Advances in Management & Applied Economics, vol.1, no.2, 2011, 23-57
ISSN: 1792-7544 (print version), 1792-7552 (online)
International Scientific Press, 2011

The Portuguese Non-Observed Economy

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Abstract

This paper aims to contribute to a better understanding of the volume of the Non-Observed Economy (NOE) in Portugal, by estimating, based on MIMIC models (multiple indicators multiple causes), its path in the period 1977-2008. On the one hand, given the influence of the tax burden, the burden of regulation and the evolution of the labour market, and on the other hand its impact on monetary, labour market and production indicators, it is estimated that the weight of NOE as a percentage of official GDP in Portugal has grown from 19% in 1977 to 23% in 2008. In particular, it is observed that after a fall in the period 1977-1982, the NOE showed an upward trend in the subsequent period, which has stabilized at around 21% since 1994. However, from the end of 2007, there has again been an increase. Finally, results show that the growth of NOE in Portugal tends positively to affect the growth of the official economy.

JEL classification numbers: O17, C39, H10, H26

Keywords: Non-observed economy, Tax burden, Regulation, MIMIC model, Portugal

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Article Info: *Revised*: August 30, 2011. *Published online*:October 31, 2011

1 Introduction

In all countries of the world there is a part of the economy, let's call it the Non-Observed Economy (NOE), whose activities are not reflected in national accounts, and its size, causes and consequences differ from country to country. This phenomenon has been discussed in several studies (e.g., Tanzi, [30, 31]; Frey and Pommerehne, [6]; Witte, [32]; Schneider and Enste, [26]; Schneider, [22, 24]). Some of these studies focus more on the measure(s), others on the causes and others on the consequences.

Considering specific causes and consequences, Schneider [23], for example, noted that in 2001/2002 the average weight of the NOE as a percentage of official Gross Domestic Product (GDP) was 16.7% in 21 OECD countries and 38.0% in 22 developing countries. In line with Schneider [23], Schneider and Klinglmair [27] observed that in 1999/2000 the average size of the NOE as a percentage of official GDP was 41% in developing countries, 38% in transition countries and 18% in OECD countries. As a result of the existing studies, it is usually considered that the NOE value, as a percentage of official GDP, fluctuates between 15% in the most developed countries and 70% in some developing countries (e.g., Frey and Schneider, [7]). In any case, it is a significant value, which in turn is underestimated, since usually the existing studies only evaluate one or few items embodied in the concept of NOE.

Independently of what it intends to measure, the first step requires a precise definition of the phenomenon under evaluation. However, it is a difficult task to define correctly the NOE (i) because of the complexity of the phenomenon, (ii) because it is a reality in constant development in accordance with the "principle of running water" in particular it adapts to changes in taxes, to penalties imposed by the tax authorities, and to moral attitudes in general (e.g., Mogensen et al., [20]), and (iii) because it incorporates several economic activities – the report of the Organization for Economic Cooperation and Development (OECD), [21], includes illegal production, unreported (hidden or underground) production, informal

production (sector), household production for own final use and production missed due to statistical deficiencies.

Clearly this OECD report was based on the System of National Accounts (SNA93) and on the European System of National Accounts (ESA95), since, according to the SNA93 and ESA95, the use of the terms NOE, illegal, underground, informal, missed, are not a simple matter of nomenclature. This conclusion is obviously reached by exploring each of the components that the OECD considers covered by NOE.

Illegal production is characterized by goods or services whose production, sale and distribution are forbidden by law (illegal drugs for example) or that are legal but forbidden as to production and possession by unauthorized individuals (e.g., it is illegal to practice medicine without a license).

Underground production, hidden or unreported, is characterized by the production of goods or services that are deliberately not recorded (in part or at all) in order to avoid the payment of taxes or to avoid meeting certain legal standards (e.g., the payment of minimum wages, maximum permitted working hours, safety and health standards), or to comply with certain administrative procedures such as statistical questionnaires.

Informal production, or the informal sector, is characterized by the production of legal goods or services, by units that operate under poor organization and on a small-scale, without division (or with minimal division) between capital and labour inputs, whose main objective is to generate income and employment for the individuals involved. In this case, there is no intention to escape taxes or contributions, or to avoid meeting labour standards. In particular, unregistered activities conducted by craftsmen, farmers, domestic workers and small traders are included in this sector.

Household production for own final use is characterized by the production of goods or services to be consumed by those who produce them.

Finally, production that is not considered, due to statistical deficiencies, is characterized by productive activities that should be considered in national

accounts, but which are prevented from being for the above reason. This is mainly due to the non-coverage of all firms in the economy, the lack of transmission of information by companies and the existence of wrong information about the companies.

Schneider and Enste ([26] : 79) provide the following table to distinguish the NOE from the registered or official economy:

Table 1 – Taxonomy of underground economic activities

Kind of Activities	*Monetary Transactions*		*Nonmonetary Transactions*	
Illegal Activities	Trade in stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling and fraud; etc.		Barter: drugs, stolen goods, smuggling, etc. Producing 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

Since the various forms of production should be included in the estimates of GDP, the distinction for this purpose is not very important. However, between countries or in a country over time, the distinction between legal and illegal becomes relevant because it has an impact on the estimates, and can cause inconsistencies in terms of analysis.

Thus, the broader definition of NOE in the sense that it can cover all the sectors emphasized by the OECD [21] (or by Schneider and Enste, [26]), is the

one that encompasses all economic transactions that contribute to GDP, but which for various reasons are not taken into account. However, the studies generally consider as NOE only one or some of the components, and thus end up significantly underestimating the object of study. Indeed, it seems that the definition used in different studies on this subject tends to depend on the purpose of the study. It even appears that the activities of NOE particularly emphasized by several studies are related to underground production. Just to cite one example, this is the definition used by Smith [28].

In sum, although the NOE comprises several components, usually – certainly due to the complexity and dynamism of the subject – only part of the NOE tends to be evaluated. Moreover, studies on the NOE in Portugal and estimates of its size are scarce. In this respect we can cite Schneider and Enste [26], Schneider [25] and Dell'Anno [3], although the former have not focused only on Portugal but on a wide range of countries.

In this paper we aim to take the first steps in estimating the NOE in Portugal, but following existing studies. Thus we are aware that the results will reflect the problem assigned to the various studies on the subject: underestimation of the NOE. However, while the estimated value for the NOE in Portugal may not be sufficiently rigorous, by means of this first item of research we aim to understand the methodology underlying the MIMIC model (multiple indicators multiple causes) and obtain the trajectory of the NOE in Portugal.

For this purpose the study is organized as follows: section 2 presents the existing methods for measuring the NOE. In section 3 we proceed to develop an empirical model – identifying the specific problem to be estimated – and given the theoretical concepts introduced and specific econometric techniques adopted, to measure the weight of the NOE in Portugal. Section 4 concludes the study by presenting the main conclusions.

2 Existing Methods of Estimation

The NOE is a complex phenomenon that is not observed, and as such is difficult to measure. Attempts directly to estimate the size of the NOE are made through statistical surveys of households and individuals, through audits of company accounts, comparisons of surveys of income and expenditure of families, analysis of income statements and external signs of wealth. However, the accuracy of the results depends on how the survey or investigation is undertaken and on the cooperation and goodwill of the respondents, who may not want to admit but to conceal their involvement in illegal or fraudulent practices, so this approach tends to be inaccurate. So the question arises: how does one measure the "invisible"? By OECD [21] a distinction is made between three groups of statistical and econometric methods: (i) monetary methods, (ii) global indicator methods, and (iii) latent variable method(s). In this section we briefly describe these methods.

2.1 Monetary methods

The monetary methods establish relations between the official GDP and monetary variables and assume that developments in monetary variables that are not explained by the models are explained by the NOE. Three monetary methods can be identified: Transaction Method, Cash/Deposit Ratio Method and Cash Demand Method.

2.1.1 Transaction method

This method was developed by Feige [5] and has as its starting point the Fisher equation,

$$MV = PT \tag{1}$$

where the total stock of money, M, multiplied by the velocity of circulation, V, equals the total number of transactions paid by that money, T, multiplied by the price of these transactions, P. It is assumed that there is a constant relationship, k,

between the money flows related to these transactions and the total value added (Y_{total}):

$$P \cdot T = k \cdot Y_{total} \tag{2}$$

since, by definition, the total value added is the sum of the official value added ($Y_{official}$) and the underground value added (Y_{under})

$$M \cdot V = k \cdot (Y_{official} + Y_{under}) \tag{3}$$

and, therefore,

$$M_t \cdot V_t = k \cdot (Y_{official\,t} + Y_{under\,t}), \qquad t = 0,\ 1,\ 2,\ \ldots n \tag{4}$$

where t represents periods of time, usually years.

Knowing the stock of money, money velocity and official value added, and assuming as known the ratio of NOE in the official economy in a base year - Feige [5] assumes that in the base year there was no NOE - the component NOE can be calculated for all subsequent years.

This method raises several problems. First, it is based on a constant ratio of currency transactions to official GDP, but there are transactions in currency that are not related to the generation of income and are included in the calculations. Furthermore, it considers that in the base year there was no NOE (or NOE takes a particular value).

2.1.2 Cash/Deposit ratio method

Derived from the model introduced by Cagan [1] (cash demand method) which calculates the correlation between money demand and the pressure of taxes in the United States (U.S.) in the period 1919-1955, the cash/deposit ratio method was used by Gutmann [12]. In this study, the author only paid attention to the cash/deposit ratio in the period 1937-1976 and therefore did not use statistical procedures. According to Gutmann [12], the cash/deposit ratio is only affected by regulatory changes or changes in the tax level. The main reason for the change in patterns of behaviour in payments is due to agents that want to hide certain

activities and to evade regulations and taxes. Therefore, the cash/deposit ratio is used to calculate the size of the NOE.

For that purpose Gutmann [12] considered that in the period immediately preceding the Second World War (1937-1941) there was no NOE. The relative increase in currency in circulation since then would be assigned only to the growth of NOE, assuming that the velocity of circulation is the same both in the NOE and the official economy. Obviously this logic contradicts the common sense notion that in war time there is a larger NOE (because of price controls and other restrictions, or because tax rates are higher). The assumptions made by Gutmann [12] have been criticized, for example, by Garcia [10], who considers that there exist more important reasons for justifying changes in the ratio.

2.1.3 Cash demand method

Also following Cagan [1], Tanzi [29, 30], in contrast to Gutmann [12], assumes that money demand is affected not only by changes in regulations or in the level of taxes, although he agrees that changes in the total amount of money due to such factors demonstrate the existence of NOE. In order to isolate the influence of regulation and taxation, Tanzi considers that the demand for cash as a proportion of total money, *C/M2*, is a function of the weighted average rate of taxes, *TW*, the share of wages and salaries in total personal income, *WS/Y*, the interest on fixed term deposits, *R*, and per capita real income, *Y/N*:

$$\ln\left(C/M2\right)_t = \beta_0 + \beta_1 \ln(1+TW)_t + \beta_2 \ln(WS/Y)_t + \beta_3 \ln R_t + \beta_4 \ln(Y/N)_t + u_t$$
$$\beta_1,\ \beta_2,\ \beta_4 > 0,$$
$$\beta_3 < 0 \qquad (5)$$

By analyzing the results of the regression, we can estimate the NOE initially by comparing the cash demand when the regulation and taxes are at their lowest level with the cash demand at the current high levels of regulation and taxes. The size of the NOE is calculated by assuming that the velocity of money is equal both in the NOE and in the formal economy.

Although widely used, this method is criticized, for example, due to the fact that not all transactions in the NOE are paid in cash and the speed of money circulation is not the same in the two economies. The monetary methods being based on assumptions that cannot be justified, the results are sensitive to the assumptions of the base year, and as these results are presented according to several different methods, they are generally considered less suitable for estimating the NOE.

2.2 Global indicator methods

To measure the total economic activity of an economy, Kaufmann and Kaliberda [15] proposed the method of calculating electricity consumption, which is the most prominent example of the global indicator approach.

This model assumes a precise and stable relationship between electricity consumption and output, electricity consumption being the physical indicator of economic activity as a whole. If we have an approximation of the product of the economy as a whole, by subtracting from this the estimated official GDP we get an estimate of the NOE. However, not all NOE activities require a considerable amount of electricity (e.g., services) and other energy sources can be used, so the NOE estimates are biased. In activities such as agriculture the relationship between electricity consumption and GDP is not stable because this activity depends on the weather. With technological progress, the use of electricity is more efficient than in the past in both NOE and the official economy.

Lackó [16, 17, 18] develops this method, assuming that some part of the NOE is associated with household electricity consumption, and thus considers household production, do it yourself activities, and other non-registered production and services. Lackó assumes that in a country where the part of the NOE associated with the household electricity consumption is high, then the rest of the NOE will also be high. This problem is translated into two equations:

$$\ln E_i = \alpha_1 \ln C_i + \alpha_2 \ln PR_i + \alpha_3 G_i + \alpha_4 Q_i + \alpha_5 H_i + u_t$$
$$\alpha_1,\ \alpha_3,\ \alpha_5 > 0,$$
$$\alpha_2,\ \alpha_4 < 0 \qquad (6a)$$

$$H_i = \beta_1 T_i + \beta_2 (S_i - T_i) + \beta_3 D_i$$
$$\beta_1,\ \beta_3 > 0,$$
$$\beta_2 < 0 \qquad (6b)$$

where: i indicates the country, E_i assesses the per capita domestic electricity consumption in Mtoe, C_i is the per capita real consumption of households (excluding the consumption of electricity in U.S. dollars (PPP)), PR_i is the real price of electricity consumption per unit (1 kWh) for households in U.S. dollars (PPP), G_i is the relative frequency of months with the need to heat houses in country i, Q_i is the ratio of energy sources other than electricity to all energy sources in household energy consumption, H_i is the per capita product of NOE, T_i is the ratio of the sum of wages, corporate profits and taxes on goods and services to GDP, S_i is the ratio of public social welfare expenditure to GDP, and D_i is the sum of the number of dependents over 14 years and inactive earners (both for 100 active earners).

In the estimation of (6a), H_i is replaced by (6b). To calculate the current size of the NOE, as the (amount of) GDP generated by a unit of electricity in NOE for each country is not known, data from other estimates for a country with a market economy were used, and divided into appropriate proportions for different countries.

Thus, the econometric results obtained can be used to establish a relationship between electricity consumption of a country and the size of its NOE. However, this method is subject to criticism: (i) not all activities of the NOE are developed only in the household sector, (ii) not all activities of the NOE require the same amount of electricity, (iii) other sources of energy can be used, (iv) there are doubts concerning the use of other indicators to measure the NOE - for example, the ratio of public social welfare expenditures to GDP, particularly in developing or transition countries.

2.3 Latent variable method

The models described above assume that the NOE could be modeled by a small number of specific variables, ignoring the circumstances and information that lead to its existence. Based on the statistical theory of unobserved variables, the latent variable method introduced by Frey and Weck-Hanneman [8, 9] considers multiple causes and multiple indicators of the NOE.

The size of the NOE is estimated based on developments in the variables which on the one hand affect the size and output growth of the NOE, and which on the other hand are the tracks of the NOE's activities in the official economy. This method uses a technique that allows a traverse analysis of the relationship between a dependent unobserved variable and one or more independent observed variables. As the unobserved variable is not known, it is replaced by a set of indicators. This methodology can be used to estimate the relative size of the variable that is not observed for several countries or time periods. To estimate the current size, a base estimate is necessary for the various countries or time periods.

Frey and Weck-Hanneman [8], for example, define as explanatory variables of the NOE's size the current tax burden, the perception of tax burden, the unemployment rate, the bureaucracy, the attitude of economic agents in the face of (the need to make) tax payments, and the per capita income. As regards the track of the NOE's activities within the official one, they define as indicators the participation rate of the male population in the workforce, the number of hours worked per week and the GNP growth rate. This method has been particularly criticized for the independent variables chosen, for the difficulty in quantifying certain variables (e.g., the attitude of economic agents faced with tax demands), and because the results are very unstable.

To conclude the methods presentation, it can be said that each method has its specific strengths and weaknesses. As suggested by the OECD, the revised methods raise serious doubts in relation to their usefulness for any purpose in which precision is important.

3 Empirical Application

As already stated in the previous section, despite the latent variable method having some limitations in estimating the size of NOE, it is the only one that takes into account:

(i) multiple causes that lead to the existence and growth of NOE;

(ii) multiple NOE indicators over time.

This method is usually referred to as the MIMIC model.

3.1 MIMIC model

The MIMIC model was initially proposed by Zellner [33] and Hauser and Goldberg [13] among others, and received this designation by Jöreskog and Goldberger [14]. In these studies, however, the application of the methodology was not in the measurement of NOE. Frey and Weck-Hanneman [8, 9] pioneered the use of this model to estimate the size of the NOE, their study having been directed to OECD countries.

Following Frey and Weck-Hanneman [9], Giles [11], Schneider [24] and Dell'Anno [2, 3], we use the MIMIC model to estimate the size of the NOE in Portugal. As was implicit in the previous section, the MIMIC model is a structural econometric model that treats the size of the NOE as an unobserved latent variable.

Being aware that it was not described in the previous section, we begin with a brief presentation. The model is a member of the LISREL (Linear Structural Relationships Interdependent) family of models and is divided into two parts, a measurement equation and a structural equation. The measurement part relates the unobserved variables to the indicators (which are observable). The structural equation component specifies the relationship between the unobservable variables and their causes. In our case we have only one unobserved variable, the size of the NOE, S, and it is assumed that it is influenced by a set of exogenous causes, C_1,

C_2, …, C_n, subject to a disturbance μ,

$$S_t = \beta_1 C_{1t} + \beta_2 C_{2t} + ... + \beta_n C_{nt} + \mu \quad (7)$$

We also assume another set of variables as indicators of the NOE's size, I_1, I_2, …, I_m, which capture the NOE's effects on variables that may be useful in predicting its size and future growth. The unobserved variable, by determining this set of endogenous indicators, is subject to a random disturbance/measurement error, ε_1, ε_2, …, ε_m,

$$I_{1t} = \lambda_1 S_t + \varepsilon_1 \quad (8a)$$

$$I_{2t} = \lambda_2 S_t + \varepsilon_2 \quad (8b)$$

$$I_{mt} = \lambda_m S_t + \varepsilon_m \quad (8c)$$

Both the structural disturbances μ and the measurement errors ε are normally distributed, mutually independent, and an expected value of zero is admitted in all variables.

The interaction over a period of time between the causes C_{it} (i = 1, 2, …, n), the size of the NOE, S_t, and its indicators I_{jt} (j = 1, 2, …, m) is shown in Figure 1.

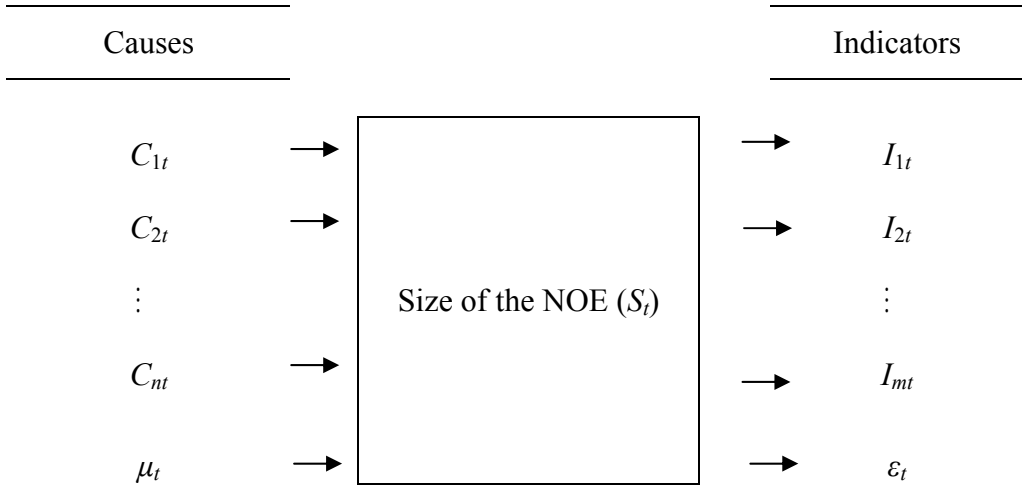


Figure 1: MIMIC model – size of the NOE as an unobserved variable

By introducing the vectors: $\mathbf{C} = (C_1, C_2, \ldots, C_n)'$, observable exogenous causes; $\boldsymbol{\beta} = (\beta_1, \beta_2, \ldots, \beta_n)'$, parameters of the structural model; $\mathbf{I} = (I_1, I_2, \ldots, I_m)'$, observable endogenous indicators; $\boldsymbol{\lambda} = (\lambda_1, \lambda_2, \ldots, \lambda_m)'$, parameters of the measurement model; $\boldsymbol{\varepsilon} = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_m)'$, measurement errors; $\boldsymbol{\theta} = (\theta_1, \theta_2, \ldots, \theta_m)'$, standard errors of ε, we can rewrite the equations (7) and (8) as,

$$S = \beta' C + \mu \tag{9}$$

$$I = \lambda \cdot S + \varepsilon \tag{10}$$

It is assumed that $E(\mu\varepsilon') = 0$ and defined $E(\mu^2) = \sigma^2$ and $E(\varepsilon\varepsilon') = \Theta^2$, where Θ is the diagonal matrix m x m, with θ (standard errors vector of the measurement errors ε) disposed in the diagonal.

The model can be solved in the reduced form, as a function of the observed variables,

$$I = \lambda(\beta' C + \mu) + \varepsilon = \Pi' C + v \tag{11}$$

where the coefficient matrix of the model in the reduced form is given by:

$$\Pi = \beta\lambda' \tag{12}$$

and the disturbance vector by:

$$v = \lambda\mu + \varepsilon \tag{13}$$

where its covariance matrix is defined as:

$$\Omega = E(vv') = \sigma^2 \beta\beta' + \Theta^2 \tag{14}$$

The assumption that the disturbance term μ and the measurement errors ε are independent is crucial to ensuring the quality of results (e.g., [3]).

3.2 Causes and indicators of the NOE

There is a vast literature on the possible causes and indicators of the NOE. For a more comprehensive view on the causes and consequences of the NOE the works of Schneider and Enste [26] and Schneider [24] are a reference. The variables used in this study as causes and indicators of NOE were therefore determined by taking into account the theory and the data available for Portugal.

In order to identify more effectively the causes of NOE, one must question the motivation of economic agents, and to this end the costs and benefits of transition from the official to the NOE should be identified. One can distinguish between four types of causes:

(i) Tax burden – the increase in the tax burden and contributions to social security are appointed by the majority of NOE studies as a major cause (e.g., Frey and Weck-Hanneman, [8]; Loayza, [19]; Tanzi, [31] and Schneider, [22, 25]). As explained by Schneider and Enste [26], taxes affect the time that the individuals of a given economy are willing to spend on working and also stimulate labour supply in the NOE. The greater the difference between the total cost of work in the formal economy and labour income after taxes, the greater the incentive to join the NOE, reflecting the difference-generally the burden of taxes and deductions for Social Security. Measured by the weight of taxes (sum of direct and indirect taxes and contributions to social security) to GDP, it is assumed as a hypothesis that an increase in the tax burden encourages the agents to enter into the NOE.

(ii) Regulation burden – as stated by Tanzi [30], the intensity of regulation, when over-weighted, leads individuals to opt more willingly for the NOE. The weight of the State in the economy offers an approach to the regulation burden existing in a country. To represent the regulation burden we use the variables "Government workforce" – measured by the ratio of the public sector workforce in the total labour force – and "Government expenditure" – measured by the weight of government consumption on GDP. The greater the regulation burden on the economy, the greater the incentive to opt for the NOE. However, it is considered that since the State is only supplied by legal activities, a State that has a very high consumption level in GDP will certainly lead the agents to decide to maintain activity in the formal economy in order to do business with the State. In this case the consumption of GDP is expected to negatively influence the size of the NOE.

(iii) Labour market evolution – this is divided into two variables, the first being "Self-Employment". As stated by Dell'Anno [3], for example, professional

incomes and self-employment incomes are under-declared to the authorities. This is due to the passing off of personal expenses as work costs, the simplified accounting system (in the Portuguese case), and the fact that it is easy to reach agreement with customers not to give any receipt and not to declare the income. Measured by the percentage of self-employed in the total labour force, it is expected that an increase in this variable positively influences the size of the NOE. The second variable is "Unemployment rate". In the literature the assumption is often made that the incentive to work in the NOE is higher for an unemployed individual. He can take advantage of the income associated with unemployment benefit and earn extra income in the NOE. However, for someone who maintains a job both in the formal economy and NOE, this variable fails to have a positive relationship with the size of NOE. Given this fact, the unemployment rate can be considered a weak indicator in the explanatory power of the NOE. It is also worth pointing out that depending on the culture, education and preference of individuals, when they are unemployed they may show preference for a job in the formal economy in order to be covered by social security benefits and not be penalized in future situations such as upon retirement. Thus, when unemployed, individuals focus their efforts on finding a job in the formal economy. Once they are employed in the formal economy, according to their preferences and availability, they may seek a job in the NOE to maximize their income. Thus we cannot speculate on the sign of this variable.

Moreover, a change in the size of the NOE can be reflected in the following indicators:

(i) Development of monetary indicators - if the activities in the NOE increase, the demand for money will be higher, as suggested by the monetary methods. Usually the demand for money as a proportion of the total amount of money in the economy (C/M2) is used as an indicator. However, following Dell'Anno [2], only the growth rate of the currency in circulation outside banks will be used.

(ii) Development of the labour market – an activity increase amongst

employees in the NOE results in a participation decrease in the formal economy, measured by the rate of participation in the workforce.

(iii) Development of the production market - the NOE's growth implies that the inputs of labour and capital into the formal economy move, at least partially, to the NOE. This can lead to a decrease in accumulation of capital stock and hence the growth rate of real official GDP is negatively affected. This hypothesis can be contradicted if the NOE and official economy act in a complementary fashion; in this case, an increase in NOE would lead to an increase in official GDP. As the latent variable NOE is not measurable, the variable growth rate of official GDP is used as a scale/reference variable. For this effect it is necessary to determine what the unit of measurement should be. Following several authors who have estimated the NOE through MIMIC models, the coefficient λ of the measurement equation associated with the official GDP growth is set at a non-zero value. It will be fixed at a positive or negative unit in order for it to be easier to establish the relative magnitude of other indicator variables. Following Dell'Anno [2], a "reductio ad absurdum" methodology is used to determine the sign of the coefficient of scale. As the author explains, in a MIMIC model the vector of structural coefficients is proportional to the coefficient of scale. When this variable is set as a variable of scale, it is implied that the effects of NOE are measured in terms of official GDP. In this case it is accepted as a hypothesis that the formal economy and NOE are perfectly complementary, and thus we assume a coefficient of scale equal to 1. The production market indicator is divided into two: half-yearly growth rate of GDP and half-yearly growth rate of gross capital formation.

3.3 Data and MIMIC model estimations

In the treatment of variables the half-yearly data of the Portuguese economy were used, from the first half of 1970 to the second half of 2008 for most of the variables (78 observations). The sources of data and concrete specification of the

variables are summarized in Table A.1 in Appendix A.

The base MIMIC model used was a 5-1-4 (five causes, one latent variable and four indicators), represented in Figure 2, which was modified by omitting the statistically insignificant variables, in order to optimize the model.

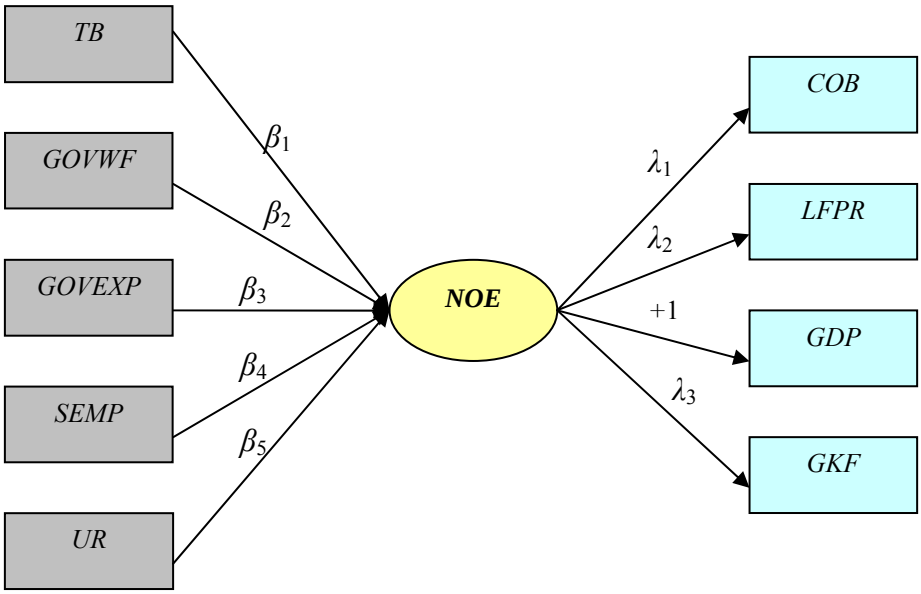


Figure 2: MIMIC model 5-1-4

We start the data treatment by testing its (non) stationarity. In order to eliminate non-stationarity the first difference in variables TB, GOVWF, GOVEXP, SEMP, UR and LFPR, is considered, along with the first difference of the logarithm of the variables COB, GDP and GKF. The software Eviews 6 was used to perform the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The results are shown in Table B.1 of Appendix B.

Univariate and multivariate normality tests were carried out, and presented in Appendix C. In line with Dell'Anno [2] and Dell'Anno et al. [4], the assumption that the variables are (multivariately) normally distributed is important in order to preserve the statistical properties of estimators. In particular, if this condition is lacking, then the maximum likelihood estimators may produce biased standard

errors and ill-behaved chi-square test of overall model fit. The tests showed that the variables TB, GOVWF, SEMP, UR and LFPR, after correction for non-stationarity, were not univariately normally distributed (Table C.1), and the variables in the MIMIC 5-1-4 model base were not multivariately normally distributed (Table C.2). In order to rectify this, we used the function Normal Scores of software LISREL 8.80 for the variables mentioned above. After this correction, the variables in the base model were already multivariately normally distributed (Table C.3).

Once the data corrections had been completed the MIMIC models were estimated. The coefficients, estimated according to maximum likelihood, are presented in Table 2. The coefficients of the causes listed in Table 2 can be directly compared in order to assess the weight of these variables in the formation of NOE, since they are defined in the same unit (percentages). Starting with a MIMIC 5-1-4 model and iterating some non-significant variables, several alternative models can therefore be presented. Basing our decision on the significance of the variables and on the Chi-square test (which indicates the overall model fit), we use the models MIMIC 5-1-3, MIMIC 4-1-3 and MIMIC 4-1-2.

3.4 NOE in Portugal

Following Dell'Anno [2, 3] and Dell'Anno et al. [4], to determine the size of the NOE an index is calculated using an existing estimation of the NOE for a base year. First, however, the index of changes in the NOE as a percentage of GDP is calculated through Equation (15):

$$\frac{\hat{S}_t}{GDP_I} = \hat{\beta}_1 C_{1t} + \hat{\beta}_2 C_{2t} + \hat{\beta}_3 C_{3t} + \hat{\beta}_4 C_{4t} + \hat{\beta}_5 C_{5t} \qquad (15)$$

where GDP_I is the official GDP in the base year. This index would be converted into a time series at its "initial level" by integration, but as in this case all variables

Table 2 –MIMIC models and estimated parameters

Models	Causes					Indicators			Chi-square (p-value)	RMSEA (p-value)	Df
	TB	GOVWF	GOVEXP	SEMP	UR	COB	LFPR	GKF			
MIMIC 5-1-4	0.0661* (1.5036)	0.0028* (1.4880)	-0.0364 (-1.1561)	0.0508** (1.8274)	-0.0188*** (-2.8927)	0.1785 (0.3662)	0.5232 (0.8551)	-1.6050* (-1.6470)	17.19 (0.44126)	0.014 (0.6057)	17
MIMIC 5-1-3	0.0692* (1.5489)	0.0027* (1.4060)	-0.0405* (-1.2836)	0.0541** (1.9483)	-0.0189*** (-2.8641)	-	0.5541 (0.8920)	-1.6344** (-1.6789)	6.30 (0.78967)	0.000 (0.8612)	10
MIMIC 5-1-2	0.0725** (1.6251)	0.0025 (1.2745)	-0.0367 (-1.1662)	0.0525** (1.8694)	-0.0190*** (-2.9244)	-	-	-1.5405* (-1.5702)	2.76 (0.59802)	0.000 (0.6664)	4
MIMIC 4-1-3	0.0762* (1.6398)	-	-0.0461* (-1.4997)	0.0545** (1.9093)	-0.0194*** (-2.8447)	-	0.4598 (0.7311)	-1.4197* (-1.4133)	5.73 (0.67700)	0.000 (0.7639)	8
MIMIC 4-1-2	0.0777** (1.6839)	-	-0.0425* (-1.4038)	0.0529** (1.8353)	-0.0193*** (-2.8641)	-	-	-1.3796* (-1.3588)	2.45 (0.48463)	0.000 (0.5503)	3

Notes: *, ** e *** indicate that the estimated coefficients are statistically significant at 10%, 5% and 1% respectively; *t* statistics are presented in brackets.
Software used: *LISREL 8.80*

are in the same degree of differentiation this method is similar to calculating the latent variable by multiplying the structural coefficients by the original data (without treatment).

In order to obtain the values of NOE in terms of official GDP, a previously known value, an exogenous estimate of NOE, is required. In order to obtain a better benchmark, a base year was chosen for which NOE's estimates are available, obtained by several methods.

For the Portuguese case, despite the lack of studies and the difficulty in obtaining estimates of the NOE, the year 1990 was selected and the data are presented in Table 3:

Table 3: NOE in Portugal in year 1990

Year	Estimation Method	Estimate (%)
1990	Physical Input	16.8[1]
Average 1990-93	Currency Demand Method	15.6[1]
Average 1989-90	Currency Demand and DYMIMIC	15.9[2]
Average 1989-91	MIMIC	20.2[3]
	Average 1990	17.1

Sources: [1] Schneider and Enste ([26]: 102);
[2] Schneider ([24]: 611);
[3] Dell'Anno ([3]: 267)

The index is scaled to take into account the value of 17.1% in 1990 and transformed from changes compared to 1990 into a time series of the NOE/GDP ratio. For each year we get the index NOE/GDP ratio through Equation (16):

$$\frac{\widehat{S}_t}{GDP_I} = \hat{\beta}_1 C_{1t} + \hat{\beta}_2 C_{2t} + \hat{\beta}_3 C_{3t} + \hat{\beta}_4 C_{4t} + \hat{\beta}_5 C_{5t} \qquad (16)$$

where $\widehat{S}_t / GDP_{1990}$ is obtained by (15); $\widetilde{S}_{1990} / GDP_{1990}$ is the exogenous estimation

of NOE and in this case is equal to 17.1%; $\left(\widehat{S}_{1990}/GDP_{1990}\right)^{-1}$ is the index value obtained in (15) for 1990; GDP_{1990}/GDP_t is the ratio used to convert the index of change of NOE as a percentage of GDP into a time series of NOE/current GDP; $\hat{S}_t/GDP_t$ is the estimated value of NOE as a percentage of official GDP. After applying this methodology to the selected MIMIC models, an average of the three indexes of NOE was arrived at, summarized in Table 4. The half-yearly results for the period 1977 to 2008 are presented in Table D.1 of Appendix D.

Table 4: NOE (as a % of official GDP) in Portugal, 1977-2008

Year	1977-80	1981-84	1985-88	1989-92	1993-96	1997-00	2001-04	2005-07	2008
NOE	16.9%	14.3%	16.0%	17.5%	21.3%	21.5%	21.4%	21.5%	22.8%

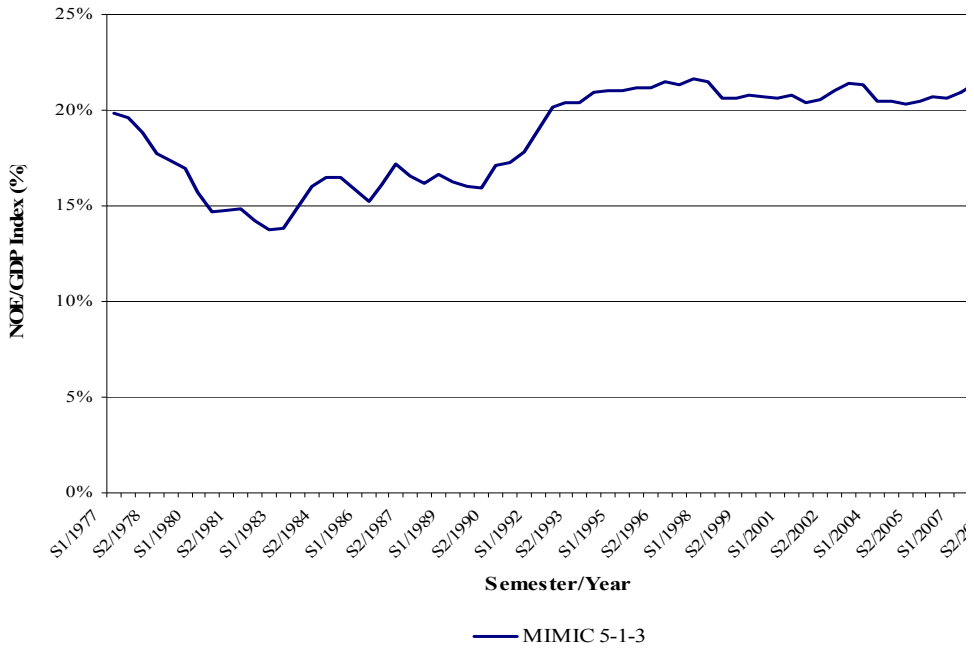
Source: Authors calculation based on used methodology – MIMIC Model.

Figure 3 below shows the evolution of NOE in the selected MIMIC models and Figure 4 shows the evolution of the average NOE for the period 1977-2008. As can be seen in this chart the weight of NOE in official GDP increased from 19% in 1977 to 23% in 2008. After the fall recorded in the period 1977-1982, NOE showed an upward trend in the subsequent period, stabilizing at around 21% from 1994. However, from late 2007, there was again a growth pattern, and in 2008 NOE reached the highest value of the entire period under study, 23% of official GDP.

Although statistically significant, it is necessary carefully to analyze the causes of NOE, because some show unexpected signs. The tax burden (TB) presents a positive signal confirming the theoretical assumptions.

The variables government workforce (GOVWF) and government expenditure (GOVEXP) indicate the degree of economic freedom and the burden

of the public sector in the economy. The first of these proved insignificant and carried little weight in the explanation of the NOE and was therefore removed from the model. The second presented a negative sign, something which was unexpected, but in accordance with the explanation suggested. In fact, it demonstrates that the State plays a considerable part in the economy, but the increase in government expenditure has the effect of reducing the size of NOE. As suggested, since the State is supplied only with legal activities, a State that has very high ratio of the government consumption on GDP will certainly lead the agents to decide to maintain their activity in the formal economy. Perhaps this is an explanatory factor regarding this signal, but nevertheless one that should be read with caution.



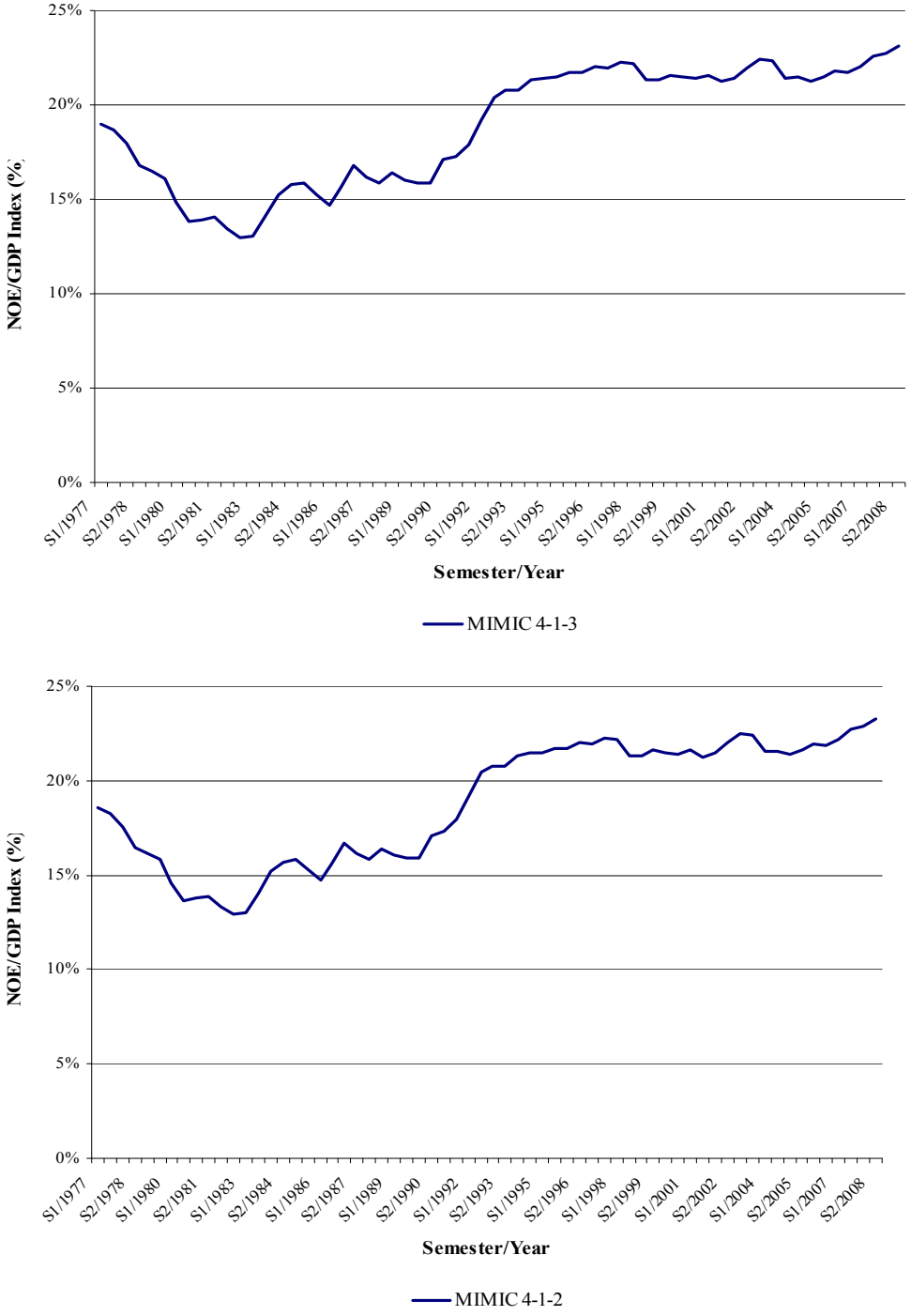


Figure 3: Portuguese NOE evolution: MIMIC 5-1-3, 4-1-3 and 4-1-2

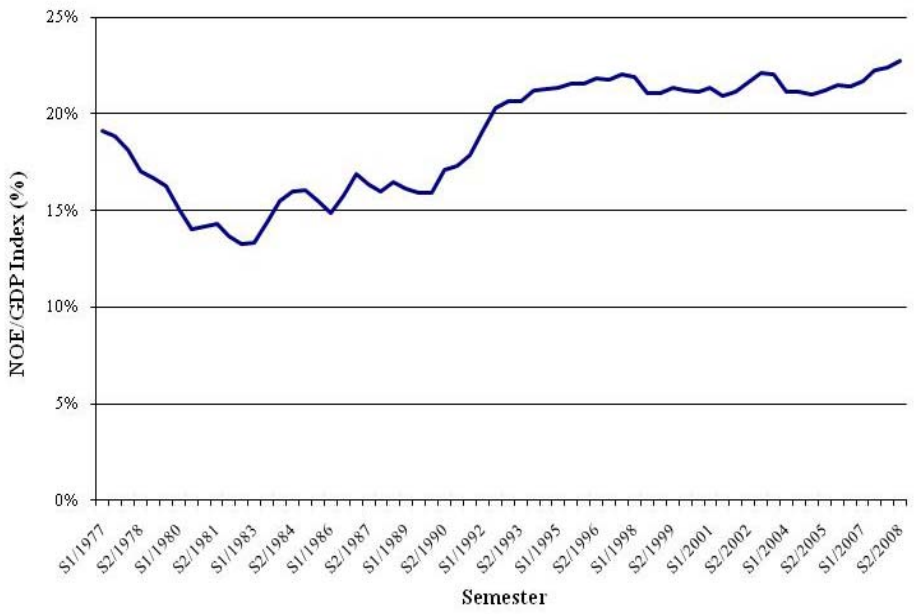


Figure 4: Portuguese NOE as a percentage of official GDP

The cause self-employment (SEMP) and unemployment rate (UR) represent the labour market. The first, with a positive sign, confirms the assumption made that professional incomes and incomes of the self-employed are under-declared to the tax authorities. The unemployment rate presented a negative sign and is statistically significant. The explanation (for this), in line with what was argued, is that the unemployed prefer to have a job in the formal economy in order to be covered by social security (and unemployment) benefits and also because the social income received while on the unemployment register in Portugal is low on average and very temporary. In Table 5 one can see this pattern in the active Portuguese population. However, this analysis does not invalidate what was said before: for someone who maintains a job both in the formal economy and in the NOE, this variable does not explain its relationship with the size of the NOE.

In order to take a closer look at the underlying causes in the pattern recorded in the NOE, in Table 5 we present a comparison of growth rates of the NOE (and causes) with those in the official GDP. Special attention should be given to the

period 1977-82. This cannot be interpreted directly, as Portugal had just emerged from the (effects of the) revolution of April 1974 and was preparing to join the then European Economic Community. Thereafter, the country adopted economic measures to meet the criteria for membership. A set of economic measures that should have had a major impact on the variables' growth rate in this period was adopted, which aimed to combat tax evasion. Included in the Economic and Social Policy Program of the first provisional government after the revolution was the adoption of standard charts of accounts for companies, which meant that during this period incomes that had not previously been considered were included in the national account. Hence, the tax revenue increased, and because some incomes previously not registered were now considered, NOE correspondingly decreased.

Table 5: NOE and its causes and official GDP growth analysis

Year	1977-82	1983-93	1994-06	2007-08
NOE/GDP	-5.9%	3.3%	0.04%	2.3%
TB	17.2%	12.8%	4.2%	3.9%
GOVWF	3.0%	2.4%	-1.2%	-6.2%
GOVEXP	1.8%	1.1%	0.01%	-0.7%
SEMP	-3.4%	0.3%	-1.4%	-3.1%
UR	-0.4%	-2.5%	1.1%	-0.4%
GDP	2.7%	2.9%	2.3%	0.3%

4 Conclusion

In this initial study the authors have aimed to make a first contribution to a better understanding of the NOE in Portugal, using, in line with the dominant literature on the subject, MIMIC models for the period 1977-2008.

The results show that the proportion of NOE in the official GDP has increased from 19% in 1977 to 23% in 2008. After the fall recorded in the period

1977-1982, NOE showed an upward trend in the subsequent period and stabilized at around 21% from 1994 (onwards). However, from the end of 2007 there was again growth pattern, and in 2008 the NOE reached the highest value of the entire period under scrutiny, 23% of (the) official GDP.

Another interesting result positively relates the growth of the NOE in Portugal to its official GDP growth. This conclusion follows from the signal associated with the coefficient of scale obtained via "reductio ad absurdum". However, given the ambiguity of this issue in the literature, more research in this area is needed.

The NOE values obtained should be read as an approximation rather than an exact value: (i) because the results depend on the variables used as indicators and causes, so it must be taken into account that this is a highly complex and constantly developing reality in accordance with the "principle of running water" – linked in particular to changes in taxes, sanctions imposed by tax authorities and moral attitudes in general; and (ii) because of limitations imposed by the MIMIC model.

In this sense, the authors' objective in terms of further research is to develop a method for estimating NOE which is able to overcome the limitations of the MIMIC model and to address the complexity and mutations in the NOE. Furthermore, the measurement and trajectory of the NOE are calculated in aggregate terms; however, it is considered desirable to disaggregate the data in space regions and in economic sectors.

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Appendix A: Data Sources

Table A.1: Data Sources

Variable	Description	Periodicity	Source	Variable after treatment
TB	(direct taxes + indirect taxes + contributions to social security) [1] / GDP	Half-yearly 1S/1977-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1st Difference "Normal Scores" [2] 63 Observations: 2S/1977-2S/2008
GOVWF	General government employment / total labour force	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1st Difference "Normal Scores" [2] 63 Observations: 2S/1977-2S/2008
GOVEXP	Government final consumption expenditure / GDP	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1st Difference 63 Observations: 2S/1977-2S/2008
SEMP	Total self-employed / total labour force	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1st Difference "Normal Scores" [2] 63 Observations: 2S/1977-2S/2008
UR	Unemployment rate	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1st Difference "Normal Scores" [2] 63 Observations: 2S/1977-2S/2008
COB	Currency outside banks	Half-yearly 1S/1970-2S/2008	IMF - International Financial Statistics Bank of Portugal	1ª Difference of the Logarithm 63 Observations: 2S/1977-2S/2008
LFPR	Labour force participation rate	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1st Difference "Normal Scores" [2] 63 Observations: 2S/1977-2S/2008
GDP	GDP, volume, at the price levels and PPPs of 2000 (USD)	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1ª Difference of the Logarithm 63 Observations: 2S/1977-2S/2008
GKF	Gross Capital Formation	Half-yearly 1S/1970-2S/2008	OECD Statistical Compendium, ed. 01#2009 - General Economic Problems	1ª Difference of the Logarithm 63 Observations: 2S/1977-2S/2008

[1] These variables are not observed half-yearly, we just had the values for the year. Taking the series half-yearly Private Consumption was deduced that, on average, the total annual private consumption is divided by 49% in the 1st half and 51% in the 2nd half of the year. These percentages were used to calculate the values of the tax burden at the end of the 1st half using the following formula: $TAX_n(1ºs)=\{[TAX_n(2ºs)- TAX_{n-1}(2ºs)]*0,49\}+TAX_{n-1}(2ºs)$.

[2] Function "Normal Scores" of the LISREL 8.80 software, used to normalize the variables.

Appendix B: Stationarity Analysis

Table B.1: Stationarity Analysis[1]

Causes		ADF			PP		
		C	T & C	None	C	T & C	None
TB	Level	0,9985	0,1178	0,9991	0,9999	0,0408	1,0000
	1st Difference	0,0002	0,0005	0,0436	0,0003	0,0007	0,0385
	2nd Difference	0,0000	0,0000	0,0000	0,0001	0,0001	0,0000
GOVWF	Level	0.3844	0.9957	0.9451	0.3235	0.9911	0.9162
	1st Difference	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000
	2nd Difference	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
GOVEXP	Level	0.0391	0.9330	0.9884	0.0847	0.9727	0.9975
	1st Difference	0.0000	0.0000	0.0041	0.0001	0.0000	0.0000
	2nd Difference	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000
SEMP	Level	0.1955	0.5318	0.6917	0.1352	0.4439	0.6713
	1st Difference	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2nd Difference	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
UR	Level	0.0201	0.0980	0.6035	0.3077	0.5793	0.5913
	1st Difference	0.0052	0.0244	0.0003	0.0000	0.0000	0.0000
	2nd Difference	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000
Indicators							
COB	Level	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	1st Difference	0.0366	0.0000	0.1736	0.0000	0.0000	0.0000
	Ln N	0.5090	0.2079	0.9993	0.5519	0.5015	1.0000
	1st Dif. Ln N	0.0007	0.0029	0.0048	0.0001	0.0000	0.0000
LFPR	Level	0.8058	0.1169	0.9929	0.8169	0.0973	0.9958
	1st Difference	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	2nd Difference	0.0001	0.0001	0.0000	0.0001	0.0001	0.0000
GDP	Level	0.9145	0.2770	0.9964	0.8803	0.5435	1.0000
	1st Difference	0.0006	0.0045	0.0119	0.0004	0.0027	0.0025
	Ln N	0.4935	0.1383	0.9946	0.1879	0.4685	1.0000
	1st Dif. Ln N	0.0034	0.0028	0.0029	0.0091	0.0277	0.0048
GKF	Level	0.7779	0.0688	0.9246	0.8392	0.4197	0.9267
	1st Difference	0.0010	0.0066	0.0001	0.0025	0.0150	0.0002
	Ln N	0.8107	0.0158	0.9577	0.7057	0.2124	0.9420
	1st Dif. Ln N	0.0011	0.0071	0.0001	0.0064	0.0331	0.0003

[1] Output of the *Eviews 6* software.

Appendix C: Normality Analysis

Table C.1: Jarque-Bera test (*p* value)

Causes	Original Sample	After Correction from Non-Stationarity
TB	0.0525*	0.0044
GOVWF	0.0342	0.0010
GOVEXP	0.0074	0.8007*
SEMP	0.0332	0.0194
UR	0.0408	0.0276
Indicators		
COB	0.0010	0.8573*
LFPR	0.1300*	0.0010
GDP	0.0387	0.2964*
GKF	0.0314	0.8086*

Notes: Jarque-Bera test performed using MATLAB – R2007b software; tested the null hypothesis that the variables are normally distributed; * indicates that the value does not reject the null hypothesis at 5% significance level.

Table C.2: Multivariate Normality Test with the Initial Variables[1]

Skewness			Kurtosis			Skewness and Kurtosis	
Value	Z-Score	P-Value	Value	Z-Score	P-Value	Chi-Square	P-Value
38.573	9.545	0.000	122.452	4.615	0.000	112.411	0.000

[1] Output from *PRELIS* 2.80S software (included in *LISREL* 8.80 software).

Table C.3: Multivariate Normality Test with the Corrected Variables [1]

Skewness			Kurtosis			Skewness and Kurtosis	
Value	Z-Score	P-Value	Value	Z-Score	P-Value	Chi-Square	P-Value
18.200	1.404	0.160	99.910	1.130	0.258	3.247	0.197

[1] Output from *PRELIS* 2.80S software (included in *LISREL* 8.80 software).

Appendix D: Half-yearly Values of the NOE Index

Table D.1: Portuguese NOE (as a % of the official GDP), 1977-2008

Semester/Year	MIMIC 5-1-3	MIMIC 4-1-3	MIMIC 4-1-2	Average
S1/1977	0.1986	0.1900	0.1857	0.19142
S2/1977	0.1958	0.1870	0.1828	0.18853
S1/1978	0.1885	0.1795	0.1756	0.18119
S2/1978	0.1773	0.1683	0.1648	0.17017
S1/1979	0.1736	0.1649	0.1616	0.16669
S2/1979	0.1696	0.1612	0.1580	0.16292
S1/1980	0.1570	0.1486	0.1461	0.15060
S2/1980	0.1467	0.1382	0.1364	0.14043
S1/1981	0.1478	0.1394	0.1377	0.14165
S2/1981	0.1487	0.1407	0.1390	0.14281
S1/1982	0.1423	0.1346	0.1334	0.13675
S2/1982	0.1379	0.1300	0.1292	0.13232
S1/1983	0.1386	0.1305	0.1300	0.13302
S2/1983	0.1491	0.1412	0.1407	0.14366
S1/1984	0.1599	0.1525	0.1517	0.15471
S2/1984	0.1645	0.1576	0.1568	0.15965
S1/1985	0.1650	0.1586	0.1580	0.16054
S2/1985	0.1589	0.1527	0.1526	0.15476
S1/1986	0.1526	0.1466	0.1470	0.14873
S2/1986	0.1609	0.1559	0.1561	0.15761
S1/1987	0.1716	0.1676	0.1671	0.16877
S2/1987	0.1658	0.1620	0.1617	0.16316
S1/1988	0.1616	0.1585	0.1584	0.15949
S2/1988	0.1661	0.1637	0.1635	0.16446
S1/1989	0.1624	0.1605	0.1605	0.16113
S2/1989	0.1600	0.1585	0.1587	0.15908
S1/1990	0.1594	0.1586	0.1590	0.15903
S2/1990	0.1710	0.1710	0.1710	0.17100
S1/1991	0.1725	0.1729	0.1731	0.17287
S2/1991	0.1781	0.1790	0.1792	0.17876
S1/1992	0.1900	0.1919	0.1919	0.19128
S2/1992	0.2012	0.2043	0.2044	0.20329
S1/1993	0.2042	0.2076	0.2079	0.20654
S2/1993	0.2043	0.2076	0.2080	0.20665
S1/1994	0.2093	0.2131	0.2134	0.21194
S2/1994	0.2102	0.2143	0.2146	0.21304
S1/1995	0.2101	0.2147	0.2148	0.21320
S2/1995	0.2119	0.2169	0.2170	0.21527
S1/1996	0.2120	0.2174	0.2174	0.21563
S2/1996	0.2145	0.2205	0.2204	0.21848
S1/1997	0.2133	0.2196	0.2194	0.21742

Table D.1: (continuation)

Semester/Year	MIMIC 5-1-3	MIMIC 4-1-3	MIMIC 4-1-2	Average
S2/1997	0.2164	0.2230	0.2227	0.22072
S1/1998	0.2148	0.2216	0.2214	0.21927
S2/1998	0.2061	0.2130	0.2130	0.21067
S1/1999	0.2061	0.2134	0.2135	0.21099
S2/1999	0.2082	0.2159	0.2161	0.21340
S1/2000	0.2069	0.2149	0.2151	0.21229
S2/2000	0.2059	0.2140	0.2142	0.21137
S1/2001	0.2076	0.2160	0.2160	0.21320
S2/2001	0.2038	0.2122	0.2125	0.20952
S1/2002	0.2055	0.2142	0.2145	0.21139
S2/2002	0.2098	0.2193	0.2201	0.21641
S1/2003	0.2141	0.2239	0.2246	0.22087
S2/2003	0.2135	0.2235	0.2242	0.22040
S1/2004	0.2048	0.2144	0.2153	0.21149
S2/2004	0.2048	0.2145	0.2156	0.21159
S1/2005	0.2028	0.2126	0.2138	0.20973
S2/2005	0.2045	0.2148	0.2162	0.21183
S1/2006	0.2073	0.2182	0.2194	0.21495
S2/2006	0.2061	0.2174	0.2188	0.21409
S1/2007	0.2090	0.2206	0.2218	0.21715
S2/2007	0.2140	0.2261	0.2273	0.22246
S1/2008	0.2150	0.2276	0.2289	0.22385
S2/2008	0.2184	0.2315	0.2328	0.22759