3c models to build the SE/GDP index.

Table 4. MIMIC models estimated

Model	Causes						Indicators		Chi Square (*p*-value)	RMSEA (*p*-value)	PGFI	d.f.
	DTSSC	IT	GE	SUBSSC	SEMP	UR	CURR	LFPR				
6-1-3	1,136***	0,680***	0,023 (0,192)	-0,444 (0,161)	0,157**	-0,67***	0,29***	0,589***	99,007	0,435	0,202	12
5-1-3a	1,387***	-	0,010 (0,609)	-0,508 (0,145)	0,009 (0,879)	-0,676***	0,032***	0,551***	85,443	0,419	0,201	10
5-1-3b	1,135***	0,621***	-	-0,311 (0,309)	0,146**	0,621***	0,029***	0,575***	92,398	0,438	0,202	10
5-1-3c	0,886***	0,690***	0,015 (0,382)	-	0,160**	-0,741***	0,030***	0,575***	90,675	0,433	0,203	10
5-1-3d	1,469***	0,68***	-0,05 (0,807)	-1,064***	0,073 (0,413)	-	0,028***	0,523***	87,659	0,425	0,2	10
4-1-3a	1,389***	-	0,010 (0,609)	-0,505 (0,146)	-	-0,683***	0,033***	0,552***	54,904	0,369	0,201	8
4-1-3b	0,825***	0,756***	-0,036*	-	0,025***	-	0,025***	0,494***	68,23	0,418	0,199	8
6-1-2a	1,172***	0,799***	0,026 (0,146)	-0,574*	0,15**	-0,684***	-	0,596***	42,525	0,418	0,12	5
6-1-2b	1,043***	0,478**	0,006 (0,726)	-0,186 (0,604)	0,080 (0,231)	-0,53***	0,031***	-	51,088	0,413	0,118	5
5-1-2a	1,128***	0,344 (0,117)	0,008 (0,641)	-0,296 (0,402)	-	-0,536***	0,030***	-	48,873	0,411	0,12	4
5-1-2b	1,168***	0,717***	-	-0,409 (0,193)	0,139**	-0,628***	-	0,581***	36,332	0,415	0,123	4

Notes: *, ** and *** indicates that the estimated coefficients are statistically significant for a significance level of 10%. 5% and 1% respectively. Presented in brackets are the *p*-values of the variables without statistical significance. Software used: AMOS version 22.0

According to Lisboa et al. (2012) the RMSEA statistic as a measure of absolute adjustment that is, examines the discrepancy in fit between the observed and estimated matrices and takes into account the approximation error of the population. One should choose models in which this statistic is higher, to evidence a better fit of the model to the data.

Regarding the PGFI, this statistic is included in the category of adjustment parsimonious measures and serves to compare alternative models, as is the present case in this dissertation. According to Lisboa et al. (2012), higher values of this statistic indicate a greater parsimony of the model.

Thus, based on the three statistics mentioned previously the MIMIC 6-1-3, 5-1-3b and 5-1-3c models were chosen.

There are several methods for model calibration. In this dissertation it was decided to follow Giles and Tedds (2002) by taking into account the critic of Breusch (2005). It is considered that what is being measured is the product of SE in Portugal as a percentage of GDP. The rate of evolution of SE as a percentage of GDP was calculated using the following equation:

$$\hat{S}_t = \hat{\beta}_1 \mathrm{DTSSC}_t + \hat{\beta}_2 \mathrm{IT}_t + \hat{\beta}_3 \mathrm{SUBSSC}_t + \hat{\beta}_4 \mathrm{GE}_t + \hat{\beta}_5 \mathrm{SEMP}_t + \hat{\beta}_6 \mathrm{UR}_t \quad (4.5)$$

In the MIMIC model, in order to estimate the size of SE is necessary to calculate an index based on an already existing estimation of the SE in a year base. The authors used 17,1% for the year 1990, taking into account that this was the value obtained in the latter study. The index is scaled so as to consider 17.1% in 1990 and transformed into the time series:

$$(\mathrm{SE} / \mathrm{GDP}) * 100 = \eta_t \quad (4.6)$$

For each year, η_t is obtained through the following equation:

$$\frac{\eta_t}{\eta_E} = \frac{\hat{S}_t}{\hat{S}_E} \quad (4.7)$$

Which means,

$$\eta_t = 17.1 \times \frac{\hat{S}_t}{\hat{S}_{1990}} \quad (4.8)$$

Where $\hat{S}_t$ is the value obtained in (4.5); $\hat{S}_E$ is the index value obtained in (4.5) for 1990; η_E is equal to 17.1%; and η_t is the estimated value of SE as a percentage of official GDP in *t*. By applying this method to the selected MIMIC models, an average index was obtained, represented in Table 5. The annual results for the period between 1970 and 2013 are presented in Table C.1.of Appendix C, where is also included the three chosen methods.

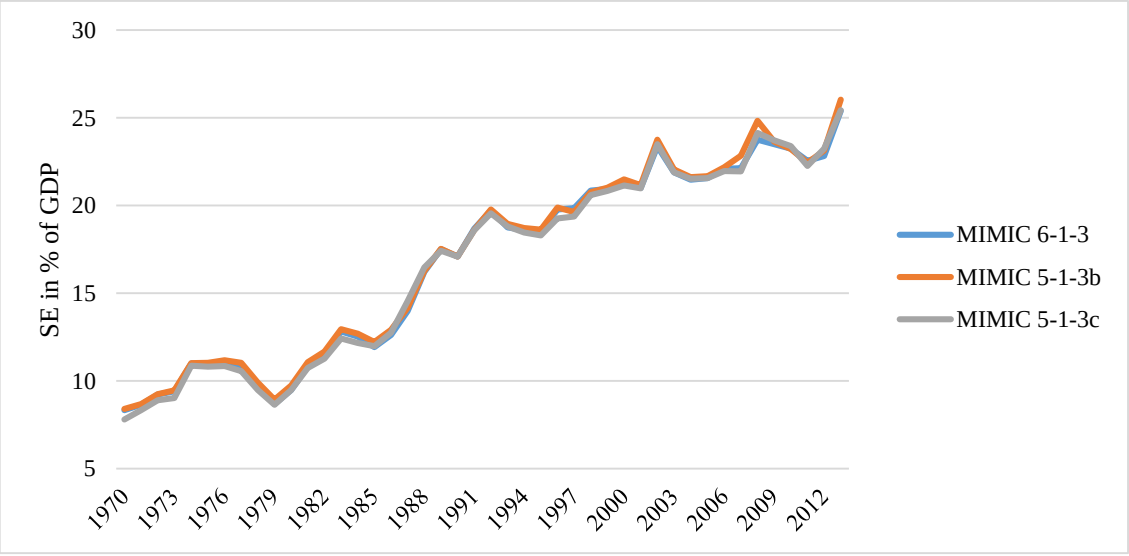
Table 5. Size of SE in Portugal (% of GDP) by MIMIC Model

Years	1970 -73	1974- 77	1978 -81	1982- 85	1986- 89	1990- 93	1994- 97	1998- 01	2002- 05	2006- 09	2010- 13
MIMIC	8.79	10.91	9.72	12.18	15.21	18.56	19.09	21.01	22.16	23.06	23.60

Source: Own calculations

Figure 14 displays the evolution of SE for the selected MIMIC models, the three of them demonstrate very similar values, it is almost impossible to distinguish the trend lines.

Figure 14. MIMIC Models 6-1-3, 5-1-3b, 5-1-3c



Source: Own calculations

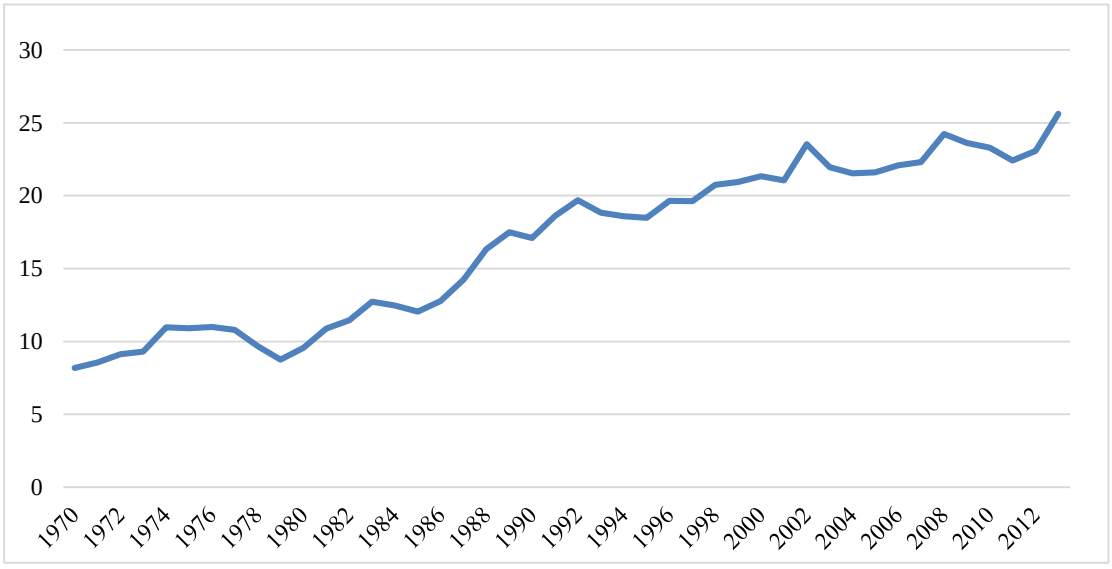
The information displayed in Figure 15 is the average evolution of SE in the official GDP between 1970 and 2013. During the period of 1970 to 1976 the SE had a fasting growth, from 8.18% to 11% of the GDP, in the following period (1977-1979) a significant reduction was verified in the SE, with an average annual growth rate of -7.26%.

Between 1980 and 1983, the SE had a substantial raise from 9.57% to 12.74%. Afterwards, in the period of 1984 to 1993, it raised from 12.46% to 18.84% of the GDP, which is a huge increase, however, it is important to notice that in 1985 and 1990 the SE decreased about 0.4% in each year.

In 1994 up to 2004, the SE grew, although at a lower rate, with an average annual growth rate of 1.34%, in this period of time it is relevant to highlight the year 2002, with 23.54%, because in 2001 the value is 21.05% and in 2003 is 21.95%. From 2004 to 2008 the SE had a notorious increment, it raised every year, starting with 21.55% in 2004 and finishing with 24.24% in 2008.

In the following period (2009 to 2011), it progressively diminished, achieving 22.42% in 2011. In 2012 the SE was 23.07% of the GDP and in 2013 accomplished its higher value for the undertaken period, 25.62%.

Figure 15. Size of SE in Portugal (% of GDP) by MIMIC Model



Source: Own calculations

It is also of great importance to discuss the statistical significance of the coefficients of SE causes and indicators.

The weight of direct taxes and social security contributions in GDP (DTSSC) presents a positive sign, which is in accordance with the theoretical considerations. The weight of indirect taxes in GDP (IT) also displays a positive sign, as foreseen in the literature. The citizens attempt to escape their fiscal obligations, so that they can have more income. Therefore, as tax burden increases, so does the SE.

The government expenditure as percentage of GDP is consistent with the theoretical assumptions, it shows a positive sign, with the exception in two non-selected models. So, an increase regulation burden leads economic agents to practise their activity in the SE.

The weight of subsidies and social security transfers in GDP (SUBSSC) presents a negative sign, which is in accordance to theoretical conventions. An increment in this variable promotes an increase cost to economic agents when they are working in SE activities, since it has access to subsidies and social transfers who is working in the official market labour.

The variable self-employment demonstrates a positive sign, confirming the assumption that self-employers income are under declared to authorities. This way, their tax burden decreases and they are able to retain more income.

The unemployment rate displays a negative sign, with the exception of 5-1-3b model, which is contradictory to literature review. It is nuclear to mention that this variable does not explain the relationship between someone who has a job in the official and shadow economy at the same time, and the size of SE. The negative sign can be explained by many factors. In Portugal, the unemployment allowance is temporary and low, it also has a maximum value of 1.048,05 €. For this reason, many individuals prefer working in the official economy, the wage is usually higher and they have social benefits.

The indicator, real amount of currency per capita in circulation outside the banking system (CURR), displays a positive sign in all models, as expected by the theoretical assumptions. Thereby, an increase in monetary transactions leads to a raise of the SE.

Finally, the indicator, labour force participation rate (LFPR) also presents a positive sign, which means that an increase in the LFPR, conducts to a raise in the size of SE. This relationship can be explained by individuals who work in the official economy but spend their weekends and free time working in SE activities.

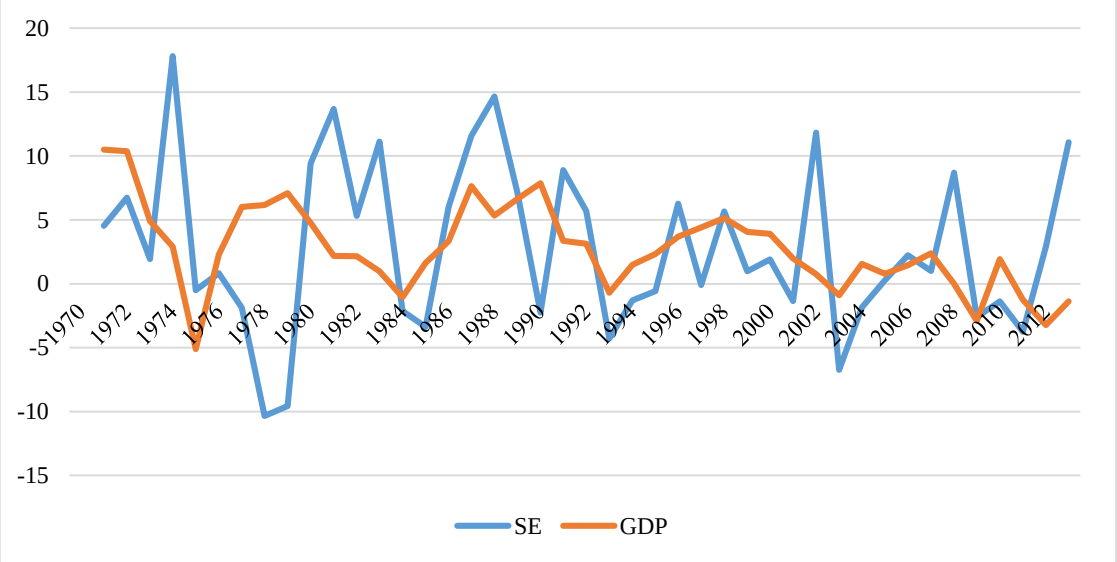
In Figure 16 there is a comparative analysis of the SE and GDP annual growth rates between 1970 and 2013. For that period of time, the average GDP annual growth rate is 2.76% and the average SE annual growth rate is 2.89%. The year 1974 presents the highest growth rate for SE (17.82%), a possible explanation can be the revolution of 25th of April, the government needed to re-organize its functions, which led to the non-declaration of income. Another possible reason is the undeclared income generated by immigrants from Portuguese colonies.

In the following period it is notorious an enormous decrease until 1980, which registers the lowest annual growth rate for the considered period. Afterwards a slow growth is observed until the year 1986. This may be due to the admission to the European Union, which happened in 1986, Portugal had adopted several economic policies to fulfil the membership criteria. Those policies, namely to fight tax evasion, must had a great impact on the growth rates in that period of time. Until 1989, the growth rate of SE had an ascended path, afterwards, the average annual growth rate was 1.9%, during the 90´s up to 2000.

In the last thirteen years, the average annual growth rate was 1.56%, however it is imperative to mention the years 2002, 2008 and 2013, they are among the highest annual growth rates of SE between 1970 and 2013, with 11.83%, 8.68% and 11.07% respectively. A possible explanation for the year 2002 is the 9/11/01, a wave of uncertainty and disinvestment struck the financial and economic world, affecting also Portugal. A reason for the SE growth rate in 2008 is the U.S. subprime mortgage crisis that occurred in 2007 and the consequent bankruptcy of Lehman Brothers in 2008, these events, led to the major economic depression ever seen, where its effects are still felt

nowadays. From that point on, Portugal has never been able to fully recover and in addition a political crisis was installed. In 2011 it was necessary to make a request for financial assistance, and so in 2013 the SE achieved its highest value 25.62% of GDP.

Figure 16. SE annual growth by MIMIC model vs GDP annual growth, 1970 to 2013



Source: Own calculations and Pordata

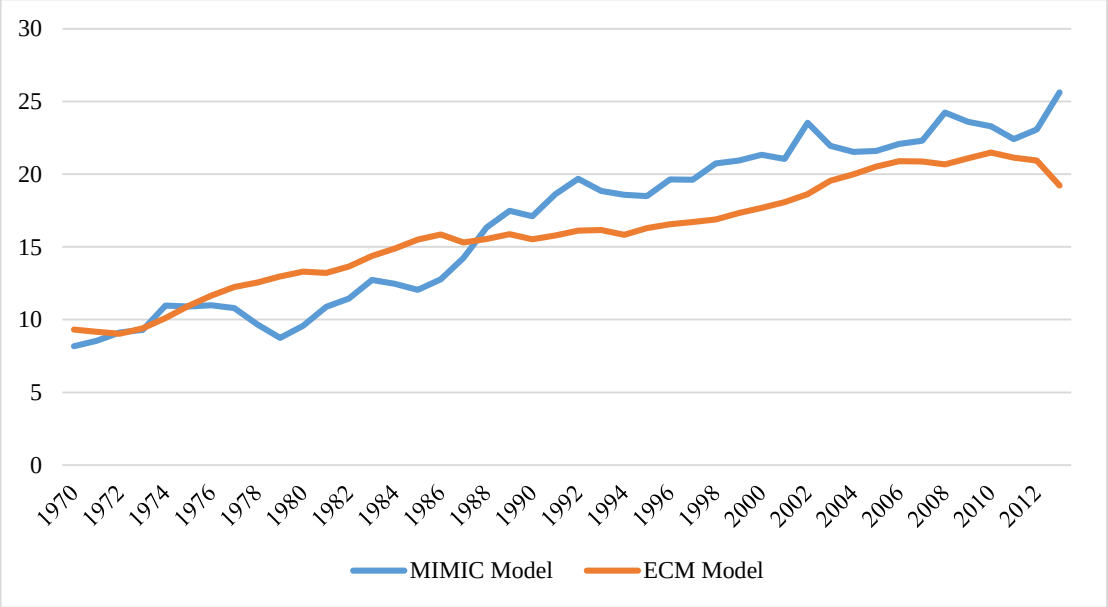
The MIMIC model has also some drawbacks. It is calculated based on an existing estimation of SE for a base year, which is one of the problematic aspects of the latent variable method. Giles and Tedds (2002) claim that there is no guarantee that the model can reflect the exact share of the shadow economy, since the causes and indicators may reflect other economic phenomena; the flexibility offered by the MIMIC model does not prevent the use of variables difficult to measure, which may contain errors.

4.3. The Shadow Economy as an average between ECM and MIMIC Model

In this section, a comparison between the two used methods is made. Figure 17 shows the output of the two approaches. It is possible to see that until 1988, the ECM model presented higher values for the size of SE, after that year the MIMIC model displayed bigger estimations. In 1987 the size of SE in percentage of official GDP by ECM model was 15.30% and 14.24% by MIMIC model, in 1988 it was 15.54% and 16.33%,

respectively. Both approaches show a positive growth for the under taken period (1970-2013).

Figure 17. Size of SE in Portugal (in % of GDP) by MIMIC and ECM model



Source: Own calculations

In Table 6 are shown the average estimated results for the size of SE in each four years, from 1970 to 2013, through the average of ECM and MIMIC model outcomes (the annual estimations are presented in table C.2 in Appendix C).

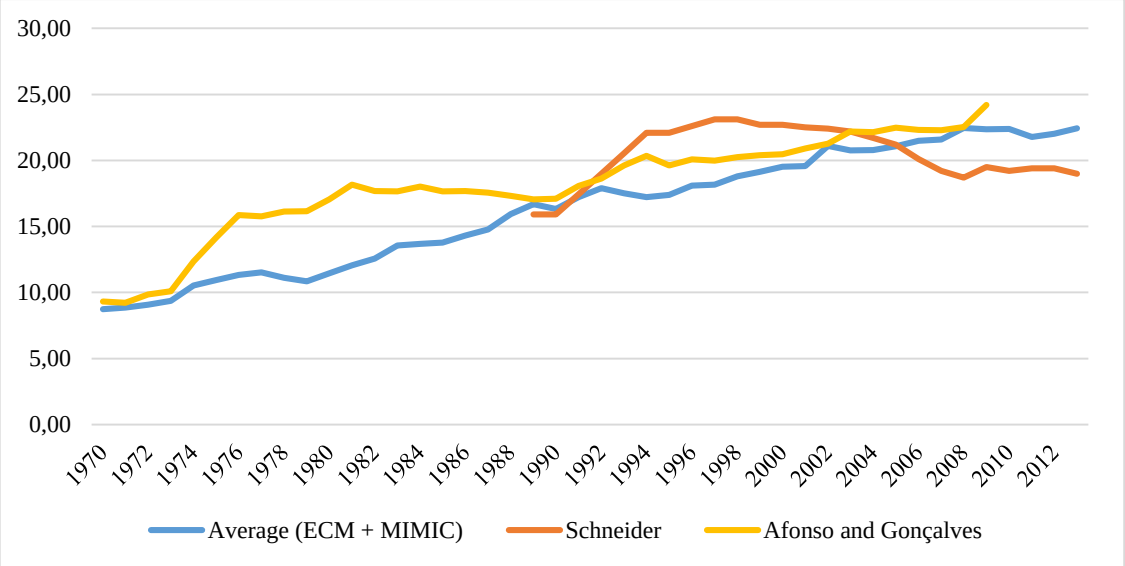
Table 6. Size of SE in Portugal (in % of GDP) - Average between ECM and MIMIC Model

Years	1970-73	1974-77	1978-81	1982-85	1986-89	1990-93	1994-97	1998-01	2002-05	2006-09	2010-13
MIMIC	8.79	10.91	9.72	12.18	15.21	18.56	19.09	21.01	22.16	23.06	23.60
ECM	9.23	11.24	13.01	14.61	15.64	15.90	16.35	17.50	19.68	20.89	20.70
Average	9.01	11.08	11.37	13.39	15.42	17.23	17.72	19.25	20.92	21.97	22.15

Source: Own calculations

In that period of time, the SE in percentage of GDP has always increased, starting in the period 1970 to 1973 with 9.01% and ending in 2010 to 2013 with 22.15%. For that period of time, the average annual growth rate of SE in GDP is 2.26%. Hence, Portugal displays for the MIMIC model, ECM and their average, a positive growth trend for the period under study.

Figure 18. Size of SE in Portugal (in % of GDP) by several authors



Source: Own calculations, Schneider (2005, 2013a), Afonso e Gonçalves (2009, 2012)

As Figure 18 presents, SE in Portugal displays a growing tendency, which is in accordance to the estimated outcomes of Afonso and Gonçalves (2009, 2012), and with Schneider up to 2003, afterwards Schneider's results are decreasing until 2013 (for further enlightening see table C.2 in Appendix C).

5. Conclusions

This dissertation provides a detailed description about a phenomenon called Shadow Economy and an attempt to estimate its size in Portugal over the period 1970 up to 2013. The SE definition, the estimation procedures and the acceptance of its effects on the official economy are not consistent, although there are several studies on the matter.

For measuring the size of SE were developed several models. Among the most commonly used are the physical input approach, with relevancy for the electricity consumption method (ECM) and MIMIC models. These two were the approaches chosen for the computation of the size of SE.

Through the Kaufmann - Kaliberda model the author achieved the following results: the size of SE evolved from 9.31% of GDP in 1970 to 19.23% of GDP in 2013. The SE presented a positive growth tendency and its annual growth rate a symmetric behaviour while comparing to the annual growth rate of GDP.

Through the MIMIC model the author attained the following estimations: the size of SE evolved from 8.18% of GDP in 1970 to 25.62% of GDP in 2013. The SE also showed a positive growth trend.

The main causes that contribute the most for the formation and growth of SE are the direct taxes and social security contributions and the indirect taxes, according to the MIMIC model. Therefore, the weight of SE in the official GDP can be reduced if a reduction in the tax burden occurs. The unemployment rate is another cause that plays an important role in explaining the SE in Portugal. The coefficient sign associated with this variable is mainly negative, which indicates that the unemployed individuals prefer having a job in the official economy instead of shadow economy.

It is important to mention that the values obtained for SE should be seen as approximations, due to the constraints imposed by the available data and the used models. Therefore, the author combined two methods to estimate the evolution of SE in the period between 1970 and 2013 in Portugal, using the ECM and MIMIC model, since there is no optimum model to compute the size of SE.

By combining the two used methods, its average revealed that the size of SE evolved from 8.75% of GDP in 1970 to 22.43% of GDP in 2013. For the period 1970-2013, it was estimated that the average annual growth rate of SE is 2.26% and for the GDP is on average 2.76%.

The shadow economy is an increasingly visible and strong trend in modern society, SE activities are practiced both in developing and developed countries and serves the interests of all society strata. So, what can be done to prevent its development? Schneider (2013a, pp. 18) proposes "Increasing electronic payments by 10 per cent annually for at least four consecutive years can shrink the Shadow Economy by up to 5 per cent". Many solutions can be displayed, however is clearly that further research is needed in this area.

References

Afonso, O. and Gonçalves N. (2012), "A Economia Não Observada em Portugal - Índice de 2011", Observatório de Economia e Gestão da Fraude.

Asea, Patrick K., (1996), "The Informal Sector: Baby or Bath Weather? A comment", Carnegie-Rochester Conference Series on Public Policy, Elsevier, vol. 45(1), pages 163-171, December.

Bajada C., (2001), "An Examination of the Statistical Discrepancy and Private Investment Expenditure", Journal of Applied Economics, Vol. IV, No. 1, 27-61.

Bajada, C. e F. Schneider (2005), "The Shadow Economies of the Asia-Pacific", Pacific Economic Review, Vol. 10, Nº 3, pp. 379-401.

Barbosa, E., Brandão, E., Pereira, S. (2013), "The Shadow Economy in Portugal: An Analysis Using the MIMIC Model", Working Paper N.º 514, Faculty of Economics and Management, Oporto University.

Breusch, T. (2005), Estimating the Underground Economy Using MIMIC Models, Working Paper, Nº 0507003, Faculty of Economics and Commerce, The Australian National University.

Buehn, A. and Schneider F. (2008), "MIMIC Models, Co-integration and Error Correction: An Application to the French Shadow Economy", Discussion Paper No. 3306, Institute for the Study of Labor (IZA).

Buehn, A. and F. Schneider F. (2012), "Size and Development of Tax Evasion in 38 OECD Countries: What do we (not) know?", CESifo Paper Discussion Series, November 2012, CESifo, University Munich, Munich.

Cagan, P. (1958), "The demand for currency relative to the total money supply", Journal of Political Economy, 66, pp. 302– 328.

Dell' Anno, R. (2007), "The Shadow Economy in Portugal: An Analysis with the MIMIC Approach", Journal of Applied Economics, Vol. 10, No. 2, pp. 253-277.

Dell'Anno, R. (2008), "What is the Relationship Between Unofficial and Official Economy? An Analysis in Latin American Countries", European Journal of Economics Finance and Administrative Sciences, 12, 185-203.

Dell' Anno, R. e F. Schneider (2003), "The Shadow Economy of Italy and Other OECD Countries: What do We Know?" Journal of Public Finance and Public Choice, Vol. 21, No.2-3, pp. 97-120.

Dell'Anno, R., M. Gómez-Antonio e A. Alañon (2007), "The Shadow Economy in Three Mediterranean Countries: France, Spain and Greece. A MIMIC Approach", Empirical Economics, Vol. 33, No. 1, pp. 51-84.

Dixon, H. (1999), "Controversy: On the use of the hidden economy estimates," The Economic Journal, 109, pp.335—337.

Duncan, O. D., (1975), "Introduction to Structural Equation Models", New York: Academic Press.

Easton S., (2001) "The Size of the Underground Economy: A Review of the Estimates", http://www.sfu.ca/~easton/Econ448W/TheUndergroundEconomy.pdf accessed on the 8th of July of 2014.

Eiras, Ana Isabel (2003), "Ethics, Corruption, and Economic Freedom", The Heritage Foundation Measuring the non-observed economy", Statistics Brief OECD, Nov 2002 n.º 5.

Engel, Eduardo M. R. A. and Hines Jr., James R. (1999), "Understanding Tax Evasion Dynamics", NBER Working Paper No. w6903.

Engle, R. F. e C. W. J. Granger (1987), "Cointegration and Error Correction: Representation, Estimation, and Testing", Econometrica, Vol. 55, No. 2, pp. 251-276.

Enste, D.H. (2010), "Regulation and Shadow Economy: Empirical Evidence for 25 OECD-Countries", Constitutional Political Economy, 21, 231-248.

Feige, Edgar L. (1979), "How big is the irregular economy?" Challenge. 22, 5-13.

Feige Edgar L. (1990), "Defining and estimating Underground and Informal Economies: The New Institutional Economics Approach", World Development, Vol 18, No 7 pp. 898-1002.

Feige, E. L., and I. Urban., (2003). "Estimating the size and growth of un-recorded economic activity in transition countries: A re-evaluation of electric consumption method estimates and their implications" William Davidson Institute Working Paper 636.

Feld, L. and Schneider, F. (2010). "Survey on the Shadow Economy and Undeclared Earnings in OECD Countries", Invited Paper written for publication in the German Economic Review, Department of Economics, University of Linz, Linz, Austria.

Frey, B. S. and Pommerehne, W.W. (1984), "The hidden economy: State and prospect for measurement." Review of Income and Wealth 30: pp. 1 – 23.

Frey, B. S. and Schneider, F. (2000) "Informal and underground economy", Working Paper, Department of Economics, Johannes Kepler University of Linz, No. 0004.

Giles, D. E. A. e L. M. Tedds (2002), "Taxes and the Canadian Underground Economy", Canadian Tax Paper No. 106, Toronto: Canadian Tax Foundation.

Gonçalves, Nuno (2010), "A Economia Não Registada em Portugal", Faculdade de Economia da Universidade do Porto.

Gutmann, P. M. (1979), "Statistical Illusions, Mistaken Policies", Challenge, The Magazine of Economic Affairs 22:5, pp. 14-17.

Jie W. Sim, Tat H. Huam, Rasli Amran, Chye T. Lee (2011), "Underground Economy; Definition and Causes", Business and Management Review Vol. 1(2) pp. 14 – 24.

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, pp. 631-639.

Kaufmann, Daniel and Kaliberda, Aleksander (1996), "Integrating the unofficial economy into the dynamics of post socialist economies: A framework of analyses and

evidence", B. Kaminski (ed.), Economic Transition in Russia and the New States of Eurasia, London: M.E. Sharpe, pp.81-120.

Lackó Mária (1998), "The hidden economies of Visegrad countries in international comparison: A household electricity approach", Halpern, L. and Wyplosz, Ch. (eds.), Hungary: Towards a market economy, Cambridge (Mass.): Cambridge University Press, p.128-152.

Lisboa J. V., Augusto M. G., Ferreira P. L. (2012), "Estatística aplicada à gestão", Porto, Vida Económica.

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, Elsevier, vol. 45(1), pages 129-162, December.

OCDE (2002), "Measuring the Non-Observed Economy: A Handbook, Paris", OECD Publications.

Pedersen, S. (2003), "The Shadow Economy in Germany, Great Britain and Scandinavia: A Measurement Based on Questionnaire Service." Study No. 10, The Rockwoll Foundation Research Unit, Copenhagen.

Pesut, M. (1992), "Statistics on the Hidden Economy and Informal Activities inside the Production Boundary of the National Accounts. An overview of National Practices." Statistical Journal of the United Nations Economic Commission for Europe. vol. 9.

Schneider F. and Buehn, A. (2014), "Estimating the Size of the Shadow Economy: Methods, Problems and Open Questions" http://www.econ.cam.ac.uk/epcs2014/openconf/modules/request.php?module=oc_program&action=view.php&id=85 accessed on the 8th of July of 2014.

Schneider, F., Buehn A., Montenegro C. (2010), "Shadow Economies All over the World: New Estimates for 162 Countries from 1999 to 2007," Working Papers wp322, University of Chile, Department of Economics.

Schneider, F. and C.C. Williams (2013), “The Shadow Economy”, IEA, London.

Schneider, F. and D. H. Enste (2000), “Shadow Economies: Size, Causes, and Consequences”, The Journal of Economic Literature, Vol. 38, No. 1, pp. 77-79.

Schneider, F. (2005), "Shadow Economies around the World: “What Do We Really Know?” European Journal of Political Economy.

Schneider F. (2012), “The Shadow Economy and Work in the Shadow: What Do We (Not) Know?” Discussion Paper No. 6423, Institute for the Study of Labor.

Schneider, F. (2013), “Shadow Economy in Europe, 2013” http://www.protisiviekonomiji.si/fileadmin/dokumenti/si/projekti/2013/siva_ekonomija/The_Shadow_Economy_in_Europe_2013.pdf accessed on the 18th of July of 2014.

Schneider F. (2013), “Shadow Economy, Tax Evasion and Corruption in Portugal and in other OECD Countries: What can be done?” http://www.nipe.eeg.uminho.pt/Uploads/ShadPortugal_2013_Schneider.pdf accessed on the 14th of January of 2014.

Schneider F. (2013), “Size and Development of the Shadow Economies of Portugal and 35 other OECD Countries from 2003 to 2013: Some New Facts”, http://www.nipe.eeg.uminho.pt/Uploads/Semin%C3%A1rios%202013/2013-03-13_Schneider35otherOECD.pdf, accessed on the 12th of January of 2014.

Smith, P. (1994), “Assessing the Size of the Underground Economy: The Statistics Canada Perspective”, Statistics Canada, Catalogue No. 13-604-MIB.

Tanzi, V. (1983), “The underground economy in the United States: annual estimates”, 1930–1980. IMF Staff Papers 30, pp. 283–305.

Weale, M., (1992), “Estimation of Data Measured With Errors and Subject to Linear Restrictions”, Journal of Applied Econometrics, Vol. 7, pp. 167-174.

Appendix A: MIMIC model data, stationary and co-integration data

Table A.1. Data used in the MIMIC Model estimation for the SE, 1970-2013

Variable	Description	Measure	Sources	Notes	Jarque-Bera *p-value*
DTSSC	(Direct taxes + Social Security Contributions)/ GDP	%	Pordata	{[(Total direct taxes, value / Gross domestic product, deflator, market prices) + (Social security contribution received by general government, value / Gross domestic product, deflator, market prices)] / Gross domestic product, volume, market prices}*100	0,1271
IT	Indirect taxes/ GDP	%	Pordata	[(Indirect taxes, value / Gross domestic product, deflator, market prices) / Gross domestic product, volume, market prices] *100	0,0762
GE	Government expenditure/ GDP	%	Pordata	(Government expenditure, volume / Gross domestic product, volume, market prices) *100	0,0000
SUBSSC	(Subsidies+ Social security benefits paid by general government)/ GDP	%	Pordata	{[(Subsidies, value /Gross domestic product, deflator, market prices) + (Social security benefits paid by general government, value /Gross domestic product, deflator, market prices)] / Gross domestic product, volume, market prices}*100	0,0103
SEMP	Self-employment Rate	%	Pordata	(Total self-employed / Labour force)*100	0,0107
UR	Unemployment Rate	%	World Bank/ Pordata	(Total unemployed / Labour force)*100	0,0002
CURR	Notes and coins issued excluding those held by MFIs	per capita, thousands of euros of 2006	Banco de Portugal	(Notes and coins issued excluding those held by MFIs/Total population)/1000	0,0120
LFPR	Labour force Participation Rate	%	Pordata	(Total active people (+15 up to 65)/Total population)*100	0,0315
GDP	Real gross domestic product index	per capita, thousands of euros of 2006	Pordata	Gross domestic product	0,0922

Notes: the variables DTCSS for the year 1971, SEMP for the period of 1970-1974, UR for the period of 1970-1982, SUBCSS for the period of 1970-1979 and CURR for the period of 1970-1978 were estimated using the available data from the study of Afonso and Gonçalves (2009); the values of Jarque-Bera *p-value* were obtain through software *EViews* 8.

Table A.2. Stationary analysis

	Level				First difference			
	ADF		KPSS		ADF		KPSS	
Variable								
Cause	**C**	**C&T**	**C**	**C&T**	**C**	**C&T**	**C**	**C&T**
DTSSC	1,0000	0,9850	1,1609	0,2336	0,0024	0,0009	0,5618	0,1407
IT	0,3651	0,7349	1,0226	0,2631	0,0000	0,0000	0,2533	0,0529
GE	0,8958	0,5794	0,8982	0,1619	0,0000	0,0001	0,8982	0,1619
SUBSSC	0,9992	0,9916	1,0883	0,2098	0,0000	0,0000	0,4551	0,1722
SEMP	0,1321	0,6775	0,5079	0,2684	0,0000	0,0000	0,3698	0,0390
UR	0,9976	0,9982	0,4224	0,1479	0,0143	0,0625	0,2360	0,1212
Indicator								
CURR	0,9849	0,9922	0,4170	0,2586	0,0009	0,0027	0,3520	0,1116
LFPR	0,6057	0,4423	0,6382	0,1265	0,0000	0,0003	0,1624	0,1483
GDP	0,9898	0,5204	1,1634	0,1963	0,0146	0,0265	0,3037	0,2549

Notes: For the tests Augmented Dickey - Fuller (ADF) and KPSS, the p-values of MacKinnon (1966) are provided. To the autoregressive correction order of the ADF tests, the AIC modified criterion of Akaike was used and for the KPSS test, the critical values for the constant are 0,352; 0,472 and 0,721 for significance levels of 10%, 5% and 1% respectively. For the constant and trend, the critical values are 0,12; 0,149 and 0,212 for significance levels of 10%, 5% and 1% respectively.

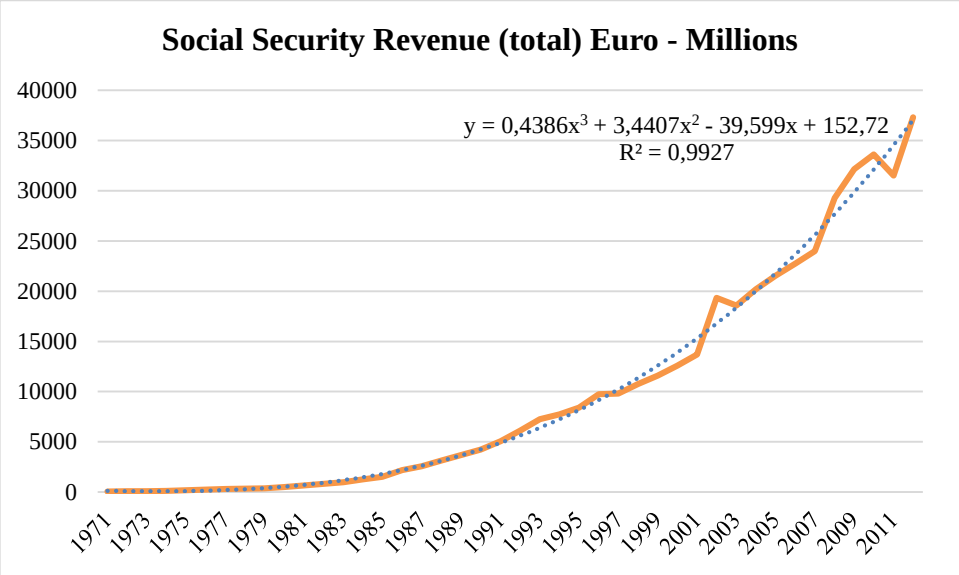
Table A.3. Co-integration analysis

Indicator	Causes (*p-values*)						Residual *t* Statistics
	DTSSC	**IT**	**GE**	**SUBSSC**	**SEMP**	**UR**	
GDP	(0,1438)	(0,4323)	(0,5081)	(0,1065)	(0,0403)	(0,0000)	-2,43449**
LFPR	(0,0038)	(0,0458)	(0,9605)	(0,0011)	(0,2801)	(0,0025)	-3,0008***
CURR	(0,0908)	(0,2584)	(0,4099)	(0,5577)	(0,7620)	(0,0025)	-1.90115*

Notes: As all variables are deviations from the mean the constant term was not included in the regression equations. The critical values of *t*-statistics were obtained from the econometric software Gretl. To a sample of 44 observations and 6 variables, the values are: 2.7194 (1% of significance***), 2.0280 (5% of significance**) and 1.6883 (10% of significance*). To the autoregressive correction order was used the augmented Dickey-Fuller (ADF) criterion.

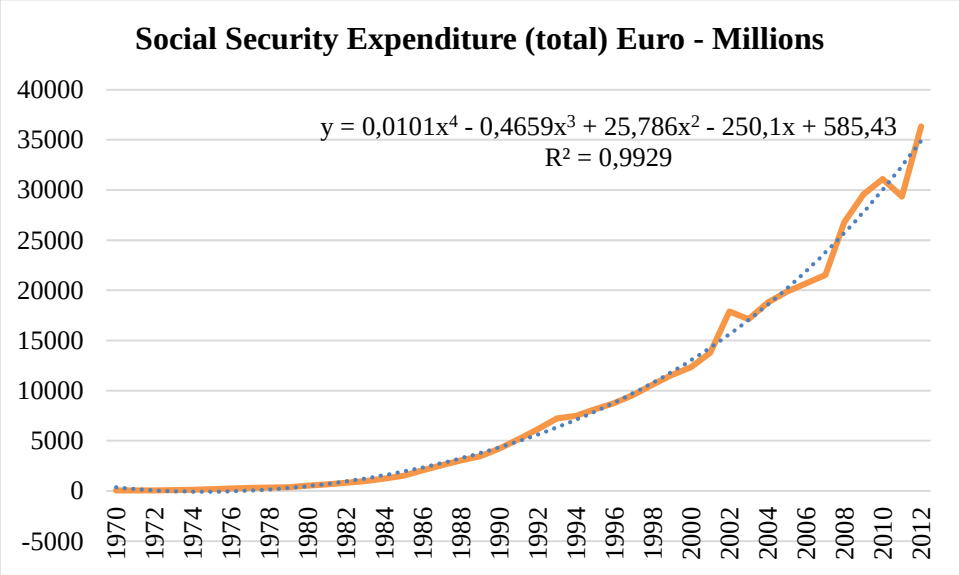
Appendix B: Estimations for the 2013 value

Figure B.1. Social Security Revenue - Estimation for the 2013 value



Source: Pordata

Figure B.2. Social Security Expenditure - Estimation for the 2013 value



Source: Pordata

Appendix C: ECM, MIMIC and other authors data

Table C.1. Size of SE (% of GDP) of Portuguese Economy, 1970-2013

Year	MIMIC 6-1-3	MIMIC 5-1-3b	MIMIC 5-1-3c	Average
1970	8,34	8,40	7,80	8,18
1971	8,64	8,68	8,33	8,55
1972	9,22	9,25	8,91	9,13
1973	9,42	9,46	9,03	9,30
1974	11,00	11,01	10,87	10,96
1975	10,87	11,03	10,82	10,91
1976	10,96	11,17	10,86	11,00
1977	10,78	11,03	10,56	10,79
1978	9,64	9,90	9,49	9,68
1979	8,67	8,94	8,64	8,75
1980	9,49	9,75	9,49	9,57
1981	10,84	11,06	10,75	10,88
1982	11,44	11,67	11,27	11,46
1983	12,83	12,95	12,42	12,74
1984	12,54	12,69	12,17	12,46
1985	11,93	12,22	11,98	12,04
1986	12,63	12,92	12,75	12,76
1987	14,00	14,18	14,55	14,24
1988	16,23	16,28	16,48	16,33
1989	17,52	17,53	17,43	17,49
1990	17,10	17,10	17,10	17,10
1991	18,68	18,60	18,59	18,62
1992	19,72	19,77	19,55	19,68
1993	18,75	18,97	18,81	18,84
1994	18,60	18,73	18,46	18,60
1995	18,53	18,63	18,30	18,49
1996	19,77	19,89	19,26	19,64
1997	19,85	19,64	19,38	19,62
1998	20,85	20,76	20,60	20,74
1999	20,95	21,02	20,84	20,94
2000	21,36	21,50	21,15	21,34
2001	21,00	21,17	20,98	21,05
2002	23,37	23,75	23,50	23,54
2003	21,90	22,07	21,89	21,95

2004	21,48	21,63	21,53	21,55
2005	21,57	21,68	21,57	21,61
2006	22,09	22,19	21,97	22,09
2007	22,13	22,85	21,95	22,31
2008	23,76	24,84	24,13	24,24
2009	23,50	23,64	23,71	23,61
2010	23,25	23,23	23,39	23,29
2011	22,55	22,44	22,25	22,42
2012	22,82	23,14	23,24	23,07
2013	25,40	26,04	25,43	25,62

Source: Own calculations

Table C.2. Size of SE (% of GDP) in Portugal between 1970-2013 – Several authors

Year	MIMIC Model	ECM Model	Average between MIMIC and ECM Model	Schneider	Afonso and Gonçalves
1970	8,18	9,31	8,75		9,31
1971	8,55	9,16	8,86		9,23
1972	9,13	9,03	9,08		9,85
1973	9,30	9,41	9,36		10,10
1974	10,96	10,10	10,53		12,36
1975	10,91	10,96	10,93		14,16
1976	11,00	11,66	11,33		15,87
1977	10,79	12,24	11,52		15,77
1978	9,68	12,56	11,12		16,13
1979	8,75	12,96	10,86		16,15
1980	9,57	13,31	11,44		17,04
1981	10,88	13,21	12,05		18,16
1982	11,46	13,66	12,56		17,67
1983	12,74	14,39	13,56		17,66
1984	12,46	14,88	13,67		18,02
1985	12,04	15,51	13,78		17,65
1986	12,76	15,85	14,31		17,67
1987	14,24	15,30	14,77		17,56
1988	16,33	15,54	15,93		17,32
1989	17,49	15,88	16,68	15,90	17,04
1990	17,10	15,53	16,32	15,90	17,10
1991	18,62	15,80	17,21	17,45	18,06
1992	19,68	16,11	17,90	19,00	18,62
1993	18,84	16,17	17,50	20,55	19,61

1994	18,60	15,82	17,21	22,10	20,36
1995	18,49	16,30	17,39	22,10	19,63
1996	19,64	16,57	18,11	22,60	20,08
1997	19,62	16,72	18,17	23,10	19,98
1998	20,74	16,88	18,81	23,10	20,24
1999	20,94	17,34	19,14	22,70	20,39
2000	21,34	17,69	19,51	22,70	20,47
2001	21,05	18,07	19,56	22,50	20,91
2002	23,54	18,64	21,09	22,40	21,28
2003	21,95	19,55	20,75	22,20	22,20
2004	21,55	20,01	20,78	21,70	22,13
2005	21,61	20,52	21,06	21,20	22,49
2006	22,09	20,89	21,49	20,10	22,30
2007	22,31	20,88	21,59	19,20	22,29
2008	24,24	20,67	22,46	18,70	22,53
2009	23,61	21,10	22,36	19,50	24,21
2010	23,29	21,49	22,39	19,20	24,80
2011	22,42	21,13	21,77	19,40	25,40
2012	23,07	20,95	22,01	19,40	
2013	25,62	19,23	22,43	19,00	

Source: Own calculations, Schneider (2005, 2013a), Afonso and Gonçalves (2009, 2012)