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THE SHADOW ECONOMY IN THE EUROPEAN UNION

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ABSTRACT

The underground economy is a matter of interest and a common challenge for countries. Tackling shadow economy problem is essential since it means losing a valuable source of revenue which has undoubtedly direct implications for the overall society. Given the importance and disparities of shadow economy in the 28 European Union countries, the purpose of this paper is to analyze deeply the shadow economy and its main determinants exclusively on the EU. To conduct the investigation, a database has been constructed for the period 2000-2015, with a particular focus on taxation, employment rates, governance quality and macroeconomic variables. Econometric estimations with panel data have been made. The empirical analysis suggests important results on the effect of some drivers on shadow economy, such as the remarkable negative influence of high tax burden on shadow economy. Results might shed light on ways to combat shadow economy.

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1. INTRODUCTION

Currently, shadow economy is a matter of interest which frequently causes trouble to governments. Indeed, shadow economy is one of the most prevalent and most damaging forms of losing revenue that the State has to deal with. In the last decades, the fight against tax evasion, the underground economy and informal jobs have become significant policy priorities in the European Union countries.

While most recent researches agree that shadow economy has declined across European Union countries in the last years, there is plenty of evidence to confirm that this phenomenon is still of high importance. The estimated size of the shadow economy in several European Union countries is reasonably large, although it is true that estimates of its size in the EU vary significantly from under 8% of Gross Domestic Product (GDP) in some countries to over 36% in others. Throughout this paper, we hope to find an explanation to this great discrepancy.

As it has been mentioned, shadow economy activities have direct implications that must be taken seriously into consideration, it is therefore crucial to be aware of them. To start with, undeclared economic activities have a detrimental impact on tax collection, severely undermining the objective of budgetary stability and rising the distorting effects of the tax system (Fernández *et al.*, 2018). As a result, public revenue and public services are logically weakened. On the other hand, informal employment is usually less secure, worst-paid and characterized by weaker working conditions (Willians & Horodnic, 2015). In addition, firms staying informal are usually less productive and innovative, affecting negatively country's human capital and technological innovations.

Now, it might be appropriate to justify the usefulness of this study. Although the research of shadow economy and its determinants has improved over the last years, to cope with this general problem, there is still further research to be done. Thus, this paper provides a specific analysis of the main determinants that can explain the existence of underground economy in the EU and how these variables might affect positively or negatively SE. Our research could help EU governments to better know which factors might increase shadow economy size so as to ensure that appropriate measures are taken to improve the situation.

In order to keep the subject of this paper tractable, the objective is to study exclusively the shadow economy in the 28 EU countries. It is expected to find differences across EU countries and the main purpose is to determine which variables can be meaningful and can explain considerably these different sizes of European Union shadow economies. As it has been mentioned, shadow economy size differs among EU countries; how to interpret these differences? What are the factors that might determine that a country has a higher percentage of SE than others? Has the economic crisis affected SE size, as many experts claim? Have some variables had a greater impact after the economic recession of 2008? In this paper, we will try to give answers to these questions.

The choice of this topic can be explained by my personal desire of eradicating as much as possible shadow economy. To my mind, and taking into account that I have studied a degree of Economics, it is challenging and motivating to learn more about the possible determinants of shadow economy in EU countries. This study is personally appealing to me since, from my point of view, one way to combat shadow economy existence is to do more and more research on the field, these researches could explain why some countries do have a higher percentage of shadow economy over total GDP. Not only would countries be aware of the determinants that cause a higher percentage of shadow economic activities, but at the same time governments might be encouraged to reply policies of countries with lower shadow economy percentages so as to reduce the importance of this phenomenon in their economy. The Director of ILO's Department of Statistics warned of the danger of having a high informal economy: "*The high incidence of informality in all its forms has multiple adverse consequences for workers, enterprises and societies and is a major challenge for the realization of decent work and for sustainable and inclusive development.*" (Diez, 2018)

The rest of the paper is structured as follows. Section 2 presents the theoretical framework: a definition of shadow economy will be provided, some methods for estimating it will be reviewed and detailed and the main believed factors determining SE size will be as well presented; in Section 3, variables and methodology employed will be described, including an analysis of data and the presentation of the hypotheses to be tested, the econometric model will be as well presented. Section 4 presents the results obtained and, finally, a discussion of the findings, conclusion and future research are presented at the end of the document in Section 5.

2. LITERATURE REVIEW

2.1 Concept of shadow economy

Shadow economy is certainly something which is often discussed in today's world. Underground economy, hidden economy, gray economy, cash economy, informal economy, black economy and shadow economy are all terms used indistinctively for this topic. Nevertheless, underground economy, in one form or another, has been in existence for centuries. As the Canadian-Indian writer Rohinton Mistry said: "*Black money is so much a part of our white economy, a tumour in the centre of the brain - try to remove it and you kill the patient.*"

Over the years, there has been an increasing government's concern about the importance of this matter and SE is believed to have decreased in the last recent years. A high percentage of SE activities means losing a valuable source of revenue which has undoubtedly direct economic, political and social implications for the overall society. Therefore, the existence of a significant percentage of shadow economy is a major problem that can affect the values of macro-magnitudes such as income per capita, which is used as a reference for the distribution of international aid funds and, therefore, can damage the design of economic policies that are based precisely on these magnitudes. Additionally, shadow economy leads to unfair competition between employers; tax evasion leading to a decrease of state income; and no social security payments which imply significant long term consequences such as pension sustainability. (Mauleón & Sardà, 2017)

When it comes to the definition of this phenomenon, there is not a unique worldwide definition. The concept of underground economy includes not only all productive illegal economic activities (such as human trafficking, drug trafficking, money laundering…) but it also includes the irregular economy. Generally speaking, it refers to all operations that remain hidden from the Public Administration to avoid payment of taxes, payment of Social Security contributions or fail to comply with labor standards or administrative regulations. A common definition is the following: "*market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP*". (Smith, 1994). There is another common definition of SE that only covers legal activities, that is, the SE is the "*unreported income from the production of legal goods and services - either from monetary or barter transactions - and so includes all economic activities that would generally be taxable, were they reported to the tax authorities*". (Buehn & Schneider, 2017).

There are different types of underground economic activities. Table 1 identifies the main ones which can be basically divided into legal and illegal activities. Among legal activities, tax evasion and tax avoidance can be distinguished. Legal activities cover the purchase and sale of goods and services that have been legally produced, this can be the case of unreported income from self-employment, do-it-yourself work or employee discounts. Illegal activities are related with movements of goods and services that are not legal such as drug dealing, smuggling, prostitution or gambling. It might be highlighted the fact that the underground economy not only convers monetary transactions but also non-monetary ones, for instance, theft for own use or barter of drugs. (Buehn & Schneider, 2017)

Table 1. Types of underground economic activities

Type of activity	Monetary transactions		Non-monetary transactions	
Illegal Activities	Trade with stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling; fraud; etc.		Barter of drugs, stolen goods, smuggling etc. 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 neighbor help

Source: Lippert & Walker (1997, p.5)

Organizations such as the Organization for Economic-Cooperation and Development (OECD) or the International Monetary Fund (IMF) distinguish between three different types of underground economic activities. In the first place, *hidden production,* which refers to legal production of goods and services that aimed to avoid paying taxes or regulations. Secondly, *illegal production*, which is based on illegal production of goods and services or products that have been done by fraudulent methods. Thirdly, *informal production* that covers the existence of businesses that are not registered legally.

To finish with the definition of underground economy, it is important to differentiate between fiscal fraud, tax evasion and underground economy since there are different concepts that tend to be confused. 'Underground economy' covers economically legal but hidden practices like black work as well as certain illegal hidden activities such as trafficking with illicit drugs or prostitution. The first component, legal undeclared activities in the shadow economy, typically includes tax avoidance, although taxes could also be evaded pursuing different actions that are separate from those of the shadow economy, for instance, when the legally obtained capital income is not truthfully reported. (Buehn & Schneider,

2016). Therefore, shadow economy and tax fraud are not the same, despite shadow economy usually generates a significant loss of fiscal revenue, this is not always the case, for instance, one example could be the unregistered but low-income street vendors.

Obviously, businesses and individuals decide to participate in the shadow economy because it has some monetary, regulatory or institutional advantages such as not to pay social security contributions or taxes, not to comply with legal labor market standards or avoid certain administrative procedures. An illustrative example of underground economy can be non-registered businesses that avoid paying income taxes or VAT or, even more simply, unreported sources of incomes which are unknown to the tax administration and allow individuals or businesses to benefit from some untaxed income.

However, shadow activities can be detected and a significant fine should be paid in that case. Indeed, governments need to have the power to reduce these shadow economy activities. For this reason, governments have the duty to impose significant fines to firms or people working in the SE. To be effective, the fines should be heavy enough to deter potential shadow economic activities; if they are too small, they could simply be regarded by firms and people as "the cost of being informal" and these fines can be ignored. This illustrates the responsibility of governments to impose heavy fines. More than 70 years ago, Kenneth Boulding (1947), an English-born American economist, already declared that "*The greater the penalties laid on sellers in the black market... the higher the black's market price.*" So, individuals make a choice when deciding breaking the law and they decide to work in the SE whenever the benefits (the opportunity cost of being formal) outweigh the costs (probability of detection and potential fine). This can be reflected in the following equation: $SE = SE\ [p\ (A, F); f; B(T, W)]$ where p is the probability of detection that in turn depends on enforcement actions A taken by the tax authority and on facilitating activities F accomplished by individuals to reduce the detection of shadow economic activities, f is the potential fine and B is the opportunity cost of remaining formal which in turn depend on the burden of taxation T and on labor costs W (Schneider, 2016). Logically, the higher the probability of detection p or the potential fine f, the lower the incentives to participate in the shadow economy, while the higher opportunity cost B, the more people are willing to take part in the shadow economy. Even though these factors can determine the decision of "breaking the law", there are multiple determinants that do also have an influence and will be explained later.

To finish with, as it has been already mentioned and as a reminder, the existence of shadow economy means that the GDP is underestimated or, in other words, that the Deficit/GDP and Debt/GDP ratios are overestimated. Since tax revenues will be reduced, this will generate negative consequences in designing the fiscal system, in equity and will ultimately damage the fiscal sustainability of the economy. Every single fiscal or monetary policy that a country decides to undertake (if shadow activities do exist) will be based on biased official data, which will consequently imply macroeconomic policy mistakes (Ahumada *et al.*, 2006). Due to these facts, there has been a growing interest in the last decades in measuring the size of the shadow economy and, accordingly, the public sector is especially interested in turning shadow economic activities into regularized work.

2.2 Methods for estimating the size and development of the SE

There is a wide variety of methods that are employed when desiring to estimate the size of the shadow economy. Logically, it is not an easy task to quantify the size of underground economy since people tend to hide it. A short description of the most widely used approaches is going to be detailed, as well as the main advantages and disadvantages of each method. Before doing so, it should be highlighted the fact that there is not an ideal method and results usually differ significantly between them. The choice of the methodology can be made per availability of data or research objectives. Moreover, there exists the possibility of combining different methods so as to increase accuracy in results.

To begin with, it would be useful to present the following figure to have an overall picture of the different available methods for estimating shadow economy.

Figure 1. Estimation methods of SE
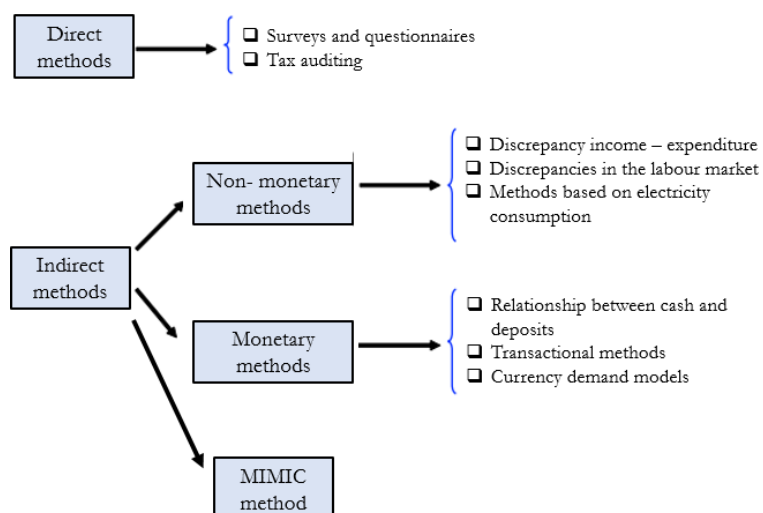
Source: own compilation based on data from Gestha (2014)

As it can be appreciated in the figure, there are basically two main types of methods:

2.2.1 Direct methods

Direct methods are based on surveys, tax auditing and other compliance methods, however, these methods usually underestimate the shadow economy since they are not representative of the total population. Indeed, tax auditing is not randomly made and does only show a part of undeclared income, leading to an underestimation of the SE. Concerning surveys, there are several factors that affect directly the accuracy of results, for instance, surveys' wording, respondent's willingness to cooperate and confess fraudulent behavior can significantly affect surveys' results. In reality, the majority of people are not proud of working in the SE and they obviously tend to hide these fraudulent behaviors meaning that survey method results are again generally underestimated. What is more, comparisons between countries is complicated due to language difficulties, the different wording of each country's languages can imply different meaning, misinterpretations of surveys questions and so on. Consequently, surveys' results might not be consistent across various countries. (Buehn & Schneider, 2017)

Despite these apparent drawbacks of direct methods, a new type of surveys that is increasingly being used might be commented. They are called surveys and the reasoning is the following: company managers should be the ones surveyed since they are supposed to have a better knowledge of how much business income and wages go unreported due to its privileged position in this matter. Accordingly, Putnins and Sauka (2015) decided to construct a survey whose design aimed to "maximize" the veracity of managers' responses. Then, an estimation of unreported business income, unregistered workers, and unreported wages was obtained which help to estimate the size of the SE as a percentage of GDP. Despite the fact that this approach seems to be appealing, much more research is needed to assure its reliability.

To conclude, although direct approaches are widely used in the real world, indirect methods are believed to be more reliable in terms of accuracy since they are based on macroeconomic variables which are correlated with shadow economy size. In the following section, most common and relevant approaches are going to be explained and summarized.

2.2.2 Indirect methods

There are different types of indirect methods. For example, discrepancy income-expenditure method considers the gap between the expenditure measure and the income measure of

GDP as an indicator of the existence of underground activities. Likewise, discrepancies in the labor market are believed to be an indicator of increased activity in the underground economy. This method considers constant labor force participation, therefore, a decrease in labor force participation would be accompanied with an increase in people working in the SE. (Schneider, 2016) Since these two methods are quite intuitive, the following lines will be devoted to the rest of methods that require a further explanation.

The currency demand approach

The currency demand approach is based on the belief that most of the informal transactions are made in cash so that an increase in currency demand will be an indicator of an increase in shadow economic activities. According to Tanzi (1983), hidden transactions are undertaken in the form of cash payments since it becomes more difficult to be discovered from the authorities. He includes in the estimation equation all factors that incentive people to work in the SE such as direct and indirect tax burdens, government regulation, state institutions and tax morale. (Buehn & Schneider, 2017). Tanzi (1983) mentions as well different conventional factors, such as income development, payment habits, interest rates, credit and other debt cards that can be substitutes for cash. So, "any "excess" increase in currency, or the amount unexplained by conventional factors, is then attributed to the rising tax burden and other reasons leading people to work in the shadow economy". Even though this approach is one of the most commonly used, Garcia (1978) and Park (1979) claimed that increases in currency demand deposits are primarily attributed to a decrease in demand deposits rather than a currency rise caused by SE activities. Although this method can be applied to many countries, it cannot be excluded from criticism. In fact, it is true that not all transactions in the SE are paid in cash. Moreover, other factors such as regulations, taxpayers' attitudes towards the state or tax morality are not taken into consideration and, therefore, hidden economy might be underestimated.

The electricity consumption method

The electricity consumption method is based on two different methods

The Kaufmann-Kaliberda method consists of regarding electricity consumption as the best indicator of total economic activity (both official and unofficial). The elasticity of electricity-total GDP is assumed to be close to one. Consequently, if the increase in electricity consumption is larger than the growth of official GDP, this can be understood as an increase in the participation in the shadow economy. (Kaufmann & Kaliberda, 1996). However, this

approach has some deficiencies since electricity consumption and shadow economic activities do not always come together. There are actually several alternative energy sources that make electricity not essential, or even sometimes it is not necessary the use of energy to work in the underground economy. This can be the case of personal services, for instance. Likewise, this method does not consider the fact that the elasticity of electricity/GDP varies across countries and over time, that is, is not always close to one. (Johnson *et al.*, 1997)

An alternative of Kaufmann-Kaliberda method is the Lackó method (1998, 1999). This method assumes that, in all economies, there is a part of household electricity consumption that is involved with no official-underground activities. As in the method explained before, it cannot be forgotten that there are some activities which do not require a significant amount of electricity and that many SE activities do not occur on households so that the electricity-consumption methods do also have some limitations when estimating the size of shadow economy.

Multiple Indicators, Multiple Causes (MIMIC) approach

The MIMIC model consists of a statistical theory on unobserved (hidden) variables, which considers multiple causes and multiple indicators of the SE measured. This approach pioneered by Frey & Week-Hannemann (1984) and further expanded by Schneider and his coauthors (2013, 2016). The shadow economy is considered as the unobservable (latent) variable and the MIMIC estimation procedure is the following:

In the first place, relationships between the latent/unobservable variable and the observable variables are specified through a structural model: $\boxed{\eta = \Gamma x + \zeta}$ where η represents the shadow economy or the latent variable, Γ is the coefficient matrix in the structural model, x is the vector of causes in the structural model and ζ is the error term in the structural model

Secondly, the unobservable variable is linked to its indicators in a measurement model, also called factor analytical model: $\boxed{y = \Lambda_y \eta + \varepsilon}$ where y represents the vector of indicators in the measurement model, Λ_y is the coefficient matrix in the measurement model, η is the latent variable or SE, and ε is the error term in the measurement model.

If we substitute the measurement equation into the structural equation, a new equation is obtained which shows the relationships between causes and indicators:

$\boxed{y_t = \pi x_t + z_t}$ where $\pi = \Lambda_y \Gamma$ and $z_t = \Lambda_y \varepsilon_t + \zeta_t$

Figure 2. The MIMIC model
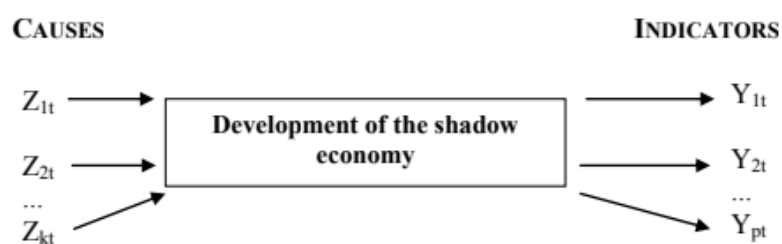
The MIMIC approach has two main goals: "*(i) to estimate the relationships between a set of observable variables, divided into causes and indicators, and the shadow economy activity (unobservable variable); and (ii) to test whether the researcher's theory or derived hypotheses as a whole fit the data.*" (Buehn & Schneider, 2017)

The MIMIC method offers advantages and disadvantages. This method makes possible the consideration of multiple indicators and multiple variables simultaneously. Additionally, the application of this approach allows flexibility, that is, causal and indicator variables can vary and are usually chosen depending on the features aimed to be studied. Nevertheless, this method has also some drawbacks. It is not possible to obtain absolute coefficients and it is at the same time difficult to distinguish causes from estimators, finally, the results are highly influenced by the data and specifications used. (Medina & Schneider, 2018)

2.3 Determinants of shadow economy

There are some drivers that might explain the existence of SE and the great discrepancy of SE size across countries, in fact, it is thought that these determinants might have an effect on SE. Before explaining these determinants that are presented in almost all academic studies of SE, it would be interesting to comment on a survey that reflects quite well why citizens decide to work in the shadow economy. The survey was done in 2013 and is called as special Eurobarometer survey no.402. The following question was raised to citizens: "what are in your opinion the reasons for doing undeclared work? and citizens asked the following:

Figure 3. Reasons for doing undeclared work
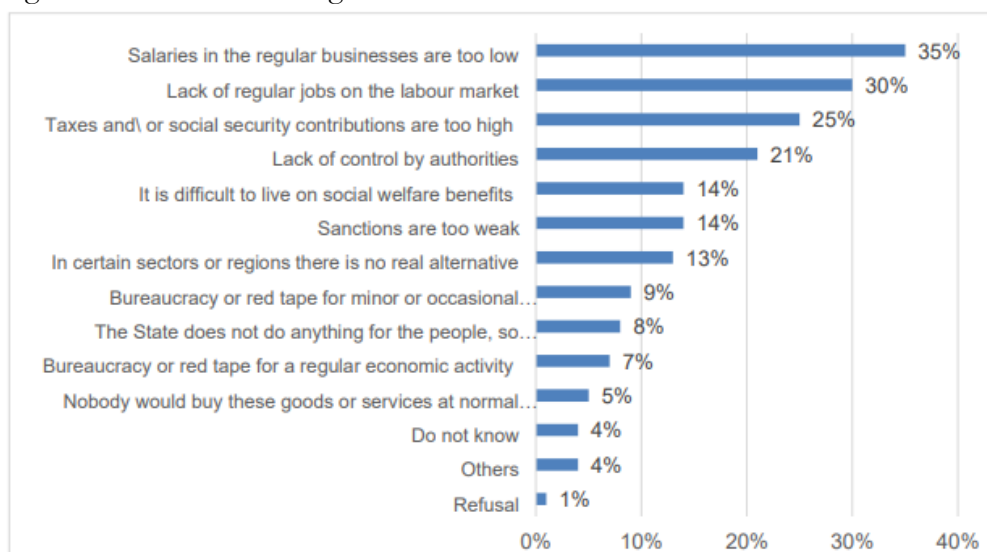
Source: Special Eurobarometer 402: Undeclared work in the European Union.

As it can be appreciated in Figure 3, there are similarities between the reasons given by citizens with respect to the drivers thought in the literature as the main determinants of SE existence. According to citizens, unemployment, taxes and social security contributions, social welfare benefits, bureaucracy or regulations might influence the decision of working in the shadow economy. Now, a brief but concrete explanation of some of the worldwide accepted determinants of SE is going to be detailed:

Tax and social security contribution burdens

Obviously, tax and social security burdens play a great role in the existence of SE. When the amount of tax and social security contribution burdens is significantly large, people are more willing to participate in the SE. In fact, "*the bigger the difference between the total labor cost in the official economy and after-tax earnings (from work), the greater the incentive to reduce the tax wedge and work in the SE.*" (Buehn & Schneider, 2017, p. 4). Therefore, countries should pay attention and try to control tax and social security contribution burdens in order to avoid negative consequences on their fiscal system.

It might be interesting to comment some differences concerning European Union countries. For instance, France is the only country that takes more than half (67%) of a worker's gross salary for social security contribution. Slovakia and Austria do also have large shares. Regarding income taxes, Denmark might be commented since despite the fact that it is the country with the lowest share of social security contributions, it is the country with the highest percentage of personal income tax (35.8%), whereas Cyprus is the one with the

lowest income tax rate of the total EU countries (Rogers & Philippe, 2020). As a consequence, both income tax and social security contributions might be considered at the same time to avoid misleading results.

2.3.1 Quality of institutions or corruption

A highly corrupt government tends to be associated with a high percentage of SE activities. Therefore, if individuals perceive institutions and the government itself as unfair and corrupt, there would be more incentives to work in the unofficial economy. On the contrary, if individuals consider that government policies are done pursuing the common interest of the whole society and public institutions are considerably fair, people would be more willing to remain formal. (Buehn & Schneider, 2017)

2.3.2 Regulations

The abundance of norms and regulations can worsen the development of official economic activity and may encourage individuals to work in the shadow economy. In fact, labor market regulations or trade barriers lead to a significant rise in labor costs, therefore, *"countries that are more heavily regulated tend to have a higher share of shadow economy in total GDP"*. (Medina & Schneider, 2018, p. 34) It might be highlighted the fact that it is not the overall extent of regulation but the enforcement which makes individuals to operate in the shadow economy.

2.3.3 Unemployment

In accordance with the International Labor Office (ILO) definition, *"the unemployment rate is the number of unemployed persons as a percentage of the labour force. The labour force is the total number of people employed and unemployed. Unemployed persons comprise persons aged 15 to 74 who: - are without work during the reference week; - are available to start work within the next two weeks; - and have been actively seeking work in the past four weeks or had already found a job to start within the next three months."*. It is interesting to comment unemployment since as Tanzi (1999, p. 347) declared *"the current literature does not cast much light on these relationships even though the existence of large underground economy activities would imply that one should look more deeply at what is happening in the labour market"* Therefore, although it is not clear the effect that has unemployment rate on shadow economy, it is initially expected that the greater the rate of unemployment, the higher the probability to work in the shadow economy, ceteris paribus. (Schneider & Williams, The Shadow Economy, 2013).

2.3.4   Productive specialization

The weight of underground economy varies significantly across sectors, meaning that productive specialization of countries does play a role when analyzing shadow economy size. Agricultural sector and services sector are believed to be the sectors that generally concentrate a greater weight of SE. So, it is assumed that countries whose economies depend on a great extent on agriculture or services sector will have a higher share of shadow economy over total GDP.

Size of the agricultural sector

Agriculture is supposed to be one of the sectors with highest level of unregistered workers. Indeed, it is a sector characterized by temporary workers and lack of regular controls so that working in the agricultural sector, in one way or another, enable workers to participate in the shadow economy. Consequently, "*the larger the agricultural sector, the more possibilities to work in the shadow economy, ceteris paribus.*" (Hassan & Schneider, 2016)

Size of the service sector

As it has been already mentioned, the service sector due to its nature is another sector that is believed to have a significant influence on the participation in shadow economy activities. In fact, the "Federación de Organizaciones de Profesionales Autónomos y Emprendedores" recently stated that the sectors where most part of underground economy is concentrated are services such as commerce or hotel and catering industry. A study done by this association revealed that mechanics, transporters, taxi drivers, hairdressers, bars and restaurants, cleaning companies are services that are usually most affected by the black economy.

2.3.5   Public sector services

Generally, it is known that the more state revenues, the better publicly provided goods and services. Consequently, an increase in the shadow economy (along with a decrease in state revenues) will worsen the quality of public sector services. So, as state revenues' have decreased due to the increase in SE activities, the government may increase tax rates so as to maintain state revenues. This increase in tax rates might encourage firms and individuals to participate even more in the shadow economy and countries will be caught in a vicious circle. To summarize, "*countries with higher tax revenues achieved by lower tax rates should have smaller shadow economies*". (Buehn & Schneider, 2017, p. 5)

2.3.6   Tax morale

"*Tax morale measures taxpayer perceptions and attitudes towards paying and evading taxes.*" (OECD, 2019). In general, taxpayers are more willing to pay all their corresponding taxes if the tax system is considered as fair and honest. Cultural or social norms have an influence and people usually behave in accordance with these norms. The better tax morale, the more taxes the tax authorities will collect.

Under-declared employment is used by employers who do not accept the formal 'rules of the game', due to their belief that the state is corrupt, or that the state does not provide them with the public goods they deserve given the taxes they pay. (Willians & Horodnic, 2015) This can be closely related with a variable that has been previously explained and does have an impact on shadow economy, which is quality of institutions or corruption.

It might be interesting to comment some aspects about the special Eurobarometer survey no. 40299, for instance, this survey asked individuals in 2013 to classify their point of views about six different types of undeclared work (where number 1 represents a totally unacceptable behavior and number 10 represents a totally acceptable behavior). The following describes the citizens viewpoints about tax evasion.

Figure 4. Acceptability of evading taxes by not or only partially declaring income
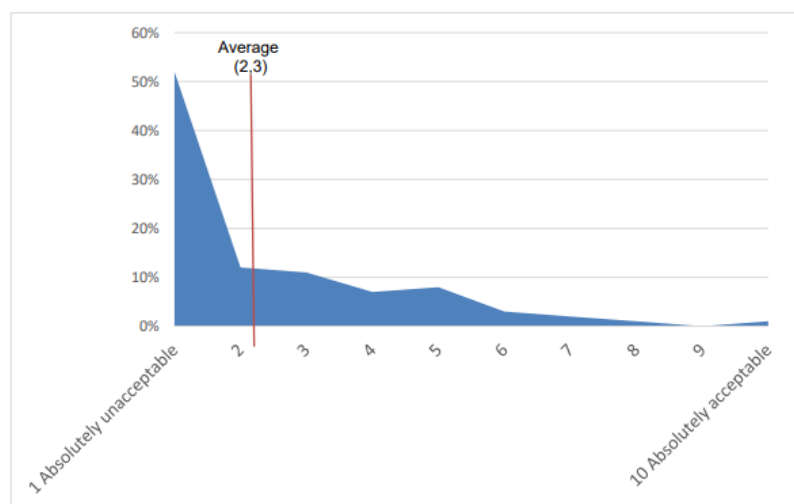
Source: Special Eurobarometer 402: Undeclared work in the European Union

It is widely known that there is a greater tax moral in north-west European countries (Finland, Sweden…) than in south-east European countries (Slovakia, Latvia, Lithuania), this can be explained by cultural or transparency factors (Alm & Torgler, 2003; Frey & Weck-Hanneman, 1984). Moreover, there is a negative correlation between underground economy

and tax morale in the European Union which is statistically significant (-0.64). (Onrubia, 2013)

"The higher the tax morale (i.e., the greater is the alignment of their beliefs with the laws and regulations), the lower the likelihood of employees participating in underdeclared employment." (Mineva & Stefanov, 2018, p. 35)

Unfortunately, it is not possible to collect reliable and concrete data from tax morale from all the countries under study meaning that this variable cannot be included in the model. However, it must be born in mind the implications that tax morale of citizens has on SE.

3. ECONOMETRIC MODELING AND DATA

3.1 Description of data and presentation of variables

This section explains in detail the data that is going to be used to construct the econometric model which particularly analyzes European Union SE and some of its determinants. That is, in order to make our study easier and tractable, the analysis will only cover the 28-EU countries. The European Union, for the years studied, is composed of 28 countries which are: Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom. Likewise, countries are going to be classified in two types: northwest EU countries (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, Sweden and UK) and southeast EU countries (Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Hungary, Italy, Malta, Poland, Portugal, Slovak Republic, Slovenia and Spain). This classification of northwest and southwest EU countries would be used for the computation of Figure 5. Likewise, the variables that we are going to analyze in our study are the following:

To start with, the main variable on which we are basing our study is shadow economy, the one used to construct Figure 5. Medina and Schneider (2018) estimate the size and development of the shadow economy over the period 1996 a 2015. They use the MIMIC method and they apply the light intensity approach, eliminating the complications that occur from GDP being used as a cause and indicator variable. Results reveal that the shadow economy has decreased from the 1990s to 2015 by 3-4 percentage points from the total 143 countries. To execute the following analysis, these data will be used.

Fiscal variables are believed to be a crucial determinant for the existence of SE. The variable that is going to be included in the model is denominated as "taxes on labor, as a percentage of total GDP". This variable appears in the report named as *Taxation Trends in the European Union* published on a yearly basis by the European Commission. Labor taxes comprises both taxes on employed labor income and taxes on non-employed labor income. Specifically, this variable includes "*taxes on individual or household income including holding gains (part raised on labor income or on social transfers and pensions), labor wage bill and payroll taxes, compulsory employers' and employees' actual social contributions, and compulsory actual social contributions by self- and non-employed persons (part paid by social transfers recipients)*" (European Commission, 2017, p. 248). It is convenient to include this variable in the model because it includes not only personal income tax but also social contributions, as well as social transfers that are paid by the state and benefits from old-age pension schemes.

Agriculture employment rate and services employment rate are going to be used as an illustration of the productive specialization of the country under study. The World Bank defines employment as working-age people engaging in activities to produce goods or services in exchange of compensation. The agriculture sector consists of "*activities in agriculture, hunting, forestry and fishing*" and the service sector includes "*wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services.*" (World Bank, 2020) These variables are in accordance with the International Labour Organization (ILO) that classifies economic activity using the International Standard Industrial Classification (ISIC) of All Economic Activities.

Additionally, variables measuring quality of governance might be appropriate for our proposed model. Kaufmann, Kraay & Mastruzzi (2010) worked hard to construct the Worldwide Governance Indicators, which main purpose is to measure quality of governance. These Worldwide Governance Indicators (WGI) are suitable for our study since they collect data from the 28 EU countries throughout the years of study. Three variables are going to be included in the model. In the first place, regulatory quality is defined as "*perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.*". It will be an indicator of the previously explained determinant named as 'regulations'. Secondly, government effectiveness indicator measures "*perceptions of the quality of public services, the quality of civil service and the degree of its independence from political pressures*". This will be an indicator of 'public sector services'. Last but not least, the level of

corruption of the desired country is going to be analyzed with control of corruption variable. This variable represents *"perceptions of the extent to which public power is exercise for private gain, including both petty and grand forms of corruptions, as well as "capture" of the state by elites and private interest"*. (World Bank, 2016). This variable will be used to represent the quality of institutions of corruption of the specific EU country.

The economic development of a country clearly plays a role when analyzing SE. Two macroeconomic variables are going to be introduced in the model: real GDP per capita and unemployment rate. According to Eurostat (2020), real GDP per capita is *"the ratio of real GDP to the average population of a specific year. GDP measures the value of total final output of goods and services produced by an economy within a certain period of time. It includes goods and services that have markets (or which could have markets) and products which are produced by general government and non-profit institutions."* Real GDP p.c.is considered as an indicator of economic activity and is often used as a measure for the development of material standards of living in a particular country. Therefore, the higher the GDP per capita, the greater rate of economic development and the lower the SE. On the other hand, unemployment rate is the *number of people unemployed as a percentage of the labor force*, following ILO definition. Undoubtedly, a higher unemployment rate denotes a weak economic growth and a higher SE, ceteris paribus.

The following table summarizes in a clear way the definition of the variables and their sources.

Table 1. Definition and source of variables

Variables	Definition	Sources
Shadow economy (% of GDP)	Informality economy, which means those economic activities and income earned that circumvent government regulation, taxation or observation	Medina and Schneider (2018)
Taxes on labor (% of GDP)	Taxes on individual or household income including holding gains, other current taxes, employers' actual social contributions and households' actual social contributions.	European Commission (2017)
Agriculture employment (% of total employment)	Employment in agriculture, modeled by International Labour Organization (% of total employment)	World Bank (2020)
Services employment (% of total employment)	Employment in services, modeled by International Labor Organization (% of total employment)	World Bank (2020)
Regulatory Quality Index	Perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development	WGI (2016)

Government Effectiveness Index	Perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures…	WGI (2016)
Corruption Index	Perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	WGI (2016)
Unemployment rate (% of labor force)	Number of unemployed persons as a percentage of the labour force.	Eurostat (2020)
Real GDP per capita (€ p.c)	The ratio of real GDP to the average population of a specific year	Eurostat (2020)

Source: own compilation based on data from WB, Eurostat, Medina & Schneider, EU Commission

In addition, the size of the shadow economy over total GDP varies significantly across EU countries. It might be convenient to take a look at the following graph, which represents the evolution of the mean average SE in the 28 European Union countries (blue line). Likewise, the green line represents average SE of the 14 northwest EU countries, while the gray line represents the mean SE of the 14 Southeast EU countries. For each year, the average of SE of the countries under study has been calculated. Obviously, the lower the SE (%) and consequently the lower the line drawn, the better.

Figure 5. Evolution of mean Shadow Economy in EU countries, 2000-2015
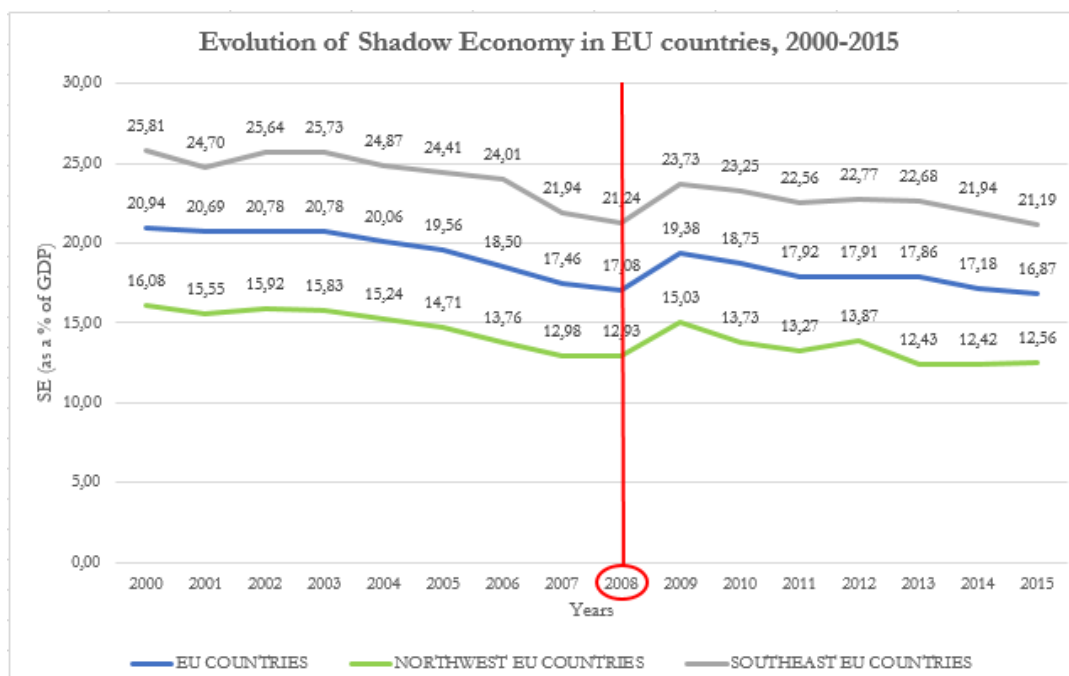
Source: own compilation based on data from Medina & Schneider (2018)

By observing the graph, it can be stated that the importance of average SE over total GDP has diminished. However, it might be commented that this decreasing tendency of SE is

suddenly reversed, coinciding with the beginning of the economic crisis that in the EU exploded in 2008. The red line clearly shows this reversal and the subsequent increase of SE on that specific year in the three situations studied or, in other words, in all the countries of the European Union. However, it cannot be denied that the overall trend is without a shadow of doubt decreasing, which is a hopeful sign in the continuing fight of governments against shadow economy and tax fraud.

As it can be appreciated in Figure 5, it is also remarkable the big discrepancy in the respective averages of northwest and southeast EU countries, which can be computed as the difference between the value represented on the grey line and the one on the green line. Apparently, it can be therefore concluded that there is a great discrepancy in average SE concerning geographical location. Nevertheless, it might be added that is not only the geographical location, indeed, there are many factors that do explain these discrepancies such as different tax morale between northwest and southeast countries, a higher GDP per capita or better quality of regulations in northwest Europe, in addition, northwest EU countries are usually the most- developed countries in EU… In fact, throughout this study, we hope to determine which of the previously explained variables are the most relevant determinants that affect significantly the percentage of SE in the European Union and help to explain this commented discrepancy.

Now, it is time to clarify the specific periods of time in which our model is going to be detailed. For this study, the whole period of years (2000-2015) is going to be analyzed. Afterwards, a comparison between two different time periods, before the economic crisis (2000-2007) and during and after the recession (2008-2015), is going to be made. Although the economic crisis has apparently not affected in a great extent EU shadow economy, it is thought that this comparison can be useful to prove whether estimated coefficients of the variables studied are different between these completely different periods of time. In other words, it is interesting to analyze separately the evolution of SE in these two moments of time to prove whether there is a structural change or some relevant discrepancies among the determinants of SE in the European Union. In addition, although we have found relevant differences in SE between EU countries, the object of the study is to study all the countries of the European Union, so we are going to study exclusively the whole 28 EU countries altogether.

3.2 Statistical analysis

A brief statistical analysis might be included to be aware of the type of data we are working with. To begin with, the means, standard deviations, minimum and maximum values of the variables under study are shown in Table 2.

Table 2. Descriptive Statistics

	Mean	Std. Dev	Min	Max
SE (%)	18.86	19.02	7.056	35.30
LABOURTAXED (%)	17.26	5.085	9.100	30.80
AGRICULTURE (%)	6.941	6.637	1.045	45.21
SERVICES (%)	66.13	9.818	29.00	87.59
REGULATORYQUALITY (Index)	1.200	0.4405	-0.1088	2.098
GOVEFFECTIVENESS (Index)	1.152	0.6247	-0.3732	2.354
CORRUPTION (Index)	-1.047	0.7993	-2.470	0.4913
UNEMPLOYMENT (%)	9.060	4.362	1.900	27.50
REALGDPpc (€)	23,630	15,610	3,010	84,420

Source: own compilation based on data from WB, Eurostat, Medina & Schneider, EU Commission

It is to mention that World Governance Indicators values range from -2.5 points to 2.5 points. More specifically, the country which is supposed to have the highest quality, effectiveness or corruption level is the one closest to 2.5 points.

Zero-order correlations might also be included and are shown in Table 3. Values can range from -1 to 1, that is, for every positive increase of X in one variable, there is a positive/negative increase of zero-order correlation coefficient in the other. That is to say, absolute coefficients of these correlations show us the relationship strength, that is, |-0.7148| has a stronger relationship than 0.3784. (Bryman & Hardy, 2009)

Table 3. Correlation matrix of variables under study

Variables	SE	TAX	AGRICULTURE	SERVICES	REGULATORY QUALITY	GOVERNMENT EFFECTIVENESS	CORRUPTION	UNEMPLOYMENT	REALGDPpc
SE	1	-0,5017	0,5196	-0,481	-0,7148	-0,6354	0,6752	0,3784	-0,6286
TAX		1	-0,4248	0,3817	0,4373	0,5817	-0,5988	-0,2497	0,4536
AGRICULTURE			1	-0,7992	-0,6665	-0,513	0,5935	0,2373	-0,5184
SERVICES				1	0,7125	0,6285	-0,7119	-0,1787	0,7436
REGULATORYQUAL					1	0,8034	-0,8899	-0,4959	0,7244
GOVERNMENTEFFEC						1	-0,8445	-0,4245	0,7008
CORRUPTION							1	0,4553	-0,7845
UNEMPLOYMENT								1	-0,4249
REALGDPpc									1

Source: own compilation based on Gretl's output

The results observed in Table 3 show correlations between the dependent variable (SE) and the independent variables. Independent variables correlations do not give much information. The ones that are important for the analysis correspond exclusively to the first row. To finish

with the statistical analysis, scatterplots might be included. These graphs of plotted points give relevant clues about the relationship between SE and the independent variables and are represented in Figure 6.

Figure 6. Scatterplots X-Y
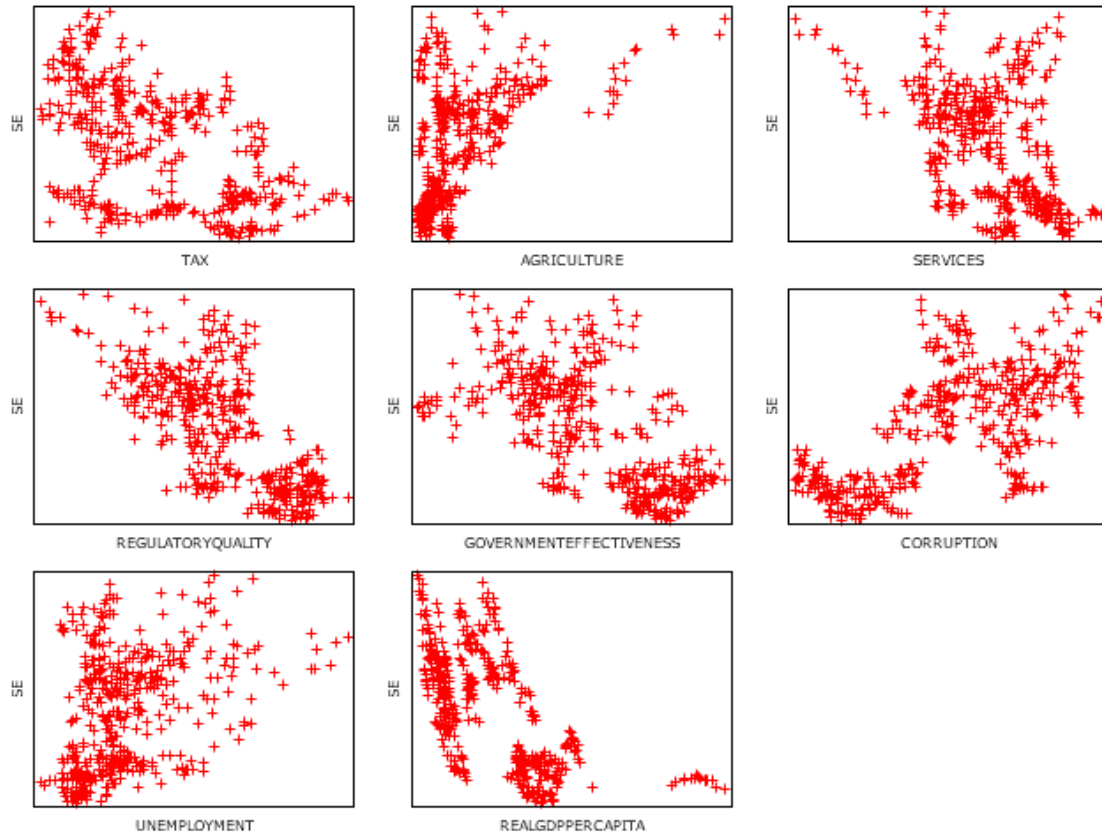
Source: own compilation based on Gretl's output

The interpretation of these graphs is quite intuitive. There are two main possibilities. Firstly, if the data show an upward pattern when moving from left to right, this means that there is a positive relationship between X and Y. That is, as the variables X increase (rightward movement), the independent variable (Y) increases as well (upward movement). The second possibility is a decreasing pattern when moving from left to right, this means that there is a negative relationship between X and Y. With this simple preliminary analysis, it can be appreciated how regulatory quality, government effectiveness and real GDP per capita do apparently have a negative relationship with respect to SE, as well that tax, agriculture, services, corruption and unemployment do have a positive one, as can be easily appreciated with the above figure.

3.3 Hypotheses

The aim of this research is to analyze the effect of some drivers on SE. Among the main contributors that lead individuals and firms to work in the underground economy, fiscal variables, productive specialization of the country, quality of governance and economic development are going to be analyzed. Based on the background information, four main hypotheses are going to be tested:

In the first hypothesis, we expect that the higher the taxes on labor, the higher is the shadow economy, ceteris paribus. Indeed, the bigger the taxation on official labor, the greater is the incentive to reduce taxes by working in the SE.

Hypothesis 1: *A higher tax burden (fiscal imposition) on labor increases SE*

The second hypothesis considers productive specialization It is thought that productive specialization of countries does play a role when explaining the great discrepancies in shadow economy size. Indeed, agricultural sector and services sector seem to generally concentrate a great weight of SE since the possibilities of working informal or having unregistered workers in these sectors is believed to be higher. So, we initially expect that the higher agriculture employment over total employment, the higher is the shadow economy, ceteris paribus. Likewise, the higher services employment over total employment, the higher is the shadow economy, ceteris paribus.

Hypothesis 2: *A big weight of agriculture and services sector in the economy increases SE*

Quality of governance might affect the decision of working in the SE. If people consider the government as unfair and corrupt, there would be more incentives to work in the unofficial economy. The same happens with regulations, for instance, government should apply regulations that promote economic development and growth. It is therefore expected that the higher quality of regulations, the lower is the shadow economy, ceteris paribus. The higher the quality of public services, the lower is the shadow economy, ceteris paribus. The higher the degree of corruption a country has, the higher is the shadow economy, ceteris paribus

Hypothesis 3: *Good quality of governance decreases SE*

It is felt that the countries which are economically more strong and, consequently, do have lower unemployment rates, have generally lower sizes of informal economy. These countries are usually more developed and therefore are supposed to have more ability to make people

work in the formal economy. Therefore, it is expected that the higher unemployment rate, the higher is the shadow economy, ceteris paribus. Additionally, the higher the real GDP per capita, the lower is the shadow economy, ceteris paribus.

Hypothesis 4: *Higher economic growth and development decreases SE*

Before ending with the hypotheses section, it would be interesting to study separately the results before and after the economic crisis with the two periods of time explained in section 3.1. Undoubtedly, the recent global crisis was the worst crisis that the history of the European Union has had to face. Some aspects such as corruption scandals or increasing unemployment rates were quite often discussed in those days. Indeed, due to the economic crisis of 2008, unemployment rates increase dramatically since March 2008 in every single Member State, although this rise was not homogenous across countries. This explanation leads us to believe that some independent variables coefficients of the model are different before and after the crisis. At least, unemployment rate coefficient is supposed to be higher in the second period studied, as well as corruption coefficient.

Hypothesis 5: *Coefficients' means are different before the crisis (2000-2007) and after the crisis (2008-2015)*

3.4 Econometric model

Taking into consideration the purpose of our study, the ideal method used is panel data since we have the *same* countries (28 members of the European Union) in which some determinants are studied across time (from 2000 to 2015). It is a method that combines cross-sectional and time series issues. One advantage of the methodology used is that panel data "Panel data usually give the researcher a large number of data points (N, T), increase the degrees of freedom and decrease the collinearity between explanatory variables and thus improve econometric estimates". In order to test the hypothesis, we will use a dependent variable which is shadow economy of every single country and different independent variables. Moreover, the panel has the form $t_{i,t}$, i=1,…,N, t=1,…,T where i represents the different countries (28 in total) and t is the time dimension (16 years).

Since there is a total of eight different independent variables to be studied, it would be convenient to construct different models to avoid having a misleading final picture. The variable which is believed to have a high influence on SE is taxation, this independent variable is going to appear in all the models and we will create the models according to

different aspects: productive specialization, quality of governance and economic development, our equation would be:

Shadow economy = f (fiscal variable, productive specialization, governance quality, economic development)

Model 1: $SE_{i,t} = \beta_0 + \beta_1 TAX_{i,t} + \beta_2 AGR_{i,t} + \beta_3 SERVI_{i,t} + \varepsilon_{it}$

Model 2: $SE_{i,t} = \beta_0 + \beta_1 TAX_{i,t} + \beta_2 REGUL_{i,t} + \beta_3 GOV_{i,t} + \beta_4 CORRUPT_{i,t} + \varepsilon_{it}$

Model 3: $SE_{i,t} = \beta_0 + \beta_1 TAX_{i,t} + \beta_2 UNEMP_{i,t} + \beta_3 GDPpc_{i,t} + \varepsilon_{it}$

Model 4: $SE_{i,t} = \beta_0 + \beta_1 TAX_{i,t} + \beta_2 AGR_{i,t} + \beta_3 SERVI_{i,t} + \beta_4 REGUL_{i,t} + \beta_5 GOV_{i,t} + \beta_6 CORRUPT_{i,t} + \beta_7 UNEMP_{i,t} + \beta_8 GDPpc_{i,t} + \varepsilon_{it}$

where $\forall i = 1,..., 28$ and $\forall t = 2000,..., 2015$

So, the main purpose behind these equations is to examine the relationship among independent variables and shadow economy. We try to find evidence on whether these independent variables have a significant positive or negative effect on shadow economy. These four model differ in the independent variables included, the model 4 is the most general one as it includes all the independent variables. Based on our models, we want to test whether the hypotheses explained before are true or not. Therefore, with respect to the parameters or coefficients to be estimated, it is expected that the signs are those presented in the table below.

Table 4. Expected signs of coefficient parameters

	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Model 1	+	+	+					
Model 2	+	-	-	+				
Model 3	+	+	-					
Model 4	+	+	+	-	-	+	+	-

Source: own compilation

The reasoning is the following. Notice that throughout the paper, it has been assumed that the higher the taxation on labor, the higher SE; the higher the agriculture employment rate, the higher SE; the higher the service employment rate, the higher SE; the better regulatory quality, the lower SE; the better quality of public service, the lower SE; the higher corruption, the higher the SE; the higher the unemployment rate, the higher SE; and the higher the GDP per capita, the lower the SE. All this statements are done considering other things equal.

4. RESULTS

Results are going to be presented below. As a reminder, panel data is going to be used as we have the same 28 EU countries that are analyzed over the 16 different periods (2000-2015). This panel data model enables the observation of the selected periods in several periods and therefore provides a more precise result. Observations are independent from each other and it is widely known that any variable that is constant overtime is out of this analysis.

Our estimated panel data model assumes the usual panel data model's assumptions: (i) there is no evidence to believe that the exogeneity property will not be fulfilled; (ii) the explanatory variables are independent and identically normally distributed; (iii) for each t, the expected value of the idiosyncratic error, given the explanatory variables in all periods and the unobservable effect, is zero: $E(u_{it}x_i|a_i)=0$; (iv) each explanatory variable changes over time (for at least some i) and there is no perfect linear relationship between explanatory variables; and (v) differentiated errors variance, conditional on all the explanatory variables, is constant: $Var\ (\Delta u_{it}|x_i)=\sigma^2$, T=2,....T. (Wooldridge, 2010, p. 478-480)

It is about time to start with the presentation of the results of the four different models. In every model, the Durbin-Watson values, which measure the degree of autocorrelation between the corresponding residual to each observation and the previous one, are closed to 0 which mean a possible presence of autocorrelation. To overcome autocorrelation problem, there are many ways to deal with this autocorrelation detected. However, a widely-used method to avoid autocorrelation is going to be used, that is, a first difference to all variables included in the models might be added, this procedure is applied to all models. First differences represent the increase or decrease of variables by computing the difference between each data item and the previous one. Therefore, the first panel data which corresponds to year 2000 will be logically lost. The first initial results, without adding first differences, are not meaningful due to the problems mentioned but they are presented in the appendix so as to appreciate the Durbin-Watson values as well as the rest of the results obtained. The next table presents the results of the four models under study after having added the first difference, Durbin-Watson values have now more sense, as can be appreciated below.

Table 5. Summary of empirical results

	Model 1	Model 2	Model 3	Model 4
const	−0,451295***	−0,269935***	−0,201246***	0,242294***
d_TaxesonLabor/GDP	0,406008***	0,455438***	0,269156***	0,313487***
d_Agriculture employment rate	0,443903***			0,23601***
d_Services employment rate	0,496935***			0,118781*
d_RegulatoryQuality		−0,956075		0,115248
d_GovernmentEffectiveness		0,173408		-0,338592
d_Corruption		1,24708**		1,00611**
d_Unemployment rate			0,311865***	0,29177***
d_RealGDPpc			−0,0002701***	−0,000194***
Fixed vs. Random Effect	FE	FE	FE	RE
R-square	0,28251	0,147255	0,42845	0,44344
Durbin-Watson	1,862046	1,822419	1,835161	1,831428
Hausman test	0,0297903	0,0143693	0,023846	0,0567281

***p<0.01, **p<0.05, *p<0.10 Source: own compilation from data based on Gretl's output

After having applied first differences and based on the results of our models, the different tests show that the AR (1) have no evidence of autocorrelation at 1%, 5%, 10% significance levels. Additionally, these results are in line with the literature. The estimated coefficients have the expected sign, with the exception of regulatory quality coefficient in model 4 and government effectiveness coefficient in model 2 but both of them are not statistically significant.

Due to the fact that we do not have found contradictory results among these four models, it might be convenient to explain in a deeper way just Model 4 procedure and results. The reasons are the following: model 4 contains all the independent variables under study and it also has the higher R-square value. This represents the % variation in the dependent variable which is explained by the independent variables. The whole process that has been followed (for each model) with the corresponding steps is going to be explained in the following lines.

For model 4, as mentioned before, we estimate shadow economy depending on tax burden, agriculture employment rate, services employment rate, regulatory quality, government effectiveness, corruption, unemployment rate and real GDP per capita:

$$SE_{i,t} = \beta_0 + \beta_1 TAX_{i,t} + \beta_2 AGR_{i,t} + \beta_3 SERVI_{i,t} + \beta_4 REGUL_{i,t} + \beta_5 GOV_{i,t} + \beta_6 CORRUPT_{i,t} + \beta_7 UNEMP_{i,t} + \beta_8 GDPpc_{i,t} + \varepsilon_{it}$$ where $\forall i = 1,..., 28$ and $\forall t = 2000,..., 2015$.

Table 6 shows the initial results of model 4 before applying first differences.

Table 6. Initial results of model 4

	FIXED EFFECTS	
	Coefficient	p-value
const	32,0526	7,13e-025***
TAXATION	0,325804	1,24e-05***
AGRICULTURE	0,331844	1,05e-07***
SERVICES	-0,305096	9,09e-012***
REGULATORYQUALI	1,044	0,0806*
GOVEFFECTIVENESS	-1,28684	0,0047***
CORRUPTION	0,861952	0,0849*
UNEMPLOYMENT	0,345944	4,15e-022***
REALGDPpc	-0,0001246	0,0174**
R-squared	0,969814	
Durbin-Watson	0,589435	

***p<0.01, **p<0.05, *p<0.10 Source: own compilation from data based on Gretl output

As can be appreciated in table 6, the R-square takes a very high value: 0.969814, which means that variables might be stationary since variables have significant tendencies over time. Durbin-Watson value might also be analyzed. This value measures the degree of autocorrelation between the corresponding residual to each observation and the previous one. Since the value is closed to 0 (0.589435), it might be commented the possible presence of autocorrelation. To overcome autocorrelation problem, first differences are going to be added. In table 7, the results of fixed and random effects for model 4, after applying first differences, can be observed.

Table 7. Results of model 4 (after applying first differences)

	FIXED EFFECTS		RANDOM EFFECTS	
	Coefficient	p-value	Coefficient	p-value
const	-0,246301	2,99e-05***	0,242294	2,07e*0,5***
d_TAX	0,272528	0,011***	0,313487	8,48e-05****
d_AGRICULTURE	0,168754	0,0210**	0,23601	0,0006***
d_SERVICES	0,12043	0,0604*	0,118781	0,0548*
d_REGULATORYQUA	0,207952	0,678	0,115248	0,8147
d_GOVEFFECTIVENESS	-0,143718	0,7331	-0,338592	0,4105
d_CORRUPTION	0,993024	0,0434**	1,00611	0,0352**
d_UNEMPLOYMENT	0,277956	2,38e-013***	0,29177	1,58e-016***
d_REALGDPpc	-0,000237	0,0001	-0,000194	0,0008***
R-squared	0,44344			
Durbin-Watson	1,831428			
Hausman test				0,0567281

***p<0.01, **p<0.05, *p<0.10 Source: own compilation from data based on Gretl output

As a result, after applying first differences to the model variables, the results shown in Table 7 are a R-square value of 0.443440 and a value for the Durbin-Watson statistic of 1.831428, which leads to the conclusion that there is no autocorrelation problem. In other words, the R-square value (0.443440) makes more sense than the one obtained previously (0.969814). The Durbin-Watson value (1.831428) is checked to discard the presence of autocorrelation.

As the value is closed to 2, there is not an autocorrelation problem between the disturbances. The model is also estimated by random effects. This model shows the corresponding Hausman test, to confirm whether the determinants of the panel data model are more consistent on the basis of the fixed effects model or on the random effects model, that is, it is to prove whether the group-specific error is uncorrelated, according to the null-hypothesis. As it can be appreciated, panel data model is always estimated by either fixed effects (FE) or random effects (RE). Then, basing our decision on Hausman's test, one model or another is chosen, the decision is based on the following hypothesis:

H_0: the specific error is not correlated (random effects)

H_1: otherwise

So, to decide which model might be applied to interpret the results obtained, the Hausman test value might be studied. In this case, it is 0.0567281($>$0.05), so the null hypothesis is not rejected and the estimates has consistency in random effects. The results of Model 4 are going to be explained in more detail, but before doing so, the general interpretation for the β's coefficient is the following: a 1 unitary increase in the independent variable (X) leads to a mean increase of β units in the dependent variable (Y), ceteris paribus.

Concerning the results of the estimated coefficient of taxes on labour, it seems that taxation is an important determinant for SE in EU countries. The coefficient is statistically positive and significant at a 1% level, not only in Model 4 but in all the models proposed. Consequently, high taxes on labor might be one of the main explanations of a huge SE. In accordance with the results presented in table 7, a 1% increase of taxes on labor is expected to increase the size of the shadow economy by 0.313487%, ceteris paribus.

With respect to the productive specialization of the country, both agriculture and services coefficients are statistically positive and significant, at a 1% and 10% significance level. Therefore, if there is a 1% increase in the employment rate, the SE will increase, in mean, 0.236010% and 0.118781% respectively. It can be therefore stated that the higher the importance of these two sector in the economy, the higher the expected SE.

Regarding the quality of governance, only the coefficient of control of corruption is statistically significant, at a 5% level. This coefficient is statistically positive. This implies that an increase of corruption is expected to increase the SE so that a 1 point increase in corruption index is expected to increase the size of the shadow economy by 1.00611%, ceteris paribus. It might be reminded the fact that World Governance Indexes take values

between -2.5 and 2.5 points, meaning that a 1 point increase is a considerable amount. This fact explains the high expected increase in SE (1.00611%)

To finish with, variables measuring the economic situation of the country might be commented. On the one hand an increase in unemployment rate is expected to increase SE. A priori one would expect that in periods of economic recessions where unemployment rates increase dramatically, the public authorities are so overwhelmed that turn a blind eye and relax regulatory compliance controls of undeclared labor, taxes… In our model, the coefficient of unemployment rate is statistically significant and positive at a 1% level, so that an increase of 1% in unemployment rate will lead to an increase, in mean, of 0.291770% in SE. On the other hand, an increase in real GDP per capita is expected to decrease SE. The coefficient of real GDP pc is also statistically significant and positive at a 1% level, which means that a 1 unit (euro per capita) increase in real GDP per capita leads to a mean decrease of 0.000124631% of SE. It might be added the fact, although this coefficient variable seems to be irrelevant according to results shown in Table 7, it is not the case since if we consider an increase of 1000 euros per capita (which is a much more plausible comparison) increase in real GDP per capita, the SE will be decreased by 0.124361%.

To sum up, it can be concluded that changes in taxation, agriculture employment rate, services employment rate, level of corruption and unemployment rate are expected to rise the percentage of shadow economy over total GDP (other things being equal), as it can be appreciated by the positive coefficients shown in Table 7. While changes in real GDP per capita are expected to decrease the percentage of SE over total GDP, ceteris paribus. Unfortunately, despite the fact that quality of regulation and government effectiveness are supposed to decrease SE percentage, in our model, these variables will not have apparently, an influence on the dependent variable. In the light of the results presented in the above table, it can be said that we have successfully proved our intuition and the first four hypotheses.

It is about time to go ahead with the testing of hypothesis 5. To refresh, the formulation of the hypothesis was the following: *Coefficients' means are different before the crisis (2000-2007) and during/after the crisis (2008-2015).* For testing this hypothesis, model 4 is going to be employed since it is the only model that includes all the independent variables. However, to study these two periods of time, the model is going to be split in two. Model 5 covers the data for 2000-2007 and model 6 for 2008-2015. It is expected that, at least, corruption and unemployment

rate coefficients have increased its importance in times of economic recession. Results are presented in the following table.

Table 8. Results of model 5 (2000-2007) and 6 (2008-2015)

	2000-2007		2008-2015	
	Coefficient	p-value	Coefficient	p-value
const	-0,0052166	0,9588	-0,224916	0,0119**
d_TAXATION	0,309892	0,0057***	0,210993	0,0991*
d_AGRICULTURE	0,117996	0,1386	0,178271	0,2684
d_SERVICES	0,062185	0,3913	0,154526	0,1492
d_REGULATORYQUALI	-0,283241	0,6418	1,13597	0,1607
d_GOVEFFECTIVENESS	-0,160677	0,7231	-0,343937	0,6672
d_CORRUPTION	0,000105	0,9998	1,55591	0,0726
d_UNEMPLOYMENT	0,17816	0,0049***	0,265933	1,99e-06***
d_REALGDPpc	-0,000637	5,61e-06***	-0,0002526	0,0028***
R-squared	0,529602		0,476502	
Durbin-Watson	1,566765		1,545789	
Hausman test		0,0000547		0,162644

***p<0.01, **p<0.05, *p<0.10 Source: own compilation from data based on Gretl output

By observing Table 8, it can be said that all coefficients have changed in value, but not in sign. A structural change can lead to large predictive errors and unreliability of the model in general. Luckily, there is no evidence in our model of structural change, i.e. we have not detected a structural breakdown throughout the observations. The variables which undoubtedly have increased its importance are corruption and unemployment, in line with our initial expectations. The coefficient of corruption of model 5 is not statistically significant, meaning that the comparison is not possible. However, if we compare corruption coefficient for the whole period (2000-2015) is notably smaller (1.06111) than the one referring to period 2008-2015(1.5591). If we study unemployment coefficient, the coefficient value for the second period is almost doubled, from an increase of 0.17816 % in SE to an increase of 0.265933% in SE.

5. CONCLUSION

To begin with, the main objective of the study was to analyze deeply European Union shadow economies. We have tried to explain the concept of shadow economy, starting from its definition and existing methods for estimating it, we have detailed the main drivers determining SE and finally we have tried to prove evidence on whether some of them do play a role in EU shadow economies. For this purpose, a database has been constructed which compiles shadow economy estimates, taxation, sector's employment rates, variables determining governance's quality and macroeconomic variables. If the initial hypotheses are

reviewed again, it can be seen that the different determinants proposed are effectively supposed to change shadow economy size. All the topics contemplated at the beginning of the paper have been successfully covered and unsurprisingly the results obtained are in line with recent literature. Indeed, the conclusions that have been drawn are the following:

Firstly, northwest and southwest EU countries do certainly behave in a different way. It has been proved that northwest EU countries have a significantly lower average SE, in comparison with southwest EU countries. It has also been demonstrated the negative trend of overall EU underground economy in the period studied, which is a quite positive finding.

Secondly, it has been checked whether fiscal imposition increase SE size. After including taxation of official labor in the four models proposed, it was found that tax burden is a clear determinant for SE in EU countries. That is, the bigger the taxation on official labor, the greater is the incentive to reduce taxes by working in the SE, meaning that high taxation on labor might be a reasonable explanation of a huge underground economy.

The next hypothesis to be tested concerned the productive specialization of the country. Both agriculture and services estimated coefficients have been statistically positive and significant, meaning that the higher the importance of these two sectors (especially, agriculture) in the economy, the higher the expected SE, ceteris paribus.

Quality of governance was expected to determine shadow economy size. It has been demonstrated that the more corrupt a country is, the higher expected SE, ceteris paribus. In other words, an increase of corruption is expected to increase the underground economy. Nevertheless, no evidence indicates that regulatory quality and government effectiveness (public services' quality) decrease SE, at least in our proposed model. Questioning these results, we can think about the need for further research of better variables measuring governance's quality. I am frankly convinced that quality of regulations and quality of public services do play a role in EU shadow economies. Probably, the lack of a complete and appropriate variable measuring these topics could be one of the causes that leads to these adverse outcomes.

Last but not least, it has been tested whether the economic situation of a particular EU country might influence SE size. Towards this end, two widely known macroeconomic variables have been used. On the one hand, we have obtained that an increase in unemployment rate increases expected SE, likewise, it has been proved that an increase in the real GDP per capita, decreases expected SE, other things being equal.

The implications are also relevant as the results suggest that a reverse change of policies (and accordingly determinants) might help to reduce significantly SE size. The first step that EU countries should follow would be to increase the consciousness on how important shadow economy is and what determinants do interfere in its existence, and this paper might shed light in this sense.

Given the role of shadow economy in the actual EU countries, it would be of great interest to study the influence of other variables. There are nonetheless many different topics that are out of this paper and would be interesting to review. For example, the analysis could be completed by studying how tax morale affects these results or it would be interesting to study the evolution of cash usage and its relation with underground economy. As mentioned some lines above, it might be interesting to continue the research of the impact that suitable regulations and better public services would have on shadow economy. Likewise, it cannot be forgotten that SE plays a big role in a country of the characteristics of Spain. It could also be interesting to study why underground economy changes so much depending on the country and why northwest countries do usually have a lower proportion of shadow economy over total GDP

As an open question for future research, it might be interesting to study the influence of Covid-19 on shadow economy size. Undoubtedly, the European Union has been seriously affected by Covid-19. It would be of great curiosity to verify whether this new crisis will lead to an increase or decrease of shadow economy. On the one hand, many businesses have stopped accepting cash, so the amount of cash in the economy is expected to decrease with this new scenario. A priori, this leads us to think that informal workers and businesses will have more difficulties since they are no longer allowed to operate with this form of payment. In principle, this should lead to a lower shadow economy. On the other hand, one opposite effect of the coronavirus might be a greater sense of impunity since, for instance, labor inspectors cannot carry out their normal work and inspections during the 'state of alarme', meaning that many businesses can continue hiring informal workers without fear of being caught. In effect, the high demand of the agriculture on these days, together with a lower number of inspections, can result in a higher number of unregistered workers. We cannot forget that this sector is closely related with the existence of underground economy, as it has been proved in our study. To finish with this, I feel obliged to comment on the great damage that the phenomenon of underground economy causes in the population. For example, in these difficult times, many women that work in the domestic service will not be able to justify

their cessation of activity and will not receive any assistance or aid, all because of their informal situation.

My feeling is that, when a country does show a huge percentage of shadow economy, the responsibility should fall to the government. Governments should focus their attention on ways to improve the situation and launch adequate policies to ensure that people prefer working in the formal economy. For doing so, it is essential to provide adequate information to the overall population to raise awareness of the importance of remaining formal and its corresponding benefits. These policies would undoubtedly bring a number of benefits to countries.

The recent sanitary crisis makes the regulatory compliance controls more important than ever so as to avoid an explosion of underground economy. In the case of Spain, it seems obvious that there is not sufficient staff to control fraud practices. I am firmly convinced that Spain should commit itself to achieve a considerable reduction of this percentage as it means significant yearly losses in state revenue. If Spanish population and the government itself alike were to work together and reduce this percentage, it would make Spain a fairer place to live. I would like to end my project with this reflection: "The most desperate thing for a society is the doubt that living honestly is useless"

6. REFERENCES

Ahumada, H., Alvaredo, F., & Canavese, A. (2006). *The demand for currency approach and the size of the shadow economy: a critical assessment.* Retrieved from https://escholarship.org/uc/item/6zn9p98b

Alm, J., & Torgler, B. (2006). "Cultural differences and tax morale in the United States and in Europe". *Journal of Economic Psychology, 27*, 234-246.

Boulding, K. (1947). "A note on the theory of the black market". *The Canadian Journal of Economics and Political Science, 13*(1), 115-118.

Bryman, A., & Hardy, M. (2009). *Handbook on data analysis.* London: SAGE Publications.

Buehn, A., & Schneider, F. (2016, March). "Size and development of tax evasion in 38 OECD countries: what do we (not) know?". *Journal of Economics and Political Economy, 3*(1), 1-11.

Buehn, A., & Schneider, F. (2017). "Shadow Economy: Estimation methods, problems, results and open questions". *Open Economics 2018, 1*, 1-29.

European Commission. (2017). *Taxation Trends in the European Union. Data for the EU Member States, 2017 Edition.* Retrieved from Taxation and Customs Union: https://ec.europa.eu/taxation_customs/sites/taxation/files/taxation_trends_repor t_2017.pdf

Eurostat. (2020). *Real GDP per capita.* Retrieved from Eurostat Data Browser Website: https://ec.europa.eu/eurostat/databrowser/view/sdg_08_10/default/table?lang=e n

Eurostat. (2020). *Unemployment rate-annual data.* Retrieved from Eurostat Data Browser website: https://ec.europa.eu/eurostat/en/web/products-datasets/-/TIPSUN20

Fernández, X., Lago, S., & Vaquero, A. (2018). "Economía sumergida y fraude fiscal en España: un análisis de la evidencia empírica"., (p. 2). Ourense.

Frey, B., & Weck-Hannemann, H. (1984). "The hidden economy as an unobserved variable". *European Economic Review, 26*, 33-53.

Garcia, G. (1978). "The currency ratio and the subterranean economy". *Financial Analysts Journal, 69*(1), 64-66.

Hassan, M., & Schneider, F. (2016). "Modelling egyptian shadow economy: A MIMIC model and the currency demand approach". *Journal of Economics and Political Economy, 3*(2), 309-339.

Johnson, S., Kaufmann, D., & Schleifer, A. (1997). "The unofficial economy in transition". *Brooking Papers on Economic Activity, 2*, 159-239. Retrieved from https://scholar.harvard.edu/files/shleifer/files/unofficial_econ_transition.pdf

Kaufmann, D., & Kaliberda, A. (1996). *"Integrating the unofficial economy into the dynamics of post socialist economies".* Washington D.C: World Bank. Retrieved from http://documents.worldbank.org/curated/en/145671468771609920/Integrating-the-unofficial-economy-into-the-dynamics-of-post-socialist-economies-a-framework-of-analysis-and-evidence

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2010, September). *The Worldwide Governance Indicators: Methodology and Analytical Issues.* Retrieved from World Bank Policy Research Working Paper No.5430: https://ssrn.com/abstract=1682130

Lackó, M. (1998). The hidden economics of visegrad countries in international comparison: a household electricity approach. In L. Halpern, & C. Wyplosz, *Hungary: Towards a Market Economy* (pp. 128-152). Cambridge, MA: Cambridge University Press.

Lackó, M. (1999). Electricity intensity and the unrecorded economy in post-socialist countries. In E. Feige, & K. Ott, *Underground Economies in Transition* (pp. 102-142). Aldershot: Ashgate.

Lippert, O., & Walker, M. (1997). *The underground economy: global evidence of its size and impact.* Vancouver: The Fraser Institute.

Mauleón, I., & Sardà, J. (2017). The underground economy, unemployment and the accuracy of estimates: the case of Spain. *International Conferences: Interdisciplinary Insights on Fraud and Corruption*, (pp. 1-18). Porto, Portugal. doi:10.13140/RG.2.2.13839.28327

Medina, L., & Schneider, F. (2018). *Shadow economies under the world: what did we learn over the last 20 years?* International Monetary Fund, African Deparment. IMF Working Papers.

Mineva, D., & Stefanov, R. (2018, September). *Evasion of taxes and social security contributions.* Retrieved from European Platform Undeclared Work.

OECD. (2019, January 25). *The role of tax morale in development.* Retrieved from OECD. Better policies for better lives: https://www.oecd.org/tax/role-of-tax-morale-in-development-conference-january-2019.htm

OECD. (2020, February 08). *OECD. Better policies for better lives.* Retrieved from OECD Product Market Regulation Statistics: https://www.oecd-ilibrary.org/economics/data/oecd-product-market-regulation-statistics/economy-wide-regulation_data-00593-en

Onrubia, J. (2013). *La reforma de la administración tributaria: mitos y realidades. Por una verdadera reforma fiscal.* Ariel.

Park, T. (1979). *Reconciliation between personal income and taxable income.* Washington D.C: Bureau of Economic Analysis.

Putnins, T., & Sauka, A. (2015). "Measuring the shadow economy using company managers". *Journal of comparative issues, 43*(2), 471-490.

Rogers, J., & Philippe, C. (2020, February 19). *The tax burden of typical workers in the EU 28-2019.* Retrieved from Institut Économique Molinary, Paris-Bruxelles:

https://www.institutmolinari.org/wp-content/uploads/sites/17/2019/07/tax_burden_EU_2019.pdf

Sardà, J. (2014). *La economía sumergida pasa factura. El avance del fraude en España durante la crisis.* GESTHA.

Schneider, F. (2016). "Estimating the size of the shadow economies of highly-developed countries: selected new results". *CESifo DICE Report, 14*(4), 45.

Schneider, F., & Williams, C. C. (2013). *The Shadow Economy.* Retrieved from Institute of Economic Affairs (IEA): https://iea.org.uk/publications/research/the-shadow-economy

Smith, P. (1994). "Assesing the size of the underground economy: the Canadian statistical perspectives". *Canadian Economic Observer, 11*(3), 18.

Tanzi, V. (1983). "The underground economy in the United States: annual estimates, 1930-1980". *IMF Staff Papers, 30*, 283-305.

Tanzi, V. (1999). Uses and Abuses of Estimates of the Underground Economy. *Economic Journal, 109*(3), 338-347.

Willians, C., & Horodnic, I. (2015). "Evaluating the prevalence of the undeclared economy in Central and Eastern Europe: An institutional asymmetry perspective". *European Journal of Industrial Relations, 21*(4), 389-406.

Wooldridge, J. (2010). *Introducción a la econometría. Un enfoque moderno.* Mexico: Cengage Learning.

World Bank. (2016). *Worldwide Governance Indicators.* Retrieved from World Bank Databank: https://info.worldbank.org/governance/wgi/

World Bank. (2020). *Employment in agriculture (% of total employment).* Retrieved from World Development Indicators: https://databank.worldbank.org/reports.aspx?source=2&series=SL.AGR.EMPL.ZS&country=#

World Bank. (2020). *Employment in services (% of total employment).* Retrieved from World Development Indicators: https://databank.worldbank.org/reports.aspx?source=2&series=SL.SRV.EMPL.ZS&country=#

7. APPENDIX

NUMBER	COUNTRIES
1	Austria
2	Belgium
3	Bulgaria
4	Croatia
5	Cyprus
6	Czech Republic
7	Denmark
8	Estonia
9	Finland
10	France
11	Germany
12	Greece
13	Hungary
14	Ireland
15	Italy
16	Latvia
17	Lithuania
18	Luxembourg
19	Malta
20	Netherlands
21	Poland
22	Portugal
23	Romania
24	Slovak Republic
25	Slovenia
26	Spain
27	Sweden
28	United Kingdom

NUMBER	NORTHWEST
1	Austria
2	Belgium
3	Denmark
4	Estonia
5	Finland
6	France
7	Germany
8	Ireland
9	Latvia
10	Lithuania
11	Luxembourg
12	Netherlands
13	Sweden
14	United Kingdom

NUMBER	SOUTHEAST
1	Bulgaria
2	Croatia
3	Cyprus
4	Czech Republic
5	Greece
6	Hungary
7	Italy
8	Malta
9	Poland
10	Portugal
11	Romania
12	Slovak Republic
13	Slovenia
14	Spain

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Modelo 1: Efectos fijos, utilizando 448 observaciones
Se han incluido 28 unidades de sección cruzada
Largura de la serie temporal = 16
Variable dependiente: SE

                  Coeficiente  Desv. Típica  Estadístico t   valor p
    ------------------------------------------------------------------
    const          7.19168      2.49237          2.885        0.0041   ***
    TAX            0.555429     0.0856243         6.487        2.49e-010 ***
    AGRICULTURE    0.743702     0.0613955        12.11         3.81e-029 ***
    SERVICES      -0.0465684    0.0330153        -1.411        0.1591

Media de la vble. dep.    18.85795    D.T. de la vble. dep.    7.055784
Suma de cuad. residuos    1052.279    D.T. de la regresión     1.588537
R-cuadrado MCVF (LSDV)    0.952714    R-cuadrado 'intra'       0.520233
F(30, 417) MCVF           280.0559    Valor p (de F)           1.3e-255
Log-verosimilitud         -826.9625   Criterio de Akaike       1715.925
Criterio de Schwarz       1843.174    Crit. de Hannan-Quinn    1766.088
rho                       0.694026    Durbin-Watson            0.527019

Contraste conjunto de los regresores (excepto la constante) -
  Estadístico de contraste: F(3, 417) = 150.724
  con valor p  = P(F(3, 417) > 150.724) = 3.68717e-066

Contraste de diferentes interceptos por grupos -
  Hipótesis nula: Los grupos tienen un intercepto común
  Estadístico de contraste: F(27, 417) = 189.133
  con valor p  = P(F(27, 417) > 189.133) = 3.54081e-215


Modelo 2: Efectos fijos, utilizando 448 observaciones
Se han incluido 28 unidades de sección cruzada
Largura de la serie temporal = 16
Variable dependiente: SE

                     Coeficiente  Desv. Típica  Estadístico t  valor p
    ------------------------------------------------------------------
    const             15.2770      2.46969          6.186        1.48e-09 ***
    TAX                0.559786    0.111858         5.004        8.29e-07 ***
    REGULATORYQUALITY -4.08513     0.877845        -4.654        4.39e-06 ***
    GOVERNMENTEFFECT~ -1.11051     0.723442        -1.535        0.1255
    CORRUPTION        -0.0991327   0.797070        -0.1244       0.9011

Media de la vble. dep.    18.85795    D.T. de la vble. dep.    7.055784
Suma de cuad. residuos    1794.298    D.T. de la regresión     2.076829
R-cuadrado MCVF (LSDV)    0.919370    R-cuadrado 'intra'       0.181923
F(31, 416) MCVF           153.0119    Valor p (de F)           2.2e-206
Log-verosimilitud         -946.5015   Criterio de Akaike       1957.003
Criterio de Schwarz       2088.356    Crit. de Hannan-Quinn    2008.784
rho                       0.837372    Durbin-Watson            0.306255

Contraste conjunto de los regresores (excepto la constante) -
  Estadístico de contraste: F(4, 416) = 23.1273
  con valor p  = P(F(4, 416) > 23.1273) = 2.82176e-017

Contraste de diferentes interceptos por grupos -
  Hipótesis nula: Los grupos tienen un intercepto común
  Estadístico de contraste: F(27, 416) = 69.3797
  con valor p  = P(F(27, 416) > 69.3797) = 6.13013e-136
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Modelo 3: Efectos fijos, utilizando 448 observaciones
Se han incluido 28 unidades de sección cruzada
Largura de la serie temporal = 16
Variable dependiente: SE

                  Coeficiente   Desv. Típica  Estadístico t   valor p
     ------------------------------------------------------------------
     const         27.1881       2.19045          12.41      2.53e-030 ***
     TAX            0.299240      0.0951130         3.146     0.0018    ***
     UNEMPLOYMENT   0.155432      0.0291556         5.331     1.60e-07  ***
     REALGDPPCEUR  -0.000630507   4.95431e-05     -12.73      1.42e-031 ***

Media de la vble. dep.   18.85795   D.T. de la vble. dep.     7.055784
Suma de cuad. residuos  1258.182    D.T. de la regresión      1.737016
R-cuadrado MCVF (LSDV)    0.943461   R-cuadrado 'intra'        0.426355
F(30, 417) MCVF          231.9495    Valor p (de F)            1.8e-239
Log-verosimilitud       -866.9936   Criterio de Akaike        1795.987
Criterio de Schwarz     1923.236    Crit. de Hannan-Quinn     1846.150
rho                       0.812910   Durbin-Watson             0.303546

Contraste conjunto de los regresores (excepto la constante) -
  Estadístico de contraste: F(3, 417) = 103.31
  con valor p  = P(F(3, 417) > 103.31) = 5.08378e-050

Contraste de diferentes interceptos por grupos -
  Hipótesis nula: Los grupos tienen un intercepto común
  Estadístico de contraste: F(27, 417) = 130.567
  con valor p  = P(F(27, 417) > 130.567) = 8.10429e-185

Modelo 4: Efectos fijos, utilizando 448 observaciones
Se han incluido 28 unidades de sección cruzada
Largura de la serie temporal = 16
Variable dependiente: SE

                     Coeficiente   Desv. Típica  Estadístico t   valor p
     ------------------------------------------------------------------
     const            32.0526       2.91226         11.01     7.13e-025 ***
     TAX               0.325804     0.0736350        4.425    1.24e-05  ***
     AGRICULTURE       0.331844     0.0612970        5.414    1.05e-07  ***
     SERVICES         -0.305096     0.0434502       -7.022    9.09e-012 ***
     REGULATORYQUALITY 1.04400      0.596048         1.752    0.0806    *
     GOVERNMENTEFFECT~ -1.28684     0.452715        -2.843    0.0047    ***
     CORRUPTION        0.861952     0.499104         1.727    0.0849    *
     UNEMPLOYMENT      0.345944     0.0337534       10.25     4.15e-022 ***
     REALGDPPCEUR     -0.000124631  5.21844e-05     -2.388    0.0174    **

Media de la vble. dep.   18.85795   D.T. de la vble. dep.     7.055784
Suma de cuad. residuos   671.7336   D.T. de la regresión      1.276880
R-cuadrado MCVF (LSDV)    0.969814   R-cuadrado 'intra'        0.693735
F(35, 412) MCVF          378.1976    Valor p (de F)            1.5e-289
Log-verosimilitud       -726.4198   Criterio de Akaike        1524.840
Criterio de Schwarz     1672.612    Crit. de Hannan-Quinn     1583.093
rho                       0.653544   Durbin-Watson             0.589435

Contraste conjunto de los regresores (excepto la constante) -
  Estadístico de contraste: F(8, 412) = 116.655
  con valor p  = P(F(8, 412) > 116.655) = 6.89181e-101

Contraste de diferentes interceptos por grupos -
  Hipótesis nula: Los grupos tienen un intercepto común
  Estadístico de contraste: F(27, 412) = 180.029
  con valor p  = P(F(27, 412) > 180.029) = 2.25771e-209
```