Energy based estimation of the Shadow Economy: The role of Governance Quality

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Abstract

The shadow economy (SE) is a pathological normalcy, not only in developing countries but also in developed ones, causing disagreeable distortions in the real economy. In this paper, we estimate the size of the informal sector in nineteen countries of the European Union (EU) by implementing three variations of the physical input approach (we use electricity consumption as input). All estimates show that EU countries experience high shadow economy levels with a decreasing trend. Moreover, we assess the explanatory power of three governance quality indicators of the informal sector using a set of panel regression specifications as well as a set of quantile regression specifications. Both approaches show that overall governance quality is the most prominent factor in determining the SE levels. Given the inherent advantage of quantile regression to identify impact differentiations across the conditional distribution of the dependent variable a significant policy action is revealed. In particular, countries with high shadow economy levels can reduce their informal sector, at an increasing rate, by improving governance quality.

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1. Introduction

The Shadow Economy (SE) is a common parasitic attribute of all economies around the world and causes significant distortions in both economy and society. Numerous definitions of the term Shadow (informal, hidden, underground, unrecorded, unreported, illegal, subterranean, parallel) Economy have been proposed in the literature, trying to capture the controversial and wide-ranging nature of it. The broadest and most common definition, which focuses only on legal activities, is: "*…those economic activities and the income derived from them that circumvent or otherwise avoid government regulation, taxation or observation*" (Del'Anno and Schneider, 2004; Schneider and Enste, 2000). The size of the SE affects, the efficacy of macroeconomic policies, tax revenues, the quantity and quality of public goods and services, international competitiveness, the cost of sovereign debt, the unemployment rate, the banking system, economic growth and productivity. As an indicative example, tax base is decreased due to the development of the SE, implying higher tax rates and lower quality and quantity of public goods and services (e.g., roads, health). The higher tax rates serve as an additional incentive for a further shift from the formal sector to the informal sector. Hence, a vicious cycle is created, amplifying the development of the SE (Eilat and Zinnes, 2002; Kaufmann and Kaliberda, 1996; Markellos *et al.*, 2016; Nelson *et al.*, Schneider and Enste, 2000; Schneider and Williams, 2013).

Reasonable approximation of the SE level may contribute positively in the real economy for at least four reasons. First, as the SE distorts the lens through which the policy maker looks at the national economy, an estimate of the size and growth of the SE helps to better understand the impact of the proposed economic policies on economic development and growth. Policy makers impose policies based on official statistical data and ignore overall Gross Domestic Product (GDP), which consists of official and unofficial GDP. To the extent that statistical data ignore the true size of the SE, a macroeconomic policy cannot be really effective. Second, the economic or financial performance of a country is heavily affected from the SE (see, among others, Hajilee *et al.*, 2017; La Porta and Shleifer, 2008;

Markellos *et al.*, 2016). As such, a variety of stakeholders in the financial sector, both inside and outside the country, such as intermediaries, regulators, credit rating agencies, lenders, corporations, risk managers and investors, are interested in an unbiased cross-country estimator of the size of the SE and its growth. Third, although the SE is a common attribute of all countries, the main causes of it may vary from country to country (Dell'Anno *et al.*, 2006). In addition, for a given country in a given period, different methods may give different estimations of the size and development of the SE (Schneider and Enste, 2000). As such, regulators and law makers, who impose regulations targeting to reduce the SE, need estimates from more than a single method. Finally, given the ongoing sovereign debt crisis in Europe, new findings fir the size and development of the SE are particularly useful.

Among a range of methods, divided into direct, indirect and MIMIC (Multiple Indicators and Multiple Causes) approaches (see, Schneider, 2005; Schneider and Williams, 2013), a physical input method is used, due to its advantages. These advantages are: first, its model-free nature, in contrast with other methods, where the results are conditional upon strong assumptions and complex econometric models; and, second, the availability and reliability of the data required by the method resulting to the minimization of estimation errors. Initially, we use the simple Electricity Consumption Method (ECM). In ECM, electricity consumption is the best single proxy of the growth rate of the total economic activity. However, this approach has been criticized since factors that affect electricity consumption, such as electricity prices and energy efficiency, are ignored. In other words, it not only assumes that electricity/output elasticity remains constant across time but also ignores any alternative forms of energy (Schneider and Enste, 2000). As a response to the above limitations, we implement a modified ECM, which consists of a regression that isolates the effects of other factors affecting the consumption of electrical energy. The model includes variables that rake into account the substitution effect, the structural-output (electricity-intensity) effect, the energy efficiency and the weather effect. In addition to this, as a next step, the use of the total final energy consumption overcomes the second limitation.

The contribution of this study to the existing literature is threefold. First, the analysis provides model-free estimations of the SE in nineteen EU countries. As such, we provide a new reference point for the size of the SE across countries, as an alternative to the existing estimations of the SE, using model dependent approaches (Schneider, 2009; Schneider *et al.*, 2010; Schneider *et al.*, 2015). Second, the modified Electricity Consumption Method overcomes main limitations of the standard ECM, amplifying the attractiveness of the method. Among the improvements, we estimate the SE using not only electricity consumption but also total final energy consumption, considering this way changes in the composition of energy consumption. The results of the MECM among several EU countries point out that Eastern and Southern European countries have a greater unofficial sector as a percentage of the official GDP in comparison with Western European countries. Third, we show by a standard panel regression specification that there is a robust negative relationship between the quality of governance and the size of the SE, while a respective quantile regression specification reveals that countries with high SE levels can reduce their informal sector, at an increasing rate, by improving governance quality.

The remaining of the paper is organized as follows: Section 2 offers a review of the literature; Section 3 describes the methodology; Section 4 presents the data and some preliminary econometric analysis; Section 5 reports the empirical findings; Section 6 shoes the robustness checks; and Section 7 contains a summary and conclusions.

2. Literature Review: SE Estimation Methods

A reliable estimation of the size of the SE is a daunting task, and although it has been investigated for a long time, it is still an open issue. The former is evident in the divergence of the available estimates of the SE of the same country, which heavily depend on the estimation method. For example, during the same period, the estimates of the SE of Canada ranged from 1.4% to 47.1% as a percentage of GDP (Tanzi, 1999). The difficulties of the measurement of the SE lie mainly on its obscure nature, and as such, all methods attempt to capture an unobserved variable. In addition, data used for the estimation of the SE are not always reliable, either due to the inefficacy of the statistical methods used, or due to the strong incentives of politicians to "tamper" the statistical data, regarding national accounts, out of self-interest (such as elections)[1]. Finally, the lack of a clear and universal definition of the SE produces incomparable results across studies. The various definitions of the SE capture different shadow economic activities affecting the estimated size of the SE.

The methods proposed in the literature regarding the estimation of the SE can be classified in three main categories: direct methods, indirect methods and model-dependent or model methods (see Bhattacharyya, 1999; Dixon, 1999; Feld and Schneider, 2010 for a comparison of the various methods). Direct methods, such as surveys and tax audits, are based on a microanalysis framework (see, among others, Feld and Larsen, 2009; Feld and Schneider, 2010). The collection of information regarding the structure and other more qualitative characteristics of the informal sector constitutes the main advantage of the microeconomic approaches. However, in most cases, direct methods lead to an underestimation of the SE, since people operating in the informal sector wish to avoid detection and the information, they provide are unreliable. In addition, direct methods are usually very complex, difficult to implement and their static nature prevents cross-period and cross-country comparisons.

Model methods combine multiple indicators with multiple causes (MIMIC model or more general Structural Equation Model with more than one unobservable variable) for the estimation the SE. Model methods assume that the informal sector can be traced to multiple areas of economic activity (e.g., in production and labor) simultaneously, and has multiple

[1] To the best of our knowledge, there is no empirical study that addresses the issue of inaccurate economic data. However, there are plenty of newspaper articles that bring the issue forward (see, for example, "How politicians poisoned statistics", *Financial Times*, 4/14/2016; "2018: the year of fake economic data", *Financial Times*, 1/16/2018).

simultaneous causes, such as reduced tax revenues and increased cost of sovereign debt (Markellos *et al.*, 2016). The specification of the MIMIC procedure is the following:

$$n = a_0 + a_1 C_1 + a_2 C_2 + \ldots + a_k C_k + u \tag{1}$$

$$\left.\begin{aligned} C_1 &= \lambda_1 n + \varepsilon_1 \\ C_2 &= \lambda_2 n + \varepsilon_2 \\ &\cdots\cdots \\ C_k &= \lambda_k n + \varepsilon_k \end{aligned}\right\} \tag{2}$$

The structural specification includes the latent variable n as a dependent variable and a set of indicators, $C_1, C_2, \ldots, C_k$ contributing to the development of the SE. Additionally, $a_0, a_1, \ldots, a_k$ are coefficients. The measurement specification models the indicators as dependent variables, while the size of the SE, i.e. n , is the explanatory variable.

Model methods are widely used (see, Frey and Weck-Hannemann 1984; Quintano and Mazzocchi 2013; Ruge 2010; Schneider 2005 and 2009; Schneider and Enste 2000; Schneider *et al.* 2010 and 2015), although they have been severely criticized (see, Ahumada *et al.* 2009; Helberger and Knepel 1988; OECD 2002). The major criticism lies on the fact that the significance of the results depends on the proper selection of causes and indicators. Therefore, the detection of the indicators and causes of the informal economy is a necessary procedure. As such, if indicators and causes are not unique, what are the appropriate model selection criteria? Model methods actually test an *a priori* hypothesis rather than *a posteriori* hypothesis, which might be generated from the dataset. Finally, model methods rely on complex and number crunching econometric models and suffer from endogeneity problems.

On the other hand, indirect methods use macroeconomic variables as an indicator of the size of the SE. Their dynamic nature is considered to be an attractive attribute. Indirect methods are divided into five broad categories: (i) national income versus national expenditure; (ii) official and real labor force; (iii) the transactions approach; (iv) the currency demand approach; and (v) the physical input method.

The *national income vs. national expenditure approach* compares national income with national expenditure and assumes that their discrepancy is caused by the existence of the SE. In the absence of informal economic activities, national income should be equal to national expenditure. The above method uses published statistical data, whose accuracy is, sometimes, dubious, especially in the case of economies in transition (Tanzi, 1999). Consequently, unreliable data imply a downward bias of the SE.

The *official and real labor force approach* attempts to estimate the SE comparing official and real labor force. It states that official labor force is negatively related to shadow labor force. An increase of official labor force implies a decrease of unofficial employment. The method ignores other factors that affect the size of the official labor force. An indicative example is a reduction of official labor force by virtue of an economic crisis. Furthermore, it is possible that individuals participate simultaneously in both sectors (see, for instance, Schneider and Enste, 2000).

The *transactions approach* has been introduced by Edgar Feige (1979) and is based on Fischer's quantitative theory of money. If the product of prices with the volume of transactions exceeds the GNP, then there is an informal sector. However, this method is characterized by several weaknesses such as its strong assumptions. Moreover, it requires that the value of the SE is zero in the base year (Schneider and Enste, 2000).

The *currency demand approach* is based on Cagan's (1958) work, who identifies three main factors that affect currency demand: the tax rate, the interest rate and the per capita income. The currency demand approach has been extended further by Tanzi (1999). The concept of this method lies in the fact that SE activities are associated mainly with transactions involving cash. As a result, the measurement of the SE can be derived from the excess demand for currency which is not explained by the observed tax burden. Despite its simplicity, the currency demand approach has weaknesses (Alm and Embaye, 2013). First, this method assumes that the velocity of money is the same in both sectors (official and non-official), something that occurs only when the elasticity of income is equal to one (Ahumada et al., 2009). Second, the basic assumption of the method, that there is no SE in the base year, is unrealistic. Third, there are more factors that may increase the demand for currency and finally, according to the currency demand approach, SE activities are performed only in cash; which is not empirically confirmed (Takala and Viren, 2010).

The *physical input approach* is based on the consumption of electricity to quantify the magnitude of the SE. Two separate branches of this approach can be identified. The first one makes use of total electricity consumption for the entire economy, while the second one focuses on the consumption of electricity in the residential sector. Kaufmann and Kaliberda (1996) estimate the unobserved growth rate for the total economic activity based on the growth rate of total electricity consumption. Towards this direction the electricity/output elasticity is an important tool. However, the constant elasticity assumption is rather unrealistic (Eilat and Zinnes, 2002). As a result, Kaufmann and Kaliberda (1996) assume three different elasticity scenarios based on the efficacy of electricity use, dividing countries into groups. After this conversion, the difference between estimated growth rate of overall GDP and official GDP represents the relative size of the SE. Johnson *et al.* (1998) use different elasticities for different countries in order for cross-country comparisons to be feasible.

The second branch of the physical input approach, usually called the Lackó approach, quantifies the SE based on residential electricity consumption. The main assumption is that energy efficiency is constant over the years. Lackó (1998 and 2000) suggests that residential electricity consumption is correlated to the magnitude of the SE and points out that if the households' SE is high, then the overall SE should be high as well. Lackó (1998 and 2000) introduces two regression specifications. In the first specification, the SE appears as the dependent variable, while in the second, the SE is the explanatory one. The physical input method is very simple and appealing. However, it is also subject to criticism. First, there are SE activities that are not energy demanding (services). Second, it ignores other energy sources (fossil fuels, renewable energy sources, etc.). Finally, it requires the estimation of different elasticities of electricity/GDP across countries and over time.

3. Methodology

3.1. The Simple Electricity Consumption Method

The ECM^S assumes that the growth rate of total electricity consumption is the best single proxy for the growth of the overall (real and shadow) economic activity. Within the ECM^s framework, the actual growth rate of electricity consumption is utilized to approximate overall economic growth via the electricity/output elasticity. Given the existing empirical evidence, Kaufmann and Kaliberda (1996) claim that the electricity/output elasticity is constant (at least in the medium-run) and close to one. In our study, we also follow the same norm assuming a unitary elasticity scenario, provided that all EU countries have almost the same energy efficiency. In other words, the growth rate of electric power consumption is the same as the growth rate of the overall GDP.

The ECM^S proceeds with the estimation of the overall GDP (GDP^T) and the official GDP (GDP^O) indices. Taking the first sample observation as the base of the index, every subsequent observation is derived by a simple chain-multiplication ($GDP^T_t = GDP^T_{t-1}(1+g_{t,e})$), where g_e is the growth rate of total electricity consumption. In a similar manner the GDP^O index is also constructed. The initial SE level is obtained exogenously by Schneider and Williams (2013). Once the initial values have been identified, every subsequent observation is derived by invoking the observed growth rate of the official GDP. Hence, the divergence between the GDP^O index and the GDP^T index implies the size of the SE.

3.2. The Modified Electricity Consumption Method

The ECM^S framework, despite its attractiveness due to its simplicity, shows strong weaknesses, as variations in electricity consumption may be attributed to factors other than economic. Eilat and Zinnes (2002) modify the ECM^S in an attempt to overcome the above limitation. The modified Electricity Consumption Method (ECM^M) by implementing a panel regression specification obtains the orthogonalized growth of electricity consumption through the respective residuals. Eilat and Zinnes (2002) use three basic regressors: 1) the increase in electricity prices to capture the price effect, 2) the change of the industry's share in GDP to capture alterations in the composition of output, and 3) the change of the private sector's share in GDP to capture efficiency changes.

Our study filters out the effects of non-economic factors by building on the specification of Eilat and Zinnes (2002). We estimate the following panel specification:

$$C_{it}^{Ele,c} = a_0 + a_1 P_{it}^{Ele,c} + a_2 U_{it}^{Ene,c} + a_3 I_{it}^{Add,c} + a_4 H_{it}^{Dd,c} + a_5 P_{it}^{Oil,c} + u_{it} \tag{3}$$

where, $C_{it}^{Ele,c}$ is the growth in electricity consumption for country i at time t, $P_{it}^{Ele,c}$ is the change in the electricity prices, $U_{it}^{Ene,c}$ is the change in energy use per \$1000 of GDP, $I_{it}^{Add,c}$ is the change in industry's value added in GDP, $H_{it}^{Dd,c}$ is the change in the Heating Degrees Days index, $P_{it}^{Oil,c}$ is the growth rate of the real crude oil price, a_k $(k = 1,..,5)$ are parameters to be estimated, while u_{it} is the error term assuming the usual properties.

Equation (3) differentiates from Eilat and Zinnes's (2002) in two main aspects. First, instead of using the private sector's share in GDP to approximate efficiency changes, we adopt the change in energy use per \$1,000 of GDP ($U_{it}^{Ene,c}$). Second, we use two additional variables, the change in the HDD index ($H_{it}^{Dd,c}$) and the growth rate of the real crude oil price ($P_{it}^{Oil,c}$). $H_{it}^{Dd,c}$ is used to capture changes in electricity consumption due to weather conditions,[2] while $P_{it}^{Oil,c}$ captures the substitution effect (Hanousek and Palda, 2006). After estimating equation (3), the residuals consist the growth rate of the electricity consumption related to the total economic activity. Once the residuals are recovered, then by following the same principles as in the case of the ECM^S, both the overall GDP (GDP^T) index as well as the official GDP (GDP^O) index can be easily constructed. The discrepancy between the GDP^O index and the GDP^T index implies the size of the SE.

3.3. The Final Energy Consumption Method

A limitation of both ECM^S and ECM^M, is the implicit assumption that electricity is the only form of energy in the economy. Of course, in reality some shadow activities can use other forms of energy such as natural gas or oil. Hence, we also apply the final energy consumption method (ECM^F), which is in principle similar to the ECM^M, but instead of electricity consumption, total final energy consumption growth is used ($C_{it}^{FE,c}$) as a dependent variable. Furthermore, given that the total final energy consumption variable aggregates several forms of energy, the panel specification, adopted to filter out the effects of the non-relevant to the SE regressors, is merely a restricted version of equation (1). In particular, the price variables, $P_{it}^{Ele,c}$ and $P_{it}^{Oil,c}$, are excluded from the specification as there is no economic intuition for their inclusion (no substitution effects can be defined). Once the restricted version of equation (3) is estimated, based on the recovered residuals the size of the SE for each country is approximated.

[2] We do not use the Cooling Degree Days (CDD) index due to lack of data.

4. Data Sources and Preliminary Econometric analysis

The data of this study consist of annual observations that span from 2007 to 2013 in nineteen EU countries (see Figure 1).[3] The data for the per capita electricity consumption (in kWh), the energy use (kg of oil equivalent) per $1,000 GDP (constant 2011 PPP), the industry value added (% of GDP), the Real official Gross Domestic Product (constant 2011 Local Currency Unit), the CPI (all items) and population[4], all come from the WDI database of the World Bank. Moreover, Eurostat is the source of data for the Heating Degrees Days (HDD) index, the total final energy consumption[5] (in thousand tons of oil equivalent), and electricity prices (including taxes and levies) which are calculated as the weighted average of industrial and other domestic consumer prices[6] (weights are calculated based on each sector's electricity consumption). Finally, Brent crude oil price comes from the US Energy Information Administration database.

[Insert Figure 1 Here]

To avoid the estimation of a spurious panel specification, panel unit-root testing is a prerequisite step. Provided that the two panel specifications for the implementation of the Modified Electricity Consumption Method and the Final Energy Consumption Method, involve variables in differences, we test for panel unit-root by using the LLC test (Levin *et al.*, 2002) directly on the differences of the variables. The unit-root tests for each variable are presented in Table 1 below. The null hypothesis of a panel-unit root is rejected at all conventional levels of significance; supporting, this way, panel stationarity for all variables.

[Insert Table 1 Here]

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[3] Data availability restricts our analysis into the selected EU countries and the examined time period.

[4] Total electricity consumption is obtained by multiplying the per capita electricity consumption by the respective population.

[5] Total final energy consumption is defined as gross inland energy consumption which is derived from crude oil and oil products, natural gas, electricity, heat solid fossil fuels, renewables and wastes.

[6] Consumers are classified as domestic if they consume between 2500 kWh and 5000 kWh per year and as industrial if they consume between 500 MWh and 2000 MWh per year.

5. Empirical Results

5.1. Estimates of the Shadow Economy with ECM^S

By implementing the steps described in section 3.1., we estimate the size of the SE based on the ECM^S. Table 2 shows the size of the SE (% of the official GDP) during the period 2007-2013, in the nineteen EU countries. The countries of our sample are categorized into three distinct groups; that is, Western, Southern and Eastern European countries.

[**Insert Table 2 Here**]

The large variation in the level of the SE across years is a limitation of the method. For instance, in Finland the informal sector decreases between 2008 and 2009 from 9.1% to 1.7%. This extreme change implies that the growth rate of total economic activity was lower than the growth rate of official GDP. Hence, we do not discuss annual variations in detail but rather we focus on the general emerging trends and the group averages. Two are the interesting aspects that emerge from Table 2. First, the majority of the countries show a decrease in the level of the informal sector. Exceptions are Austria, Estonia, Latvia and Poland, where SE increases. Given the limitations of the method, all results should be treated with caution. The second interesting aspect is that Western European countries show on average, a lower level of informal sector (9.2%) compared to Southern European countries (16.9%). Similarly, Southern European countries show, on average, a lower level of informal sector (16.9%) compared to Eastern European countries (23.1%).

[**Insert Figure 2 Here**]

Although the size and structure of the informal sector depends on a range of factors, a stylized fact in the literature is that the level of income is a fundamental factor in influencing the SE (Torgler and Schneider, 2009). Empirical findings from countries with different income levels show that the SE is inversely related to the level of income. Our estimates come to confirm this empirical fact, as Figure 2 reveals a strong negative relationship between the levels of the SE and the per capita GDP. This strong negative relationship can be seen as initial evidence for the robustness of our findings.

5.2. Estimates of the Shadow Economy with ECM^{M}

For the implementation of the ECM^{M} we estimate a balanced panel specification (see equation 1), with cross-sectional fixed-effects (the Hausman test rejects the null hypothesis with a *p*-value=0.001). The estimated coefficients along with the respective *p*-values in parentheses are illustrated in equation (4) below:

$$C_{it}^{Ele,c} = \underset{(0.90)}{0.01} + \underset{(0.00)}{0.09}P_{it}^{Ele,c} + \underset{(0.00)}{0.22}U_{it}^{Ene,c} + \underset{(0.00)}{0.31}I_{it}^{Add,c} + \underset{(0.00)}{0.10}H_{it}^{Dd,c} + \underset{(0.00)}{0.06}P_{it}^{Oil,c} \quad R^2 = 0.63 \tag{4}$$

All the coefficients are statistically significant at the 0.01 significance level, having at the same time the theoretically expected sign.[7]

Based on equation (4), we recover the residuals, and by following the steps described in section 3.2. we estimate the share of the SE for each country. Table 3 presents the size of the SE as a percentage of the official GDP for the nineteen EU countries. The only pronounced difference of the ECM^{M} compared to the ECM^{S} is that the main limitation of the latter is corrected by the former. That is, the variation in the SE levels across the years for all countries is now more controlled, showing no extreme changes. Regarding the two main aspects revealed by the estimates of the ECM^{S}, these still hold for the estimates delivered by the ECM^{M}. In particular, we still observe that the majority of the countries show a decrease in the level of the informal sector and Western European countries show on average the lowest level of informal sector (11.0%) compared to the other two groups of countries (Southern European countries show, on average, an informal sector equal to 22.1% while the respective value for the Eastern European countries is 23.0%).

[7] Overall, the model appears to be well specified as the Durbin-Watson statistic (DW=1.89) indicates absence of serial correlation, and the biased-corrected scaled Lagrange Multiplier (LM) test (Baltagi *et al.*, 2012) suggests no cross-sectional dependence in the residuals (the LM statistic fails to reject the null hypothesis with *p*-value=0.18).

[Insert Table 3 Here]

A final notable characteristic (also observed in the ECM^{M} results) is that the majority of Eastern European countries indicate high levels of the SE. Provided that these countries have completed their transition phase to the market economy relatively recently (and became members of the EU in May 2004), this may be the explanation for the observed high levels of their informal sector. On the other hand, the respective high levels of the SE for the three Southern European countries may be attributed mainly to the relatively lower quality of their institutions (compared to Western European countries) and high taxation due to the fiscal adjustment that took place during debt crisis. Finally, Figure 3 shows the scatterplot of the average estimated level of the SE for each country against the respective average of the real GDP. Again, the average level of the SE is negatively related to the GDP.

[Insert Figure 3 Here]

5.3. Estimates of the Shadow Economy with ECM^{F}

To implement the ECM^{F} we estimate the restricted version of equation (1), using $C^{FE,c}$ as a dependent variable with fixed-effects (the Hausman test rejects the null with a *p*-value=0.001). The estimated coefficients along with the respective *p*-values in parentheses are illustrated in equation (5) below:

$$\underset{}{C_{it}^{Ele,c}} = \underset{(0.23)}{-0.01} + \underset{(0.02)}{0.31}U_{it}^{Ene,c} + \underset{(0.00)}{0.45}I_{it}^{Add,c} + \underset{(0.00)}{0.15}H_{it}^{Dd,c} \quad R^2 = 0.53 \tag{5}$$

Equation (5)[8] estimates the share of the SE for each country. Table 4 presents the size of the SE for each country. The estimates of the SE by the ECM^{F} approach are qualitatively similar to the ECM^{M} estimates. We still observe a negative trend in the SE levels, as

[8] All coefficients are significant at the 0.01 significance level and the signs are theoretically consistent. Additionally, there is no evidence of serial correlation (DW=1.76) and cross-sectional dependence in the residuals (the LM statistic *p*-value=0.15).

Western European countries show the lowest level of informal sector (11.5%), followed by the other two groups of countries (Southern and Eastern European countries). Finally, a negative relationship between the SE and the per capita GDP is established (see Figure 4).

[Insert Table 4 Here]

[Insert Figure 4 Here]

6. Robustness Checks

In this section the estimates of the SE, under the three alternative approaches, are assessed across factors commonly utilized to explain the informal sector. In the literature there is a wide range of variables conscripted to describe the SE. These can be categorized into two broad groups. The first group incorporates economic variables (tax rate, *etc.*), while the second group includes variables that describe the overall governance quality (e.g., government effectives, *etc.*).[9] Over the set of available factors, our specification includes income taxes, profits, capital gains (% GDP), price inflation of all goods and services (proxied by the growth of the GDP deflator) as explanatory factors, and one variable that captures the overall governance quality (we use sequentially three such variables: government effectiveness, rule of law and control of corruption).[10, 11]

For the structure of our analysis, a natural path to model the variability of the SE is within a panel framework. Given the panel set-up, a modelling concern is related to the heterogeneity across time and countries, that is the choice between a fixed-effects and random-effects specification. An accurate final decision necessitates taking into consideration

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[9] As the purpose of this section is not to review the factors affecting the level of the SE, we simply report the two broad categories. For a more extensive review see Schneider and Enste (2000).

[10] The source of the two economic variables is the World Development Indicators database of the World Bank, while the source of all the governance indicators is the Worldwide Governance Indicators database of the World Bank.

[11] Having three different estimates for the SE and three sequentially used proxies for governance quality, it becomes apparent that we estimate nine different specifications.

the three following issues: 1) the cross-section and time dimensions of the panel, 2) the correlation of the error term with the regressors and 3) the variability of the regressors. Provided that fixed-effects estimation reduces the degrees of freedom, short panels with a considerable number of explanatory variables favor the random-effects specification. Where the error term is expected to be correlated with the regressors, the fixed-effects specification is preferable. Finally, if the regressors change at a slow pace over time, then the fixed-effects specification is expected to absorb most of their explanatory capacity. In our case, given that both dimensions of our panel are relatively small but, most importantly, that the regressors change fairly slowly (e.g., overall governance quality or the level of inflation in EU countries is not expected to change significantly from year to year[12]), the first modelling choice is the random-effects specification. The general form of the two-way random-effects specification is the following:

$$SE_{it}^{J} = w_{1,J,\mathrm{k}} + w_{2,J,\mathrm{k}} T_{it}^{\mathrm{s}} + w_{3,J,\mathrm{k}} P_{it}^{\mathrm{g}} + w_{4,J,\mathrm{k}} GI_{it,\mathrm{k}} + v_{i,J,\mathrm{k}} + m_{t,J,\mathrm{k}} + u_{it,J,\mathrm{k}} \quad \text{with } J = S, M, F \text{ and } \mathrm{k} = 1,2,3 \tag{6}$$

where, SE_{it}^{J} is the level of the SE for country i at time t estimated by the method J (SE_{it}^{S}, SE_{it}^{M} and SE_{it}^{F}, represent respectively the estimates from ECM^{S}, ECM^{M} and ECM^{F}). T_{it}^{s} is the share of all income taxes to GDP, P_{it}^{g} is the GDP deflator inflation, $GI_{it,\mathrm{k}}$ denotes the governance index used each time ($GI_{it,1}$, $GI_{it,2}$ and $GI_{it,3}$ represent government effectiveness, rule of law and control of corruption, respectively), $v_{i,J,\mathrm{k}}$ are cross-section random-effects error terms, $m_{t,J,\mathrm{k}}$ are period random-effects error terms and finally, $u_{it,J,\mathrm{k}}$ are error terms assuming the usual properties.

[12] See, for instance, the (former) Bank of England Governor Mervyn King (2012) who notes: "...the results in terms of low and stable inflation have been impressive. There have been pronounced reductions in the mean, variance and persistence of inflation in Britain and elsewhere".

Before we proceed with the estimation, the random-effects specification needs to be confirmed by the appropriate formal testing. We start by conducting Breusch and Pagan's (1980) LM test, to check if both variance components (period and cross-section) jointly are equal to zero for all nine specifications. In all cases, the LM test rejects the null hypothesis supporting that the two-way random-effects specification behaves better with the existing heterogeneity than the pooled OLS. Similarly, the *F*-test for a two-way fixed-effects rejects, in all cases, the null hypothesis (that the period and country dummies are jointly equal to zero) implying that the fixed-effects specification is preferable than the pooled OLS. Hence, we proceed by executing the Hausman (1978) test for selecting between the two competing specifications.

When testing (all nine specifications) the null hypothesis of a two-way random-effects model against the two-way fixed-effects model, the chi-squared test statistic is consistently zero, implying estimation of negative variances. This is not an uncommon result for small samples provided that the Hausman statistic can be negative even asymptotically (Schreiber, 2008). A potential reason for receiving non-positive variance values is the violation of the orthogonality condition between the individual effects and the explanatory variables (Magazzini and Calzolari, 2010). Provided that in the literature, the most significant factor for explaining cross-country differences in the observed levels of the SE is overall governance quality, we expect a high degree of correlation between the individual effects and the governance indicators.[13] As a result, we disregard the two-way random-effects specification, and the Hausman (1978) test is reconducted using only period random-effects (the term $v_{i,J,\mathrm{k}}$ in equation (6) is dropped). The testing results support the use of the period random-effects specification over the period fixed-effects one, as in all cases (nine equations) we fail to reject

[13] In fact, by regressing government effectiveness, rule of law and control of corruption on the individual effects dummies we receive very high coefficients of determination. In particular, 0.97, 0.98 and 0.99, respectively.

the null hypothesis.[14] The estimates of the period random-effects specification for the nine different regressions, are presented in Table 5.

[Insert Table 5 Here]

For regressions (1) to (9) in Table 5, the estimated coefficients appear to be significant at the conventional levels of significance showing at the same time theoretically consistent signs. In particular, all examined governance quality indicators are significant, under all approaches used to the proxy SE, with rule of law having the greatest impact compared to the other two indicators in affecting the levels of the SE. Based on these findings, we may argue that our SE estimates appear robust as for the factors commonly used in explaining the levels of the SE in different countries.

The estimates based on the one-way random effects specification allow us to assess only the average effect of the regressors on the SE. Hence, these estimates neglect differentiations in the magnitude of the effects across the range of the conditional distribution of the dependent variable, an issue that may be of crucial importance when policy decisions are to be made in fighting the SE. As a result, we estimate for the pooled structure of the data (allowing time dummies to capture heterogeneous period effects) the following quantile regression specification:

$$SE_{it}^{J(\tau)} = w_{1,J,\mathrm{k}}^{(\tau)} + w_{2,J,\mathrm{k}}^{(\tau)} T_{it}^{\mathrm{s}} + w_{3,J,\mathrm{k}}^{(\tau)} P_{it}^{\mathrm{g}} + w_{4,J,\mathrm{k}}^{(\tau)} GI_{it,\mathrm{k}} + \sum_{z=1}^{6} w_{4+z,J,\mathrm{k}}^{(\tau)} D_z + u_{it,J,\mathrm{k}} \quad \text{with } J = S, M, F \text{ and } \mathrm{k} = 1,2,3 \tag{7}$$

where, SE_{it}^{J} , T_{it}^{s}, P_{it}^{g} , $GI_{it,\mathrm{k}}$ and $u_{it,J,\mathrm{k}}$ are defined as previously, D_z are time dummies and finally, $w_{\lambda,J,\mathrm{k}}^{(\tau)}$ are the coefficients to be estimated ($\lambda = 1,\ldots,10$) for the τ quantile. The quantile regression estimates for the above specification are shown in Table 6.

[Insert Table 6 Here]

[14] The chi-squared p-values of the Hausman test for all examined hypotheses are: 0.62, 0.91, 0.19, 0.57, 0.76, 0.21, 0.37, 0.96 and 0.85. The variance components in the one-way (period) random-effects models are estimated with the Swamy and Arora (1972) estimator.

The estimation results for the quantile specification do not qualitatively change the overall inference derived from the random-effects panel estimates in Table 5. In particular, all the estimated coefficients appear to be significant at the conventional levels of significance (the only exception is the inflation coefficient in equation 3 in Table 6), presenting also the theoretically expected signs. Again, all governance quality indicators are significant for all equations, with rule of law having the highest impact in affecting the levels of the SE. These findings robustify further the validity of our estimates about the development of the SE for each country. But most important of all, in the case of the quantile regression, are the quantile specific coefficient estimates for each explanatory variable. These quantile coefficient estimates (for ten different quantiles) along with the 95% confidence bands, for the three major regressors across the nine different specifications are shown in Table 7.

[Insert Table 7 Here]

Starting from the effect of taxes on the conditional distribution of the SE, the majority of the specifications (see the first column of figures in Table 7) show significant impact at lower quantiles, while as we move progressively to higher quantiles, the impact turns out to be insignificant. Hence, this finding implies that as countries increase the efficiency of their tax collecting mechanisms, for all types of income, they can reduce the magnitude of their informal economy. For instance, at the lower parts of the conditional distribution, 1.00% increase in the share of taxes on GDP will result to approximately 0.57% decrease (on average) in the respective share of the SE on GDP.

On the other hand, inflation seems to have a relatively stable and mostly significant impact throughout the conditional distribution of the SE (see the second column of figures in Table 7). Clearly, low levels of inflation are associated with low levels of the SE but given the already low-price levels in EU there is limited room for action as far as policy making is concerned. Indicatively, a 1.00% decrease in the inflation rate, on average, will result at a

0.78% decrease in the share of the SE on GDP. Finally, overall governance quality seems to be the most prominent factor in determining the SE levels. The estimated coefficients are consistently significant throughout the conditional distribution of the SE and their effect increases as we move progressively to higher quantiles. This implies that countries with high SE levels are able to reduce the informal sector, at an increasing rate, by improving their overall governance quality. For example, at the upper parts of the conditional distribution, a 1.00 unit increase in governance quality will result to approximately a 10.18% decrease (on average) in the respective share of the SE on GDP.[15]

7. Conclusions

This paper measures the size of the SE using data from the energy markets. It provides model-free estimations of the SE in nineteen EU countries and extends the standard Electricity Consumption Methods to incorporate alternative forms of energy and non-constant electricity/output elasticity. The method utilized in the current paper overcomes the main limitation of standard Electricity Consumption Methods; that is, the extreme variations in the SE level across time. The estimations are comparable with those of other studies that use different methods. The variation across years has been significantly reduced, showing no significant changes. Our results can be used as a new reference point for the size of the SE across countries, since they are not dependent on *a priori* assumptions regarding the definition, the size, the effect and the causes of the SE.

The results of the current paper show a flourishing SE in the European Union, at least during the period of the financial crisis. The unweighted average size of the SE in the EU

[15] The results in the literature are inconclusive. For example, Johnson *et al.* (1997) find that corruption affects the shadow economy positively (and the official economy negatively), while Dreher and Schneider (2010), using a larger sample, find no such significant relationship. See also Togler and Schneider (2009).

ranged from 17.5% of the official GDP in 2008 to 17% in 2013. Our results also indicate that better-performing economies (Western European countries) are associated with smaller informal sectors as a percentage of the GDP. During the analyzed period, the unweighted average size of the SE is 11.5% for Western European countries, and 23.6% and 23.5% for Southern and Eastern European countries, respectively. The empirical findings suggest a robust relationship between the SE and proxies that quantify overall governance quality conditioning also on standard economic factors. Furthermore, the results show that countries with high SE levels can reduce their informal sector, at an increasing rate, by improving governance quality.

Finally, a caveat in our analysis is that due to lack of data our sample does not include more countries internationally, and especially emerging countries where the effects of the SE are more eminent. Future research may investigate the impact of the SE more deeply and, possibly, suggest a theoretical economic mechanism through which policy strategies or the adjustment of various macroeconomic variables can affect the results of studies on the SE.

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List of Figures and Tables

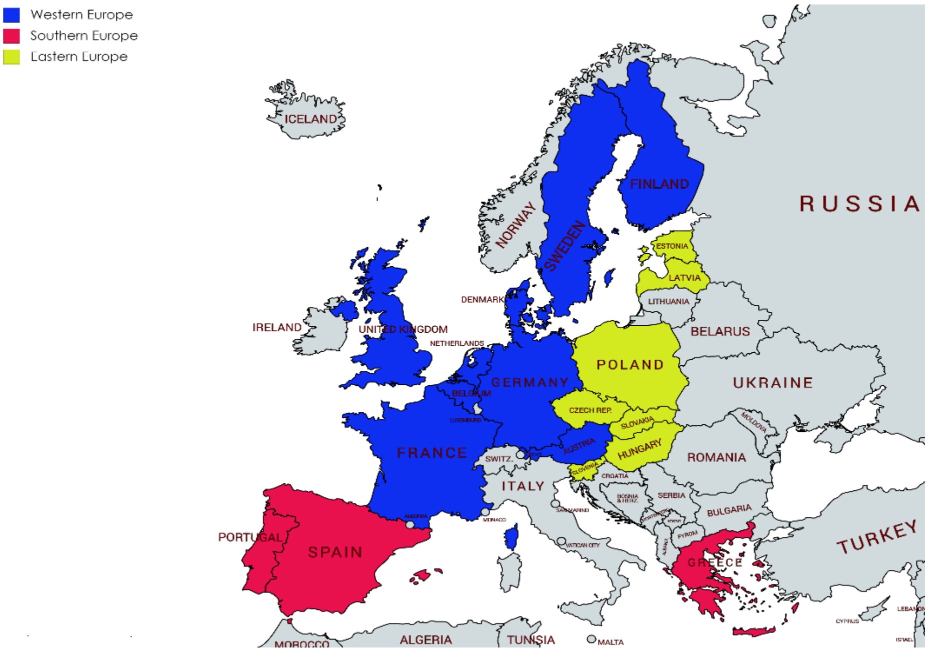

Figure 1. Sample Countries

Notes: Western European Countries are signified with a blue color (Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Sweden and U.K.); Southern European Countries are signified with a red color (Greece, Portugal and Spain); Eastern European Countries are signified with a yellow color (Czech Rep., Estonia, Hungary, Latvia, Poland, Slovenia and Slovak Rep.).

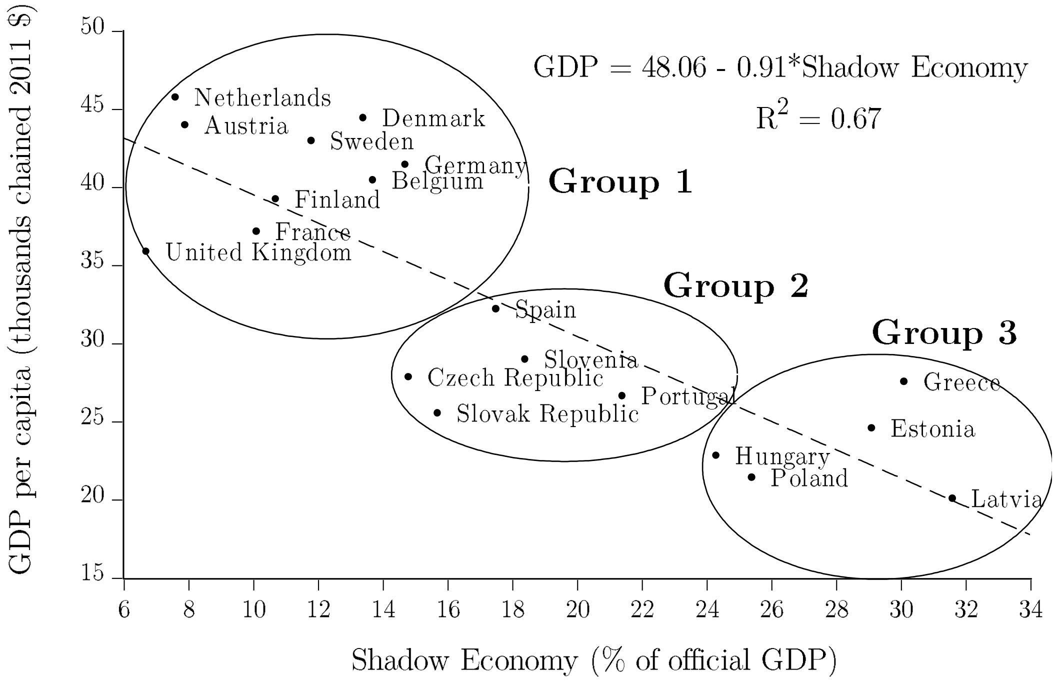

Figure 2. Scatterplot for the average SE and the average real (ECM^S).

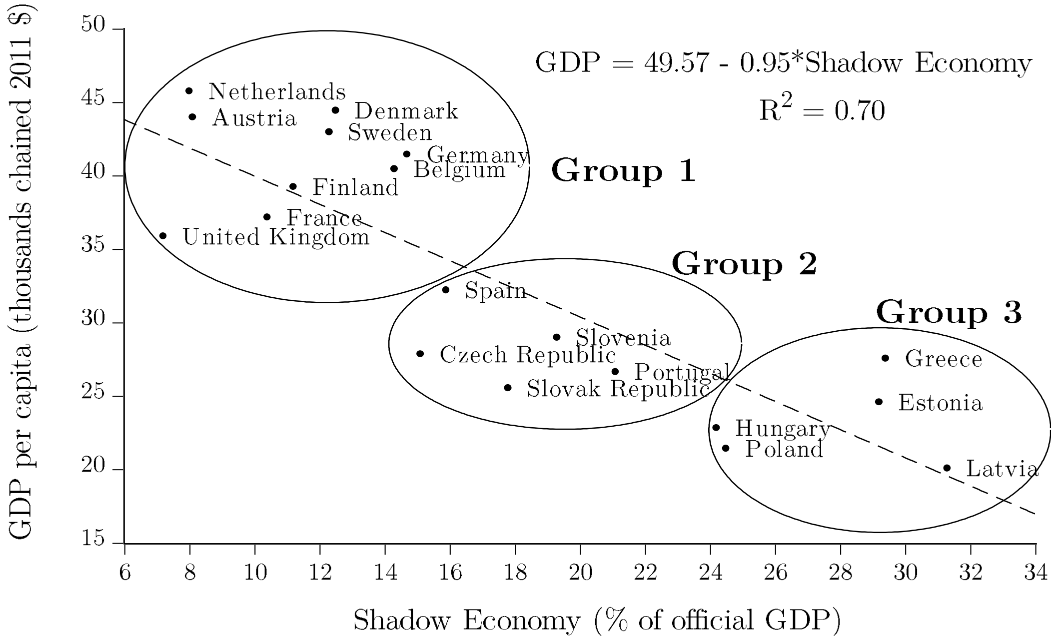

Figure 3 Scatterplot for the average SE and the average real GDP (ECM^M).

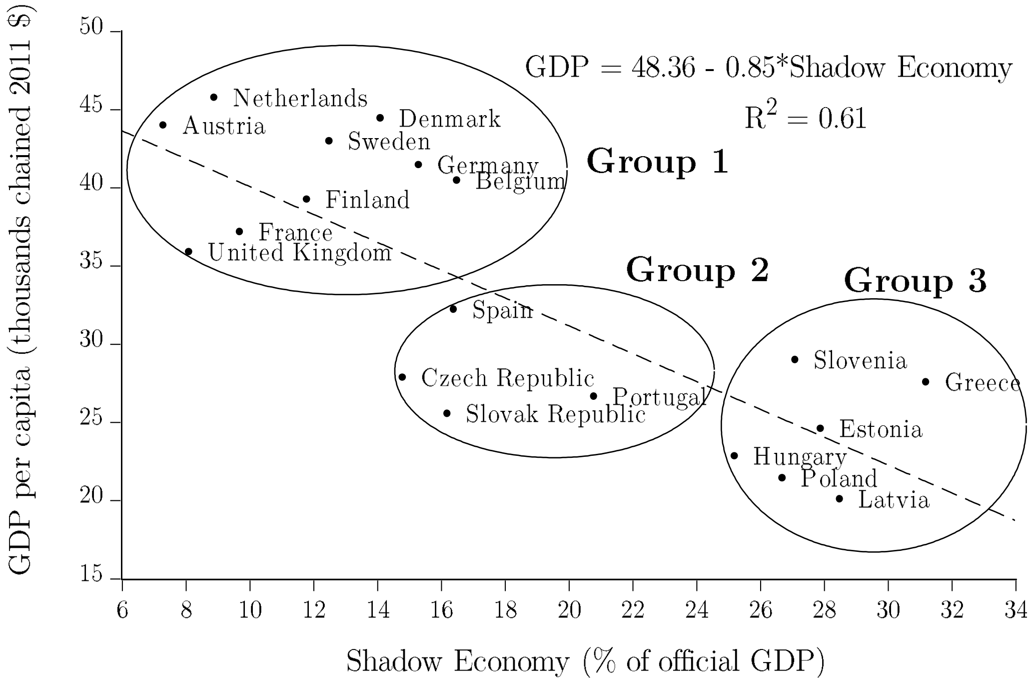

Figure 4 Scatterplot for the average SE and the average real GDP (ECM^F).

Table 1. LLC panel unit-root test results

Variable	LLC test statistic	p-value
$C^{Ele,c}$	-15.98***	0.000
$C^{FE,c}$	-18.30***	0.000
$H^{Dd,c}$	-16.65***	0.000
$P^{Ele,c}$	-11.06***	0.000
$P^{Oil,c}$	-11.17***	0.000
$I^{Add,c}$	-9.56***	0.000
$U^{Ene,c}$	-11.75***	0.000

Notes: *** denotes rejection of the null hypothesis for a panel unit-root at the 0.01 significance level.

Table 2. Shadow Economy (% of the official GDP) based on ECM^{S}

Country	**Year**							**Average (2007-2013)**
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	
	Panel A: Western Europe (WE) Countries							
Austria	9.4	9.7	6.2	12.0	12.6	14.3	13.8	**11.1**
Belgium	18.3	17.0	8.5	15.2	10.2	9.7	9.4	**12.6**
Denmark	14.8	12.5	7.1	8.9	6.2	3.9	4.0	**8.2**
Finland	14.5	9.1	1.7	10.0	4.8	4.7	3.5	**6.9**
France	11.9	13.7	9.2	15.1	7.6	9.6	9.7	**11.0**
Germany	14.7	14.0	8.1	15.2	13.4	15.3	11.3	**13.1**
Netherlands	10.1	10.4	5.3	7.1	7.5	5.0	4.2	**7.1**
Sweden	15.6	12.7	7.2	13.2	6.3	8.3	5.1	**9.7**
U.K.	10.6	9.0	2.3	3.3	-0.8	-1.2	-2.0	**3.0**
Average WE	**13.3**	**12.0**	**6.2**	**11.1**	**7.5**	**7.7**	**6.5**	**9.2**
	Panel B: Southern Europe (SE) Countries							
Greece	25.2	27.4	23.5	17.1	18.3	21.5	10.4	**20.4**
Portugal	19.2	18.2	18.1	20.9	18.2	15.4	14.2	**17.7**
Spain	19.3	18.8	11.4	12.5	10.4	9.9	6.5	**12.6**
Average SE	**21.2**	**21.4**	**17.6**	**16.8**	**15.6**	**15.6**	**10.3**	**16.9**
	Panel C: Eastern Europe (EE) Countries							
Czech Rep.	17.0	16.4	10.2	13.9	13.0	13.1	12.8	**13.8**
Estonia	29.5	31.3	23.3	34.3	30.3	38.0	37.5	**32.0**
Hungary	23.8	24.1	17.4	20.6	21.3	22.1	21.1	**21.4**
Latvia	27.6	29.3	21.8	30.0	31.4	44.4	39.8	**32.0**
Poland	25.9	28.1	23.5	30.6	33.4	34.1	35.4	**30.1**
Slovenia	24.7	20.9	6.6	13.9	18.9	18.4	19.4	**17.5**
Slovak Rep.	16.8	17.3	9.8	15.2	18.5	13.8	15.3	**15.2**
Average EE	**23.6**	**23.9**	**16.1**	**22.6**	**23.8**	**26.2**	**25.9**	**23.1**

Notes: For the period 2011-2013 the size of the SE for U.K. illustrates negative values and obviously, this is not a plausible result. Feige and Urban, (2003) note that the estimation of negative values is a significant shortcoming of the method. In such cases, the reduction of the growth rate in the consumption of electricity is attributed to factors that are not associated to the economic activity (e.g. whether conditions) and therefore to the growth rate of the informal sector. A common solution is to assume a different from unity electricity/output elasticity. For instance, in the case of the U.K. an elasticity value equal to 0.7 delivers more expected results.

Table 3. Shadow Economy (% of the official GDP) based on ECM^M

Country	2007	2008	2009	2010	2011	2012	2013	Average (2007-2013)
	Panel A: Western Europe (WE) Countries							
Austria	9.4	7.7	8.0	8.7	8.0	8.1	7.0	**8.1**
Belgium	18.3	15.4	12.7	14.7	13.1	13.8	12.4	**14.3**
Denmark	14.8	12.7	13.5	12.4	12.1	10.3	11.6	**12.5**
Finland	14.5	10.5	8.8	12.6	9.9	11.0	11.2	**11.2**
France	11.9	10.7	10.6	14.3	8.2	8.6	8.3	**10.4**
Germany	14.7	12.6	13.3	14.6	15.2	17.4	14.8	**14.7**
Netherlands	10.1	8.1	8.7	5.9	9.1	6.8	7.2	**8.0**
Sweden	15.6	13.8	14.0	14.1	8.5	10.3	10.0	**12.3**
U.K.	10.6	9.7	8.6	6.2	4.9	4.9	5.8	**7.2**
Average WE	**13.3**	**11.2**	**10.9**	**11.5**	**9.9**	**10.1**	**9.8**	**11.0**
	Panel B: Southern Europe (SE) Countries							
Greece	25.2	33.0	33.5	32.5	26.0	30.0	25.5	**29.4**
Portugal	19.2	17.7	23.3	23.9	23.2	20.5	20.0	**21.1**
Spain	16.8	16.6	16.6	15.3	16.8	13.1	15.9	**15.9**
Average SE	**20.4**	**22.4**	**24.5**	**23.9**	**22.0**	**21.2**	**20.5**	**22.1**
	Panel C: Eastern Europe (EE) Countries							
Czech Rep.	17.0	16.6	15.1	14.1	14.1	14.1	14.6	**15.1**
Estonia	29.5	30.7	27.0	29.8	24.0	31.9	31.3	**29.2**
Hungary	23.8	25.3	24.6	22.5	22.7	25.0	25.8	**24.2**
Latvia	27.6	31.2	24.0	25.6	30.7	41.0	38.7	**31.3**
Poland	25.9	23.4	22.7	23.9	24.4	24.8	26.2	**24.5**
Slovenia	24.7	19.1	11.6	17.5	20.4	19.9	21.6	**19.3**
Slovak Rep.	19.3	18.4	18.6	17.9	17.5	17.0	15.7	**17.8**
Average EE	**24.0**	**23.5**	**20.5**	**21.6**	**22.0**	**24.8**	**24.8**	**23.0**

Notes: For the period 2011-2013 the size of the SE for U.K. illustrates no negative values. Obviously, the estimates obtained by the ECM^M appear to be more plausible.

Table 4. Shadow Economy (% of the official GDP) based on ECM[F]

Country	2007	2008	2009	2010	2011	2012	2013	Average (2007-2013)
	Panel A: Western Europe (WE) Countries							
Austria	9.4	10.4	5.5	8.1	6.9	4.3	6.8	**7.3**
Belgium	18.3	21.8	16.5	20.3	14.4	12.2	12.1	**16.5**
Denmark	14.8	14.2	14.3	15.8	16.6	11.6	11.6	**14.1**
Finland	14.5	12.9	7.4	12.2	11.6	12.7	11.1	**11.8**
France	11.9	12.0	9.3	10.7	7.7	7.7	8.5	**9.7**
Germany	14.7	18.1	15.1	14.6	14.1	15.4	14.8	**15.3**
Netherlands	10.1	10.2	7.3	10.6	9.9	7.3	7.2	**8.9**
Sweden	15.6	13.0	12.7	13.3	11.9	10.8	10.1	**12.5**
U.K.	10.6	10.2	5.9	7.4	3.9	4.9	5.6	**6.9**
Average WE	**13.3**	**13.6**	**10.4**	**12.6**	**10.8**	**9.7**	**9.8**	**11.5**
	Panel B: Southern Europe (SE) Countries							
Greece	25.2	34.5	37.4	40.3	36.8	26.3	25.2	**32.2**
Portugal	19.2	20.6	24.9	25.9	27.5	17.2	19.6	**22.1**
Spain	19.3	16.3	14.1	16.3	19.3	14.1	15.6	**16.4**
Average SE	**21.2**	**23.8**	**25.5**	**27.5**	**27.9**	**19.2**	**20.1**	**23.6**
	Panel C: Eastern Europe (EE) Countries							
Czech Rep.	17.0	18.1	14.2	13.1	14.5	12.5	14.5	**14.8**
Estonia	29.5	34.3	24.8	22.0	23.0	30.6	31.1	**27.9**
Hungary	23.8	28.7	26.2	21.4	22.0	15.5	25.0	**23.2**
Latvia	27.6	26.9	20.0	23.2	28.7	34.1	38.9	**28.5**
Poland	25.9	27.4	24.4	29.1	27.6	26.5	26.1	**26.7**
Slovenia	24.7	34.4	25.8	29.1	29.5	25.1	21.4	**27.1**
Slovak Rep.	16.8	20.1	15.8	20.4	14.6	10.3	15.4	**16.2**
Average EE	**23.6**	**27.1**	**21.6**	**22.6**	**22.8**	**22.1**	**24.6**	**23.5**

Notes: For the period 2011-2013 the size of the SE for U.K. illustrates no negative values. Obviously, the estimates obtained by the ECM[M] appear to be more plausible.

Table 5. Panel estimates for the period random-effects specifications

Regressors	Dependent variable			Dependent variable			Dependent variable		
	SE^S	SE^M	SE^F	SE^S	SE^M	SE^F	SE^S	SE^M	SE^F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
w	29.90***	30.74***	30.90***	30.52***	31.93***	32.29***	25.67***	26.68***	26.77***
T^s	-0.59***	-0.40***	-0.34**	-0.66***	-0.44***	-0.37***	-0.67***	-0.46***	-0.42***
P^g	0.74***	0.52***	0.56***	0.82***	0.60***	0.63***	0.85***	0.60***	0.63***
G^e	-8.83***	-9.01***	-9.05***	-	-	-	-	-	-
R^l	-	-	-	-8.96***	-9.77***	-9.98***	-	-	-
C^c	-	-	-	-	-	-	-5.53***	-5.94***	-5.79***
Regression Diagnostics									
R^2	0.554	0.601	0.513	0.543	0.632	0.544	0.522	0.592	0.486
F_{test}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JB_{test}	0.000	0.000	0.000	0.008	0.001	0.216	0.028	0.139	0.412

Notes: SE^S, SE^M and SE^F signify the method used to estimate SE, that is ECM^S, ECM^M and ECM^F respectively. ** and *** denote the rejection of the null hypothesis at the 0.05 and 0.01 significance levels, respectively. R^2 is the coefficient of determination, F_{test} is testing the joint significance of all regressors and finally, JB_{test} is testing the normality of the residuals.

Table 6. Quantile Regressions Estimates (data in a panel set-up)

Regressors	Dependent variable			Dependent variable			Dependent variable		
	SE^S	SE^M	SE^F	SE^S	SE^M	SE^F	SE^S	SE^M	SE^F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
w	28.18***	27.49***	30.65***	32.48***	31.54***	33.88***	26.94***	26.74***	26.73***
T^s	-0.31**	-0.34**	-0.46**	-0.45***	-0.35***	-0.43***	-0.44**	-0.37*	-0.35
P^g	0.95**	0.97**	0.59	0.74*	0.86**	0.46	0.78	0.82**	0.73*
G^e	-9.16***	-8.73***	-9.04***	-	-	-	-	-	-
R^l	-	-	-	-9.75***	-9.98***	-9.64***	-	-	-
C^c	-	-	-	-	-	-	-6.20***	-6.70***	-6.54***
D	yes	yes	yes	yes	yes	yes	yes	yes	yes
Regression Diagnostics									
R^2_{pseudo}	0.409	0.415	0.335	0.398	0.440	0.374	0.379	0.397	0.317
RR_{test}	0.764	0.004	0.002	0.616	0.892	0.594	0.931	0.117	0.271
SE_{test}	0.266	0.095	0.051	0.367	0.005	0.000	0.481	0.021	0.000
JB_{test}	0.000	0.004	0.027	0.000	0.001	0.230	0.000	0.393	0.605

Notes: SE^s, SE^M and SE^F signify the method used to estimate SE, that is ECM^S, ECM^M and ECM^F respectively.*, ** and *** denote the rejection of the null hypothesis at the 0.1, 0.05 and 0.01 significance levels, respectively. R^2_{pseudo} is the coefficient of determination, RR_{test} the Ramsey RESET test, SE_{test} is the slope equality test over the different quantiles for the governance quality indicators and finally, JB_{test} is testing the normality of the residuals.

Table 7. Estimated coefficients per quantile for the equations 1 to 9 (in Table 6)

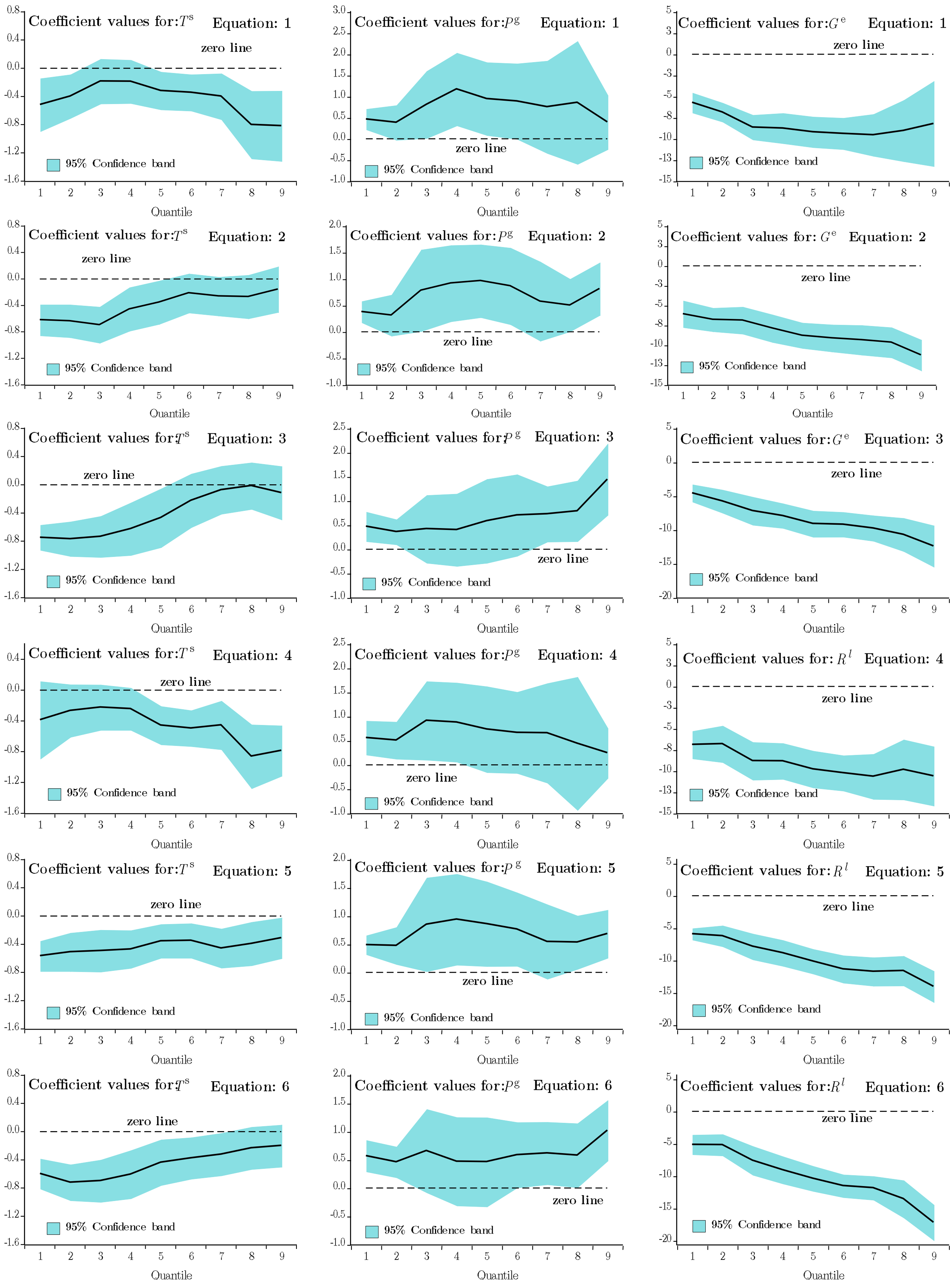

Table 7. Cont'd