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Essays in Decentralization: Efficiency, Shadow Economy and Regional Resilience

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Contents

List of tables

List of figures

Introduction

Fiscal decentralization, that is, the allocation of tax and spending powers to lower levels of government, is now an established policy objective in many developed and developing countries. It is also actively promoted as a development strategy by organisations such as the World Bank (Azfar et al., 2001; World Bank, 2000). From the USA to China, and across Europe, increasing the transfer of resources and powers to subnational tiers of governments has been justified as a means of improving economic performance (Rodríguez-Pose and Ezcurra, 2011). For developed countries, the index of regional authority computed by Hooghe et al. (2010) for 42 democracies and semi-democracies reveals that 70% of countries have decentralised since 1950. In light of this trend, there is increased need to understand the impact of fiscal decentralization in a country. The main question to be answered is whether it is advantageous to give sub-national governments more authority and autonomy in revenue and expenditure decisions, or whether such issues are better decided at the central level of government.

This trend towards decentralization has stimulated investigation into its effects in several areas, such as economic growth (Baskaran and Feld, 2013; Rodriguez-Pose and Ezcurra, 2011); regional disparities (Lessmann, 2009; Rodríguez-Pose and Ezcurra, 2011); interpersonal inequality and poverty (Sepúlveda and Martínez-Vázquez, 2011; Tselios et al., 2012); government quality (Enikolopov and Zhuravskaya, 2007; Kyriacou and Roca-Sagalés, 2011); civil conflict and terrorism (Dreher and Fischer, 2010; Ezcurra, 2015).

This thesis focuses on two issues that have received only minor attention in the literature on the effects of decentralization. From an economic perspective, the advantages of decentralization typically cited in the literature (Azfar et al., 2001; Lockwood, 2006; Oates, 1999) can be summed up as follows. First, decentralization is claimed to improve allocative efficiency, in the sense that the goods provided by local governments will be better matched to the preferences of the local population. This is sometimes known as the preference matching argument. Second, decentralization is argued to lead to more efficient delivery of government services. In this literature, production efficiency is interpreted broadly to accommodate inefficiencies such as corruption, waste, and poor governance. There is now quite a large literature on decentralization and allocative efficiency. There is, in contrast, no literature focusing on decentralization and productive inefficiency. The lack of empirical research is surprising considering that economic efficiency is the central argument for fiscal decentralization, while the arguments against it revolve around its potential negative impact on resource distribution and macroeconomic stability. The first chapter of the thesis attempts to fill this gap by examining the effects of fiscal decentralization on technical efficiency in several OECD countries.

Chapter 1 provides evidence on the relationship between fiscal decentralization and technical efficiency. There are, to the best of our knowledge, no studies addressing the subject of technical efficiency as a key aspect of the potential impact of decentralization. It is therefore an original contribution, since it evaluates the effects of fiscal decentralization on technical efficiency not by examining government or public sector performance, but by examining technical efficiency in the economic activity of the country as a whole. The first stage of this study begins with a Data Envelopment Analysis (DEA) to obtain technical efficiency estimates for a sample of 23 Organisation for Economic Co-Operation and Development (OECD) countries over the period 1992 to 2009. A second stage explores the effects of fiscal decentralization and other control variables on technical efficiency. Considering all the control variables, the results reveal a statistically significant negative relationship between fiscal decentralization of public expenditure and technical efficiency.

The second chapter of the thesis studies the effects of decentralization on shadow economy. The prediction of the theoretical analysis is that there is less shadow economy in federal countries than in unitary states (Teobaldelli, 2011). The argument is that competition among local governments and the mobility of agents induce politicians in these jurisdictions to adopt fiscal policies that are closer to the social optimum than those implemented in a centralised economy. In particular, federal system policies are characterised by lower taxation, better provision of productive services, and lower rents to politicians. In turn, more efficient fiscal policy increases the net marginal productivity of labour in the formal sector and reduces the incentive of individuals to operate in the shadow economy. For similar reasons, countries whose policy makers are relatively more insulated from outside interests are more likely to be characterised by a larger informal sector.

Chapter two of the thesis is aimed at providing empirical evidence on the various effects of decentralization on the size of the shadow economy. The study employs an econometric model with panel data for a sample of 23 OECD countries over the period 1999 to 2009 and indicators of fiscal decentralization of expenditure and revenue. A second stage explores the effects of fiscal decentralization on shadow economy using disaggregated expenditure data (education, health and social protection). The results reveal a statistically significant negative relationship between fiscal decentralization of public expenditure and shadow economy. The same is found for decentralization of expenditure in education and social protection, which negatively affects shadow economy. The findings suggest that fiscal decentralization is an appropriate instrument for reducing shadow economy. These results are consistent with previous findings in the literature (Feld and Frey, 2002; Torgler, 2005a and Torgler, 2005b).

Little research has been done so far on the economic performance of the regions in decentralized countries. This study can contribute to this strand of the literature by studying the resilience of Spanish regions. Spain is a good example of a decentralized country where recent decades have seen a variety of regional growth patterns. This makes it a perfect candidate for this analysis.

Importantly, most existing analyses of regional resilience focus on the role played by the composition of the productive structure and the degree of specialisation (i.e, Cuadrado-Roura and Maroto, 2016; Martin et al.,2016), thereby overlooking other potential factors that may affect the behaviour of regions in the context of an economic crisis. The reason behind this trend might be that in biological and ecological research, diversity has been argued to play a key role in influencing developmental robustness (see Jones et al., 2004 or Matilla and Seeley, 2007). Following this natural analogy, the focus in economic resilience studies has been on testing whether diversification/specialisation of the industry mix increases economic robustness. However, there are several factors, not specific to the labour market or the diversity and composition of the productive structure, such as social, human or public capital, for example, that could significantly affect a region's resilience. These variables are included in the analysis of Spanish regional resilience described in chapter three.

Chapter three of the thesis analyzes the characteristics that most influence the resilience of a region. The analysis begins with the construction of a new composite index of resilience for the 17 regions of Spain in the different periods of recession and recovery from 1980 to 2015. The DEA approach is used to obtain this new index. A second stage analyses the factors that could contribute to regional resilience. The regions were characterised by means of multiple factor analysis, chosen for its strong potential for defining homogeneous groups of objects, or, in this case, regions. Variables were selected to determine regional recovery capacity. Differences between the new index of resilience and that of Martin (2012) are also analysed. The findings suggest that regions with productive structures focused on market services show a higher index of resilience in periods of recovery, whereas those focused on industry are more resilient in periods of crisis. Thus, the resilience of the Spanish regions varies according to their productive structures and specialisation.

The thesis concludes by suggesting several lines for future research on the topics of decentralization and regional resilience.

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Chapter 1

Does decentralization contribute to efficiency? Evidence from OECD countries

1.1 Introduction

Decentralization has become a relevant topic in recent decades and its economic impact has given rise to intense debate. This problem is an open, ongoing process affecting many countries; viz., Spain's 1978 Constitution or Italy's constitutional reforms of 2001. Decentralization means the transfer of power and responsibility for public affairs from the central government to regional and local governments.

Calls for the decentralization of power and the granting of subnational autonomy were historically centred on cultural, ethnic, linguistic and religious arguments. Central to this discourse was the value of preserving and promoting cultural and ethnic identity, as reflected in subnational differences in lifestyle and modes of interaction. But decentralization is motivated by quite different reasons. In the past several decades, a large number of unitary countries have sought decentralization as means of searching for a more efficient and leaner public sector. Other countries became disenchanted with the performance of former planning and centralized policies. Indeed, fiscal decentralization deals with how the public sector is organized and how to create opportunities for higher growth and welfare. Decentralization governance can restore confidence in public policies and provide a basis for broader policy consensus. On the other hand, some decentralization movements are designed to contain centrifugal forces, ethnic conflicts, and/or separatist movements, and to smooth out social and political tensions by means of allowing more local autonomy. In some cases there may even be some political opportunism using decentralization for merely electoral objectives (Martínez-Vazquez, et al., 2015). However, the thrust of the discourse has shifted from decentralization as a means to preserve local uniqueness to decentralization as a way to adapt to, and therefore embrace, economic globalization (Rodríguez Pose and Gill, 2005).

It has often been suggested, moreover, that decentralization is a means to achieve economic growth or reduce regional inequality, and there has been much discussion about its relationship to these and its role in explaining corruption. Thus, we are as likely to hear arguments for it as against it. There is, however, little research directly focused on the impact of fiscal decentralization on technical efficiency. Some studies have addressed efficiency in specific areas of public services, such as health or education (Barankay and Lockwood, 2007; Letelier, 2011) or public sector efficiency as a whole (Adam et al., 2014), but, as far as we know, none has analyzed the impact of fiscal decentralization on overall economic efficiency. Efficiency is key to a country's ability to avoid waste by using as few inputs as output production allows, or by producing as much output as input usage allows. In other words, the best possible use of scant resources is vital to maximize production for the population.

The aim of this paper is to fill a gap in the existing literature by furthering the study of fiscal decentralization, which is the type of decentralization on which most papers have focused to date, and by examining its impact on technical efficiency. We consider this a worthwhile topic of research, because technical efficiency is essential if a country is to make the most of its available resources. Thus, we begin the first stage of this study with a DEA to obtain technical efficiency estimates for a sample of 23 Organisation for Economic Co-Operation and Development (OECD) countries over the period 1992 to 2009. In a second stage, we explore the effects of fiscal decentralization and other control variables on technical efficiency.

The chapter is structured as follows. Section two summarizes the theoretical arguments for and against the existence of a relationship between decentralization and technical efficiency. Section three describes the tools used to measure technical efficiency and fiscal decentralization. Section four provides details of the estimated model and presents the results. The final section presents the main conclusions.

1.2 Decentralization and efficiency

There are, to the best of our knowledge, no studies addressing the subject of technical efficiency as a key aspect of the potential impact of decentralization. This paper is therefore an original contribution, since it evaluates the effects of fiscal decentralization on technical efficiency not by examining government or public sector performance, but by examining technical efficiency in the activity of a country as a whole.

The notion of fiscal decentralization as a means to increase technical efficiency is based on the fiscal federalism theory, which originated in seminal papers by Tiebout (1956), Musgrave (1959), Oates (1972) and Brennan and Buchanan (1980). The said authors argue that fiscal decentralization can increase technical efficiency in several ways: by bringing government closer to the preferences of citizens; by promoting governmental accountability; and by increasing competition between jurisdictions. Oates (1972) specifically argues in his "decentralization theorem" that local governments are better able to match the allocation of public goods to local needs and preferences, and thus provide a better level of social welfare than is possible through centralized resource allocation. The underlying assumption is that different jurisdictions will have different needs and preferences and that these should be met by distributing public resources accordingly. A centralized government may be unaware of or ill-informed about regional and local needs and opt for uniform provision of public goods. The same bundle of goods will not necessarily suit all people, however. Oates (1972) argues further that centralization proves costly if the government has to provide different sets of public goods to meet public preferences in each jurisdiction. If preferences vary geographically, uniform provision of public goods by central governments will force some local populations to accept a larger or smaller amount of goods and services than they find desirable. Moreover, Oates´s (1972) theorem predicts a greater efficiency of decentralized service delivery in terms of allocative efficiency, which is using available resources to better match taxpayers´preferences and needs. A direct test of this is hard to do and actually has never been performed[1].

[1] The ultimate test for the efficiency effects of decentralization would be to be able to observe increases in the utility of taxpayers following decentralization and having expanded the budget. However, there have been over the years a number of indirect tests performed for the greater efficiency of decentralized delivery, such as those related to the Tiebout (1956) hypothesis reflecting the greater variety and heterogeneity of services under decentralized settings, taxpayers mobility across jurisdictions, and possibly the capitalization of differential efficiencies into house values.

A second concept of efficiency is that of production efficiency, or delivering a particular bundle of public services at a minimum cost. Being able to produce and deliver public services at a lower cost should translate into an increased quality and quantity of the services. Considering these changes represents a main alternative avenue for testing the efficiency effects of decentralization. Since education and health are among the most important types of decentralized services (OECD, 2013), a lot of the empirical literature has focused on those two areas.

Tiebout (1956) and Musgrave (1959) argue in favour of fiscal decentralization as a means to achieve more efficient distribution of public resources, greater awareness of the real preferences of the local population and better adjustment of public policies in order to satisfy them.

With greater autonomy and more funds at their disposal, regional governments have no choice but to address the needs of their population using their own resources, instead of expecting a solution in the form of public goods or services from a central government that is further removed from and less aware of local needs and preferences. This leads to greater economic efficiency at regional and local level throughout the entire country and to better use of resources that might otherwise be wasted (Rodríguez-Pose and Ezcurra, 2011).

Another argument in favour of fiscal decentralization is that it results in better governance, since proximity to the population places constraints on activities such as the diversion of public funds, favouritism towards particular interest groups, and the shirking of responsibilities, all of which would have a negative impact on a country's technical efficiency (Hindriks and Lockwood, 2009).

Fiscal decentralization also improves efficiency through so-called "yardstick competition" or competition among jurisdictions (Tiebout, 1956; Shleifer, 1985; Prud'homme, 1995; Donahue, 1997; Martínez-Vázquez and McNab, 2003). Faced with the risk that some individual voters or firms might be tempted to "vote with their feet" and move to another jurisdiction, local governments tend to compete to design better and more efficient policies (Tiebout, 1956; Donahue, 1997; Martínez-Vázquez and McNab, 2003). Residents have the advantage of being able to measure the outcome of local government policies and the performance of public employees by comparing service provision and taxation in their own with those in neighbouring jurisdictions and judge whether public resources are being wasted (Besley and Smart, 2007). Indeed, free movement of the population and competition among jurisdictions force local governments to clamp down on any inefficiency, rent-seeking behaviour or corrupt practices (Breton, 1996). Competition also encourages innovation, because the most successful local policies can be transferred from one region to another, thereby generating significant technical efficiency gains (Donahue, 1997).

Although the arguments described so far revolve around the idea that fiscal decentralization results in increased technical efficiency, there is no empirical proof of the fact. Indeed, not all of the arguments are in favour. Fiscal decentralization can have a negative impact on technical efficiency, as argued by authors such as Prud'homme, (1995) and Stein (1997). This negative impact may be due to the number of potential advantages that central governments obtain from the provision of public goods. In the presence of economies of scale, further decentralization makes the production and distribution of public goods more costly (Stein, 1997). In addition, local and regional governments are often too small to deliver public goods and services efficiently (Prud'homme, 1995). There are probably more advantages to centralized distribution in the case of capital-intensive goods, where mass investment is needed to reduce unit distribution costs (Frenkel, 1986).

Prud'homme (1995) argues that basic needs, such as food, education, security, health, infrastructure and other services, are universal, varying little from one region to another, and can therefore be better provided by a central government. Even if cross-regional variation is acknowledged, however, regional governments may still lack the capacity to take full advantage of fiscal autonomy (Rodríguez-Pose and Gill, 2006). Indeed, as far as we are aware, there is no empirical evidence to prove that local or regional governments show any real superiority when it comes to identifying the needs and preferences of each jurisdiction (Prud'homme, 1995).

Another problem with regional governments is the increased danger of their falling prey to corrupt practices or pressure from lobbies: two further impediments to technical efficiency (Prud'homme, 1995). Local governments can easily become the victims of manoeuvring by elites or lobbies (Inman and Rubinfeld, 2000; Storper, 2005) and thus more vulnerable to corruption, nepotism and clientelism. Tanzi (1995) also believes that corruption is more common at local than at national level, particularly in developing countries.

As already noted, there is no empirical evidence regarding the impact of fiscal decentralization on technical efficiency in countries. More research has gone into exploring the relationship between decentralization and economic growth, because it is more challenging to measure a country's efficiency than it is to estimate its economic growth by its GDP.

Most research on decentralization and growth is based on the premise that the transfer of resources to lower levels of government influences growth via the impact on resource allocation (Martínez-Vázquez and McNab, 2003). In other words, greater autonomy leads to greater efficiency, greater satisfaction among the population and ultimately to greater growth. Despite all the empirical literature on this topic, however, the findings are inconclusive. Some studies report a negative relationship between fiscal decentralization and economic growth (Davoodi and Zou, 1998; Zhang and Zou, 1998), while others find the link to be positive (Lin and Liu, 2000; Akai and Sakata, 2002; Iimi, 2005) or even non-existent (Davoodi and Zou, 1998; Woller and Phillips, 1998). ThieBen (2003), meanwhile, describes the relationship as inverted U-shaped, that is, an increase in fiscal decentralization brings about an increase in economic growth, but only up to a certain point, beyond which the relationship changes direction, and economic growth declines as fiscal decentralization increases. Blöchliger and Égert (2013) analyze the relationship between fiscal decentralization and economic activity. Based on a set of growth regressions, the results suggest that the relationship between fiscal decentralization and GDP per capita, productivity or human capital is positive and statistically significant. Moreover, they find that the relationship between decentralisation and GDP appears to be non-linear, revealing decreasing returns of decentralisation. Feld and Schnellendach (2011) also said that theory suggests various counteracting effects in the relationship between fiscal decentralization and growth. And it does not give a clear-cut prediction on which of the effects will dominate the others. Essentially, the net effect of fiscal federalism on growth is an empirical issue. Sobel et al. (2013) suggest in their paper that greater decentralization probably improves growth because it results in government policies more conducive to entrepreneurship and business success. They test and confirm this hypothesis using several business climate measures for the U.S. states. Rodríguez-Pose et al. (2009) find that, contrary to expectations that fiscal decentralization is likely to have a positive effect on government efficiency and economic growth, decentralization has coincided in the sample countries with a relative increase in current expenditures at the expense of capital expenditures, which has been associated with lower levels of economic growth in countries where devolution has been driven from above (India and Mexico), but not in Spain, where it has been drive from below.

The question left begging, however, is what circumstances accompany such a phenomenon. In this paper, we aim to provide some answers by examining the arguments both for and against the impact of decentralization on efficiency and to obtain some conclusive findings regarding this relationship by conducting an empirical analysis.

1.3 Measuring technical efficiency and decentralization

In this section, we describe our choice of instruments to measure technical efficiency and decentralization. We first define what we mean by technical efficiency and then describe the DEA method we will use to calculate it.

Technical efficiency occurs when maximum output is obtained from a given input level, or minimum input is used to obtain a given output level. Technical efficiency analysis can therefore have an output-maximization orientation or an input-minimization orientation. The objective with the former is to calculate the maximum increase in output that can be achieved without changing the level of input, while that of the latter is to obtain a given level of output with the minimum amount of input.

Building on a previous study by Debreu (1951), Farrell (1957) introduces a measure of technical efficiency, which he defines (p. 254) as: “one minus the equi-proportional reduction in all inputs that still allows the production of given outputs”. A decision making unit (DMU) that obtains a score of one is said to be technically efficient when it is impossible for it to achieve an equiproportional reduction in input while obtaining a given level of output. A score of less than one indicates technical inefficiency.

Farrell’s method for technical efficiency analysis was generalized for multi-output contexts and reformulated by Charnes, Cooper and Rhodes (1978) as a mathematical programming problem, later termed DEA, which is the approach to be used in this paper to obtain efficiency estimates for the sample countries.

In DEA, mathematical programming techniques are applied to the observed data in order to estimate production frontiers with which to evaluate the efficiency of each production unit. Two of the main advantages of this approach are that there is no need to specify a parametric form for the production function, and that it can be used in multi-output contexts. It does, however, have its drawbacks in that the frontier is calculated from a set of observations and is therefore sensitive to data-measurement errors and outliers, and that the non-statistical nature of the approach makes it impossible to draw statistical inferences from the results. Nevertheless, DEA is very widely used to estimate production frontiers, as can be appreciated from the existing literature (Charnes and Neralic, 1990; Seiford and Zhu, 1998; Afonso and St. Aubyn, 2006; Rayp and Van De Sijpe, 2007).

In this analysis, the performance of each DMU is measured relative to an envelopment surface composed of other DMUs from the sample representing current technology. Those DMUs that are enveloped by the surface are classed as efficient; while those outside it are classed as inefficient. The closer the DMU is to the border, the greater its efficiency.

Technical efficiency is measured in terms of the maximum proportional reduction in all inputs that is possible keeping output constant, but it can also be calculated as the maximum proportional increase in output that is possible keeping all inputs constant. Both measures provide the same results under constant returns to scale, but not under variable returns to scale. This study is maximum-output-oriented under variable returns to scale. The justification for adopting an output orientation is that a country will aim to produce the maximum quantity of goods and services from its available resources. The assumption of variable returns to scale implies that each production unit has the optimum operating level for its input and output structure, and thus ensures that the model will evaluate pure technical efficiency, irrespective of scale considerations.

Thus, the output-maximization-oriented model assuming variable returns to scale can be written as follows:

$$
\begin{aligned}
& Max Z_0^0 = \varnothing_0 \\
& s.t: \\
& x_{ji0} - \sum_{i=1}^{n} x_{ji}\lambda_i \geq 0,\ j = 1,...m \\
& -\varnothing_0 y_{ri0} + \sum_{i=1}^{n} y_{ri}\lambda_i \geq 0, r = 1,...k \\
& \sum_{i=1}^{n} \lambda_i = 1, i = 1,...n \\
& \lambda_i \geq 0, \forall i
\end{aligned}
$$

using $\lambda_i (i = 1, 2,...n)$ and $i_0(\varnothing_0)$ as the efficiency index for each unit, with constrained input/output. This measure satisfies that $1 \leq \varnothing_0 \leq \infty$, and $\varnothing_0 - 1$ is the maximum proportional increase in outputs that is possible using the same quantity of inputs. The $1/\varnothing_0$ index defines the technical efficiency level, which ranges between 0 and 1.

The variables in this problem include λ_i weights on the n DMUs, which enable the construction of a composite unit producing $\sum_{i=n}^{n} y_{ri}\lambda_i$ of output $r(r = 1,...k)$, which is greater than or equal to the amount produced by unit i_0.

The technical efficiency of the sample countries is calculated from the usual variables found in the literature (Maudos et al., 2000; Puig-Junoy, 2001; Ezcurra et al., 2009): GDP for output; and number of employed, and physical and human capital stock as inputs[2].

These variables are examined in a sample of 23 OECD countries for the period 1992 to 2009. There are several reasons for this choice of study sample. One, already noted, is that the second stage of the analysis focuses on the way decentralization affects efficiency and the sample is therefore constrained by the availability of decentralization data. Another is that the relative homogeneity of development levels OECD countries means that this choice of sample, which is no novelty in the published research on decentralization and growth (Thießen, 2003; Thornton, 2007; Baskaran and Feld, 2013), avoids the problem of having to compare countries with very different levels of development. Advanced economies show a marked tendency towards convergence in

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[2] Details of the variables are given in the table A1.1 in the appendix.

terms of aggregate productivity, technology growth, and per capita income (Rodríguez-Pose and Ezcurra, 2011). This economic convergence, that is, the reduction in economic differences between OECD countries along with similar growth dynamics, is also useful in correcting any potential bias due to omitted variables.

Table 1.1 shows the average technical efficiency scores of the 23 OECD sample countries assuming variable returns to scale over the period 1992-2009[3]. Countries with a score of one are technically efficient, that is, they lie on the production frontier. In this case, 6 of the 23 countries qualify as technically efficient: Iceland, Luxembourg, Poland, Switzerland, the United Kingdom and the United States. These results are consistent with those of other studies (Henderson and Russell, 2005). There are also some, such as Italy, Norway or France, which score less than, but very close to, 1 (0.974, 0.964 and 0.952, respectively).

[3] Table A1.2 in the appendix shows the technical efficiency scores for the same countries under constant returns to scale. Here, only one country (Luxembourg) has a score of 1, in contrast to the results under variable returns to scale where there were 6 technically-efficient countries. Despite scoring less than 1 under constant returns, the majority of the previous six countries (USA, Poland, and UK) come very close.

Table 1.1: Technical efficiency scores for OECD countries, 1992-2009

Variable returns to scale	Mean	Standard deviation	Ranking
Australia	0.761	0.031	15
Austria	0.838	0.017	12
Belgium	0.887	0.027	8
Canada	0.849	0.035	10
Denmark	0.914	0.020	7
Finland	0.808	0.025	13
France	0.952	0.050	4
Germany	0.923	0.127	6
Hungary	0.626	0.049	18
Iceland	1.000	0.000	1
Ireland	0.936	0.087	5
Italy	0.974	0.054	2
Luxembourg	1.000	0.000	1
Mexico	0.848	0.033	11
Netherlands	0.781	0.023	14
Norway	0.964	0.070	3
Poland	1.000	0.000	1
Portugal	0.663	0.023	17
Spain	0.737	0.057	16
Sweden	0.867	0.023	9
Switzerland	1.000	0.000	1
United Kingdom	1.000	0.000	1
United States	1.000	0.000	1
Mean	0.884	0.033	

Source: authors' own calculations

Having defined and calculated technically efficiency for the sample countries, we now define the concept of fiscal decentralization, describe how it is measured, and mention some cross-country differences.

Much power over public decision-making has, in recent times, been handed over from central governments with jurisdiction over the whole country to lower (regional and/or local) tiers of government. The concept of decentralization the term used to describe this transfer of power is complex and takes different forms: fiscal, political or administrative; each with its own characteristics and political implications.

This paper focuses on fiscal decentralization, that is, the delegation of powers of expenditure and taxation to lower levels of government, using two standard measures: subnational share of total public expenditure and subnational share of total government tax revenue (e.g., Oates, 1985, 1993; Davoodi and Zou, 1998; Woller and Phillips, 1998; Thieben, 2003; Iimi, 2005).

Table 1.2: Fiscal decentralization in OECD countries, 1992-2009

Decentralization	Expenditure				Revenue			
Country	Mean	St. Dev.	Δ (%)	Ranking	Mean	St. Dev.	Δ (%)	Ranking
Australia	0.383	0.018	1.44%	12	0.398	0.018	-1.39%	14
Austria	0.419	0.016	4.46%	11	0.453	0.027	-0.18%	10
Belgium	0.448	0.028	6.35%	8	0.464	0.019	1.45%	8
Canada	0.609	0.015	3.26%	3	0.621	0.043	-5.75%	3
Denmark	0.506	0.016	-3.08%	5	0.496	0.014	-2.07%	7
Finland	0.469	0.032	-13.56%	7	0.516	0.070	-21.19%	6
France	0.308	0.020	2.11%	17	0.345	0.019	3.19%	16
Germany	0.633	0.063	18.52%	2	0.670	0.079	-5.48%	2
Hungary	0.293	0.019	-0.91%	18	0.341	0.080	-4.00%	17
Iceland	0.283	0.040	10.61%	19	0.307	0.030	3.89%	18
Ireland	0.247	0.065	-12.22%	20	0.272	0.057	-10.54%	19
Italy	0.352	0.052	14.06%	15	0.401	0.033	3.00%	13
Luxembourg	0.197	0.011	-2.81%	22	0.214	0.008	0.46%	22
Mexico	0.373	0.067	19.34%	14	0.443	0.118	33.22%	11
Netherlands	0.380	0.020	2.99%	13	0.413	0.036	-8.63%	12
Norway	0.321	0.046	-13.23%	16	0.241	0.030	0.36%	21
Poland	0.436	0.111	-34.38%	10	0.348	0.116	26.87%	15
Portugal	0.157	0.020	6.16%	23	0.189	0.022	1.91%	23
Spain	0.490	0.084	19.17%	6	0.548	0.038	7.57%	4
Sweden	0.441	0.047	12.79%	9	0.459	0.033	-1.50%	9
Switzerland	0.736	0.096	23.32%	1	0.851	0.417	177.45%	1
United Kingdom	0.228	0.010	-2.29%	21	0.245	0.017	-3.83%	20
United States	0.567	0.025	0.63%	4	0.516	0.237	-9.50%	5
Mean	0.403	0.040	2.73%		0.424	0.068	8.06%	

Source: authors' own calculations

As can be seen from Table 1.2, the OECD countries included in the sample show significant variation in their degree of fiscal decentralization, both in expenditure and tax revenue terms. The most decentralized in terms of expenditure are Switzerland, Germany and Canada (all federal states) with Portugal, Luxembourg and the United Kingdom at the lower end of the scale. Although fiscal decentralization is on the rise in most countries, the average increase is only 2.73% (Rodríguez-Pose and Ezcurra, 2011), due to steep declines by countries such as Poland, Finland and Norway (-34.38%, -13.56%, and -13.23%, respectively). In terms of the decentralization of revenue, there is a 66% gap between the most decentralized (Switzerland) and the least decentralized country (Portugal). Decentralization of revenue is growing at a higher rate overall (average, 8.06%) than that of expenditure. The highest rate of increasing decentralization (a spectacular 177%) in revenue is shown by Switzerland, while Finland shows the highest rate of decline (-21%).

These measures of fiscal decentralization, are considered by Rodríguez-Pose and Gill (2006) as the most appropriate of all those available, in the absence of reliable alternatives. They have, nevertheless, been criticised for not measuring the degree of autonomy in regional government expenditure, and failing to make a distinction between tax- and non-tax revenue (Ebel and Yilmaz, 2003; Rodden, 2004; Stegarescu, 2005). To overcome the limitations of the fiscal decentralization indicators, we use an indicator based on Hooghe et al. (2008) to measure the degree of political decentralization in the sample countries[4].

1.4 Estimation and results

The second stage of this study is to analyse the way in which decentralization in the sample countries affects their technical efficiency. We therefore need to determine whether the highest efficiency scores coincide with the highest degrees of decentralization or otherwise. To do this, we use technical efficiency as the dependent variable in an econometric model written as follows:

$$TE_{it} = \alpha + \beta FD_{it} + \gamma PD_{it} + \delta X_{it} + u_{it} \qquad (1.1)$$

where TE_{it} denotes technical efficiency in country i in period t, FD stands for fiscal decentralization, PD for political decentralization, X for the control variables and u is the random error.

The chosen control variables are GDP per capita, dependent population, consumer price index (CPI), population density, trade openness and ethnic segregation, all of which, except the last, are commonly used in literature concerning the relationship between efficiency in public service delivery and decentralization (Christopoulos, 2007; Letelier, 2011; Adam, Delis and Kammas, 2014). All the time-varying control variables are lagged one period in order to avoid any problem of reverse causality with the dependent variable. Using lagged values of the level variables is implemented by some scholars to adequately address the problem (Strumpf and Oberholzer-Gee, 2002; Filippetti and Sacchi, 2013).

[4] Further details of the resulting indicator are provided in the appendix.

Real GDP per capita is used to control for economic development. Countries with high GDP are expected to have more productive, and therefore more efficient, public and private sectors (Adam, Delis and Kammas, 2014).

The dependent population ratio (share of total population under 16 and over 65) is a demographic variable which is expected to have a negative impact on efficiency by increasing taxes to strengthen social benefit programs (Adam, Delis and Kammas, 2014).

The CPI is used as an inflation indicator to help explain technical efficiency gaps between countries (Christopoulos, 2007). The rate of inflation may have a negative impact on total factor productivity (Miller and Upadhyay, 1997), thereby reducing economic growth and technical efficiency.

In relation to population density, there are studies that try to see whether regions with higher levels of efficiency are those with very high population density (Raab and Lichty, 2002), a factor that is expected to generate economies of scale and thus increase efficiency (Adam et al., 2014). Population density is associated with the concept of "economies of agglomeration", roughly definable as all the advantages to be drawn from spatial concentration. Market dynamics lead to agglomeration, which leads to profitability and competition, and these, in turn, lead to an improvement in a country's efficiency. The perceived advantage of spatial concentration in the efficiency of the various economic, social, political, and other activities of a region or country can be explained in economic terms as indivisibilities or economies of scale (Manrique, 2006). Agglomeration also has its negative side, however, since it tends to generate congestion and social conflict, all of which negatively impact on efficiency.

Trade openness is another factor that has been used to explain cross-country technical efficiency gaps. It is thought to boost competition between countries, encourage the adoption of technological advances and thus increase productive efficiency (Christopoulos, 2007). This theory is in line with the findings of Harrison (1996) and Frankel and Romer (1999), among others, who argue that more open economies, achieve higher rates of economic and productivity growth.

The last of our control variables is ethnic segregation (Alesina and Zhuravskaya, 2011). Countries with high ethnic segregation are expected to exhibit lower efficiency since this implies political unrest and poorer governance (Alesina and Zhuravskaya, 2011). Geographical segregation could encourage secessionary movements, thus putting additional stress on the central government, which may have to channel more resources into appeasement or repression and fewer into providing productive public goods and maintaining the quality of local governance. Therefore, the possibility of central governments' responding to secessionary threats by promoting decentralization suggests higher decentralization in ethnically-segregated countries. Use of the ethnic segregation variable is a novelty in the literature on the relationship between decentralization and public sector efficiency (Rayp and Van De Sijpe, 2007; Adam et al., 2014) or economic growth (Ezcurra and Rodríguez-Pose, 2013), where the ethno-fractionalization variable is widely used. Segregation offers the advantage of capturing the geographical location of the various ethnic groups.

In the following table (Table 1.3) we can see the descriptive statistics of employed variables.

Table 1.3: Descriptive statistics, 1992-2009

Variable	Obs	Mean	St.Dev.	Min	Max
Ef. Constant returns	414	0.795	0.122	0.549	1.000
Ef. Variable returns	414	0.884	0.118	0.566	1.000
FD expenditure	414	0.403	0.150	0.123	0.950
FD revenue	414	0.423	0.189	0.004	2.476
Political decentralization	396	9.178	4.952	0.000	18.000
Log. GDP pc	414	9.886	0.635	7.984	10.938
Dependent population	414	66.592	1.838	58.301	71.450
CPI	414	89.490	16.559	1.153	141.445
Population density	414	122.359	115.171	2.277	490.079
Trade openness	406	0.7864	0.5069	0.1658	3.3408
Ethnic segregation	378	0.046	0.068	0.0006	0.244

Source: authors´own calculations

Having defined the control variables, we proceed to describe the model to be estimated. Since technical efficiency scores range between 0 and 1, we use a Tobit model that is commonly found in the literature on the second stage of DEA, where DEA efficiency scores are related to potential explanatory factors (Panizza, 1999; Afonso and St. Aubyn, 2006; Adam et al., 2014).

The analysis uses random rather than fixed effects. The random effects estimator takes into account country data from different observed periods, and breaks down the error term into two parts: a fixed term and country-specific random error. This controls for individual heterogeneity, since each random error can be interpreted as a set of country-specific factors not included in the regression (Greene, 1999). The reason for using random instead of fixed effects is that DEA technical efficiency estimates (Table 1.1) show more cross-country than inter-temporal variation. Individual country efficiency scores vary little over time. Indeed, countries such as Iceland, Luxembourg, Poland, Switzerland, the UK and the US, maintain the same score from 1992 through to 2009.

Table 1.4 shows the results from the Tobit model using panel data and random effects with variable returns to scale and Table 1.5 shows the same but with constant returns to scale. Due to missing data on political decentralization we estimate four separate models.

Table 1.4: The impact of decentralization on technical efficiency (Tobit model)

	Variable returns to scale							
Fisc. Dec. Expenditure	-.2221***		-.1796***		-.2207***		-.1892***	
	(.0457)		(.0850)		(.0835)		(.0924)	
Fisc. Dec. Revenues		-.1344		-.0876		-.0941		-.0552
		(.0689)		(.0750)		(.0644)		(.0617)
Political decen.			-.0050***	-.0055***			-.0044***	-.0051***
			(.0021)	(.0021)			(.0022)	(.0022)
log. GDP p.c.	.0457	.0067	.0362	.0066	.0881	.0516	.1034	.0622
	(.0482)	(.0402)	(.0482)	(.0459)	(.0480)	(.0526)	(.0632)	(.0624)
Dependent pop.	-.0412***	-.0440***	-.0475***	-.0493***	-.0392***	-.0410***	-.0445***	-.0466***
	(.0055)	(.0056)	(.0064)	(.0064)	(.0055)	(.0059)	(.0067)	(.0068)
CPI	-.0005	-.0004	-.0006	-.0005	-.0005	-.0005	-.0006	-.0006
	(.0003)	(.0003)	(.0003)	(.0003)	(.0003)	(.0003)	(.0004)	(.0004)
Pop. Density	-.0002	-.0003	-.0001	-.0001	-.0002	-.0003	-.0001	-.0001
	(.0003)	(.0003)	(.0003)	(.0003)	(.0002)	(.0003)	(.0003)	(.0003)
Openness	-.0164	-.0160	-.0039	-.0047	-.0480	-.0461	-.0442	-.0396
	(.0423)	(.0310)	(.0334)	(.0336)	(.0367)	(.0387)	(.0410)	(.0409)
Segregation					-.0133	-.1533	-.2668	-.3399
					(.5589)	(.6180)	(.5944)	(.6249)
Constant	2.082***	2.5377***	2.3882***	2.7159***	1.5732***	1.9661***	1.6202***	2.0525***
	(.5381)	(.4710)	(.5594)	(.5443)	(.5402)	(.6194)	(.7201)	(.7324)
Observations	383	383	366	366	349	349	332	332
Wald chi2	69.13***	67.07***	78.02***	75.10***	70.13***	65.21***	76.10***	72.92***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

Table 1.5: The impact of decentralization on technical efficiency (Tobit model)

	Constant returns to scale							
Fisc. Dec. Expenditure	-.0548		-.0202		-0.0691		-.0441	
	(.0442)		(.0458)		(.0446)		(.0455)	
Fisc. Dec. Revenues		.0194		.0243		.0200		.0249
		(.0162)		(.0155)		(.0157)		(.0154)
Political decen.			-.0049***	-.0051***			-.0045***	-.0048***
			(.0012)	(.0012)			(.0012)	(.0012)
log. GDP p.c.	.1289***	.1341***	.1181***	.1203***	.1476***	.1489***	.1551***	.1514***
	(.0330)	(.0347)	(.0324)	(.0326)	(.0271)	(.0279)	(.0277)	(.0274)
Dependent pop.	-.0151***	-.0144***	-.0185***	-.0183***	-.0140***	-.0134***	-.0170***	-.0171***
	(.0031)	(.0033)	(.0035)	(.0035)	(.0030)	(.0031)	(.0033)	(.0033)
CPI	-.0006***	-.0006***	-.0006***	-.0006***	-.0006***	-.0006***	-.0007***	-.0006***
	(.0001)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
Pop. Density	-.0007***	-.0008***	-.0004	-.0005***	-.0005***	-.0006***	-.0003	-.0003
	(.0003)	(.0003)	(.0002)	(.0002)	(.0002)	(.0002)	(.0001)	(.0001)
Openness	.0654***	.0593***	.0749***	.0707***	.0509***	.0448***	.0545***	.0502***
	(.0218)	(.0264)	(.0219)	(.0220)	(.0214)	(.0216)	(.0208)	(.0209)
Segregation					.2054	.1721	-.1336	-.1605
					(.3749)	(.3948)	(.3315)	(.3450)
Constant	.1645	.0838	.3742	.3377	-.1143	-.1640	-.0712	-.0529
	(.3509)	(.3833)	(.3612)	(.3649)	(.2985)	(.3077)	(.3136)	(.3133)
Observations	383	383	366	366	349	349	332	332
Wald chi2	124.87***	112.46***	160.06***	162.70***	129.62***	126.86***	171.72***	173.27***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

We focus, when commenting the results, on the latest model of all estimated (columns 7 and 8) as it is the one that includes all control and explanatory available variables.

We can highlight that fiscal decentralization of expenditure with variable returns to scale (Table 1.4) is statistically significant and has a negative impact on the technical efficiency of the sample countries, whereas fiscal decentralization of revenue lacks significance[5]. Political decentralization also has a negative sign and is statistically significant from both the expenditure and the revenue perspective. So we can say that institutional detail matters (Voigt and Blume, 2012).

With constant returns to scale (Table 1.5), only the variable of political decentralization and not the variables of fiscal decentralization (expenditure and revenue), appears significant with a negative sign.

Potential correlation between the fiscal decentralization measures and random disturbances advises caution in the interpretation of the results of the Tobit model discussed so far. There are at least two possible sources of correlation: 1) the omission of explanatory variables that are correlated with decentralization and determine the technical efficiency of the country; and 2) reverse causality; that is, the possibility that technical efficiency is what determines the degree of fiscal decentralization. When working with panel data models affected by endogeneity, we can use fixed or random effect 2SLS methods to obtain consistent estimates. In this context one can use: the Balestra and Varadharajan-Krishnakumar (1987) generalized 2SLS (G2SLS) or Baltagi (1981) error-component 2SLS (EC2SLS). The latter is the weighted average of the within and between 2SLS estimators, which is shown in Baltagi and Liu (2009) to have more instruments than G2SLS and to be more efficient in small samples. These advantages prompted us to use the EC2SLS estimator[6].

Following the literature we employ the population as the instrumental variable for fiscal decentralization (Arikan, 2004; Lessmann and Markwardt, 2010). We have checked that this variable is positive correlated with fiscal decentralization, and in

[5] We have tested an estimation including the squared fiscal decentralization index to study the possibility of a non-linear relationship between decentralization and efficiency. However we find no significance for the squared fiscal decentralization index so it suggests that there is no evidence of a non-linear relationship between the two variables.

[6] See Baltagi and Liu (2009) for further details.

relation to the exogeneity condition, it seems reasonable to assume that population is uncorrelated with the random disturbance in our model.

The results obtained with the instrumental variables (Table 1.6) show that fiscal decentralization of expenditure remains significant (column 7) and retains the same sign as in the previous estimation. In other words, countries with higher decentralization of expenditure are found to have lower technical efficiency. With respect to fiscal decentralization of revenue, we are able to state that, while it shows no significance with variable returns of scale (Table 1.6), it appears significant and negative (Table 1.7, column 8) with constant returns of scale. In the case of political decentralization, it is not significant.

Thus, we are able to conclude that fiscal decentralization of expenditure has a negative impact on technical efficiency with statistical significance, while the results for the impact of political decentralization vary according to the model considered. These results contrast with the results obtained by Blöchliger and Égert (2013) that suggest that fiscal competition between jurisdictions has become fiercer over the past 10 or 15 years, enhancing public sector efficiency.

Of the control variables included in vector X (Table 1.6), those that are significant have the expected sign, except for trade openness. Positive GDP coefficients, that is, higher GDP per capita, are associated with higher levels of technical efficiency (columns 7 and 8). The sign of the dependent population variable is negative, however. A higher ratio of dependents to total population has a negative impact on efficiency in all cases. The CPI also appears as statistically significant (columns 7 and 8) with the expected sign (negative). Trade openness is significant with a sign opposite to expectations in columns 7 and 8. The remaining control variables (population density and ethnic segregation) have no statistical significance in the estimations. These results are consistent with those reported in other studies (Christopoulos, D., 2007; Adam et al., 2014).

To test the robustness of these findings, we re-estimate the model using constant returns to scale (Table 1.7). In columns 7 and 8, containing all the variables, it can be seen that fiscal decentralization retains both its significance and its sign in the estimation using constant returns to scale. The same occurs with political decentralization, which is not significant. All the remaining variables except trade openness have the expected signs.

Finally, in view of the limitations of the fiscal decentralization indicators used in this study, the same estimations are repeated using alternative indicators developed by Stegarescu (2005). Please see the appendix for further details (Table A1.3).

Table 1.6: The impact of decentralization on technical efficiency (EC2SLS model)

	Variable returns to scale							
Fisc. Dec. Expenditure	-0.2576		-.4220***		-.4267***		-.3825***	
	(.1646)		(.1677)		(.1308)		(.1038)	
Fisc. Dec. Revenues		.0860		.0228		-.0500		-.0797
		(.1006)		(.1119)		(.0725)		(.0690)
Political decen.			-.0010	-.0040***			.0011	-.0013
			(.0018)	(.0014)			(.0017)	(.0015)
log. GDP p.c.	.0307	.0323	.0808***	.0438	.1281***	.1006***	.2113***	.1765***
	(.0261)	(.0256)	(.0297)	(.0272)	(.0271)	(.0221)	(.0255)	(.0214)
Dependent pop.	-.0173***	-.0167***	-.0138***	-.0192***	-.0206***	-.0178***	-.0200***	-.0184***
	(.0034)	(.0039)	(.0041)	(.0038)	(.0039)	(.0039)	(.0042)	(.0042)
CPI	-.0003	-.0005***	-.0006***	-.0007***	-.0003	-.0004	-.0011***	-.0011***
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0003)	(.0003)
Pop. Density	-.0001	-.0001	-.0000	-.0001	-.00005	.00004	-.00003	.00006
	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.00009)
Openness	-.0103	-.0127	-.0149	-.0084	-.0461	-.0609***	-.0503***	-.0582***
	(.0198)	(.0200)	(.0206)	(.0199)	(.0249)	(.0234)	(.0230)	(.0224)
Segregation					.2495	.0183	-.0343	-.1606
					(.2382)	(.1991)	(.1815)	(.1674)
Constant	1.3095***	1.1664***	.7947***	1.1993***	.5281	.5858***	-.2857	-.0848
	(.2927)	(.3222)	(.3353)	(.3151)	(.2933)	(.2708)	(.2664)	(.2403)
Observations	383	383	366	366	349	349	332	332
Wald chi2	44.13***	40.63***	51.06***	52.13***	61.69***	56.06***	97.10***	92.63***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

Table 1.7: The impact of decentralization on technical efficiency (EC2SLS model)

	Constant returns to scale							
Fisc. Dec. Expenditure	-.6896***		-.9555		-.6308***		-.5847**	
	(.2841)		(.8480)		(.1477)		(.1806)	
Fisc. Dec. Revenues		-.3875		-.4913		-.2964***		-.2672**
		(.2139)		(.2937)		(.0896)		(.0856)
Political decen.			.0002	-.0032			-.0018	-.0032
			(.0047)	(.0023)			(.0016)	(.0016)
log. GDP p.c.	.1158***	.0497	.2409***	.0839	.1700***	.0873***	.2094***	.1526***
	(.0395)	(.0666)	(.0936)	(.0714)	(.0308)	(.0363)	(.0387)	(.0291)
Dependent pop.	-.0021	-.0177***	.0084	-.0180***	-.0136***	-.0177***	-.0134***	-.0160***
	(.0040)	(.0084)	(.0124)	(.0091)	(.0036)	(.0047)	(.0040)	(.0045)
CPI	.0001	-.0001	-.0004	-.0004	-.0003	-.0004	-.0008**	-.0008***
	(.0003)	(.0003)	(.0003)	(.0004)	(.0002)	(.0002)	(.0002)	(.0003)
Pop. Density	-.0002	-.0003	-.0005	-.0002	-.0003	-.0003	-.0002	-.0001
	(.0004)	(.0007)	(.0011)	(.0007)	(.0001)	(.0002)	(.0002)	(.0001)
Openness	.0294	.0595	.0155	.0654	.0804***	.0805***	.0853***	.0630***
	(.0257)	(.0377)	(.0340)	(.0448)	(.0257)	(.0312)	(.0262)	(.0270)
Segregation					.4911	.2438	.1386	-.0183
					(.3567)	(.3855)	(.4288)	(.2657)
Constant	-.0062	1.0633	-1.3967	.8098	-.2060	.6408	-.5733	-.0191
	(.4381)	(.8759)	(1.1205)	(.9212)	(.3330)	(.4358)	(.4166)	(.3348)
Observations	383	383	366	366	349	349	332	332
Wald chi2	53.23***	36.64***	45.06***	30.53***	104.48***	67.76***	128.38***	94.23***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

1.5 Conclusions

The aim of this study was to examine the impact of fiscal decentralization on technical efficiency in a sample of 23 OECD countries over the period 1992-2009. In this way, it makes a new contribution to the literature, which has so far focused on the impact of decentralization on efficiency in specific areas of the public sector, such as health or education, but not on countries' overall technical efficiency. Fiscal decentralization is a subject with arguments both for and against, and some authors claim that it has a positive impact on efficiency (Tiebout, 1956; Oates, 1972) while others take the opposite view (Prud´homme, 1995; Stein, 1997). There is still much work to be done precisely on how to improve the design and implementation of fiscal decentralization systems. Thus, this study set out to shed some empirical light on a hitherto unexplored aspect of the issue.

The results show that fiscal decentralization of expenditure and revenue has a negative impact on technical efficiency; that is, countries that are more decentralized show lower levels of technical efficiency. Taking into account the model with all control variables, the fiscal decentralization of expenditure always appears significant and negative when we consider variable returns of scale (situation more appropriate to evaluate pure technical efficiency of a country, irrespective of scale considerations).

In order to compensate to some extent for limitations found in the selected fiscal decentralization indicators, we introduced a political decentralization indicator developed from that of Hooghe et al. (2008), finding that, in the tobit model, the political decentralization also appears significant and affecting negatively to efficiency.

Therefore, these results show that fiscal decentralization of expenditure adversely affects the technical efficiency of the sample countries and the same occurs with fiscal decentralization of revenue but considering constant return of scale in the EC2SLS model estimation.

So in this world when decentralization is an ongoing process it is necessary to continue working on the effects of all kind of decentralization on different economic aspects as efficiency. In moving forward it will be important to find better instrumental variables in order to better deal with the issue of endogeneity. And it would also be important to improve the standardization and overall quality of decentralization data, something international organizations like the OECD or the World Bank have talked about doing in the past.

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Appendix

Table A1.1: Description of the control variables

Variables	Source	Period	Units and definition
GDP per capita	World Development Indicators, World Bank	1992-2009	Gross Domestic Product, $ of 2000 (in logs)
Num. of employed	World Development Indicators, World Bank	1992-2009	Number of persons (in logs). Employed population
Physical capital stock	Berlemann and Wesserhöft, October 2012	1992-2009	$ of 2000 (in logs). Physical capital stock includes lands improved, lands purchased, machinery and equipment, roads, railways etc. schools, offices, hospitals, private houses and commercial and industrial premises.
Human capital	World Development Indicators, World Bank	1992-2009	Average number of years schooling of total population * number employed
Dependent population	World Development Indicators, World Bank	1992-2009	Ratios of population under 16 and over 65 to total population
Consumer price index	World Development Indicators, World Bank	1992-2009	Consumer Price Index (2005=100)
Population density	World Development Indicators, World Bank	1992-2009	Inhabitants per square km.
Trade openness	World Development Indicators, World Bank	1992-2009	(Exports+Imports)/GDP (constant 2005 US$)
Ehtnic segregation	Alesina and Zhuravskaya (2011)	2000	Index of ethnic segregation calculated by Alesina and Zhuravskaya (2011)

Table A1.2: Technical efficiency of OECD countries assuming constant returns to scale, 1992-2009

Constant returns to scale	Mean	Standard deviation	Ranking
Australia	0.751	0.027	13
Austria	0.655	0.023	21
Belgium	0.735	0.019	15
Canada	0.836	0.026	7
Denmark	0.853	0.027	6
Finland	0.712	0.069	17
France	0.755	0.013	12
Germany	0.668	0.025	20
Hungary	0.614	0.052	23
Iceland	0.822	0.041	10
Ireland	0.930	0.089	5
Italy	0.723	0.024	16
Luxembourg	1.000	0.000	1
Mexico	0.827	0.027	8
Netherlands	0.750	0.023	14
Norway	0.823	0.051	9
Poland	0.997	0.013	3
Portugal	0.655	0.023	22
Spain	0.705	0.019	18
Sweden	0.801	0.060	11
Switzerland	0.699	0.082	19
United Kingdom	0.976	0.022	4
United States	0.997	0.007	2
Mean	0.795	0.033	

Source: authors' own calculations

Political decentralization index

Political decentralization is meant to give the local/regional population or their elected representatives more power in public decision making. For this analysis, we use some of the best-known indices, which are those that appear in Hooghe et al. (2008). They cover a broad range of aspects of decentralization, including fiscal autonomy, representation, executive power, policy scope, etc., in 42 countries for the period 1950 to 2006. Based on the indicators of Hooghe et al. (2008), we develop our own indicator of political decentralization, which is the sum of three indices:

1) Institutional depth: the extent to which a regional government is autonomous rather than deconcentrated (values between 0 and 3).
2) Policy scope: the range of policies for which a regional government is responsible (values between 0 and 4).
3) Representation: the extent to which a region is endowed with an independent legislature and executive (vales between 0 and 4).

Stegarescu indicators

The fiscal decentralization indicators used in this study, subnational share in total public expenditure and subnational share in total government tax revenue, have been criticised for the reasons described in a previous section. We therefore perform a new estimation using the fiscal decentralization indicators of Stegarescu (2005), specifically the TD1 indicator, which the author claims to be the most appropriate because it considers only own taxes that are mainly independently chosen by sub-central governments as autonomous, is thus defined as

TD1= SCG (sub-central government) own tax revenue from (a) to (c) /GG (general government) total tax revenue

(a) SCG determines tax rate and tax base
(b) SCG determines tax rate only
(c) SCG determines tax base only

Since the above indicator for the 23 OECD countries of interest are available from 1965 to 2001, the estimation period in this case will be 1992-2001, that is, a different one from that used in the previous estimations (1992-2009). Furthermore, since these indicators are for the decentralization of tax revenue, the estimation is oriented in that direction.

The results, shown in Table A1.3, are not comparable with the previous ones, due to the peculiarities of the fiscal decentralization indicator used in the estimation and to the difference in the estimation period.

It can be seen in column 1 that fiscal decentralization is significant and has a negative sign, thus confirming the previous results, which established that fiscal decentralization of revenues has a negative impact on technical efficiency. Political decentralization in the Tobit model is also significant and with a negative sign (columns 2 and 4).

In the model including instrumental variables, political decentralization is still significant and negative (columns 6 and 8); unlike fiscal decentralization, which presents different signs. In fact, taking into account all the variables except segregation, the sign for fiscal decentralization has changed from negative in the all the other estimations to positive. This is the only model showing it to have a positive impact on technical efficiency.

Table A1.3: The impact of decentralization on technical efficiency (Stegarescu indicators)

	TOBIT model				EC2SLS model			
	Variable returns of scale				Variable returns of scale			
TD1 Stegarescu	-.0025***	-.0010	-.0021	-.0007	.0034	.0044***	-.0000	-.0002
	(.0012)	(.0012)	(0012)	(.0012)	(.0030)	(.0019)	(.0022)	(.0012)
Political decen.		-.0056***		-.0055***		-.0055***		-.0031***
		(.0018)		(.0018)		(.0015)		(.0013)
log. GDP p.c.	.0325	.0305	.0876	.0680	-.0173	.0554	.0026	.1309***
	(.0597)	(.0692)	(.0902)	(.0851)	(.0597)	(.0503)	(.0606)	(.0446)
Dependent pop.	.0114	.0068	0.0138	.0090	.0047	.0070	.0082	.0127
	(.0118)	(.0116)	-0.012	(.0118)	(.0088)	(.0078)	(.0086)	(.0073)
CPI	-.0006	-.0006	-.0005	-.0006	-.0003	-.0005	-.0003	-.0005
	(.0004)	(.0004)	(.0004)	(.0004)	(.0002)	(.0003)	(.0002)	(.0002)
Pop. Density	.00003	.0001	.0001	.0002	.0002	.0004***	.00009	.0002***
	(.0002)	(.0001)	(.0002)	(.0002)	(.0003)	(.0001)	(.0002)	(.0001)
Openness	-.0230	-.0167	-.1034	-.0711	.0114	-.0122	-.0202	-.0912***
	(.0634)	(.0593)	(.0835)	(.0832)	(.0514)	(.0380)	(.0645)	(.0436)
Segregation			-.5054	-.5157			-.4190	-.1655
			(.5245)	(.5260)			(.4997)	(.2256)
Constant	.3649	.5475	-.2211	.1379	.8390	.0672	.6404	-.7244
	(.6266)	(.7536)	(1.022)	(.9747)	(.7116)	(.5417)	(.7116)	(.4813)
Observations	163	163	154	154	163	163	154	154
Wald chi2	8.04***	18.45***	12.38***	19.73***	4.27***	23.11***	4.68***	142***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

Chapter 2

Can fiscal decentralization mitigate the shadow economy? An empirical analysis

2.1 Introduction

The shadow economy (SE) is a worldwide and growing phenomenon that most societies try to bring under control. Governments approach the problem with different means, such as prosecution and penalties. Shadow activities lead to a deterioration in labour conditions, harm the business environment through unfair competition, and threaten the financial sustainability of social protection systems (European Commisions, 2007; OECD, 2012; Williams and Renooy, 2013). There is an obvious need, therefore, to fight against undeclared activities and turn them into regularized work.

Most researchers attempting to measure the SE meet with the problem of how to define it. A common definition includes all unregistered economic activities contributing to the Gross Domestic Product (GDP) officially calculated (or observed) (Frey and Pommerehne, 1984; Feige, 1989, 1994; Schneider, 1994a, 2003, 2005, 2007; Feld and Schneider, 2010). Another comes directly from the 1993 United Nations System of National Accounts (SNA), according to which the underground economy includes legal production activities that are:

"deliberately concealed from public authorities for the following kinds of reasons: to avoid payment of income, value added or other taxes; to avoid payment of social security contributions; to avoid having to meet certain legal standards such as minimum wages, maximum hours, safety or health standards, etc; to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms." (Eurostat, et. al, 1993 p. 153 and OECD, 2002, p. 139).

The SE poses a serious problem for the public sector, because it leads to a loss of revenue in terms of unpaid income tax, public social security contributions and VAT; it hampers attempts to generate social cohesion by reducing the government's available resources for investing in social integration and tax mobility (Williams and Windebank, 1998); it weakens unions and undermines collective bargaining power (Gallin, 2001); and, if a significant segment of the population engages consistently in such activity, it may encourage a more carefree attitude towards law in a broader sense (Renooy et al., 2004).

There are two points of view on the causes of undeclared work: the liberal open-market perspective and the structuralist perspective. The first of these sees the SE as a direct consequence of excessive tax burden, government corruption and stifling control and regulation. In order to halt its growth, therefore, countries would have to opt for the reduction of fiscal pressure, deregulation and minimal state intervention (De Soto, 1989, 2001; Becker, 2004; London and Hart, 2004). According to the second point of view, undeclared work is a direct consequence of inefficient regulation, coupled with the absence of intervention in the labor market and social protection (Gallin, 2001; Davis, 2006; Meagher, 2010; Slavnic, 2010).

The SE has reached massive proportions, accounting for 17.2% of GDP in 162 countries between 1999 and 2006/2007 (Schneider et al., 2010), which can raise crucial issues, such as inadequate fiscal capacity for growth in the case of developing countries (Besley and Persson, 2010). In addition, developed countries, especially in southern Europe, having faced severe crises and critical budgetary positions, report high percentages of SE, above 20% of GDP.

There are different ways for governments to deal with the crisis, such as reducing public spending or raising taxes to increase government revenue. But such measures meet with strong resistance from large sectors of society. Policy makers often propose strict enforcement strategies to combat the SE, different strategies must therefore be considered to control the SE which is undermining countries' attempts to emerge from the crisis.

What impact, if any, does fiscal decentralization have on the shadow economy? Decentralization can exert influence on the SE in two ways: by improving public sector efficiency (the efficiency effect) or by reducing the distance between official and economic agents, which increases the probability of detection of SE activities (the deterrence effect). In this paper we are going to study the effect of fiscal decentralization on the SE using a sample of 23 OECD countries for the period 1999 to 2009.

This paper examines various aspects that have so far been left largely unaddressed. Its first contribution is to undertake the analysis with panel data, in contrast to the cross-sectional approach used in previous studies. The main advantages of using panel data are that it provides valid information on countries by studying them over time obtains a more complete picture of the problem and enables easier interpretation of the dynamics of change; and, by linking the time-specific and country-specific dimensions of the problem, increases the model's degrees of freedom.

The paper's second contribution is to analyze the effect of the fiscal decentralization of expenditure and revenue on the SE, both in aggregate terms and functionally disaggregated into education expenditures, health expenditures and social protection expenditures, all of which directly affect the citizen's utility function. The consideration of these decentralized and disaggregated indicators of expenditure is one of the innovations of this study with respect to previous ones. The literature tends to find a positive link between the level of decentralization and individuals' life satisfaction (Frey and Stutzer, 2000; Voigt and Blume, 2009; Díaz-Serrano and Rodríguez-Pose, 2012). These results are consistent with the 'fiscal decentralization theorem' (Tiebout, 1956; Klugman, 1994): a better matching of public goods and services delivery to the needs of citizens leads, ceteris paribus, to greater satisfaction with policy and political institutions. Institutions, in turn, lead to improvements in individual well-being (Frey and Stutzer, 2012). Citizens find government spending in education, health and social protection useful, since it affects them directly and brings them well-being. If expenses are decentralized, regional and local authorities, whose proximity gives them a better understanding of their citizens' needs and preferences are able to provide more adequate quantities of public goods and services. As a result, residents will be more satisfied with their authority's performance, less tempted to work in the SE, and more inclined to pay the taxes needed to provide these services. Likewise, shadow employment leads to lower tax revenues, thus fewer resources for governments to spend on education, health and social protection, and ultimately a negative impact on citizens' utility. Díaz-Serrano and Rodríguez-Pose (2015) analyze whether decentralization has an impact on citizens' satisfaction with public services, such as education and healthcare, and whether it is a potential driver of trust in institutions and public policies. They find health and education to be crucial elements in the generation of public trust. Their analysis reveals that the perceived state of education and health services is affected by the degree of decentralization. More specifically, they indicate that fiscal decentralization, measured as the expenditure capacity of sub national governments, exerts a positive influence on satisfaction with political institutions.

Thus, one of the objectives of this study is to analyze whether the greater spending capacity of regional governments in areas such as education, health and social protection, directly affects citizens' satisfaction, and dissuades them from joining the shadow economy which hampers their governments' attempts to meet their needs.

The work is structured as follows: after this introduction, section two presents a review of the literature dealing with the relationship between decentralization and the SE. Section 3 describes the data used in the analysis. Section 4 explains the empirical model and discusses the results. The fifth and final section presents the main conclusions.

2.2 Review of the literature

The literature on the SE shows that the tax burden and social security contributions, labor market regulations, the quality of public goods and services, and the state of the "official" economy are the principal reasons why a SE exists (Johnson et al., 1998; Friedman et al., 2000; Schneider and Enste, 2000).

In relation to the tax burden and social security contributions, and given that taxes affect the work-leisure choice and encourage people to join the SE, it is the distortion of the overall tax burden that is the key concern of economists. The greater the difference between pre-tax earnings and post-tax earnings in the formal economy, the greater will be people's incentive to avoid any deduction from their gross income by working in the SE. Most of the deduction goes to social security and income tax payments, and these, therefore, are main reasons behind the existence and growth of the SE.

Some studies find the tax burden to have an increasing effect on the SE (Schneider, 1994b, 2000, 2004, 2005, 2007; Johnson et al., 1998) and all find statistically significant evidence of the influence of taxes on SE (Kirchgaessner, 1983, 1984; Klovland, 1984; Schneider, 1986).

Although, as far as we know, little work has been done on the impact of fiscal decentralization on SE, we are able to cite some papers that focus on these issues (Alexeev and Habodaszova, 2007; Torgler et al., 2010, among others).

The main argument in favor of decentralization is based on Oates' (1972) decentralization theorem, which claims that local governments are in a better position to achieve a more efficient supply of public goods and services given their understanding of citizens' preferences. In other words, the transfer of power to regional governments increases the efficiency of the public sector, and contributes to greater development and economic growth (Oates, 1993; Baskaran and Feld, 2009). Local authorities are better informed about local needs and can thus provide the socially-optimal amount of public goods. Not all the arguments are in favour, however. Fiscal decentralization can have a negative impact on economies, as argued by authors such as Prud'homme, (1995) and Stein (1997). This negative impact may be due to the number of potential advantages that central governments are able to obtain from the provision of public goods. In the presence of economies of scale, further decentralization makes the production and distribution of public goods more costly (Stein, 1997). In addition, local and regional governments are often too small to deliver public goods and services efficiently (Prud'homme, 1995). There are probably more advantages to centralized distribution in the case of capital-intensive goods, where mass investment is needed to reduce unit distribution costs (Frenkel, 1986).

A government that is in tune with the public goods needs of local companies is more likely to prevent firms from transferring their activity to the SE. Moreover, the increase of efficiency resulting from decentralization increases tax morale (the issue of whether citizens find fiscal evasion justifiable) and consequently limits SE activities (Torgler et al., 2010). Likewise, closer proximity between government employees and citizens facilitates the supervision of clandestine activities (Dell'Anno and Teobaldelli, 2012; Buehn et al., 2013). Decentralization also improves government efficiency and therefore reduces the SE (the efficiency effect). Thus, we can expect that the greater the degree of decentralization, the smaller the SE.

The deterrence effect is based on three factors which determine the decision to migrate into the SE: 1) expected net cost savings from tax avoidance and non-payment of social security contributions; 2) market regulations and 3) fines and the probability of detection (Allingham and Sandmo, 1972; Feld and Larsen, 2011). The importance of the last factor may be influenced by the degree of decentralization, since it reduces the distance between bureaucrats and economic agents. The greater the frequency of their face-to-face contact, the greater the probability of detection and, therefore, the lower the expected net gains from SE activities. Decentralization enhances the deterrent effect and is expected to reduce the size of the SE, but the opposite effect is possible. Another problem with regional governments is the increased danger of their falling prey to corrupt practices or pressure from lobbies (Prud'homme, 1995). Local governments can easily become the victims of manoeuvring by elites or lobbies (Inman and Rubinfeld, 2000; Storper, 2005) and thus more vulnerable to corruption, nepotism and clientelism. Tanzi (1995) also believes that corruption is more common at local than at national level, particularly in developing countries.

Until now, studies of the influence of decentralization on the SE have focused on the analysis of cross-sectional data as opposed to the panel data approach adopted in this paper. In fact, Buehn et al. (2013, p. 2570) mentioned that "…using a panel data instead of a cross-section data set would be preferable as this would allow us to control for unobserved heterogeneity between countries…"

Although there is substantial literature on various aspects of the SE, few studies address the impact of decentralization. Alexeev and Habodaszova (2007) analyze the effect of decentralization on local government incentives to provide local public goods. They use a cross-section model for a sample of 82 countries. The results show that decentralization reduces the size of the SE by curbing corruption and improving productivity through greater provision of public goods.

Torgler et al. (2010) study the relationship between decentralization, tax morale and the SE. The effect of decentralization on tax morale is analyzed using individual data from the Swiss International Social Survey Programme (ISSP). In order to complement the micro approach, they also look at the relationship between decentralization and the SE using cantonal level Swiss data. They find that a higher degree of fiscal decentralization increases tax morale and reduces the size of the SE.

Teobaldelli (2011) analyzes the relationship between federalism and the SE. Her theoretical analysis finds that the SE is smaller in federal than in unitary countries. The results are tested using a cross-section of up to 73 countries. The size of the SE was found to be smaller by all the decentralization measures considered.

Buehn et al. (2013) study the impact of decentralization on the SE. The results obtained for a sample of 73 countries reveal that fiscal decentralization has no significant impact on the SE, and is therefore not an appropriate policy instrument for reducing it. Although all the measures of political decentralization show negative coefficients, the only significant coefficient is that of the number of vertical tiers of government. As a result, their cautious interpretation is that political decentralization is useful in controlling the SE. The share of sub-national government employment in total civilian government employment (government employment decentralization) has a highly significant negative effect on the SE (a deterrent effect), and finally, employment decentralization is more effective in controlling the SE in countries with weak institutional quality.

Goel and Saunoris (2014) examine the effects on the SE of various forms of decentralization of government functions. They use four dimensions of decentralization: the tiers of government and subnational government employment (physical decentralization); and subnational government expenditures and subnational government revenue (fiscal decentralization). While baseline results show decentralization to reduce the SE, they find differences in its effectiveness only between physical and fiscal decentralization: greater physical decentralization is more effective at reducing widespread shadow economies, while fiscal decentralization is more effective with smaller shadow sectors.

2.3 Data

In this section we explain the data employed for the empirical analysis.

It is very difficult to obtain concise information regarding the SE because the agents who participate in it do not wish to be identified. Therefore, the SE data used in this paper are the estimated sizes and trends obtained by Buehn and Schneider (2012a) for 39 OECD developed countries for the period 1999 to 2010. We consider 23 countries in our sample because the data from IMF for decentralization is for these 23 countries.

In general terms, the possible methods for determining the scope of the SE can be grouped into direct and indirect methods. Most of them quantify the SE as a percentage of GDP.

Direct methods are mainly based on large-scale surveys. Surveys are used in many countries (Norway by Isachsen et al., 1982; Denmark by Mogensen et al., 1995, and Pedersen, 2003), but present some of the drawbacks common to all surveys: money and time costs, the difficulty of obtaining a representative sample, lack of cooperation from the agents involved, subjectivity in the design and administration of the questionnaire, and so on. These drawbacks generate doubts regarding the reliability and credibility of such data.

It is more common when using indirect methods to calculate the SE with representative indicators and/or tracking undeclared labor statistics, which are to be found among data collected for other purposes (GHK and Fondazione Brodolini, 2009).

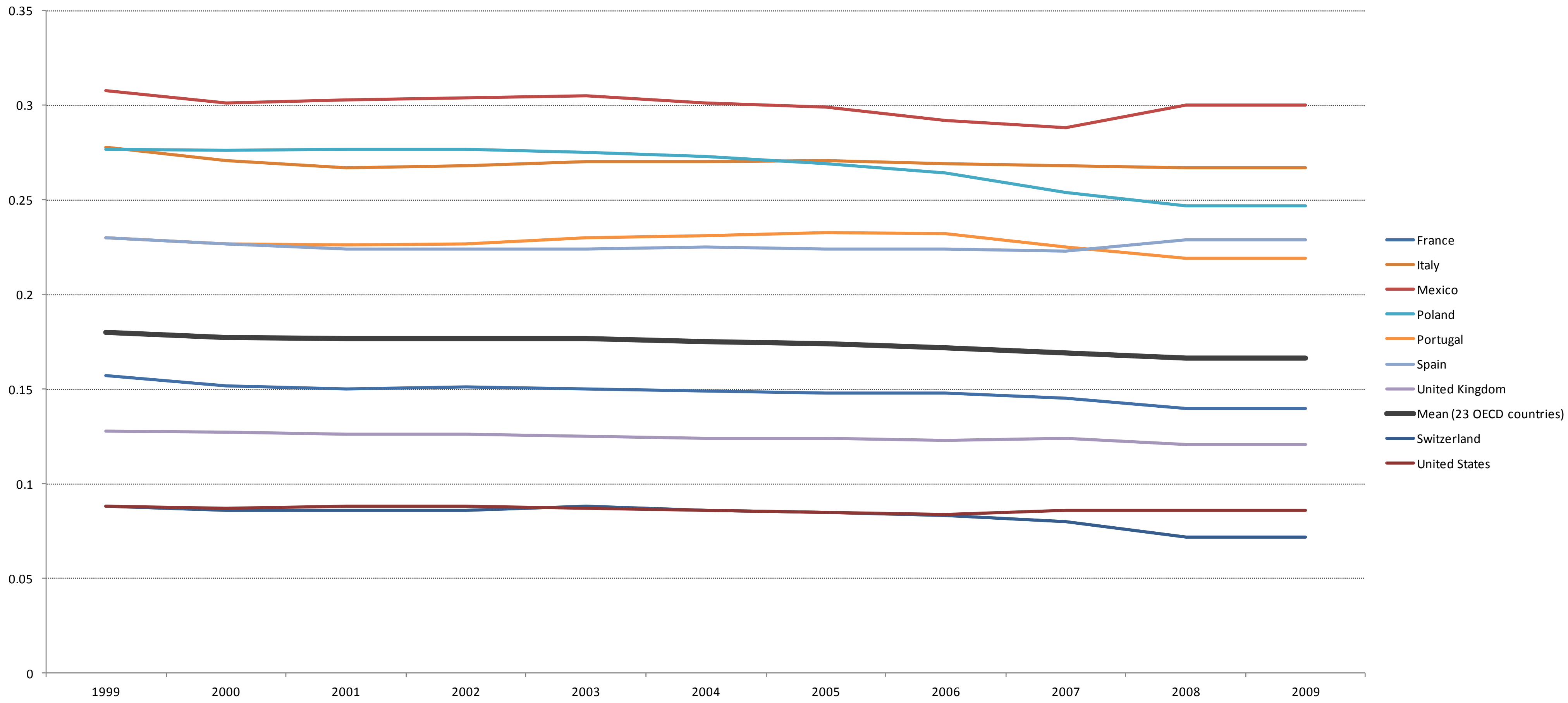
Buehn and Schneider (2012a) use a specific type of indirect measure known as the MIMIC approach (Multiple Indicators Multiple Causes). The MIMIC procedure assumes that the SE remains an unobservable phenomenon (latent variable) that can be estimated using measurable causes of illicit employment, e.g. the tax burden and regulatory intensity, and indicators reflecting illicit activities, e.g. the currency demand or official working time.

This approach is not free from criticism (Breusch, 2005; Feige, 2015). One disadvantage of the MIMIC procedure is that it produces only relative estimates of the size and development trend of the SE. Nevertheless, there is a consensus in the academic community with regards to the suitability of indirect methods to measure the SE and survey methods to explore its nature (European Commission, 2007b; OECD, 2012). The reliability of the MIMIC procedure is confirmed by the fact that it is commonly used by entities such as the World Bank to measure the global SE (Schneider et al., 2010). Moreover, it yields relative magnitudes of the shadow SE for subsequent econometric estimation.

From the indicators mentioned above and using the MIMIC approach, Buehn and Schneider (2012a) estimate the SE data shown in Table A2.1 in the appendix. Figure 2.1 shows only means for 23 OECD countries and those with more extreme values. It can be seen that the sample country with the largest SE as a percentage of its GDP is Mexico with 30% on average throughout the period. It is followed by Italy and Poland with 27% and 26.7%, respectively. At the opposite extreme, we find Switzerland (8.3%) and United States (8.6%).

In Table A2.1 we can see the size of SE for studied countries. A study by Schneider (2009) reports that the crisis that started in 2008 would increase the SE in 21 OECD countries by an average of 0.5 percent of GDP during 2009, after a run of annual declines since 2001. The crisis is likely to have shifted the incidence of noncompliance toward the sectors most affected by the downturn or trigger a higher incidence of some forms of noncompliance (Brondolo, 2009). Therefore, during times of economic downturn, rising unemployment, lower disposable income, and fears about the future, a greater number of individuals tend to drift into “shadow activities” – by taking on additional employment that goes unreported, or underreporting shop sales, for example – in order to improve personal finances and compensate for missing income streams. We are unable to confirm this with the data at our disposal, however.

Figure 2.1: Estimated shadow economy for selected OECD countries



Source: Authors' own calculation from Table A1.1 in the appendix

In the following paragraphs we detail the explanatory variables that will be used in the empirical analysis.

The first is the fiscal decentralization of expenditure and revenue, which involves the delegation of responsibilities for expenditure and/or revenue to lower levels of government. For the study we use two widely-used measures of fiscal decentralization: the subnational share of total public expenditure and the subnational share of total government revenue (e.g. Oates, 1985, 1993; Davoodi and Zou, 1998; Woller and Phillips, 1998; Thieben, 2003; Iimi, 2005). According to Rodríguez-Pose and Gill (2006), these measures are the most appropriate of those available in the absence of more reliable alternatives. Nonetheless, these indicators have been criticized for failing to identify the degree of autonomy in regional government expenditure, and also failing to differentiate between tax and non-tax sources of revenue (Ebel and Yilmaz, 2003; Rodden, 2004; Stegarescu, 2005). These indicators have been computed from Government Finance Statistics (IMF)[7].

[7]See tables A2.2 and A2.3 in the appendix for more details.

Table 2.1: Indicators of decentralization (1999-2009)

Decentralization	Total expenditure		Total revenue		Expenditure on education		Expenditure on health		Expenditure on social protection	
Country	Mean	Ranking	Mean	Ranking	Mean	Ranking	Mean	Ranking	Mean	Ranking
Australia	0.385	15	0.386	15	0.599	9	0.480	14	0.101	19
Austria	0.422	10	0.445	11	0.438	16	0.572	11	0.204	16
Belgium	0.465	9	0.472	7	0.857	6	0.253	17	0.389	10
Canada	0.619	3	0.626	3	0.950	2	0.892	4	0.462	4
Denmark	0.510	6	0.495	6	0.511	13	0.966	2	0.612	2
Finland	0.473	7	0.462	8	0.552	12	0.689	8	0.542	3
France	0.314	16	0.353	16	0.279	17	0.204	18	0.240	12
Germay	0.666	2	0.685	2	0.966	1	0.782	6	0.420	8
Hungary	0.299	18	0.338	17	0.570	10	0.706	7	0.225	14
Iceland	0.305	17	0.326	18	0.564	11	0.016	21	0.448	5
Ireland	0.240	20	0.263	19	0.207	20	0.496	13	0.167	18
Italy	0.389	14	0.423	13	0.279	18	0.660	9	0.090	21
Luxembourg	0.191	22	0.215	22	0.246	19	0.050	19	.	
Mexico	0.418	11	0.517	5	.		.		.	
Netherlands	0.392	13	0.395	14	0.485	14	0.382	15	0.236	13
Norway	0.292	19	0.228	21	0.640	8	0.380	16	0.196	17
Poland	0.399	12	0.432	12	0.485	15	0.632	10	0.365	11
Portugal	0.171	23	0.201	23	0.086	21	0.046	20	0.097	20
Spain	0.546	5	0.572	4	0.928	4	0.927	3	0.433	6
Sweden	0.471	8	0.460	9	0.705	7	0.824	5	0.419	9
Switzerland	0.780	1	0.945	1	0.895	5	0.988	1	0.614	1
United Kingdom	0.230	21	0.244	20	.		.		0.211	15
United States	0.578	4	0.450	10	0.928	3	0.533	12	0.427	7

Source: Author's own calculations from Government Finance Statistics (IMF)

The data in Table 2.1 reveal significant cross-country differences in the degree of fiscal decentralization. In fact, on the expenditure side (columns 2 and 3), the difference between the most decentralized country, Switzerland, and the least decentralized, Portugal, is 60.9%. There is a similar picture on the revenue side (columns 4 and 5), where the difference is even greater, 74.4% between the most decentralized (Switzerland) and the least decentralized country (Portugal).

In addition to these aggregate measures of fiscal decentralization in terms of expenditure and revenue, we use other disaggregated measures of fiscal decentralization in expenditures, more specifically, expenditure on education, health and social protection. These indicators are defined as the percentage spent by sub central governments on education, health and social protection, respectively, in relation to total national spending in those areas[8].

According to Table 2.1, the country with the most decentralized education expenditure regime is Germany, while that with the least is Portugal. With respect to health expenditure, the most decentralized country is Switzerland and the least is Iceland. Finally, for social protection expenditure, Italy shows the lowest degree of decentralization, while Switzerland once again shows the highest.

The tax morale indicator measures the individual's willingness to pay taxes, in other words, recognition of the moral duty to pay taxes or the belief that paying taxes is a way of contributing to society. The data are drawn from the World Values Survey Wave (WVS) and the European Values Study (EVS), where citizens are asked if they consider fiscal evasion justifiable. The response scale ranges from 1 to 10, where 1 means that the respondent considers that tax cheating is never justifiable, and 10, means that the respondent considers that it is always justifiable. Although this indicator can be computed for later periods, we use the one for 1999 to avoid problems of simultaneity with the SE indicator.

Using the available data, we compute a tax morale indicator using the average rating weighted by the number of respondents and answers obtained. The results are summarized in Table 2.2.

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[8]See tables A2.4, A2.5 and A2.6 in the appendix for more details.

Table 2.2: Tax morale of OECD countries

Australia	2.15	Luxembourg	3.35
Austria	2.10	Mexico	3.08
Belgium	3.61	Netherlands	2.74
Canada	2.08	Norway	2.71
Denmark	2.00	Poland	2.14
Finland	2.55	Portugal	2.44
France	3.04	Spain	2.35
Germany	2.37	Sweden	2.42
Hungary	2.09	Switzerland	2.60
Iceland	2.23	United Kingdom	2.43
Ireland	2.29	United States	1.72
Italy	2.39		

Source: Authors'own calculations from World Values Survey and European Values. Study period 1995-1999

The overall observation is that all countries show a tax morale index of between 2 and 3 indicating that they do not consider tax cheating justifiable. Belgium appears to be the country with the loosest tax morale (over 3.5), while the United States is the one with the strictest (1.72).

Other control variables included in the empirical analysis are the following[9]:

GDP per capita is used as an indicator of the country's economic development. It is expected to show a negative sign, given that more prosperous and developed countries with better public institutions have better measures with which to combat the SE. These are also countries where the official economy performs better, thus discouraging firms from participating in SE sectors.

Ethnic segregation (Alesina and Zhuravskaya, 2011) is a variable that has not been used in other studies. Use of the ethnic segregation variable is a novelty in the literature on the relationship between decentralization and the shadow economy, where the usual variable has been ethnic fractionalization (Teobaldelli, 2011; Goel and Saunoris, 2014). Segregation offers the advantage of capturing the geographical location of the various ethnic groups and of being more closely correlated with fiscal decentralization than is the case for fractionalization.

[9]Further details of the control variables are given in the Appendix (table A2.7).

Demographic characteristics, such as urban population may affect the SE (Schneider and Torgler, 2007). A higher level of *urbanisation* might increase anonymity, and thus reduce loyalty towards the state; which might lead to a higher level of SE.

Self-employed persons do not, per se, have lower tax morale than other taxpayers, but they do have better opportunities for tax evasion (Torgler et al., 2010). Therefore, we expect a positive sign.

The *institutional quality* variable is the mean value of the three governance indicators: “government effectiveness”, “control of corruption”, and “rule of law” provided by Kaufmann et al. (2009). We expect to find that the higher the quality of the country’s government institutions, the lower the level of SE (Buehn et al., 2013).

Local autonomy (Treisman, 2002) is a dummy variable for whether local governments have a degree of autonomy in some specific aspect of government or the constitution grants exclusive power of decision on the matter to the national government. It is used to compensate for the limitations introduced by the fiscal decentralization indicators, such as failing to measure the degree of autonomy in regional government expenditure, and failing to make a distinction between tax- and non-tax revenue (Ebel and Yilmaz, 2003; Rodden, 2004; Stegarescu, 2005). It is an indicator of political decentralization that Buehn et al. (2013) expected to have a negative sign, because it would indicate the validity of the efficiency and tax morale effects. However, we can also predict a positive sign, because local governments are more susceptible to corruption or to being captured by interest groups (Prud’homme, 1995), both of which act as drivers of the SE.

The number of vertical *tiers* of government (Treisman, 2002) is also an indicator of political decentralization that is expected to show a negative sign. It varies between 1 and 6 and can be used as a proxy for the distance between bureaucrats and economic agents.

Tax revenues (Buehn et al., 2013) is the variable for the government’s total tax revenues as a percentage of GDP. The expected sign is ambiguous. On the one hand, if the correlation between tax revenues and SE is positive, it means that the higher the government’s tax revenues, the higher the taxes that citizens have to pay and in consequence, the higher the incentive to join the SE. On the other hand, we can expect a negative sign because the higher the government’s tax revenues, the higher its capacity to spend on providing its citizens with public goods and services and the lower the incentive to defraud.

Finally, we use a variable for the highest *marginal corporation tax rate*. The higher the rate of tax that firm have to pay, the higher their motivation to participate in the SE (Buehn et al., 2013).

2.4 Empirical analysis and results

The objective of this study is to determine whether a country's degree of fiscal decentralization has an effect on the size of its SE. Therefore, we estimate an econometric model using panel data, where the dependent variable is the SE and the explanatory variables are fiscal decentralization and all the control variables defined in the section above.

$$SE_{it} = \alpha + \eta_t + \beta FD_{it} + \gamma X_{it} + u_{it} \qquad (2.1)$$

where SE_{it} refers to the shadow economy in country i in period t, and η_t is a vector of year dummies to control for events specific to each year, such as a crisis affecting all countries, FD is fiscal decentralization, X the control variables and u the random error term.

The analysis uses random effects rather than fixed effects. Estimation with random effects considers the data for each country in each study period and decomposes the error into two parts: a common fixed part, plus a specific random part for each country. This controls for individual heterogeneity because each random error can be interpreted as a set of country-specific factors that are not included in the regression (Greene, 1999).The reason for using random instead of fixed effects is that SEs (Table A2.1) show more cross-country than inter-temporal variation.

The following table (Table 2.3) shows the estimation results. Among them, we can highlight the significant negative impact of fiscal decentralization in expenditure on the SE. That is, the higher a country's degree of fiscal decentralization in expenditure, the lower its level of SE. This empirically validates the fact that a higher degree of decentralization reduces the distance between government employees and economic agents. The hypothesis that we set up was that decentralization would reduce the size of the SE.

However, the same is not found for the impact of fiscal decentralization in revenues, which does not appear to be significant. In relation to the other explanatory variables, we observe that those that appear to be significant show the expected sign. This is the case of GDP per capita, which shows that the higher a country's GDP per capita, the lower its level of SE. This implies that more developed countries have more capacity to control this type of activity. Finally, tax burden has a negative sign. The marginal corporation tax rate is not significant, so there is no proof of a higher tax rate being associated with higher SE in the sample countries. Therefore, these results do not support the liberal thesis that higher tax rates push economic agents into the SE. We are able to note that political decentralization, local autonomy, is not significant, which implies that increasing the having greater power of decision of local authorities in governing issues has no impact on the size of the SE.

Given the characteristics of the dependent variable (SE), and as a robustness analysis, a Tobit model was also estimated yielding results very similar to those obtained with the OLS model. The significant variables displayed are the same as in the least squares model.

Potential correlation between the fiscal decentralization measures and random disturbances advises caution in the interpretation of the results of the model discussed so far. Several techniques have been adopted to deal with this problem. Using instrumental variables, the most appropriate approach has probably posed a challenge due to the scarcity of time-variant exogenous instruments. When working with panel data models affected by endogeneity, we can use fixed or random effect 2SLS methods to obtain consistent estimates. The search for the optimal set of instrumental variables led us to two alternative random effect estimators: the Balestra and Varadharajan-Krishnakumar (1987) generalized 2SLS (G2SLS) or the Baltagi (1981) error-component 2SLS (EC2SLS). The latter is the weighted average of the within and between 2SLS estimators, which is shown in Baltagi and Liu (2009) to have more instruments than G2SLS and to be more efficient in small samples. These advantages prompted us to use the EC2SLS estimator[10].

Following the literature, we use population as the instrumental variable for fiscal decentralization (Arikan, 2004; Lessmann and Markwardt, 2010; Alexeev and Habodaszova, 2012). We consider population to be an appropriate instrument because it is correlated with fiscal decentralization and we assume it to be uncorrelated with the random disturbance.

[10]See Baltagi and Liu (2009) for further details.

The results are similar to the previous ones (Table 2.3). In fact, the only change worth noting is that fiscal decentralization in revenues now appears significant and shows a negative sign, as does fiscal decentralization in expenditures. Thus, the influence of fiscal decentralization on SE is verified. Fiscal decentralization has potential as an instrument for countries to control and reduce the size of SE.

Table 2.3: Effects of fiscal decentralization on SE

	OLS		EC2SLS	
fd expenditures	-2.5803***		-14.9519***	
	(.8216)		(5.5111)	
fd revenues		-.2018		-4.6921***
		(.2060)		(1.3671)
tax morale	2.8468	3.3939	2.0305	.9892
	(1.6373)	(1.8526)	(8.8967)	(1.7752)
GDP per capita	-13.8403***	-14.4102***	-11.1046***	-10.7397***
	(2.1046)	(2.2086)	(4.1553)	(3.0171)
ethnic segregation	12.7070	8.7490	18.2551	31.1611***
	(11.8073)	(13.2796)	(61.5054)	(13.4892)
urbanisation	-5.33e-09	1.15e-09	9.94e-09	-4.77e-08***
	(1.17e-08)	(1.27e-08)	(2.94e-08)	(1.60e-08)
self-employed	.0101	.0115	.0026	.0151
	(.0069)	(.0069)	(.0106)	(.0139)
institutional quality	-.1323***	-.0945	-.2622***	-.1960
	(.0598)	(.0585)	(.1122)	(.1201)
local autonomy	.4843	.3465	.0885	1.5130***
	(.6113)	(.6867)	(3.0480)	(.7001)
tiers	-1.2543	-1.4070	-1.2944	-.5422
	(1.0564)	(1.1989)	(5.7987)	(1.1273)
tax burden	-.1200***	-.1157***	-.1648***	-.0941***
	(.0252)	(.0250)	(.0398)	(.0489)
corporate tax rate	-.0068	-.0101	.0014	.0063
	(.0117)	(.0116)	(.0184)	(.0238)
_constant	79.5638***	80.5465***	76.5127***	65.1984***
	(11.0175)	(11.8138)	(33.8524)	(14.7481)
Observations	198	198	198	198
Wald chi2	284.92***	269.01***		
F (20,178)			6.13***	5.73***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

One contribution to the literature of influence of fiscal decentralization on SE will be to consider fiscal decentralization in expenditure disaggregated by areas; specifically education, health and social protection. These areas of expenditure were selected because they are the ones that the public perceives to have the most direct impact on their welfare. We believe that when a government spends on education, health or social protection, it positively affects the welfare or utility of its citizens, and consequently, it will positively influence economic agents to remain in the official economy, encouraging the payment of taxes to finance this type of expenditure. The decentralization of expenditures benefits the public because local and regional authorities are closer to them and have a better understanding of their needs and preferences in relation to education, health and social protection.

First of all, we estimate 3 linear models using panel data; then, taking into account the endogeneity problem, we perform two-stage estimation with instrumental variables and panel data. As instruments for the decentralization of expenditure in education, health and social protection, we use, the same variables lagged one period (for want of an alternative).

Focusing on estimations with instrumental variables, which are considered more accurate when dealing with the problem of endogeneity, we can see in Table 2.4 (columns 5 and 7) how the decentralization of spending on education and social protection has a negative effect on the SE, in other words, makes it decrease. This result agrees to our expectations, since, if people perceive government spending in a certain area to increase their welfare, we might imagine they would be less inclined to work in the SE, which would consequently reduce in size. According to fiscal federalism theory, fiscal decentralization may help to increase efficiency in the allocation of resources, as it is often posited that subnational governments have an information advantage over central governments when it comes to responding to the needs and preferences of local citizens (Ezcurra and Rodríguez-Pose, 2009). Moreover, decentralization gives sub-central governments incentives to spend more on education. Several studies conclude that decentralization boosts spending on education. Busenmeyer (2008) finds that fiscal decentralization affects education spending positively. Rodriguez-Pose and Krojier (2009), Gonzalez Alegre (2010), and Grisorio and Prota (2011) all observe that decentralization increases current expenditure, which includes education. So, when decentralized, spending appears to be more in line with objective indicators of need. The simple correlation between PISA results and subcentral government share of spending indeed suggests a positive relationship between decentralization and educational outcomes. Simply put, more decentralized countries tend to have better student performance (OECD, 2013). In consequence, better students in a country implies a country more developed and with more capacity to control SE. So our results confirm the fact that more decentralized country spends more in education, which implies a country more developed and less SE.

Other significant variables in these estimations (Table 2.4) are GDP, ethnic segregation and local autonomy. Ethnic segregation positively affects SE; and local autonomy also has a positive sign. Countries where local governments have a certain degree of autonomy in decision-making show higher levels of SE. As already mentioned, local governments are more susceptible to corruption and more likely to be captured by interest groups, which suggest a positive effect on the SE, in contrast to the predictions of Buehn et al. (2013). On the other hand, we find that GDP negatively affects the shadow economy.

Table 2.4: Effects of disaggregated expenditure on SE

	OLS			EC2SLS		
fd exp. education	-0.9704			-4.3472***		
	(1.1336)			(1.7530)		
fd exp. health		-.2546			-.6166	
		(.2413)			(.4081)	
fd exp. social protection			-.1917			-1.3524***
			(.2883)			(.6183)
tax morale	4.2594***	4.5979	4.7351	2.0944	2.3653	2.0019
	(2.1056)	(2.4238)	(2.4690)	(1.2642)	(1.2803)	(1.1991)
GDP per capita	-14.6540***	-16.2015***	-14.5367***	-13.565***	-14.8745***	-14.3829***
	(2.4491)	(2.4841)	(2.6350)	(2.2466)	(2.2613)	(2.2569)
ethnic segregation	16.9947	13.4733	13.3987	32.8333***	22.4205***	25.4619***
	(16.3064)	(18.5524)	(18.8996)	(10.2756)	(9.3566)	(8.7711)
urbanisation	1.05e-08	1.24e-08	1.92e-08	-2.01e-08	-2.63e-08***	-2.75e-08***
	(1.29e-08)	(1.37e-08)	(1.38e-08)	(1.03e-08)	(1.04e-08)	(9.96e-09)
self-employed	.0094	.0119	.0056	.0052	.0115	.0050
	(.0072)	(.0067)	(.0082)	(.0094)	(.0092)	(.0120)
institutional quality	-.0834	-.0631	-.0822	-.1333	-.1566***	-.1941***
	(.0585)	(.0568)	(.0563)	(.0799)	(.0794)	(.0902)
local autonomy	.7111	.6014	.4996	1.4225***	1.2607***	1.2761***
	(.8298)	(.9551)	(.9713)	(.4921)	(.4909)	(.4586)
tiers	-2.1008	-2.2644	-2.3632	-1.3257	-1.0385	-1.1088
	(1.5119)	(1.7431)	(1.7479)	(.9105)	(.9125)	(.8412)
tax burden	-.1163***	-.1306***	-.1085***	-.0884***	-.0786***	-.0185
	(.0262)	(.0250)	(.0258)	(.0349)	(.0331)	(.0379)
corporate tax rate	-.0145	-.0146	-.0226	-.0033	-.0031	-.0061
	(.0116)	(.0114)	(.0120)	(.0155)	(.0159)	(.0191)
_constant	81.0900***	87.9984***	80.3631***	78.1274***	81.1075***	78.9450***
	(13.0885)	(13.6657)	(14.2492)	(10.9967)	(11.0788)	(10.9143)
Observations	175	175	168	174	173	165
Wald chi2	244.16***	257.90***	221.96			
F test				8.91***	8.61***	7.92***

Notes: standard deviation in parentheses

Significance levels: *0.05 < p < 0.10, **0.01 < p < 0.01, ***p < 0.01

2.5 Conclusions

Almost all governments in the world try to control shadow economic activities both because they are partially illegal and because they have an eroding effect on the tax base and the viability of the social security system. So one of the big challenges for every government is to identify and undertake efficient incentive-oriented policy measures to make the shadow economy less attractive, and the official economy more inviting. Successful implementation of such policies could help to stabilize, or even reduce, the size of shadow economies (Buehn and Schneider, 2012b). This article argues that fiscal decentralization should reduce the SE.

The aim of this study was to examine the impact of fiscal decentralization on SE in a sample of 23 OECD countries over the period 1999-2009. In this way, it makes two new contributions to the literature: the use of panel data in the analysis; and the use of disaggregated indicators of decentralization of expenditure.

As we have observed in the empirical results, countries with higher levels of fiscal decentralization of expenditure show lower levels of shadow economy. More decentralized countries are better able to control illegal activities such as SE.

This study also looks at the effect of fiscal decentralization disaggregated by area of expenditure and political decentralization on the shadow economy. According to the results obtained, when it comes to combating the shadow economy, the decentralization of expenditure on education and social protection have the same impact as the aggregated indicator of expenditure. Fiscal decentralization can therefore be considered an effective strategy for curbing the growth of SE. However, empirical evidence suggests that countries with political decentralization, that is local governments with a degree of decision-making autonomy, show higher levels of SE.

Therefore, in a world where decentralization is an ongoing process, it is necessary to continue working on the effects of all forms of decentralization on different economic issues, such as SE. In moving forward, it will be important to find more reliable instrumental variables for handling the issue of endogeneity. It will also be important to further standardize and improve the overall quality of decentralization data, something international organizations such as the OECD or the World Bank have talked about doing in the past. Moreover, even after 20 years of intensive research, the size, causes, and consequences of the shadow economy are still controversially debated in the literature and further research is needed to improve our understanding of the phenomenon.

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Appendix

Table A2.1: Size of shadow economy[11]

	Year										
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Australia	0.144	0.143	0.143	0.141	0.139	0.137	0.137	0.137	0.137	0.132	0.132	0.1
Austria	0.1	0.098	0.097	0.098	0.098	0.098	0.098	0.096	0.097	0.095	0.095	0.1
Belgium	0.227	0.222	0.221	0.22	0.22	0.218	0.218	0.214	0.208	0.203	0.203	0.2
Canada	0.163	0.16	0.159	0.158	0.157	0.156	0.155	0.153	0.152	0.149	0.149	0.2
Denmark	0.184	0.18	0.18	0.18	0.18	0.178	0.176	0.17	0.165	0.153	0.153	0.2
Finland	0.184	0.181	0.179	0.178	0.177	0.176	0.174	0.171	0.166	0.164	0.164	0.2
France	0.157	0.152	0.15	0.151	0.15	0.149	0.148	0.148	0.145	0.14	0.14	0.1
Germany	0.164	0.16	0.159	0.161	0.163	0.161	0.16	0.156	0.153	0.148	0.148	0.2
Hungary	0.254	0.251	0.248	0.245	0.244	0.241	0.24	0.237	0.237	0.231	0.231	0.2
Iceland	0.16	0.159	0.158	0.16	0.159	0.155	0.151	0.15	0.144	0.138	0.138	0.2
Ireland	0.161	0.159	0.159	0.159	0.16	0.158	0.156	0.155	0.159	0.159	0.159	0.2
Italy	0.278	0.271	0.267	0.268	0.27	0.27	0.271	0.269	0.268	0.267	0.267	0.3
Luxembourg	0.1	0.098	0.098	0.098	0.098	0.098	0.097	0.096	0.093	0.091	0.091	0.1
Mexico	0.308	0.301	0.303	0.304	0.305	0.301	0.299	0.292	0.288	0.3	0.3	0.3
Netherlands	0.133	0.131	0.131	0.132	0.133	0.132	0.132	0.132	0.131	0.127	0.127	0.1
Norway	0.192	0.191	0.19	0.19	0.19	0.185	0.185	0.182	0.181	0.177	0.177	0.2
Poland	0.277	0.276	0.277	0.277	0.275	0.273	0.269	0.264	0.254	0.247	0.247	0.3
Portugal	0.23	0.227	0.226	0.227	0.23	0.231	0.233	0.232	0.225	0.219	0.219	0.2
Spain	0.23	0.227	0.224	0.224	0.224	0.225	0.224	0.224	0.223	0.229	0.229	0.2
Sweden	0.196	0.192	0.191	0.19	0.187	0.185	0.186	0.182	0.18	0.177	0.177	0.2
Switzerland	0.088	0.086	0.086	0.086	0.088	0.086	0.085	0.083	0.08	0.072	0.072	0.1
United Kingdom	0.128	0.127	0.126	0.126	0.125	0.124	0.124	0.123	0.124	0.121	0.121	0.1
United States	0.088	0.087	0.088	0.088	0.087	0.086	0.085	0.084	0.086	0.086	0.086	0.1
Mean (23 OECD countries)	0.180	0.177	0.177	0.177	0.176	0.175	0.174	0.172	0.169	0.166	0.166	0.174

Source: Buehn and Schneider (2013)

[11] Estimations before 2007 are taken from Buehn and Schneider (2012)
*Data for 2009 and 2010 are not available; therefore, estimations are a linear interpolation of the national average for 2008.

Table A2.2: Fiscal decentralization of total expenditure in OECD countries, 1999-2009

	Year											
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Australia	0.401	0.401	0.383	0.377	0.381	0.380	0.378	0.384	0.387	0.387	0.375	0.385
Austria	0.440	0.441	0.410	0.407	0.408	0.401	0.405	0.418	0.422	0.432	0.454	0.422
Belgium	0.430	0.432	0.435	0.467	0.465	0.482	0.479	0.483	0.479	0.482	0.485	0.465
Canada	0.608	0.613	0.623	0.624	0.624	0.627	0.631	0.614	0.615	0.616	0.615	0.619
Denmark	0.504	0.499	0.505	0.512	0.522	0.524	0.530	0.541	0.495	0.495	0.488	0.510
Finland	0.465	0.471	0.483	0.478	0.483	0.489	0.491	0.490	0.497	0.496	0.357	0.473
France	0.283	0.290	0.291	0.297	0.303	0.317	0.321	0.327	0.339	0.342	0.342	0.314
Germay	0.656	0.661	0.671	0.672	0.667	0.668	0.666	0.665	0.667	0.669	0.663	0.666
Hungary	0.273	0.281	0.289	0.286	0.302	0.326	0.332	0.310	0.302	0.294	0.297	0.299
Iceland	0.292	0.302	0.302	0.304	0.308	0.310	0.309	0.338	0.338	0.246	0.310	0.305
Ireland	0.269	0.291	0.296	0.306	0.307	0.311	0.317	0.143	0.138	0.137	0.127	0.240
Italy	0.361	0.372	0.373	0.385	0.385	0.400	0.399	0.397	0.400	0.405	0.398	0.389
Luxembourg	0.200	0.202	0.202	0.200	0.193	0.182	0.181	0.185	0.186	0.186	0.179	0.191
Mexico	0.363	0.366	0.386	0.406	0.416	0.430	0.446	0.446	0.446	0.446	0.446	0.418
Netherlands	0.384	0.388	0.385	0.394	0.398	0.404	0.403	0.392	0.391	0.387	0.381	0.392
Norway	0.338	0.323	0.333	0.268	0.273	0.269	0.271	0.276	0.284	0.291	0.283	0.292
Poland	0.431	0.419	0.408	0.426	0.370	0.383	0.384	0.387	0.387	0.390	0.408	0.399
Portugal	0.147	0.155	0.160	0.169	0.161	0.173	0.176	0.178	0.185	0.188	0.185	0.171
Spain	0.454	0.473	0.479	0.541	0.565	0.565	0.580	0.587	0.591	0.595	0.577	0.546
Sweden	0.447	0.453	0.447	0.457	0.456	0.454	0.446	0.485	0.502	0.519	0.520	0.471
Switzerland	0.661	0.661	0.719	0.722	0.735	0.747	0.757	0.950	0.800	0.921	0.901	0.780
United Kingdom	0.221	0.221	0.233	0.233	0.230	0.234	0.233	0.236	0.237	0.230	0.227	0.230
United States	0.578	0.583	0.600	0.601	0.595	0.596	0.594	0.564	0.565	0.552	0.530	0.578
Mean	0.400	0.404	0.409	0.414	0.415	0.421	0.423	0.426	0.420	0.422	0.415	0.415

Source: own elaboration from Government Finance Statistics (IMF)

Table A2.3: Fiscal decentralization of total revenues in OECD countries, 1999-2009

	Year											
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Australia	0.406	0.394	0.382	0.388	0.382	0.385	0.379	0.380	0.382	0.373	0.397	0.386
Austria	0.475	0.470	0.430	0.433	0.438	0.422	0.431	0.440	0.433	0.446	0.478	0.445
Belgium	0.452	0.439	0.456	0.466	0.462	0.484	0.484	0.489	0.497	0.498	0.466	0.472
Canada	0.616	0.620	0.619	0.628	0.628	0.630	0.635	0.601	0.662	0.676	0.574	0.626
Denmark	0.490	0.495	0.507	0.511	0.517	0.506	0.508	0.496	0.460	0.469	0.482	0.495
Finland	0.477	0.440	0.462	0.465	0.475	0.478	0.481	0.479	0.471	0.487	0.367	0.462
France	0.325	0.334	0.331	0.344	0.356	0.358	0.364	0.364	0.377	0.382	0.353	0.353
Germay	0.686	0.685	0.687	0.692	0.687	0.708	0.696	0.693	0.688	0.686	0.632	0.685
Hungary	0.300	0.309	0.330	0.347	0.356	0.371	0.377	0.390	0.342	0.316	0.281	0.338
Iceland	0.293	0.303	0.314	0.325	0.331	0.341	0.351	0.333	0.344	0.345	0.306	0.326
Ireland	0.288	0.293	0.326	0.346	0.351	0.341	0.196	0.182	0.190	0.206	0.175	0.263
Italy	0.380	0.410	0.417	0.424	0.428	0.444	0.449	0.428	0.433	0.440	0.402	0.423
Luxembourg	0.212	0.207	0.217	0.231	0.232	0.220	0.211	0.205	0.202	0.217	0.212	0.215
Mexico	0.408	0.400	0.429	0.464	0.493	0.533	0.593	0.593	0.593	0.593	0.593	0.517
Netherlands	0.394	0.392	0.387	0.399	0.425	0.417	0.399	0.383	0.385	0.380	0.387	0.395
Norway	0.255	0.246	0.260	0.236	0.231	0.217	0.202	0.197	0.199	0.187	0.279	0.228
Poland	0.338	0.331	0.431	0.438	0.461	0.480	0.457	0.463	0.444	0.464	0.442	0.432
Portugal	0.196	0.184	0.199	0.199	0.198	0.217	0.226	0.206	0.206	0.213	0.173	0.201
Spain	0.537	0.544	0.543	0.566	0.576	0.591	0.584	0.585	0.576	0.628	0.564	0.572
Sweden	0.430	0.460	0.425	0.465	0.463	0.462	0.457	0.451	0.454	0.473	0.524	0.460
Switzerland	0.699	0.670	0.744	0.737	0.739	0.735	0.736	0.942	1.017	0.897	2.477	0.945
United Kingdom	0.219	0.216	0.232	0.246	0.263	0.259	0.254	0.255	0.254	0.253	0.235	0.244
United States	0.604	0.596	0.601	0.649	0.661	0.657	0.633	0.004	0.004	0.004	0.541	0.450
Mean	0.412	0.410	0.423	0.435	0.441	0.446	0.439	0.416	0.418	0.419	0.493	0.432

Source: Author's own calculations from Government Finance Statistics (IMF)

Table A2.4: Fiscal decentralization of expenditure on education (OECD countries, 1999-2009)

	Year											
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Australia	0.613	0.610	0.604	0.607	0.606	0.599	0.601	0.595	0.596	0.594	0.564	0.599
Austria	0.454	0.450	0.435	0.440	0.446	0.376	0.357	0.458	0.457	0.467	0.477	0.438
Belgium	0.873	0.868	0.865	0.862	0.857	0.852	0.848	0.850	0.847	0.843		0.857
Canada	0.943	0.943	0.948	0.950	0.950	0.954	0.957	0.946	0.957			0.950
Denmark	0.490	0.494	0.509	0.514	0.524	0.510	0.514	0.579	0.505	0.493	0.492	0.511
Finland	0.519	0.515	0.512	0.572	0.578	0.581	0.597	0.544	0.549			0.552
France	0.265	0.264	0.272	0.275	0.282	0.275	0.279	0.284	0.288	0.293	0.297	0.279
Germany	0.974	0.973	0.972	0.971	0.969	0.969	0.965	0.962	0.959	0.955	0.952	0.966
Hungary	0.617	0.614	0.610	0.608	0.601	0.597	0.592	0.499	0.480	0.487		0.570
Iceland	0.555	0.572	0.554	0.543	0.541	0.537	0.528	0.600	0.600	0.591	0.587	0.564
Ireland	0.213	0.212	0.233	0.219	0.207	0.208	0.207	0.188	0.194	0.190		0.207
Italy	0.299	0.272	0.276	0.285	0.280	0.296	0.302	0.259	0.256	0.266		0.279
Luxembourg	0.179	0.176	0.233	0.250	0.251	0.253	0.259	0.266	0.272	0.278	0.284	0.246
Mexico												
Netherlands	0.469	0.466	0.477	0.479	0.480	0.483	0.487	0.490	0.499	0.503	0.502	0.485
Norway	0.622	0.625	0.629	0.633	0.628	0.635	0.645	0.644	0.657	0.656	0.665	0.640
Poland	0.468	0.483	0.483	0.488	0.489	0.487	0.484	0.484	0.482	0.487	0.496	0.485
Portugal	0.091	0.086	0.080	0.080	0.071	0.070	0.063	0.093	0.101	0.103	0.105	0.086
Spain	0.739	0.929	0.936	0.936	0.936	0.935	0.937	0.963	0.965	0.965	0.971	0.928
Sweden	0.715	0.704	0.656	0.698	0.707	0.684	0.676	0.711	0.746	0.755		0.705
Switzerland	0.899	0.903	0.905	0.889	0.885	0.881	0.875			0.923		0.895
United Kingdom												
United States	0.942	0.944	0.941	0.938	0.935	0.933	0.936	0.916	0.920	0.918	0.891	0.928
Mean	0.569	0.576	0.578	0.583	0.582	0.577	0.577	0.566	0.566	0.567	0.560	0.573

Source: Author's own calculations from Government Finance Statistics (IMF)

Table A2.5: Fiscal decentralization of expenditure on health (OECD countries, 1999-2009)

	Year											
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Australia	0.479	0.480	0.471	0.475	0.482	0.475	0.471	0.484	0.491	0.488	0.485	0.480
Austria	0.808	0.753	0.651	0.680	0.662	0.675		0.367	0.370	0.376	0.379	0.572
Belgium	0.276	0.285	0.319	0.309	0.363	0.394	0.432	0.049	0.050	0.052		0.253
Canada	0.974	0.950	0.958	0.958	0.927	0.808	0.823	0.818	0.812			0.892
Denmark	0.965	0.964	0.965	0.953	0.956	0.958	0.955	0.966	0.982	0.981	0.980	0.966
Finland	0.725	0.721	0.723	0.719	0.711	0.696	0.690	0.609	0.604			0.689
France	0.255	0.266	0.313	0.252	0.250	0.179	0.160	0.141	0.121	0.102		0.204
Germany	0.250	0.303	0.488	0.689	0.968	0.977	0.980	0.983	0.986	0.989	0.993	0.782
Hungary	0.731	0.729	0.733	0.724	0.710	0.705	0.699	0.693	0.688	0.682	0.676	0.706
Iceland	0.022	0.023	0.022	0.018	0.016	0.015	0.014	0.013	0.014	0.012	0.010	0.016
Ireland	0.507	0.503	0.501	0.499	0.500	0.496	0.494	0.492	0.490	0.489	0.487	0.496
Italy	0.586	0.632	0.598	0.706	0.720	0.725	0.627	0.691	0.666	0.652		0.660
Luxembourg	0.183	0.094	0.084	0.054	0.030	0.018	0.018	0.017	0.016	0.016	0.015	0.050
Mexico												
Netherlands	0.668	0.662	0.652	0.640	0.643	0.672	0.086	0.046	0.045	0.044	0.041	0.382
Norway	0.717	0.625	0.628	0.302	0.296	0.279	0.269	0.269	0.266	0.263	0.270	0.380
Poland	0.133	0.097	0.466	0.728	0.689	0.798	0.802	0.806	0.809	0.813	0.816	0.632
Portugal	0.048	0.044	0.041	0.050	0.035	0.036	0.035	0.056	0.055	0.055	0.054	0.046
Spain	0.838	0.923	0.922	0.943	0.949	0.953	0.949	0.928	0.929	0.931	0.935	0.927
Sweden	0.868	0.866	0.656	0.864	0.850	0.840	0.797	0.842	0.834	0.826		0.824
Switzerland	0.988	0.989	0.989	0.989	0.992	0.994	0.997			0.967		0.988
United Kingdom												
United States	0.618	0.619	0.611	0.596	0.580	0.582	0.593	0.417	0.423	0.418	0.400	0.533
Mean	0.554	0.549	0.561	0.578	0.587	0.585	0.545	0.484	0.483	0.482	0.467	0.534

Source: Author's own calculations from Government Finance Statistics (IMF)

Table A2.6: Fiscal decentralization of expenditure on social protection (OECD countries, 1999-2009)

	Year											
Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Mean
Australia	0.095	0.092	0.091	0.097	0.104	0.099	0.102	0.107	0.112	0.116	0.102	0.101
Austria	0.252	0.261	0.239	0.228	0.225	0.234		0.146	0.150	0.152	0.151	0.204
Belgium	0.597	0.602	0.608	0.620	0.351	0.288	0.219	0.200	0.199	0.201		0.389
Canada	0.469	0.497	0.496	0.499	0.504	0.512	0.515	0.335	0.334			0.462
Denmark	0.635	0.628	0.627	0.631	0.634	0.642	0.646	0.566	0.569	0.577	0.575	0.612
Finland	0.643	0.649	0.667	0.636	0.638	0.637	0.576	0.215	0.222			0.542
France	0.216	0.199	0.196	0.215	0.240	0.305	0.309					0.240
Germany	0.383	0.391	0.411	0.431	0.441	0.444	0.435					0.420
Hungary	0.322	0.319	0.331	0.312	0.285	0.234	0.202	0.082	0.082	0.080		0.225
Iceland	0.546	0.561	0.507	0.567	0.584	0.599	0.617	0.247	0.244	0.240	0.221	0.448
Ireland	0.142	0.205	0.226	0.250	0.226	0.229	0.230	0.053	0.053	0.060		0.167
Italy	0.112	0.103	0.113	0.115	0.123	0.112	0.113	0.038	0.037	0.037		0.090
Luxembourg												
Mexico												
Netherlands	0.334	0.340	0.307	0.281	0.263	0.258	0.327	0.117	0.124	0.120	0.121	0.236
Norway	0.192	0.189	0.204	0.205	0.187	0.179	0.188	0.194	0.203	0.210	0.209	0.196
Poland	0.897	0.886	0.605	0.295	0.291	0.313	0.327	0.102	0.101	0.100	0.097	0.365
Portugal	0.081	0.101	0.133	0.127	0.140	0.147	0.221	0.033	0.032	0.029	0.026	0.097
Spain	0.333	0.587	0.614	0.643	0.669	0.671	0.818	0.106	0.107	0.109	0.105	0.433
Sweden	0.416	0.524	0.635	0.388	0.370	0.381	0.362	0.277				0.419
Switzerland	0.576	0.578	0.900	0.885	0.824	0.899		0.289	0.292	0.284		0.614
United Kingdom								0.211	0.211	0.210		0.211
United States	0.575	0.587	0.614	0.603	0.602	0.601	0.595	0.141	0.138	0.132	0.115	0.427
Mean	0.391	0.415	0.426	0.401	0.385	0.389	0.378	0.182	0.178	0.166	0.172	0.317

Source: Author's own calculations from Government Finance Statistics (IMF)

Table A2.7: Control variables

Variables	Units and definition	Source
GDP per capita	Gross domestic product, in 2005 $ (in logs)	World Development Indicators, World Bank
Ethnic segregation	Index of ethnic segregation calculated by Alesina and Zhuravskaya	Alesina and Zhuravskaya (2011)
Urbanisation	Urban population refers to people living in urban areas as defined by national statistical offices.	World Development Indicators, World Bank
Self-employed	Self-employed, total (% of total employed)	World Development Indicators, World Bank
Institutional quality	The average of three indicators of governance. These three indicators are: *Government Effectiveness* captures perceptions of the quality of public services, the quality of the civil service and its degree of independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. *Control of Corruption* captures perceptions of the extent to which public power is exercised for private gain. *Rule of Law* captures perceptions of the extent to which agents have confidence in and abide by the rules of society.	World Development Indicators, World Bank
Local autonomy	Dummy variable for countries whose local governments have some degree of "autonomy" in some specific areas of governance and whether the constitution grants exclusive power of decision on this issue	Daniel Treisman, Decentralization Dataset, 2008
Tiers	Number of vertical tiers of government	Daniel Treisman, Decentralization Dataset, 2008
Tax burden	Tax revenue (% of GDP)	World Development Indicators, World Bank
Corporate tax rate	Highest *marginal corporate tax rate*	OECD

Chapter 3

Why are some Spanish regions more resilient than others?

3.1 Introduction

Resilience is a relatively new term in economics. Although the concept has been used for some time in the physical, engineering and ecological sciences, it has only very recently attracted attention from regional analysts, spatial economists and economic geographers and has grown in popularity since the last international economic crisis. Reggiani et al. (2002) argued that the notion of “resilience” should be a key factor in the exploration of spatial economic dynamics; especially in as far as it determines how well such systems respond to shocks, disturbances and perturbations. In broad terms, the basic idea is that different degrees of resilience explain variation in economic growth trends across the regions of a country (Fingleton et al., 2012; Martin, 2012).

Although there is no universally-shared definition of regional economic resilience, there are three main ways of interpreting the concept: engineering resilience, ecological resilience, and adaptive resilience. Probably the most frequently invoked meaning or definition is that of so-called “*engineering resilience*”, which focuses on the system’s resistance to disturbances (shocks) and its speed of return to the pre-shock state. Many discussions assume the system to be in “equilibrium” prior to the shock, and define resilience in terms of stability around the equilibrium point, or steady state (e.g. Holling, 1973; Pimm, 1984; Walker et al., 2004). “Engineering” resilience could therefore be defined as the ability of a system to return to its assumed point of equilibrium or recover its configuration following a shock or disturbance. It focuses on resistance to shocks and stability around equilibrium. The field of ecology, however, has provided a second perspective, known as “*ecological resilience*”, which focuses on the role of shocks or disturbances in pushing a system beyond its “elasticity threshold” to a new domain. In this case, resilience is measured by the magnitude of disturbance or shock that can be absorbed before the system changes form, function, or position (Holling, 1973). According to this definition, systems are characterised by multiple stability domains, and, if a shock pushes a system beyond the "elasticity threshold" for its existing domain or state, it may move to a different domain or state. Finally, "adaptive resilience" is defined as the ability of a system to undergo anticipatory or reactionary reorganisation of form and/or function so as to minimise the impact of a destabilizing shock (Martin, 2012).

These different interpretations of resilience suggest, therefore, that this concept encompasses four interrelated dimensions: resistance, recovery, re-orientation and renewal (Martin, 2012). Resistance is the vulnerability or sensitivity of a regional economy to disturbances and disruptions, such as recessions. Recovery refers to the speed and degree of recovery from such a disruption. Re-orientation concerns the extent to which the regional economy undergoes structural re-orientation and the resulting implications for jobs and incomes. Renewal is the degree of renewal or resumption of the growth path that characterised the regional economy prior to the shock. These different aspects of regional economic resilience may clearly interact in different ways and lead to different outcomes.

Given our interest in analysing regional characteristics that might influence regional resilience, we begin by constructing a composite index of resilience for the 17 regions of Spain over the period 1980 to 2015, using the DEA approach. In addition to this characterisation, a further objective of this study is to compare our resilience indicator with those formulated by Martin (2012) and used in most studies on resilience (Sánchez, 2012; Di Caro, 2014, Lagravinese, 2014). Thus, we aim to determine whether our indicator performs the same as those of Martin (2012) by observing whether regional resilience scores vary according to which indicator is used to evaluate them. Multiple Factor Analysis (MFA) is used to characterise regions by their resilience. This is a novel use of this methodology in papers of this kind, and one which allows the simultaneous analysis of groups of different partial indicators measured at different points in time.

We study the case of the Spanish regions because, in our view, they present an interesting example of regional differences in terms of GDP or employment, for example, during times of crisis. The most densely populated regions, i.e. Cataluña, Andalucía, Madrid and Valencia, determine the overall pattern. At the same time, numerous regions, such as Galicia and Asturias, are unable to maintain the pace set by this more dynamic group. Moreover, last economic crisis left Spain among the countries hardest hit by rising unemployment. According to Cuadrado-Roura and Maroto (2015), the recent economic and financial crisis had a significant and particularly adverse impact on Spain, heavily affecting all regions, albeit with notable differences. The aim of this article, therefore, is to analyse the resilience patterns of Spanish regions, focusing on production specialisation and public, human and social capital as explanatory factors.

The chapter is structured as follows. Section two offers a review of the literature on resilience. Section three describes the methodology and results of the composite index of resilience and MFA. Section four provides the main conclusions.

3.2 Review of literature

Most studies have focused on how different factors have impinged on the different levels of adaptability and resilience shown by regions of Europe. Martin (2012), for example, compares three British crises (1979-1983; 1990-1993; 2008-2010), underlining the importance of local economic structures in regional resilience. His analysis is confined to movements in employment rather than output. Employment tends to take much longer than output to recover from a recession, and is thus arguably the more critical variable, since a major decline in employment in a region or area can have profound consequences for the local labour market. A regional or local economy may resume output growth following a recession without achieving a similar recovery in employment, thereby creating major problems of adjustment for the local unemployed population. The extent and manner in which regional employment rebounds following a recession is thus arguably more insightful as an indicator of regional economic resilience.

Focusing on European regions at the NUTS 2 level, Brakman et al. (2014) analyse the relevance of two possible determinants of regional resilience to shocks: the degree of urbanisation and specialisation. They take the Great Recession, the economic and financial crisis that began in 2008, as their shock and explore how the resilience of EU NUTS 2 regions varies with the unemployment rate and real per capita GDP. Their findings show that EU regions with a relatively large share of the population living in commuting areas, in combination with specialisation in medium high-tech industries, are relatively resilient, that is, less affected by the crisis. This result suggests a link with international trade.

In examining the resilience of Spanish regions, Sánchez et al. (2014) try to identify the factors behind regional resilience in rural areas of Andalucía for two time periods (2000-2008 and 2008-2012). Their two-period design enables them to use DEA to identify areas with changes in their resilience patterns and determine the impact of a wide range of regional factors. Their results show the agricultural sector as one of the best at resisting the impact of a crisis. Rural areas with more diversified economic and productive activities, held up mainly by the building sector, performed best during the economic boom.

Meanwhile, Rosell et al. (2011) seek to determine the impact of different factors on the degree of resilience of the Catalan territories during the last crisis. Their results indicate that business density, sectoral specialisation, the percentage of foreign population, and rurality impact on the resilience levels of these territories. Finally, Marrades (2011) assesses regional resilience for Spanish regions using a composite indicator. His point is that focusing on employment changes may be the best option for understanding how regions become resilient to exogenous shocks. As far as the resistance and recovery dimensions of resilience are concerned, a focus on employment is justified by the fact that it is less elastic than output when a crisis occurs. The results obtained by Marrades show the top scorers in the 1979 recession to have been Rioja, Navarra, Murcia, Galicia, Baleares, and Extremadura; and the top five in the 1991 recession to have been Rioja, Navarra, Madrid, Canarias and Baleares.

Regional resilience to economic shocks is the result of two combined factors: regional shock-resistance and subsequent 'recovery' capabilities (Lagravinese, 2014; Martin, 2012). The resilience of the various regions will vary according to their characteristics. Martin and Sunley (2014) identify three main sets of factors: contextual, compositional and collective. Contextual factors refer to how local and regional agents are embedded within and affected by wider-scale national-level institutions and policies, and even international networks and the global division of labour. Compositional factors make reference to the sectoral/industrial structure of local and regional economies. Collective factors include the characteristics of and relationships between local economic agents within each regional economy.

The economic literature has identified numerous quantitative features of regional economies that shape their ability to resist and adapt to shocks and change (Crescenzi, 2009; Crescenzi and Rodríguez-Pose, 2011). Two key sub-dimensions influencing regional resistance are the regional industry mix, and a group of regional competitiveness/innovation factors. The regional industry mix, i.e. the sectoral structure of the regional economy, is a key factor in determining regional crisis resistance. 'Conventionally, […] manufacturing and construction industries have been viewed as being more cyclically sensitive than private service industries, and the latter more sensitive than public sector services, which are often assumed to be largely immune to economic recessions' (Martin, 2012: 13). Regional sensitivity is the result of the combination of these sectoral sensitivities 'weighted' by the shares of these sectors in the regional economy, influencing the adjustment of the regional economy, its output and employment to cyclical shocks.

Regional specialisation has also played a decisive part in how regions across Europe have weathered the crisis. Possibly most of the impact was felt by the building sector. Spanish coastal areas, which had thrived during the economic boom years thanks to the construction and sale of second homes, are a clear example of the construction-led bust. Construction was among the first and hardest hit sectors with value-added for this sector falling between 6 and 20% -and employment between 10 and 20%-especially in countries such as Ireland, Latvia, Estonia, Portugal, Greece and Spain, all of which had experienced property bubbles during the pre-crisis period. Industry as a whole also declined by more than 2% across the EU between 2007 and 2011. Behind this average, however, lie declines of more than 5% in the seven member states most severely affected by the crisis.

Industrial variety spreads risks across a region and can better accommodate idiosyncratic, sector-specific shocks (Dissart, 2003; Essletzbichler, 2007; Davies and Tonts, 2010; Desrochers and Leppala, 2011). Regional variety in skills-based industries is expected to enable speedier recovery from sector-specific shocks, as it is easier for redundant employees to find new jobs in a region with skills-based industries in which their skills are still found relevant (Diodato and Weterings, 2014). As well as preventing the destruction of regional human capital, this stems the outflow of highly-skilled workers to other regions. Specialised regions have few potential sources of renewal and diversification and their ability to diversify along new growth paths might be hampered by their specialised industrial structure (Boschma and Lambooy, 1999; Hassink, 2005; Martin and Sunley, 2006).

Another subset of regional factors likely to shape the ability to react to external shocks has to do with the determinants of regional competitiveness. The accumulation of human capital and the allocation of (public and/or private) resources to R&D activities are long-term structural characteristics of regional economies that are slow to adjust. They shape local growth trajectories through two key channels. First, both regional human capital and innovation efforts are crucially linked with the capability of the local economy not only to generate new knowledge but also to absorb new, externally generated ideas and cognitions (Crescenzi, 2009; Crescenzi and Rodríguez-Pose, 2011). Regional human capital is positively and significantly associated with economic performance during the crisis, whereas R&D intensity is negatively linked to short-term economic performance. The existing evidence on the long-term growth and innovation dynamics of the EU regions (Crescenzi and Rodríguez-Pose, 2011; Rodríguez-Pose and Crescenzi, 2008) has shown that local R&D investments have a weak association with regional innovation and growth, while human capital is a stronger predictor of long-term regional growth and innovation. It is human capital endowment that can provide the flexibility and creativity required to respond to negative shocks.

When a country is hit by an economic crisis, flexibility, creativity and innovation are the factors that determine how its regions perform in, for example, the skills level of the workforce. A better-educated workforce facilitates the generation, assimilation and absorption of innovation, as well as short-term adaptation and medium-term adaptability to new challenges (OECD, 2011).

3.3 Methodology and results

3.3.1 Construction of a Composite Index of Resilience

Our first objective of this study is to develop a composite index of resilience. As in previous papers, we consider the best factors to explain a region's response and recovery capacity to be employment and GDP. These two key variables in economic development and public well-being and quality of life, will therefore be used to construct the index.

We will focus on Spanish NUTS 2 regions, using data from the INE (Instituto Nacional de Estadística - National Institute of Statistics) and BD.MORES (Base de datos regionales de la economía española, Ministerio de Hacienda y Administraciones Públicas - the regional economic database of the ministry of the treasury and public administration). The data are GDP at constant market prices and employment figures for the period 1980-2015.

We analyse the trajectory of the Spanish regions from 1980 to 2015 in order to identify their ability to cope with and recover from the impact of successive economic crises during the period analysed. We consider 7 periods of analysis (Table 3.1), as specified by the Spanish Business Cycle Dating Committee (Spanish Economic Association, Universitat Autónoma de Barcelona), who construct an index of economic activity to determine the dates of *peaks* and *troughs* in *economic activity* in Spain. The CF index of economic activity (CF stands for Comité de Fechado, i.e., dating committee) pools data from several sources to extract the latent level of economic activity in real time. Specifically, they include the following economic indicators: Gross Domestic Product or GDP, Industrial Production Index, Employment, Purchasing Managers Index or PMI, Indicator of activity in the services sector, Economic sentiment index or ESI, Consumer confidence index.

The CF index combines information from the list of series detailed above using a dynamic factor model (e.g., Camacho, Pérez-Quirós and Poncela, 2013). The model specification allows for simultaneous quarterly and monthly observations, as well as the interpolation of data as yet unreleased. The dynamic factor model combines all this information to generate a unique latent index of economic activity[12].

Table 3.1: Periods of analysis

Period 1	Recovery	1980-1991
Period 2	Crisis	1992-1993
Period 3	Recovery	1994-2007
Period 4	Crisis	2008-2009
Period 5	Recovery	2010
Period 6	Crisis	2011-2013
Period 7	Recovery	2014-2015

Figure 3.1, shown below, depicts the evolution of GDP and employment for Spain.

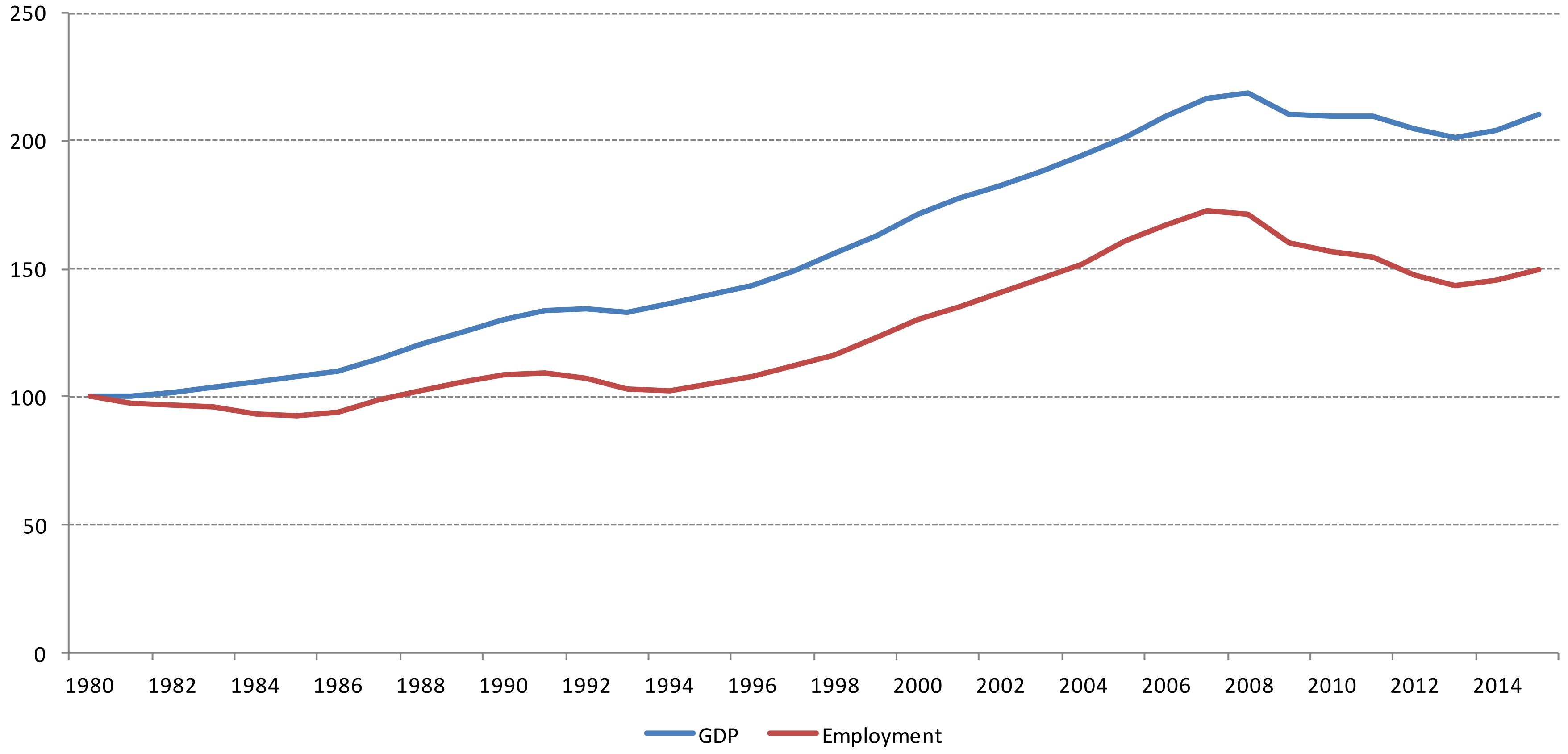
The 1992 recession is the one that perhaps best fits the mold of a typical recession. It is preceded and followed by two relatively lengthy expansions and therefore leaves room for little ambiguity. Economic growth picked up pace around 1986 when Spain joined the European Union. By 1992, a number of factors probably conspired against the momentum of the previous six years. The Gulf war adversely affected oil prices and has to be considered one of the propellants behind the U.S. recession of 1990 to 1991. Meanwhile, in Japan, the property boom went bust, sinking its economy into a seemingly never-ending cycle of deleveraging. A number of countries in Europe would be caught in the exchange rate mechanism (ERM) crisis of 1992, which led several countries, including Spain, into significant currency devaluations.

Since 2008, both the domestic and international economic landscapes have been grim. The recession that started in 2008 was followed by a full blown financial crisis of international proportions. Within the Eurozone, things were further complicated by a sluggishly-evolving institutional structure and a sovereign debt crisis. These factors

[12] For more details, http://asesec.org/CFCweb/en/

hinder the dating of the end of the recession that began in 2008. However, a closer look at the Spanish economic trend during this period reveals some improvement by the end of 2009. The subsequent recovery, while very gradual, was visible in the two largest sectors of the economy: the industrial and services sectors. It can therefore be considered to peak in 2010, the year that marked the start of the second period of recession leading to the trough of 2013.

Figure 3.1: GDP and employment trends (indexes, 1980=100; 1980-2015)



Using GDP and employment data, we apply the methodology used by Martin (2012) to develop an indicator of resistance to a crisis, for employment and for GDP, and an index of recovery from a crisis. The index is the ratio of change in employment or output in a particular region to the corresponding change nationwide. The majority of papers on this topic analyse regional resilience levels based on GDP per capita or employment data, using the Martin index. Such is the case of Sánchez (2012), Lagravinese (2014) or Di Caro (2014).

This paper calculates individual regional GDP and employment growth rates for each sample period (Tables A1 and A2) and uses the results to compute indicators of resistance to the economic crisis and capacity to face the recovery stages.

$$\text{Index Employ}_{rt} = (\Delta E_{rt}/E_{rt}) / (\Delta E_{Nt}/E_{Nt}) \qquad (3.1)$$

where $\Delta E_{rt}/E_{rt}$ is the change in employment for region r in period t, and $\Delta E_{Nt}/E_{Nt}$ is the change in employment in period t for the country as a whole.

$$\text{Index GDP}_{rt} = (\Delta GDP_{rt}/GDP_{rt}) / (\Delta GDP_{Nt}/GDP_{Nt}) \qquad (3.2)$$

where $\Delta GDP_r/GDP_r$ is the change in GDP for region r in period t, and $\Delta GDP_{Nt}/GDP_{Nt}$ is the change in GDP in the period t for the country as a whole.

Given that the indicators are quotients, their interpretation changes according to whether the quotient is positive or negative. They therefore need to be normalised for the sake of uniform interpretation. Normalisation for a positive national growth rate is as follows:

Example: $$C^{*}_{GDPr}(1977-85) = \frac{C_{GDPr(1977-85)} - Min(C_{GDPr(1977-85)})}{Max(C_{GDPr(1977-85)}) - Min(C_{GDPr(1977-85)})}$$

Normalisation for a negative national growth rate is given below:

Example: $$C^{*}_{employ\,r}(1977-85) = 1 - \left(\frac{C_{employ\,r(1977'85)} - Min(C_{employ\,r(1977-85)})}{Max(C_{employ\,r(1977-85)}) - Min(C_{employ\,r(1977-85)})} \right)$$

Thus, normalised indicators take values between 0 and 1 and are interpreted as: the greater the indicator, that is, the closer it is to 1, the greater the level of resilience or recovery capacity. Conversely, the smaller the indicator, that is, the closer it is to zero, the lower the level of resistance or recovery capacity (Tables 2 and 3).

Table 3.2: Crisis indexes

	CRISIS					
	1992-93		2008-09		2011-13	
	C_{GDPr}	$C_{employr}$	C_{GDPr}	$C_{employr}$	C_{GDPr}	$C_{employr}$
Andalucía	0.328	0.000	0.856	0.411	0.510	0.106
Aragón	0.631	0.675	0.753	0.512	0.652	0.253
Asturias	0.000	0.536	0.129	0.520	0.000	0.115
Baleares	0.680	0.851	0.583	0.677	1.000	1.000
Canarias	1.000	0.576	0.559	0.324	0.952	0.365
Cantabria	0.297	1.000	0.645	0.808	0.255	0.168
Castilla y León	0.884	0.941	0.953	0.782	0.303	0.124
Castilla La Mancha	0.282	0.609	0.884	0.553	0.463	0.000
Cataluña	0.520	0.265	0.514	0.256	0.744	0.166
Valencia	0.543	0.340	0.000	0.000	0.545	0.261
Extremadura	0.506	0.548	0.987	0.765	0.635	0.019
Galicia	0.654	0.978	0.537	1.000	0.635	0.147
Madrid	0.635	0.460	1.000	0.870	0.946	0.288
Murcia	0.375	0.911	0.845	0.173	0.732	0.338
Navarra	0.466	0.619	0.350	0.944	0.578	0.158
País Vasco	0.641	0.774	0.020	0.662	0.637	0.059
La Rioja	0.534	0.863	0.327	0.812	0.298	0.188

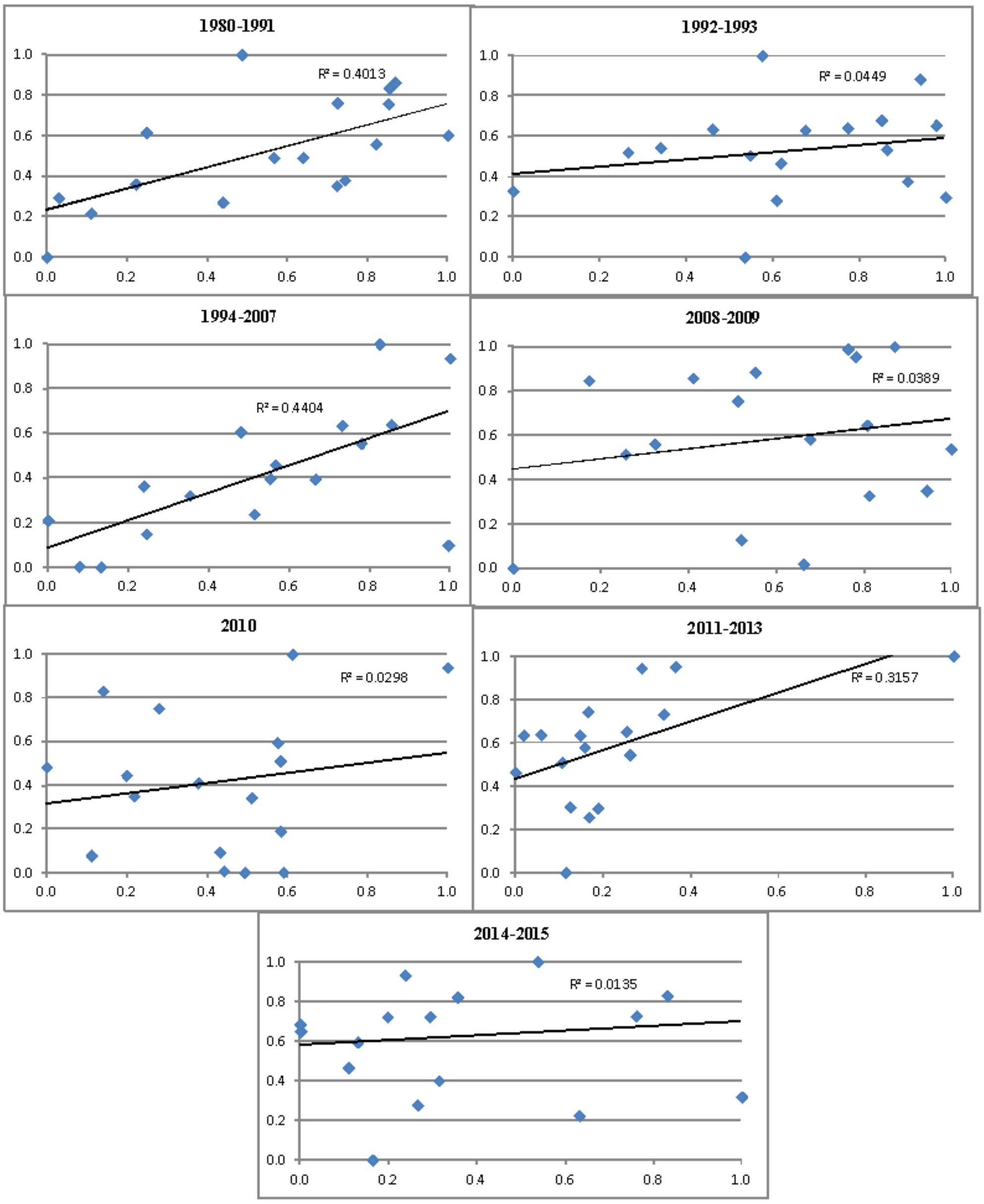
Table 3.3: Recovery indexes

	RECOVERY							
	1980-91		1994-2007		2010		2014-15	
	R_{GDPr}	$R_{employr}$	R_{GDPr}	$R_{employr}$	R_{GDPr}	$R_{employr}$	R_{GDPr}	$R_{employr}$
Andalucía	0.835	0.854	0.554	0.779	0.008	0.442	0.726	0.761
Aragón	0.491	0.565	0.321	0.352	0.832	0.140	0.224	0.632
Asturias	0.000	0.000	0.002	0.078	0.446	0.198	0.650	0.001
Baleares	0.864	0.869	0.099	0.996	0.191	0.583	0.828	0.831
Canarias	0.380	0.743	0.638	0.855	0.410	0.377	0.319	1.000
Cantabria	0.217	0.110	0.238	0.512	0.349	0.218	0.000	0.164
Castilla y León	0.361	0.222	0.000	0.132	0.511	0.582	0.402	0.314
Castilla La Mancha	0.761	0.724	0.458	0.566	0.095	0.432	0.822	0.356
Cataluña	0.558	0.821	0.396	0.552	0.595	0.576	0.932	0.237
Valencia	0.490	0.639	0.636	0.731	0.078	0.111	1.261	0.602
Extremadura	1.000	0.486	0.149	0.245	0.002	0.590	0.595	0.130
Galicia	0.293	0.030	0.210	0.000	0.483	0.000	0.724	0.294
Madrid	0.602	1.000	1.000	0.825	0.343	0.510	1.000	0.538
Murcia	0.755	0.852	0.937	1.000	0.000	0.493	0.684	0.000
Navarra	0.352	0.723	0.606	0.480	1.000	0.613	0.465	0.109
País Vasco	0.270	0.439	0.364	0.238	0.938	1.000	0.720	0.197
La Rioja	0.615	0.248	0.394	0.665	0.751	0.279	0.277	0.265

These indicators could be used to identify each region’s performance on the GDP and employment indicator, but our aim here is to gather the information given by these two indicators into a composite indicator that will measure their resilience in terms both of GDP and employment.

Given the scatter plots obtained (Figure 3.2), we consider both variables to be useful for explaining regional performance patterns, because, although they are positively correlated, there are differences between the two. We therefore use GDP and employment to compute our resilience index.

Figure 3.2: Scatter graphics of Martin's GDP and employment indexes



The composite index of resilience will be obtained via DEA, which has certain advantages for measuring resilience. Firstly, it has potential for dealing with a variety of values and data, which is of considerable value given the multifaceted nature of resilience. Secondly, it provides a method of data standardisation, whereby "decisional units" are ranked from zero to one, according, in this case, to their level of resilience.

DEA can be used to rank regions in terms of their resilience by computing a composite index. This approach provides a scheme of weights for variables defining regional resilience, thus avoiding the use of arbitrary weightings or aggregation based on the personal views of experts. The literature has previously explored the usefulness of DEA for building composite indexes in similar contexts (Reig, 2010; Sánchez et al., 2014).

DEA is a mathematical programming technique designed by Charnes et al. (1978) to calculate different measures of efficiency in production units, or decision-making units (*DMU*) in general. The basic theoretical framework underlying DEA is a production function, in which it is assumed that a set of $k = 1,...,K$ *DMU* make use of a vector of *inputs* $x = (x_1,...x_M)$ to produce a vector of *outputs* $y = (y_{1,...,}y_R)$. In a basic DEA model, the efficiency of DMU_0 is defined by the maximum of a ratio that transforms *inputs* to *outputs* (Reig et al., 2011):

$$Max_{u_{r0}v_{m0}} \frac{\sum_{r=1}^{R} u_{r0} y_{r0}}{\sum_{m=1}^{M} v_{m0} x_{m0}}$$

subject to: (3.3)

$$\frac{\sum_{r=1}^{R} u_{r0} y_{rk}}{\sum_{m=1}^{M} v_{m0} x_{mk}} \leq 1 \qquad k = 1,...,k$$

$$u_{r0} \geq 0 \quad r = 1,...,R$$

$$v_{m0} \geq 0 \quad m = 1,...,M$$

The weights u_{r0} and v_{m0} represent the non-negative weightings applied to *output* y_{r0} and *input* x_{m0}, which are chosen in order to place DMU_0 in the most favourable light, such that they are computed by maximizing its efficiency ratio. Thus, a specific weighting is used for each DMU under evaluation, subject to the constraint that the efficiency ratios computed with these weightings have an upper bound of one. Thus, for the dominance of one DMU_0 over any other DMU_k positive weightings u_{r0} and v_{m0} are required such that

$$\sum_{r=1}^{R} u_{r0} y_{r0} - \sum_{m=1}^{M} v_{m0} x_{m0} \geq \sum_{r=1}^{R} u_{r0} y_{rk} - \sum_{m=1}^{M} v_{m0} x_{mk} \quad \text{for all other } DMU_k \qquad (3.4)$$

After transformation to a linear form, expression (3.3) can also be used to assess the relative resilience performance of a decision-making unit. It can be simplified by assuming a single input (equal to unity) for each unit. A single input produces different intensities of several factors that are relevant to resilience assessment. Thus for each DMU_0 the following model can be computed.

$$Max_{\mu_{r0}} h_0 = \sum_{r=1}^{R} \mu_{r0} I_{r0}$$

subject to: (3.5)

$$\sum_{r=1}^{R} \mu_{r0} I_{rk} \leq 1 \qquad k = 1, \ldots, K$$

$$\mu_{r0} \geq 0 \qquad r = 1, \ldots, R$$

where h_0 is the technical efficiency (here, resilience) score for DMU_0; μ_{r0} is the weighting attached to indicator r in the resilience assessment of DMU_0; I_{rk} represents the value of indicator r for DMU_k. The objective function involves finding the maximum value of a composite index derived from a set of indicators associated with different stages of resilience change processes.

Table 3.4 gives the resilience indexes of 17 Spanish regions for the various crisis and recovery periods considered. The most resilient regions in the first crisis are seen to be Canarias, Cantabria, Castilla y León and Galicia. In the crisis of 2008-09, Galicia is again the most resilient region along with Madrid; and in the last crisis, the regions that emerge as the most resistant are Baleares, Canarias and Madrid. In the recovery stages, Baleares, Extremadura and Madrid are the most resilient between 1980 and 1991, and Navarra and País Vasco in 2010. In the last stage, 2014-15, the islands and Valencia lead the resilience ranking. The islands and Madrid therefore emerge as the most resilient regions for the majority of the sample periods.

Table 3.4: Resilience index (1980-2015)

	Crisis			Recovery			
	1992-93	2008-09	2011-13	1980-91	1994-2007	2010	2014-15
Andalucía	0.328	0.856	0.510	0.977	0.779	0.442	0.906
Aragón	0.717	0.753	0.652	0.623	0.352	0.832	0.639
Asturias	0.536	0.520	0.115	0.000	0.078	0.446	0.515
Baleares	0.887	0.731	**1.000**	**1.000**	0.996	0.583	**1.000**
Canarias	**1.000**	0.559	0.952	0.743	0.855	0.428	**1.000**
Cantabria	**1.000**	0.860	0.255	0.218	0.512	0.350	0.164
Castilla y León	**1.000**	0.953	0.303	0.375	0.132	0.582	0.415
Castilla La Mancha	0.615	0.884	0.463	0.868	0.566	0.432	0.652
Cataluña	0.520	0.514	0.744	0.846	0.552	0.626	0.739
Valencia	0.550	0.000	0.545	0.679	0.731	0.111	**1.000**
Extremadura	0.581	0.987	0.635	**1.000**	0.245	0.590	0.472
Galicia	**1.000**	**1.000**	0.635	0.293	0.210	0.483	0.574
Madrid	0.660	**1.000**	0.946	**1.000**	**1.000**	0.510	0.841
Murcia	0.917	0.845	0.732	0.945	**1.000**	0.493	0.542
Navarra	0.641	0.944	0.578	0.723	0.606	**1.000**	0.369
País Vasco	0.810	0.662	0.637	0.441	0.364	**1.000**	0.571
La Rioja	0.880	0.812	0.298	0.615	0.665	0.751	0.324

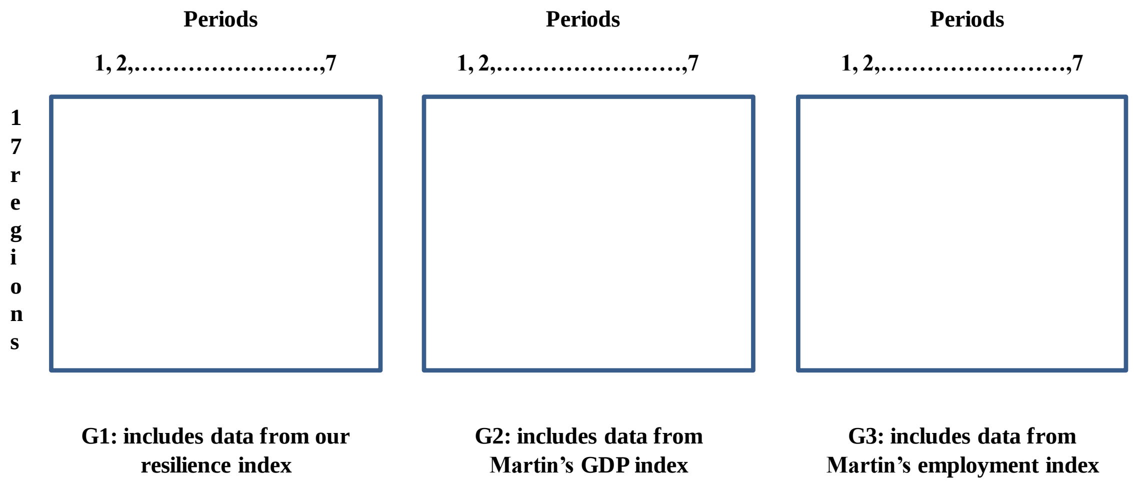
3.3.2 Multiple Factor Analysis

The MFA method has been used to study the evolution of latent economic variables, such as welfare, development or, as in this case, resilience. This method enables the analysis of groups of different indicators measured at different points in time. It is possible, therefore, to include qualitative changes in the latent variable by selecting the most suitable indicators for each point in time. This multivariate exploratory method permits us to study the resilience of the Spanish regions from an essentially graphic perspective. The decision to study numerical data using graphic representations is supported by the psychology of human information processing, which could be summarised as follows: *perception in graphics optimises the capacity of our information processing system*, (Batista and Martínez, 1989). This method enables us to synthesise and analyse the large amount of information we need to handle.

The MFA, developed by Escofier and Pagés (1992, 1994), is a factorial method adapted to the treatment of data tables in which the same set of individuals is described through several groups of variables. The groups can be combinations of several quantitative or qualitative variables, tables of variables derived from other three-dimensional tables, or the same set of variables measured over different time periods. The organisation of original data into groups of variables enriches their study, because the pursued goals are not restricted to obtaining a typology of individuals defined by a set of variables; they extend to the search for possible relationships between the structures obtained within each group. The variables of a group measured on a set of individuals form a two-dimensional table.

This study works with 3 tables, one for each resilience index considered (our own, Martin's GDP index and Martin's employment index) and each table contains 17 rows, one for each region, and 7 columns, one for each period of analysis (3 crisis periods and 4 recovery periods). We construct the global table by juxtaposing these 3 (Figure 3.3).

Figure 3.3: Tables used in the analysis



The aim of the analysis is to reveal the main factors of maximum variability described, in a balanced manner, by the various groups of variables. The MFA technique is based on Principal Component Analysis (PCA) and comprises two phases. In the first, each group of variables or table is analysed separately by PCA. The second phase involves the analysis of the global table, where each table has been weighted by the inverse of the first eigenvalue of its individual PCA from the first phase. This weighting scheme balances the loadings of the various groups on the first factor extracted. Being a complete factorial analysis, the MFA shows the classic results of PCA. In the analysis of categorical tables, MFA shows the results of Multiple Correspondence Analysis (MCA).

The objective of MFA is to check for the presence of structures that are common to groups of variables (tables). It also provides an overall picture of the relationships between groups, based on Escofier's RV coefficient (Escofier and Pagés, 1992; 1994), which is obtained from the coefficients of linear correlation between any two variables. Its value is between 0 (for no relationship between variables of the two groups considered) and 1 (clouds representing the groups are homothetic). The RV coefficients enable quantification of the global similarity between groups of indicators.

For the factor scores of the individuals (or cases); MFA provides two different results; namely, partial and global points (individuals).

By **partial point**, we mean the factor score of an individual based on the values of only one group of variables. Thus, in this study there will be 3 partial individuals for each Spanish region, G1, which reflects only the values of our own resilience indicator; G2, which reflects the values of Martin's GDP indicator; and G3, which reflects the values of Martin's employment indicator.

Individuals whose partial points are close to one another are exhibiting low internal variability and reflecting the previously-detected common structure between tables. Individuals whose partial points are more distant from each other, meanwhile, are exhibiting high internal variability and therefore constitute exceptions to the common structure. In our case, regions whose partial points are close will perform similarly on all three indexes. Those with more distant partial points, on the other hand, will perform differently on at least one of the three resilience indexes.

The **global or mean points** of each region refer to the factor score of an individual considering every value of every variable in every group. A global point is the barycenter or mean of its respective partial points, and therefore offers a more synthetic picture of an individual. In our study, the global points reflect the resilience of the regions according to all three indexes jointly.

The possibility of plotting partial and global points simultaneously on the same factorial plane provides a powerful visual instrument for the comparison of regional resilience from multiple points of view. A full description of this method is given in Lebart et al. (1995) and Escofier and Pagés (1992). Several applications of MFA to trend data can be found in García Lautre and Abascal (2003); García Lautre (2001), Abascal, García Lautre and Landaluce (2004).

MFA offers the possibility of including illustrative or supplementary elements (individuals or variables) as in any exploratory factor analysis. The supplementary variables are included in new groups or tables. These elements do not play an active role in the factor structure but can be projected onto the factorial planes, thereby enriching their interpretation. Supplementary variables contain information that is relevant but cannot be considered to directly affect the issue at hand. Examples of this type of variable in the case that concerns are regional endowments of public or human capital in each period.

The supplementary variables that will characterise the Spanish regions are those detailed below. A review of relevant literature was undertaken to aid identification of such variables. They can be classified into 2 groups: value of capital and production structure.

In the following table (Table 3.5) we can see the descriptive statistics of employed variables.

Table 3.5: Descriptive statistics

	Units	N	Minimum	Maximum	Mean	Stand. Deviation	Source
GDP	Thousands of €	629	3,554,855.00	200,807,804.00	45,973,769.82	45,893,738.18	BD. Mores and INE
Employment	Thousands of people	629	78.20	3,581.35	872.79	796.33	BD. Mores and INE
Value of capital							
Social capital per capita	Index	510	37.48	1,989.18	375.69	362.83	Fundación BBVA e Ivie
Public capital per capita	Thousands of €	510	2.88	19.00	9.29	3.84	Fundación BBVA e Ivie
Illiterates and uneducated	%	527	19.09	80.16	47.60	14.89	INE
High school graduates	%	527	15.13	49.64	331.63	7.14	INE
Vocational training graduates	%	527	0.58	24.74	9.51	5.13	INE
University graduates	%	527	3.72	28.91	11.25	4.66	INE
Value of human capital	%	527	2.13	3.20	2.58	0.22	INE
Productive structure							
Agriculture	%	561	0.12	15.24	5.43	3.70	INE
Industry	%	561	5.31	34.82	20.22	7.31	INE
Construction	%	561	4.37	14.56	8.44	1.87	INE
Market services	%	561	36.84	73.27	50.27	8.31	INE
Non-market services	%	561	7.76	28.08	15.69	3.40	INE
Productive specialization	%	561	0.24	0.56	0.34	0.07	INE

Value of capital

To analyze the effects of capital on resilience, we focus on three types of capital: public, human and social.

Public capital is given by the variable public capital per capita in thousands of Euros at constant 2008 prices. The data were supplied by the Fundación BBVA and Ivie (Instituto Valenciano de Investigaciones Económicas). The role of the public sector investor is crucial in the economic growth of all countries. A country's level of infrastructure (in transport, water supply and sanitation, urban, health, education, etc.) depends on public sector investment activity, which, if misdirected or insufficient, can constrain both private enterprise and public services. The share of public capital stock employed in private production makes these infrastructures a key factor in the economic growth of every country or region. Public investment also plays an important role in the economic cycle, especially in the economic policy debate arising from the current recession, because it can be used as a stabilisation mechanism to offset declining private investment. The importance of long-term results is discussed, as are the short term effects, which can also be counterproductive, by driving out private investment (the crowding out effect). Thus, it is of great interest to study the evolution of public investment and how it has affected economic growth. Our analysis therefore includes a public capital variable to study its possible influence on regional resilience (Gil et al., 2003; Ezcurra et al., 2005).

Several different variables are taken in relation to **human capital**. Specifically, employed population by level of education and region (expressed in %): and shares of illiterates and uneducated, high school graduates, vocational training graduates and university graduates. These data are taken from the Labour Force Survey of INE. Another variable taken to determine the value of human capital is the value of per capita human capital measured in terms of the number of workers without human capital that would be required to attain an equivalent level of productivity. At the same time, the aggregate human capital of a region will be the number of workers without human capital required to attain the productivity capacity of the population. The data were accessed from the Fundación Bancaja e Ivie (Instituto Valenciano de Investigaciones Económicas)[13].

Some authors (Glaeser and Saiz, 2004) claim that qualifications can increase resilience and economic growth, because "workers with college degrees and higher educational qualifications are more flexible and agile in an economic downturn" (Christopher et al., 2010). The overall view (Chapple and Lester, 2010; Sheffi, 2005, among others) is that highly skilled workers strengthen regional resilience. The quality of human capital also affects regional growth (Crescenzi et al., 2015). Wide regional gaps in human capital endowment also have repercussions in terms of infrastructure, services, and thereby income inequalities (Lagravinese, 2014).

The value of **social capital** is given by the variable social capital per capita. These data were accessed from the Fundación BBVA and Ivie (Instituto Valenciano de Investigaciones Económicas). Many papers consider social capital as an intangible asset which facilitates the achievement of personal and group results, both economic and social, by generating positive externalities or potential benefits for members of a

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[13] Capital Humano en España y su distribución provincial. Enero de 2013. Database available at: http://www.ivie.es/es/banco/caphum/series.php

particular social group[14]. These benefits derive from mutual trust, and shared rules and beliefs concerning the expectations and behaviour of group members. Paxton (1999) highlights that a relevant characteristic of social capital – which makes it something more than trust, rules and shared values – is that its positive effects are generated from a social network. Thus, the scope of the network that makes up the group and benefits from these effects on its members is a key aspect of social capital. It should be noted that the size of the network can vary greatly, sometimes being limited to the closest circle but potentially reaching the whole of society and including all its members. To calculate social capital one needs to model the investment it involves and make assumptions concerning what moves individuals when determining their optimal investment (Glaeser et al., 2002), including their estimations of the expected future profitability and costs associated with their investment. Social capital data have been used in various analyses (Pastor and Tortosa 2008; Peiró and Tortosa 2015; Salas and Sanchez 2012; Barrutia and Echebarria 2010; Boix and Galletto 2009; Gleave, Petrey and Carroll 2012; Manca 2011, 2012; Miguélez, Moreno and Artís 2008, among others) of the relationship between social capital and economic performance, many studies having confirmed its importance.

Production structure

Regional production structure is a key factor in explaining a region's capacity to recover from a crisis, that is, regional resilience (Crescenzi et al., 2015). A region's resilience may be explained by industrial sector performance and specific industrial activities during and after a recessionary event. The role of the manufacturing sector in explaining regional economic growth and convergence across areas depends on its ability to sustain higher investments, and its capacity for capital accumulation and the production of tradable goods (Porter, 2003; Rodrik, 2013). The business cycle literature has long studied the close relationship between shocks affecting industrial employment and aggregate employment fluctuations and the role of industry in national and regional

[14] Molina et al. (2008, 17-22) provides a review of the concept of social capital.

economic growth during booms and busts (Garcia-Mila and McGuire, 1993).

Furthermore, certain economic sectors are known to be more subject to cyclical economic fluctuations than others and as such suffer the most from economic downturns (Conroy, 1975; Siegel et al., 1995; Ormerod, 2010). The manufacturing and construction industries typically appear to suffer more during an economic crisis than does the services sector, which is more flexible and able to absorb and renew itself more rapidly. The presence of a significant number of public employees, moreover, enhances resilience to economic shocks, and can almost fully absorb the effects of a recession. The geographical distribution of these activities across regions might therefore be expected to play a role in explaining spatial differences in resistance to recessionary shocks (Martin, 2012).

Thus, besides including the production structure of each region, we also include a variable for productive specialisation, *SI,* which is calculated from a specialisation index based on the Herfindahl concentration index:

$$SI = \sum_{i=1}^{N} s_i^{\,2}$$

where s_i is the share of the i^{th} activity in total activities. The index is the sum of the squared shares of each of the n economic activities in total economic activities. We calculate the productive specialisation index from the share of each activity (GDP of each activity) in total productive activity (total GDP of the economy). The i^{th} activities included in the index are agriculture, construction, industry, market services and non-market services. The index has a theoretical range of close to zero to 1, with higher values indicating higher specialisation. Regional specialisation in a specific sector can often be an advantage during periods of economic growth, but can also become a disadvantage in a time of crisis.

3.3.2.1 MFA of resilience in the Spanish regions[15]

The complete data for the 17 Spanish regions comprises 3 different resilience indicators measured over seven consecutive periods (Figure 3.3) and 13 supplementary variables. This section examines all this information simultaneously by MFA to explore three issues: firstly, a comparison of the three resilience indicators; secondly, the structure of relationships between the resilience indicators, including the time effect (seven periods) and the supplementary variables; and, finally, a characterisation of the regions in terms of their resilience and of the socioeconomic features represented by the supplementary variables.

The MFA of the three resilience tables (Figure 3.3) provided the first two factors which, together, account for over 50% (the first 36.99% and the second 17.10%) of the total variance in the table. This is considered sufficient to enable us to project the variables (the supplementary ones included) and individuals onto planes formed by factor 1 (horizontal axis) and factor 2 (vertical axis) as shown in Figures 4, 5 and 6. These graphs make it possible to analyse the three issues mentioned above. It may be worth briefly recalling some basics of how to interpret them. In such graphs, the factorial coordinate of each variable is connected to the origin of coordinates by an arrow. Two points that are close together on the graph mean that the arrows are separated by an angle close to zero degrees, so the two variables are sure to be positively correlated. If the angle is close to 180 degrees, then the correlation is negative and if it is close to 90 degrees, the correlation is close to zero. In addition, the value of the coordinate of one point is the linear correlation of the variable with the corresponding factor. Variables that are close to a factor have strong (positive or negative) correlation with that factor and very weak correlation with the other factor.

Comparative analysis of the three resilience measurement methods is conducted using the RV coefficients (Table 3.6) and the variables graph (Figure 3.4). The RV values indicate the existence of a common structure between the 3 tables, which is stronger between our resilience index and the remaining two.

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[15] The appendix gives the MFA for other crisis and recovery periods according to Sánchez (2012).

Table 3.6: RV relation coefficients between indexes

	Our resilience index	Martin's GDP index	Martin's employment index
Our resilience index	1.000		
Martin's GDP index	0.718	1.000	
Martin's employment index	0.803	0.458	1.000

The detected common structure is supported by the fact that the resilience indicators point roughly in the same direction for each period. Thus, the three resilience indicators for recovery periods 1, 2, 4 and crisis period 3 point to the left in the variable graph (Figure 3.4) and the indicators for crisis periods 1 and 2 and recovery period 3 point to the top right of the graph. It should be noted that the GDP resilience indicators in crisis periods 1 and 2 are quite far from the two remaining indicators (composite and employment). Moreover, the three indicators for recovery period 3 are also separate from each other. This shows that the common structure between the 3 tables is less obvious; suggesting that, in these periods, the three methods will yield clearly distinct resilience scores for the Spanish regions.

The second issue, the analysis of the structure of relationships between the resilience indicators and the supplementary variables, is addressed by again giving meaning to the two factors by using the variables graph (Figure 3.4). The supplementary variables relating to the socioeconomic characteristics of the regions are projected onto the variables graph (Figure 3.4, variables in black). These variables are the means for the time period considered (1980-2015). Means were used because a detailed analysis of their evolution has confirmed their stability and high correlation over time. This enables a simpler analysis with no need to enter each of the 13 variables for each of the 7 periods considered.

According to the factorial plane (Figure 3.4), factor 1 (horizontal axis) mainly reflects resilience in recovery periods 1, 2 and 4 and crisis period 3, since these indicators point to the left, showing their strong negative correlation with this factor. The supplementary variables public capital, share of industry in the economy and, less clearly, vocational training and human capital, point to the right on the plane, showing these variables to be positively correlated with factor 1. High school graduates, market services and productive specialisation, on the other hand, point to the left, and are therefore negatively correlated with it. Finally, social capital points slightly to the left, showing a certain negative correlation with factor 1.

In consequence, regions with negative factor scores on factor 1 are more resilient than the mean in recovery periods 1, 2, 4 and in crisis period 3. The graphs show these regions to be characterised as above average in terms of share of high school graduates and market services and below-average in terms of public capital and share of industry in the economy. They also appear, albeit more modestly, to be above average in terms of social capital. The opposite applies to those regions with positive scores on factor 1. We could therefore say that the most resilient regions in the recovery periods (1, 2 and 4) are those that stand out for their specialisation in market services and for their share of population with a high school education. In contrast, the industry share in their economies is barely significant.

Factor 2 (vertical axis) mainly reflects the resilience in crisis periods 1 and 2 and recovery period 3, since these indicators clearly point upwards, and are therefore strongly positively correlated with it. The supplementary variables are not closely correlated with factor 2, since none of them points clearly upwards or downwards on the plane (Figure 3.4). Only university graduates, human capital and vocational training graduates show a slight positive correlation with factor 2, while construction and percentage of uneducated are slightly negatively correlated with it.

Thus, regions with positive factor scores on factor 2 are more resilient than the mean in crisis periods 1 and 2 and recovery period 3. The graphs depict these regions as being above the mean in higher studies, human capital and vocational training and below the mean in construction and without studies. The opposite can be said for those regions with positive scores on factor 2.

Those regions with high scores on both factors can be said to be characterised by opposing correlations between their component variables. For instance, regions that have positive scores on both factors (lying in quadrant IV) are above the mean for resilience in crisis periods 1,2 and recovery period 3 and below the mean in recovery period 4 and vice versa. It is remarkable that this opposition reflects a resilience trend already pointed out in section 3.3.2. The characterisation of the regions lying towards the centre of the quadrants, far from the origin of coordinates is very enriching, as explained in the following lines.

All the interpretations of the variables graph (Figure 3.4) are supported by the correlation matrix of resilience indicators and supplementary variables (Table A3.4). Indeed, although some correlation coefficients are not very high, they confirm what was said above.

Now that the factors have a meaning, we are ready to address the final issue, the characterisation of the regions in terms of their resilience and the socioeconomic features represented by the supplementary variables.

To do this, each Spanish region is projected on the factorial plane 1-2 taking all the information relating to its resilience, that is, the global points of MFA are obtained (Figure 3.5). For the sake of brevity, the positions of only a few regions are commented on.

According to the interpretation of Figure 3.5, the regions in quadrant IV on the plane appear to be above average in terms of resilience in crisis periods 1 and 2 and recovery period 3 and below average in recovery period 4. A look at Tables 3.2 and 3.3, which give the indicators of resilience, shows that Castilla y León, Galicia and Cantabria are more resilient in crisis periods 1 and 2. Navarra and País Vasco, which are also in quadrant IV, are the most resilient in recovery period 3 (2010). These results coincide with those of Cuadrado-Roura and Maroto (2016) who observed that the regions on the River Ebro (País Vasco, La Rioja and Navarra, Aragón) experienced above-average growth after 2007, and all these regions are situated in the same quadrant (IV). A look at Table 3.4 shows that these regions are, in general, very poorly positioned in period 4, thus fulfilling the opposition effect mentioned above. Quadrant II contains Valencia, a region whose characteristics are completely opposite to those of the regions just mentioned. As expected, Valencia is the most resilient region in period 4 and is poorly positioned in crisis periods 1 and 2 and in recovery period 3.

Quadrant III, which represents recovery periods 1, 2 and 4, and crisis 3, can be seen to contain the regions of Baleares and Canarias, Madrid and Murcia, which are the best performers in terms of resilience in these periods. The most resilient regions in recovery periods 1 and 2, Baleares, Madrid and Murcia, stand out for having above-average industry specialisation and, in particular, economies concentrated mainly on market services (chiefly tourism), as can be seen in Figure 3.4. They also stand out for having an above-average percentage of high school graduates. According to Maroto (2012), the effects of a crisis can differ substantially across industries. The manufacturing, mining, energy and construction sectors, for instance, tend to be much more badly affected by business cycles than is the case for services sectors. This is reflected in the performances of Baleares and Madrid, whose specialisation is the services sector. The same quadrant (III) contains the regions that show most resilience in crisis 3, namely, Baleares, Madrid and Canarias.

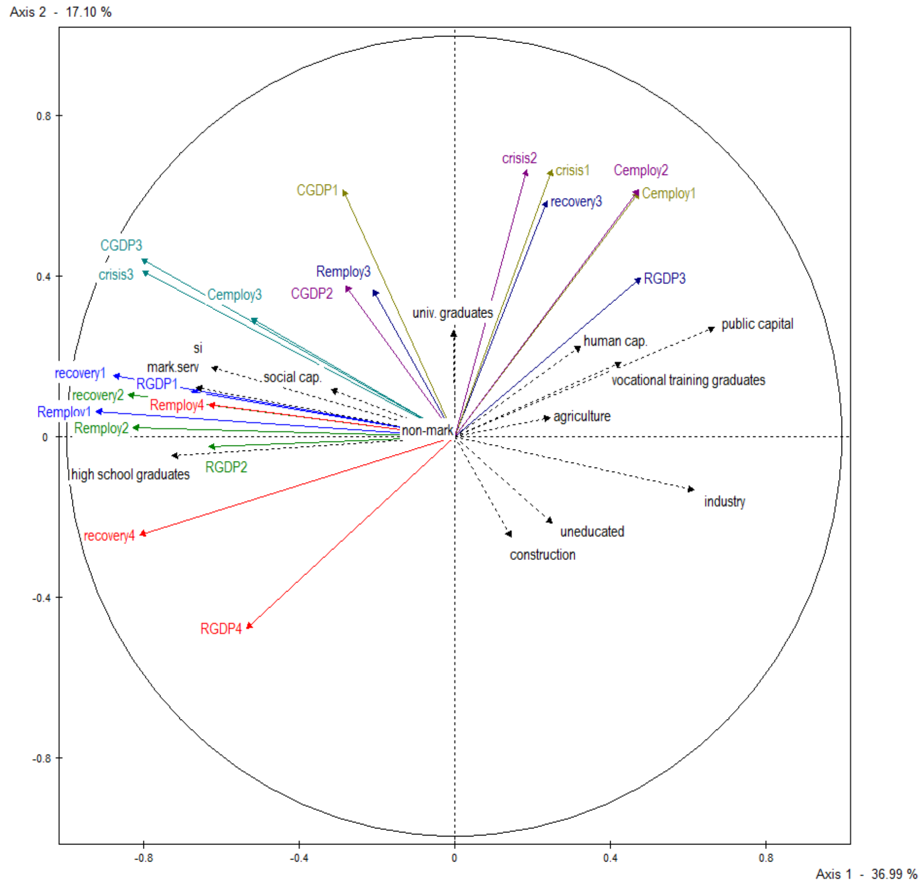
And finally, in quadrant I, we find Asturias, which is below the mean for resilience in all periods, especially crisis period 3. The supplementary variables on which Asturias scores above the mean are construction, percentage of uneducated and industry.

So, as can be seen from the results, different productive and regional specialisation patterns produce different levels of resilience in the Spanish regions. The conclusion drawn by most studies is that the analysis of industry structures, regional specialisation and gaps with the national average can explain regional economic growth and, of course, possible regional convergence or divergence within a country in terms of productivity and per capita income. Thus, regions with a relatively high share of industries with above-average sensitivity to the business cycle can, ceteris paribus, be expected to be significantly affected by a recession (De Groot et al., 2011).

Bristow (2010) suggested that the most resilient regions were already specialised in more dynamic, less sensitive sectors. These resilient regions have, moreover, steadily maintained their specialisation patterns, and reinforced their competitive advantages during and after the crisis.

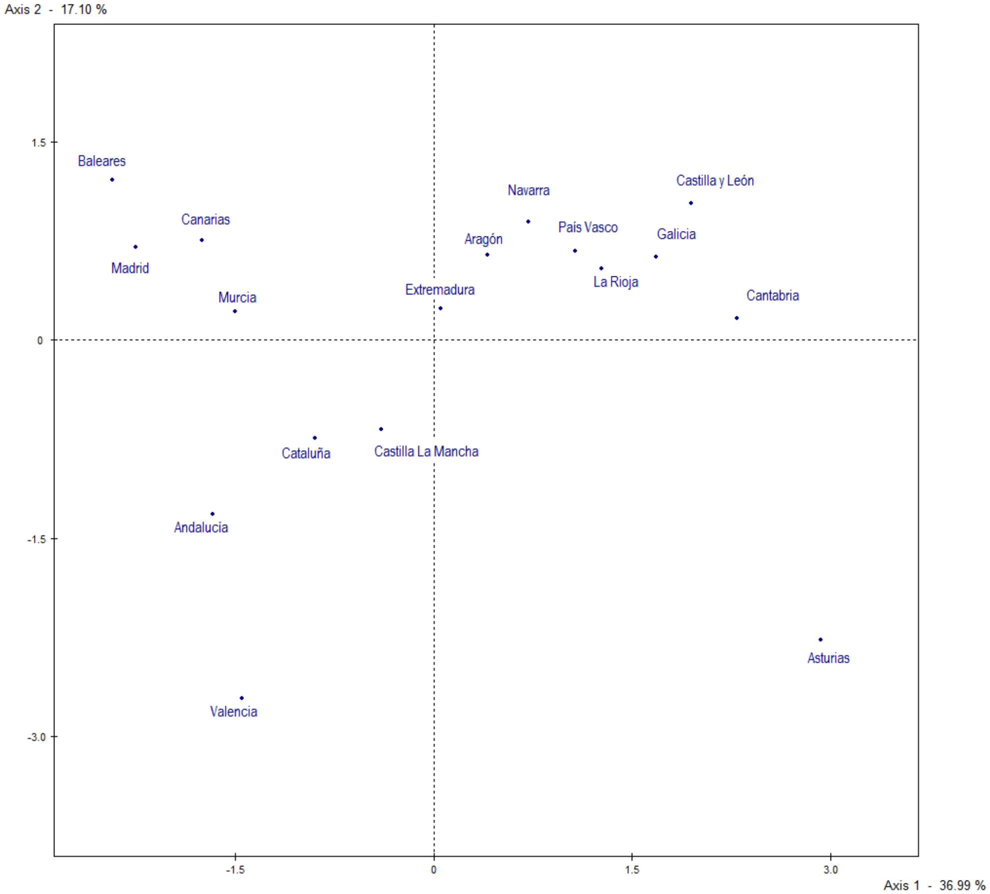
The various crisis periods in Spain and the policies used to address them have had a clear impact at the regional level. One of the most remarkable effects has been the increase in regional economic disparities (Cuadrado and Maroto, 2016). In consequence, there is a small group of regions that can be considered economically resilient, as they have responded better and more flexibly to the general negative framework, versus another group of regions that have been heavily hit by the crisis and have shown no clear capacity to react.

Figure 3.4: Variables projected on the factorial plane (1-2)



Our index	Martin 's GDP index	Martin's employment index	Period
Recovery1	RGDP1	Remploy1	1980-91
Crisis1	CGDP1	Cemploy1	1992-93
Recovery2	RGDP2	Remploy2	1994-2007
Crisis2	CGDP2	Cemploy2	2008-09
Recovery3	RGDP3	Remploy3	2010
Crisis3	CGDP3	Cemploy3	2011-13
Recovery4	RGDP4	Remploy4	2014-15

Figure 3.5: Global points on the factorial plane (1-2)



MFA also provides the partial points of each region represented in Figure 3.6. This graph enables us to return to the first issue, the common structure between the three indicators of resilience. As explained at the beginning of the section, the three tables share a common structure that is least obvious between groups 2 (GDP indicators) and 3 (employment indicators). The variability of the partial points, which is known as "within variability", is measured with respect to that of their respective global points. Thus, regions with low within-variability are stable in terms of their ranking across the three resilience indicators considered, whereas as that of regions with high within-variability, will vary greatly, according to which indicator is used.

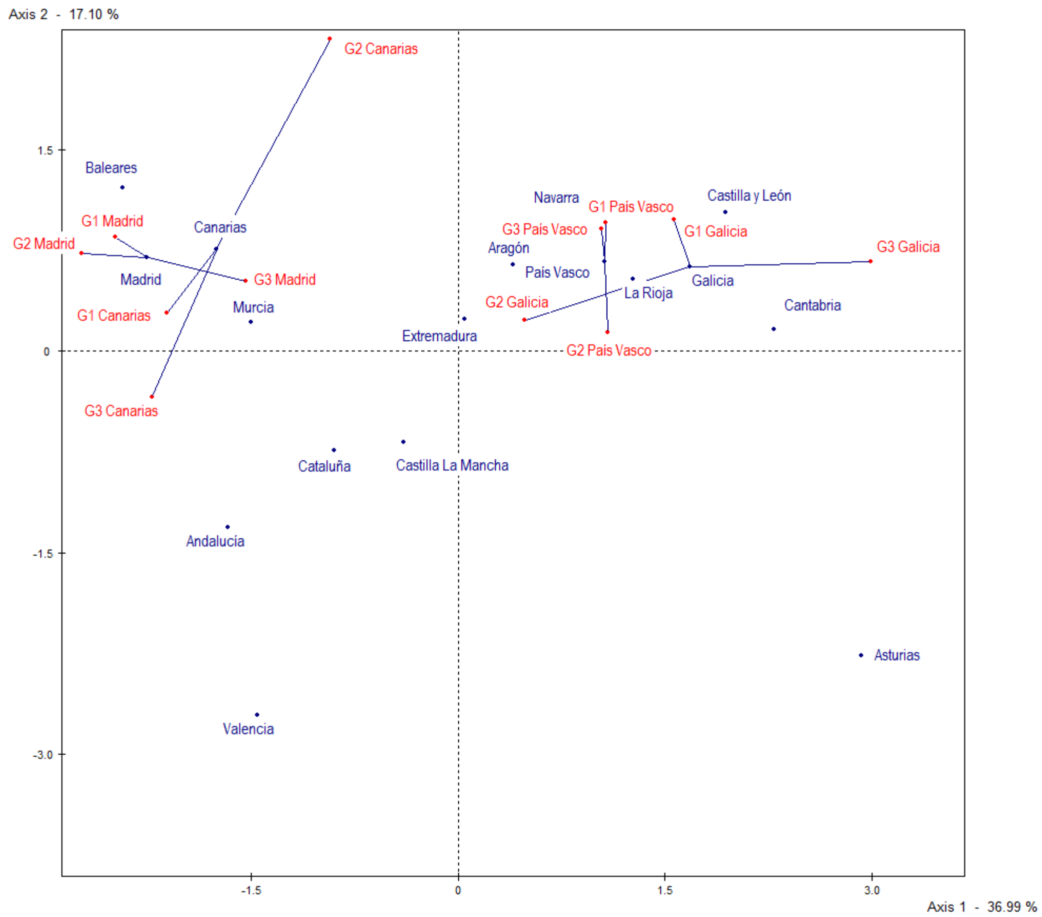
The only partial indicators represented are those of the regions with the highest within-variability on axis 1 (Galicia) and axis 2 (Canarias); and those with the lowest within-variability among the partial individuals, País Vasco (least inertia on axis 1) and Madrid (least inertia on axis 2). The analysis of these regions is enough not only to reveal some specific differences between the three resilience indicators considered but also to confirm the overall stability between the three methods. Thus, Galicia and Canarias occupy very distinct positions on the plane (Figure 3.5) and therefore differ greatly in terms of resilience. Thus, Galicia is clearly below the mean in recovery periods 1, 2, 4 and crisis period 3 when employment indicators are used, whereas, it appears close to the mean in these periods when GDP indicators are used. Being a hybrid between the employment and GDP resilience indicators, our indicator (group 1) places Galicia close to the global point. The analysis for Canarias is similar but in relation to factor 2. Madrid and País Vasco have different partial points but the closeness of their positions on the plane suggests that their results are not affected by the type of resilience indicator used.

Table 3.7 shows the regions with the highest and lowest within-variability on factors 1 and 2. The highest variability is that of Galicia and Extremadura on axis 1 and Canarias and Asturias on axis 2. At the other extreme, the lowest variability is that of País Vasco and La Rioja on axis 1, and Madrid and Extremadura on axis 2. In general, researchers try to explain regional resilience based on Martin's employment indicator (2012). Our analysis suggests, however, their conclusions might vary significantly if, instead of using employment, they were to use GDP, as shown in Figure 3.6.Thus, given that our indicator can be seen as a hybrid of these two indicators, we suggest that the joint use of both indicators can help to smooth the results.

Table 3.7: Within-variability partial points

Cases with the highest within- variability				Cases with the lowest within- variability			
axis 1	Variability	axis 2	Variability	axis 1	Variability	axis 2	Variability
Galicia	24.380	Canarias	23.635	País Vasco	0.010	Madrid	0.338
Extremadura	21.922	Asturias	15.720	La Rioja	0.604	Extremadura	0.389
Canarias	7.864	Aragón	14.271	Navarra	1.251	La Rioja	1.028
Baleares	6.810	Valencia	12.074	Cataluña	1.532	Castilla y León	1.247
Asturias	6.703	Murcia	7.668	Castilla La Mancha	1.961	Andalucía	1.608
Madrid	6.076	Baleares	4.903	Cantabria	2.237	Galicia	1.691
Castilla y León	5.740	Cataluña	4.573	Aragón	2.441	Castilla La Mancha	2.076
Murcia	4.157	Navarra	3.125	Valencia	2.558	País Vasco	2.571
Andalucía	3.753	Cantabria	3.085	Andalucía	3.753	Cantabria	3.085

Figure 3.6: Global and partial points on the factorial plane (1-2)



3.4 Summary and conclusions

There has been increasing interest in and invocation of the notion of resilience in the social and environmental sciences over the past few years, and the concept has even entered national, regional and local policy discourse. According to Hanley (1998), however, the concept, while highly suggestive, suffers from imprecise definition and weak conceptualisation, which in turn weakens its marketability as an analytical or explanatory tool. Our aim here has been to try to identify which characteristics of a region most influence its resilience. We begin by constructing a composite index of resilience for the 17 regions of Spain for the period 1980 to 2015, using the DEA approach. In a second stage, we apply MFA in order to analyse the factors that make regions more or less resilient and compare our index of resilience to that of Martin (2012). MFA is a multivariate exploratory method that enables us to study the resilience of the Spanish regions from an essentially graphic perspective. By plotting the resilience index scores and the socioeconomic variables on the same graph, we are able to establish an interesting relationship between the two and derive an interpretation of the influence of socioeconomics on regional resilience.

Our results show that the resilience of Spanish regions varies according to their socio economic characteristics. In the first two crisis periods, 1992-92 and 2008-09, and in 2010 (year of recovery) the most resilient regions are Castilla y León, Cantabria, Galicia, La Rioja, País Vasco and Navarra. These are industry-oriented regions with higher-quality public and human capital and show the highest percentages of vocational training graduates. Baleares, Canarias, Madrid and Murcia show resilience especially in recovery periods, 1, 2 and 4. They stand out as having above-average productive specialisation, and in particular, as economies mainly focused on market services. They also have a population with an above-average share of high-school graduates.

Another finding from this study is that the results differ greatly according to whether we take into account our own index of resilience or that of Martin (2012). A different choice of indicator would cause some regions, such as Galicia or Canarias, to vary their position on the plane and consequently their characterisation in terms of resilience. In this respect, observation shows that the partial 1, which represents our indicator of resilience, is the closest in all cases to the mid-point. This would justify the use of both GDP and employment for the characterisation of resilience.

The increasing use of the concept of resilience in regional studies calls for further work on the issue of what determines the resilience of an economy (regional or local), and what causes it to increase or decline. This article focuses mainly on productive specialisation, productive structure and public, human and social capital. Naturally, these elements or factors only partially explain the resilience capacity of regional economies. Other aspects requiring exploration include the institutional framework, the entrepreneurship capacity and the export dynamics of each region. Some of these potential factors relate to those analysed here, but there is clearly much scope for further analysis.

Although of an exploratory nature, the arguments and analysis contained in this article suggest that further, more detailed, research would be worthwhile. One possibility would be a more rigorous statistical analysis of the reaction and recovery dynamics of regional economies to recessionary shocks, using advanced time series techniques.

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Appendix

Table A3.1: Growth rates in recession periods

	CRISIS					
	1992-1993		2008-2009		2011-2013	
	GDP growth rate	Employment growth rate	GDP growth rate	Employment growth rate	GDP growth rate	Employment growth rate
Andalucía	-2.475	-5.825	-3.351	-7.229	-5.055	-8.093
Aragón	-0.580	-3.500	-3.563	-6.641	-4.320	-6.382
Asturias	-4.532	-3.978	-4.847	-6.597	-7.677	-7.988
Baleares	-0.270	-2.892	-3.913	-5.686	-2.531	2.317
Canarias	1.732	-3.842	-3.962	-7.736	-2.780	-5.074
Cantabria	-2.670	-2.380	-3.786	-4.929	-6.363	-7.379
Castilla y León	1.003	-2.585	-3.153	-5.078	-6.116	-7.883
Castilla La Mancha	-2.766	-3.727	-3.295	-6.405	-5.292	-9.330
Cataluña	-1.275	-4.913	-4.055	-8.127	-3.848	-7.398
Valencia	-1.132	-4.652	-5.111	-9.612	-4.871	-6.293
Extremadura	-1.365	-3.939	-3.082	-5.178	-4.410	-9.110
Galicia	-0.434	-2.456	-4.007	-3.813	-4.407	-7.617
Madrid	-0.554	-4.239	-3.056	-4.566	-2.808	-5.975
Murcia	-2.184	-2.685	-3.374	-8.611	-3.913	-5.393
Navarra	-1.611	-3.693	-4.391	-4.139	-4.701	-7.490
País Vasco	-0.515	-3.159	-5.070	-5.771	-4.397	-8.648
La Rioja	-1.185	-2.851	-4.438	-4.904	-6.145	-7.140
TOTAL	-1.112	-4.140	-3.834	-6.675	-4.261	-6.967

Table A3.2: Growth rates in recovery periods

	RECOVERY							
	1980-1991		1994-2007		2010		2014-2015	
	GDP growth rate	Employment growth rate	GDP growth rate	Employment growth rate	GDP growth rate	Employment growth rate	GDP growth rate	Employment growth rate
Andalucía	45.763	15.787	60.502	85.300	-1.181	-1.986	3.153	5.063
Aragón	31.655	7.673	53.000	53.217	1.007	-3.638	2.736	4.197
Asturias	11.475	-8.208	42.739	32.587	-0.018	-3.320	3.090	-0.040
Baleares	46.938	16.210	45.843	101.572	-0.696	-1.213	3.238	5.540
Canarias	27.061	12.660	63.225	90.978	-0.113	-2.339	2.815	6.673
Cantabria	20.369	-5.109	50.333	65.266	-0.276	-3.214	2.551	1.053
Castilla y León	26.305	-1.972	42.670	36.652	0.157	-1.217	2.884	2.063
Castilla La Mancha	42.706	12.137	57.423	69.256	-0.951	-2.041	3.233	2.345
Cataluña	34.394	14.862	55.420	68.274	0.378	-1.252	3.323	1.546
Valencia	31.588	9.727	63.151	81.689	-0.995	-3.798	3.597	4.001
Extremadura	52.540	5.448	47.458	45.151	-1.197	-1.176	3.044	0.827
Galicia	23.511	-7.365	49.446	26.758	0.081	-4.405	3.151	1.926
Madrid	36.179	19.880	74.867	88.768	-0.290	-1.613	3.380	3.565
Murcia	42.497	15.717	72.852	101.908	-1.202	-1.704	3.118	-0.047
Navarra	25.946	12.096	62.195	62.805	1.455	-1.051	2.936	0.686
País Vasco	22.564	4.123	54.397	44.619	1.291	1.072	3.148	1.280
La Rioja	36.737	-1.229	55.356	76.709	0.794	-2.879	2.781	1.735
TOTAL	33.521	9.509	58.919	68.648	-0.204	-2.005	3.215	3.017

Table A3.3: Correlation matrix

	efficiency	NIDH	agriculture	industry	construction	mark.serv	non-mark	si	public cap	uneducated	high school	voc. Train	university	human cap.	social cap.	recovery1	RGDP1	Remploy1	recovery2	RGDP2	Remploy2	recovery3	RGDP3	Remploy3	recovery4	RGDP4	Remploy4	crisis1	CGDP1	Cemploy1	crisis2	CGDP2	Cemploy2	crisis3	CGDP3	Cemploy3
efficiency	1.000																																			
NIDH	0.786	1.000																																		
agriculture	-0.716	-0.678	1.000																																	
industry	0.114	0.525	-0.050	1.000																																
construction	-0.797	-0.868	0.538	-0.512	1.000																															
mark.serv	0.594	0.244	-0.701	-0.609	-0.214	1.000																														
non-mark	-0.693	-0.750	0.600	-0.481	0.748	-0.319	1.000																													
si	0.670	0.364	-0.756	-0.516	-0.283	0.982	-0.402	1.000																												
public cap	-0.372	0.089	0.397	0.452	0.045	-0.674	0.245	-0.627	1.000																											
uneducated	-0.796	-0.853	0.816	-0.212	0.716	-0.481	0.537	-0.566	0.149	1.000																										
high school	0.496	0.106	-0.548	-0.646	-0.057	0.893	-0.187	0.870	-0.723	-0.444	1.000																									
voc. Train	0.393	0.693	-0.363	0.764	-0.647	-0.227	-0.517	-0.112	0.327	-0.536	-0.383	1.000																								
university	0.536	0.783	-0.544	0.372	-0.630	0.113	-0.284	0.185	0.212	-0.828	0.076	0.451	1.000																							
human cap.	0.418	0.763	-0.483	0.527	-0.584	-0.054	-0.298	0.032	0.427	-0.737	-0.151	0.619	0.922	1.000																						
social cap.	0.589	0.421	-0.239	0.256	-0.615	0.116	-0.379	0.177	-0.081	-0.361	0.074	0.516	0.089	0.080	1.000																					
recovery1	0.222	-0.139	0.099	-0.538	0.035	0.344	0.237	0.318	-0.445	-0.036	0.498	-0.453	-0.051	-0.332	0.215	1.000																				
RGDP1	-0.023	-0.410	0.411	-0.582	0.298	0.146	0.393	0.098	-0.349	0.293	0.318	-0.592	-0.322	-0.517	0.007	0.892	1.000																			
Remploy1	0.452	0.124	-0.242	-0.406	-0.217	0.502	0.007	0.491	-0.502	-0.298	0.578	-0.254	0.150	-0.138	0.418	0.897	0.633	1.000																		
recovery2	0.625	0.153	-0.298	-0.437	-0.355	0.643	-0.182	0.617	-0.643	-0.391	0.732	-0.212	0.112	-0.158	0.500	0.703	0.489	0.790	1.000																	
RGDP2	0.359	0.158	-0.191	-0.085	-0.395	0.223	0.008	0.182	-0.367	-0.388	0.356	-0.064	0.378	0.087	0.386	0.551	0.250	0.689	0.746	1.000																
Remploy2	0.553	0.053	-0.227	-0.470	-0.283	0.620	-0.154	0.586	-0.627	-0.274	0.706	-0.263	-0.025	-0.246	0.526	0.702	0.534	0.772	0.974	0.664	1.000															
recovery3	0.266	0.560	-0.021	0.476	-0.405	-0.292	-0.157	-0.156	0.490	-0.296	-0.430	0.623	0.421	0.469	0.336	0.011	-0.070	0.017	-0.195	-0.102	-0.258	1.000														
RGDP3	0.311	0.745	-0.266	0.715	-0.622	-0.241	-0.493	-0.112	0.550	-0.433	-0.454	0.790	0.539	0.658	0.279	-0.420	-0.573	-0.279	-0.336	-0.158	-0.408	0.787	1.000													
Remploy3	0.300	0.338	-0.154	0.023	-0.234	0.068	0.048	0.159	-0.041	-0.365	0.049	0.336	0.294	0.275	0.363	0.365	0.247	0.400	0.135	0.087	0.109	0.553	0.172	1.000												
recovery4	0.325	-0.050	-0.430	-0.569	-0.025	0.728	-0.074	0.689	-0.671	-0.107	0.653	-0.461	-0.084	-0.312	0.036	0.516	0.333	0.647	0.531	0.332	0.523	-0.360	-0.378	0.004	1.000											
RGDP4	0.210	0.013	-0.259	-0.124	-0.009	0.278	-0.136	0.268	-0.649	-0.105	0.424	-0.340	0.048	-0.188	-0.133	0.390	0.287	0.458	0.279	0.315	0.219	-0.322	-0.389	0.133	0.636	1.000										
Remploy4	0.311	-0.036	-0.290	-0.628	-0.076	0.703	-0.014	0.657	-0.322	-0.082	0.528	-0.366	-0.084	-0.208	0.092	0.391	0.268	0.464	0.479	0.169	0.491	-0.251	-0.191	-0.129	0.794	0.116	1.000									
crisis1	0.025	0.142	0.030	-0.082	-0.193	0.143	-0.160	0.130	0.148	-0.073	0.016	0.164	-0.040	0.004	0.042	-0.328	-0.281	-0.362	-0.004	-0.149	-0.036	0.070	0.209	-0.074	-0.303	-0.507	-0.003	1.000								
CGDP1	0.172	0.219	-0.163	-0.315	-0.280	0.412	-0.049	0.404	0.008	-0.195	0.239	-0.045	0.136	0.038	0.054	0.199	0.064	0.186	0.152	0.063	0.102	0.178	0.236	0.195	0.324	-0.086	0.547	0.521	1.000							
Cemploy1	-0.064	0.140	0.207	0.138	-0.092	-0.152	-0.142	-0.134	0.336	0.022	-0.197	0.234	-0.046	0.044	-0.018	-0.424	-0.270	-0.513	-0.202	-0.311	-0.231	0.208	0.253	-0.061	-0.566	-0.502	-0.328	0.888	0.212	1.000						
crisis2	-0.204	-0.096	0.434	-0.136	0.215	-0.274	0.461	-0.284	0.386	0.105	-0.246	-0.066	0.142	0.115	-0.220	0.124	0.231	-0.065	-0.104	-0.054	-0.181	0.382	0.065	0.209	-0.477	-0.408	-0.243	0.255	0.031	0.370	1.000					
CGDP2	-0.322	-0.408	0.422	-0.567	0.399	0.031	0.610	-0.074	0.089	0.287	0.094	-0.565	-0.092	-0.197	-0.293	0.478	0.562	0.313	0.149	0.128	0.166	-0.117	-0.439	0.070	-0.022	-0.163	0.130	0.050	0.134	0.014	0.686	1.000				
Cemploy2	-0.033	0.226	0.167	0.128	0.046	-0.237	0.111	-0.174	0.513	-0.160	-0.226	0.206	0.344	0.401	-0.310	-0.250	-0.158	-0.401	-0.329	-0.333	-0.446	0.453	0.402	0.096	-0.544	-0.392	-0.251	0.328	0.096	0.481	0.758	0.197	1.000			
crisis3	0.406	0.193	-0.396	-0.539	-0.172	0.705	-0.068	0.701	-0.527	-0.374	0.670	-0.228	0.162	-0.145	0.120	0.686	0.440	0.739	0.625	0.470	0.539	0.092	-0.115	0.298	0.666	0.353	0.545	0.091	0.568	-0.139	0.009	0.226	-0.144	1.000		
CGDP3	0.403	0.188	-0.355	-0.531	-0.191	0.681	-0.060	0.672	-0.508	-0.363	0.650	-0.215	0.154	-0.152	0.142	0.707	0.469	0.744	0.633	0.482	0.548	0.101	-0.111	0.306	0.641	0.331	0.549	0.113	0.597	-0.120	0.034	0.251	-0.129	0.996	1.000	
Cemploy3	0.598	0.240	-0.438	-0.492	-0.186	0.801	-0.392	0.817	-0.495	-0.291	0.743	-0.209	-0.086	-0.224	0.268	0.317	0.252	0.379	0.591	0.025	0.595	-0.083	-0.155	0.016	0.491	0.126	0.520	0.307	0.321	0.195	-0.154	-0.009	-0.106	0.581	0.562	1.000

Sensitivity Analysis

MFA of resilience in the Spanish regions according to Sánchez (2012) periods (1977-2015)

The MFA is conducted as in section 3.3.2.1 to explore whether the results vary if other time periods are considered (Table A3.4). In this case we consider Sánchez (2012) periods.

Table A3.4: Periods for the analysis

Period 1	Crisis	1977-1985
Period 2	Recovery	1986-1990
Period 3	Crisis	1991-1994
Period 4	Recovery	1995-2006
Period 5	Crisis	2007-2011
Period 6	Recovery	2012-2015

The complete dataset for the 17 Spanish regions comprises 3 different resilience indicators measured over six consecutive periods and 13 supplementary variables. The MFA of the three resilience tables provided the first two factors, which explain more than the 50% of the total variance in the table (the first 37.64% and the second 20.78%).

Comparative analysis of the three resilience measurement methods is conducted using the RV coefficients (Table A3.5) and the variables graph (Figure A3.1). The RV values reveal a shared common structure between the 3 tables, which is more obvious between our resilience index and the remaining two.

Table A3.5: RV relation coefficients between indexes

	Our resilience index	Martin's GDP index	Martin's employment index
Our resilience index	1.000		
Martin's GDP index	0.746	1.000	
Martin's employment index	0.744	0.431	1.000

The detected common structure is supported by the fact that the resilience indicators point roughly in the same direction for each period. Thus, the three resilience indicators of period 4 point to left in the variable graph (Figure A3.1) any similarly occurs in the rest of periods except 1 and 3. It should be noted that employment resilience indicators in periods 1 and 3 are quite far from the two remaining indicators (composite and GDP). This feature reflects that the common structure between the 3 tables is less obvious; suggesting that in these periods the three methods will yield clearly distinct resilience scores for the Spanish regions.

The second issue, the analysis of the structure of relationship between resilience indicators and supplementary variables, is addressed by again giving meaning to the two factors using the variables graph (Figure A3.1).

The first is an opposition factor, that is to say, it opposes the resilience indicators of period 5, which represents the last crisis, 2007-2011, with those of the remaining periods considered, mainly those of recovery, 2, 4 and 6. Therefore, regions that have positive (negative) scores on factor 1 are more (less) resilient than the mean in period 5 and, in general, less (more) resilient in the above-mentioned recovery periods. Note that regions with scores close to zero may either be around the mean for resilience in all these periods or above the mean but experiencing a compensation effect.

The second is also an opposition factor since the resilience indicators of recovery period 2 oppose those of crisis periods 1 and 3. Therefore, regions that have positive (negative) scores in factor 2 are more (less) resilient than the mean in period 2 and less (more) resilient periods 1 and 3. Note that regions with scores close to zero may experience a compensation effect like that of factor 1.

The supplementary variables relating to the socioeconomic characteristics of the regions are projected onto the variables graph (Figure A3.1, variables in black). The supplementary variables industry and public capital point clearly towards the right, as do vocational training graduates and human capital, albeit more weakly. In consequence, these variables are positively correlated with indicators of resilience of crisis period 5. It is worth noting that public capital is highly correlated with the resilience indicators of period 5 and that industry is opposite to the resilience indicators of periods 6 and 4 (negatively correlated with them). Conversely, high school graduates, market services, production specialisation and social capital point to the left, and are therefore positively correlated with the resilience indicators of all recovery periods. High school graduates, market services, production specialisation points also towards down so, there will be more intensely correlated with the resilience indicators of period 6 and with the employment resilience indicators of periods 1 and 3.

In consequence, regions with positive factor scores on factor 1 (more resilient than the mean in crisis period 5 and less in recovery periods) are above the mean in industry and social capital and below the mean in high school graduates, market services and productive specialisation. The most resilient regions in this period, 2007-2011, are characterised by an industry-centred productive structure and above-average public and human capital. Likewise, they are characterised by having a population with high percentage of vocational training graduates.

And finally, in the recovery stages, we can say that the social capital variable, which points to the left, is associated with the recovery periods, especially period 2. The association is positive but not very strong. Finally, the high school graduates, market services and productive specialisation variables show a positive association with the recovery indicators, as shown by their position in the plane, especially in period 6. The opposition of the industry variable to the variables just mentioned is striking. This implies that industry share in the economy negatively correlates with high school graduates, market services and productive specialisation, and then we expect a negative relationship of industry with the recovery variables especially those of period 6. Therefore, we could say that the most resilient regions in the recovery periods are those that stand out for their specialisation in market services, for their share of the population a high school education, and above-average social capital. The share of industry in their economies, in contrast, is barely significant.

Now that the factors have a meaning, we are ready to address the final issue, the characterisation of the regions in terms of their resilience and how clearly they are reflected in the supplementary variables. To do this, each Spanish region is projected on the factorial plane 1-2 taking all the information relating to its resilience, that is, the global points of MFA are obtained (Figure A3.2). For the sake of brevity, the positions of only a few regions are commented on.

According to the interpretation of Figure A3.2, the regions farther to the right in the plane will be those that are above average in terms of resilience in crisis period 5. If we look at Tables 2 and 3 which show the indicators of resilience, we observe that País

Vasco, Navarra, La Rioja and Aragón are the ones that behave best in that period. The cases of Navarra and Aragón are peculiar since they are located in the middle of the global point graph. This may be due to the compensation effect noted above. Navarra is one of the regions that are best placed in period 5 but it also remains around the mean in the rest of the periods. This is why its position has remained centred on the plane. Aragón behaves very well in crisis period 5 but also in the last recovery period (6); it therefore occupies an intermediate position on the plane. In times of crisis, País Vasco stands out for its greater resilience. It is an industry-centred region with a greater endowment of public and human capital and also has the highest percentage of people with vocational training.

As we have already explained, the factors are of opposition, which explains the situation of Valencia on the left side of the plane since it is the worst performer in period 5 and the best in recovery period 6, in opposition to the País Vasco.

A look at crisis periods 1 and 3 shows that the indicators point downwards towards the left. That quadrant contains the regions of Baleares and Canarias, which perform best in terms of resilience during these crisis periods. The most resilient regions in crisis periods 1 and 3, Baleares and Canarias, stand out for having above-average productive specialisation, and in particular, a strong economic focus on market services, as shown in Figure A3.1. They also stand out for having an above-average percentage of high school graduates.

Figure A3.1: Variables plotted on the factorial plane (1-2)

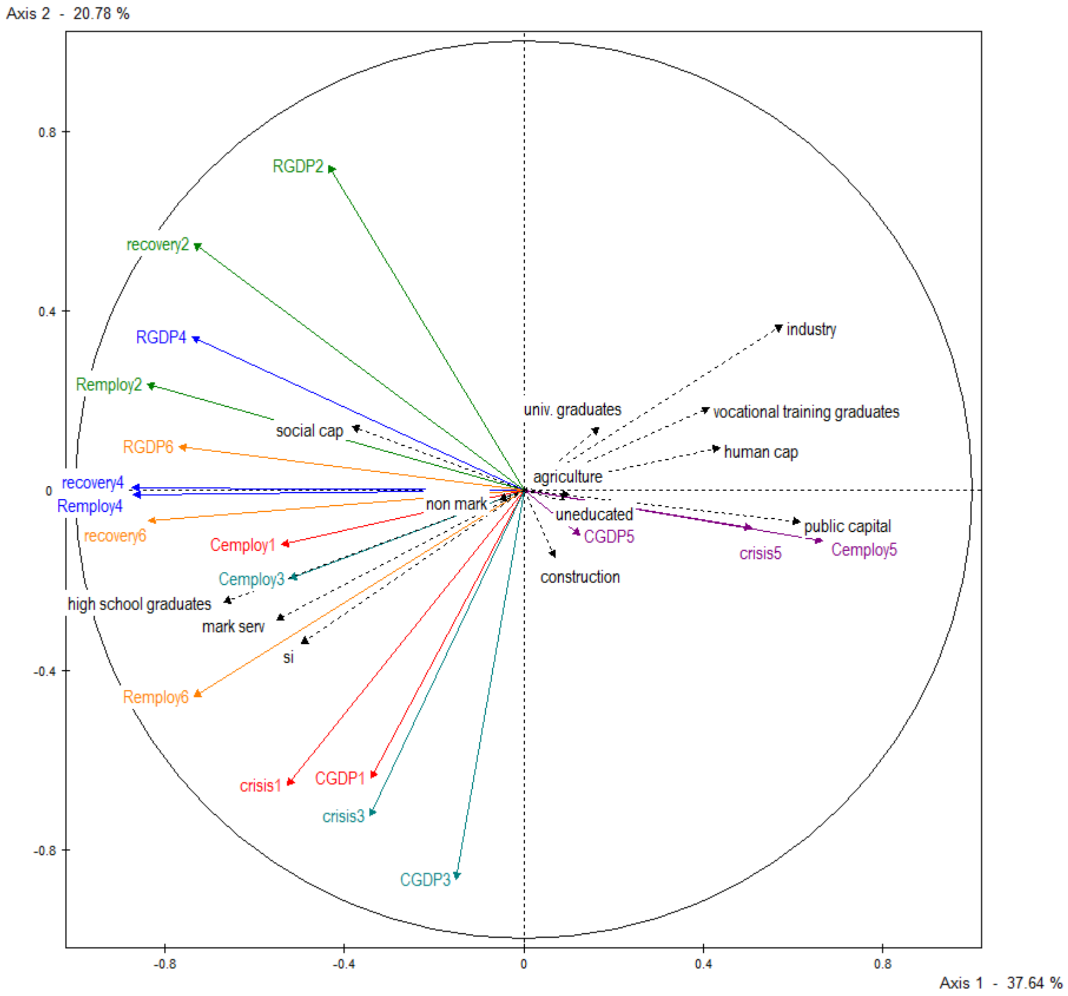
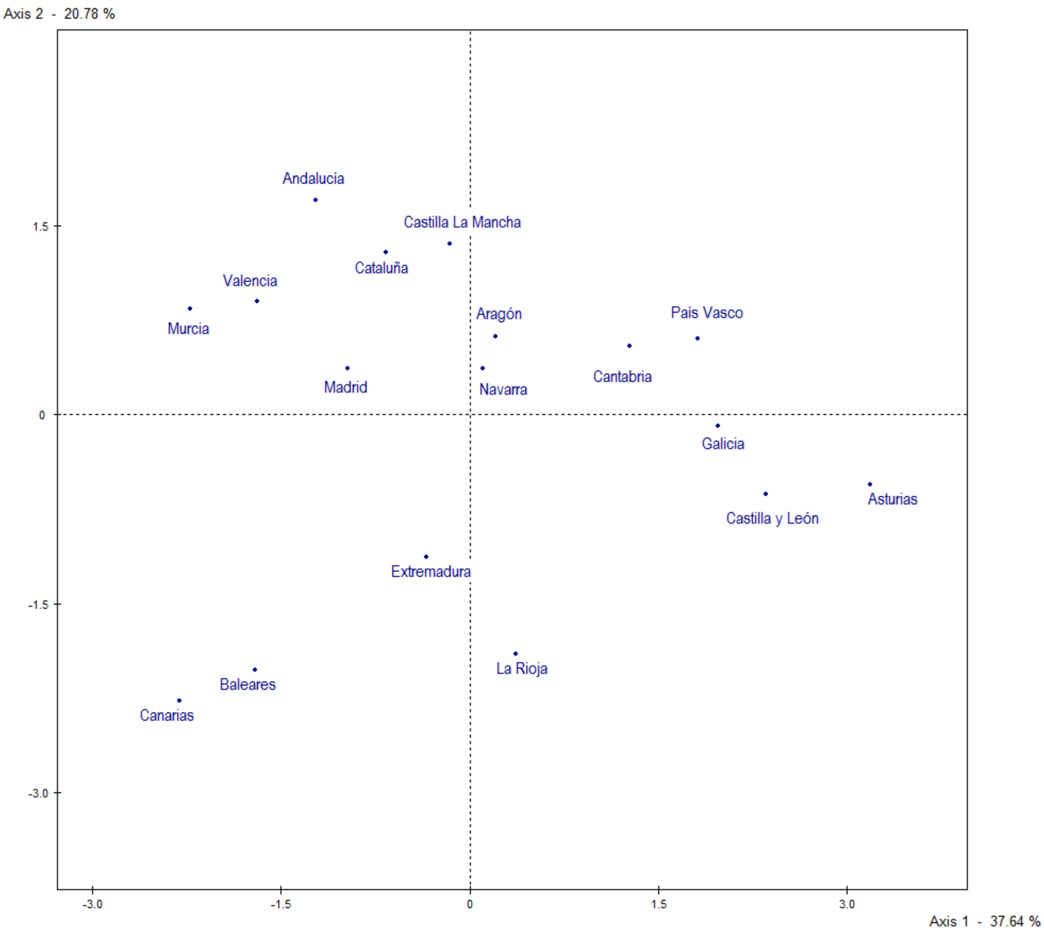


Figure A3.2: Global points on the factorial plane (1-2)



Directions for Future Research

Given that the results and conclusions of the three studies carried out in this thesis are provided at the end of each chapter, this section reviews possible extensions of the work performed here. What follows, therefore, are some brief remarks on different possible lines for future research.

1. New decentralization measures

In chapters 1 and 2 the means used to quantify the degree of fiscal decentralization of the OECD countries are the subnational share of total public expenditure and the subnational share of total government tax revenue (Government Finance Statistics, IMF). Both these fiscal decentralization measures are widely used in the literature (Oates, 1985, 1993; Davoodi and Zou, 1998; Woller and Phillips, 1998; Thieben, 2003; Iimi, 2005) and are considered by Rodríguez-Pose and Gill (2006) as the most appropriate of all those available, in the absence of reliable alternatives. They have, nevertheless, been criticised for not measuring the degree of autonomy in regional government expenditure, and failing to make a distinction between tax- and non-tax revenue (Ebel and Yilmaz, 2003; Rodden, 2004; Stegarescu, 2005).

The literature has also proposed various non-fiscal measures to account for the multiple aspects of decentralization (Kaufman, 1963; Stephens, 1974; Smith, 1979; Bahl, 1999; and Treisman, 2002, provide comprehensive discussions of the factors that together describe the extent of fiscal decentralization). The ratio of sub-central government employment to total government employment (Arikan, 2004), the population-normalised number of sub-central jurisdictions (Oates, 1985) and even the number of tiers of sub-central government are just a few of the many alternatives that have, at one time or another, been used to measure decentralization. Generally speaking, despite the additional information that may be obtained, the comparison of employment figures or the number of government tiers or sub-central jurisdictions without accounting for differences in statutes and degrees of autonomy across countries can be expected to present problems.

In view of these difficulties, a few approaches aim at improving the measurement of fiscal decentralization by taking into account the vertical decision-making structures, particularly with respect to tax revenues[16]. Among these, the most comprehensive effort was made by the OECD, which provided a methodological framework for the classification of subnational tax revenues by degree of tax autonomy. Detailed figures are reported for a number of OECD and EU accession countries, though only for 1995-97[17]. Both the OECD study and Ebel and Yilmaz (2003), who used these data, use a definition of fiscal decentralization based exclusively on the degree of subnational tax autonomy, i.e. the ratio of own tax revenue controlled by sub-central governments to total subnational revenue. This measure does not account for the relative size of sub-central government, however.

Using the OECD classification of tax autonomy, Stegarescu (2005) provides measures of tax and revenue decentralization, thereby relating autonomous subnational government tax revenue to total central government tax revenue. However, the analysis of fiscal decentralization could analogously be extended to classify subnational expenditure or borrowing by degree of autonomy, drawing, for example, on the classifications proposed by the Council of Europe (1997) or the World Bank Decentralization Project. This approach would involve breaking down sub-central government expenditure by function and degree of local legislative and executive discretion.

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[16] Pola (1999), for example, provides figures on the degree of self-financing by local and regional governments in 15 EU countries, distinguishing between different types of taxes. Blankart (2000) compares Germany and Switzerland using the share of general government tax revenue that is determined by central government legislation as a measure of fiscal centralization. Some attempts have also been made to classify sub-central government functions according to the degree of discretion; see, for example, Owens and Norregaard (1991) and Pola (1999) for European countries. However, no corresponding figures on fiscal decentralization are reported there.

[17] See OECD (1999). Based on a joint initiative with the World Bank and the Council of Europe, among others, the OECD has, since 2000, carried out surveys on the design of fiscal systems across levels of government for a group of countries. The first results were presented for six EU accession countries; see OECD (2002a and 2002b).

Hooghe et al. (2010, 2016) also elaborate a regional authority index for several developed and developing countries. This index covers a broad range of aspects of decentralization, including fiscal autonomy, representation, executive power, policy scope, etc.

In consequence, further work is needed to find better decentralization indicators to capture with accuracy the multidimensional nature of the devolution of power and resources from central to subnational tiers of government.

2. Transmission mechanisms of decentralization on technical efficiency and shadow economy

One important contribution to the decentralization literature will be an empirical analysis of the transmission mechanisms that account for the effect of decentralization on technical efficiency and shadow economy. This thesis studies the effects of decentralization on these issues but does not fully explore the transmission mechanisms.

The theoretical literature on fiscal federalism identifies two benchmark channels through which fiscal decentralization is expected to affect efficiency positively, namely (i) increased electoral control and (ii) yardstick competition among local governments resulting from decentralization. According to the electoral control mechanism, decentralization reduces the inclination of officials to divert rents and increases the probability of "bad" incumbents being voted out of office, thus positively affecting overall government efficiency (Hindriks and Lockwood 2009). Moreover, Seabright (1996) shows that rent-seeking politicians, when running in decentralised elections, use incentives to lure the voters in each (local) constituency. To get re-elected in a national election, in contrast, politicians would seek to please the voters only in a majority of the localities. Similar results are obtained by Myerson (2006) and Hindriks and Lockwood (2009). According to the theory of yardstick competition (see e.g., Shleifer 1985; Besley and Case 1995), citizens are at an advantage when they are able to evaluate the performance of their policy makers by comparing the policy choices of their own political representatives with those of the policy makers in neighbouring regions. Therefore, fiscal decentralization may increase efficiency, as it offers citizens an opportunity to compare public services and taxes across jurisdictions and helps them to assess whether their government wastes resources through low human capital capacity or rent-seeking (Besley and Smart 2007).

With respect to the impact of the transmission mechanisms of decentralization on shadow economy, enhanced efficiency in decentralised systems increases acceptance of state interventions as well as tax morale (Torgler et al., 2010) and may, thereby, reduce the size of the shadow economy (efficiency effect). The closer the distance between bureaucrats and economic agents and/or the greater the frequency of face-to-face contact, the higher the probability of workers in the shadow economy being discovered and the lower the expected gains from informality (Allingham and Sandmo, 1972). Decentralization increases the effectiveness of surveillance and should thereby reduce the size of the shadow economy (deterrence effect).

The idea for the future will be to study the transmission mechanisms through which decentralization affects technical efficiency or shadow economy.

3. New methods to analyse the relationship between decentralization and efficiency; and decentralization and shadow economy

In chapters 1 and 2 of this thesis, an econometric model with panel data is used to analyse the relationship between decentralization and efficiency (chapter 1) and decentralization and shadow economy (chapter 2). The idea, for future research, will be to analyze these relationships using a Bayesian model averaging approach (BMA).

Standard statistical practice ignores model uncertainty. Data analysts typically select a model from some class of models and then proceed as though the selected model had generated the data. This approach ignores the uncertainty in model selection, leading to over-confident inferences and decisions that are more risky than might appear. BMA provides a coherent mechanism for accounting for this model uncertainty (Hoeting et al., 1999).

The idea is to declare *a priori* that the “true” model is unknown, which implies a departure from the classical methodology in which conditioning on a specified model is essential. Consequently, instead of traditional conditioning, the employed Bayesian inference attaches prior non-informative beliefs to the model parameters (i.e., coefficients and error variance). In the next-averaging-step, the (unconditional) estimator is computed as a weighted average on these conditional estimators (Asatryan and Feld, 2015).

4. New samples to analyse the relationship between decentralization and efficiency; and decentralization and shadow economy

The relationships between decentralization and efficiency and decentralization and shadow economy will be analysed using different samples of countries. Chapters one and two consider OECD countries, but it would be interesting to do the same with a sample of developing countries. This will enable comparison of the results to see whether decentralization has the same effects in developed countries as in developing ones.

5. Possibility of including additional supplementary variables in resilience analysis

Chapter three of the thesis analyses the determinants of Spanish regional resilience focusing on productive structure and public, human and social capital. Given the limited number of Spanish regions (17), however, it will be interesting to extend the analysis to other European regions. It will also be worth considering other variables that might influence regional resilience. In particular, what factors enable a region to adjust and adapt over time? The answer is likely to lie in a number of areas, with the relevant importance of each factor being different across regions and over time, but the sort of factors that appear to have been helpful in the past would include: a strong regional system of innovation (Clark et al., 2010; Howells, 1999); strength in factors that create a 'learning region' (Archibugi and Lundvall, 2001); a modern productive infrastructure (transport, broadband provision, etc.); a skilled, innovative and entrepreneurial workforce; a supportive financial system providing patient capital; a diversified economic base, not over-reliant on a single industry. Others that might be included are variables relating to regional demographics, regional innovation, regional knowledge systems, regional dynamism, institutional arrangements, macroeconomic and financial indicators, fiscal policy indicators, labour market institutions or socio-cultural indicators.

Having collected all the data for European regions, the next stage will be to analyse whether these variables have any impact on resilience and identify the most suitable econometric model to reveal the positive and negative effects and their significance.

Chapter three describes an exploratory analysis of factors that may influence resilience. So here the idea will be to further this analysis and determine whether the results obtained by MFA are robust with econometric results.

6. Spatial resilience

Another possibility when studying resilience is to consider the concept of "spatial resilience". This concept has its roots in meetings and discussions of the Resilience Alliance (http://www.resalliance.org), an international consortium of researchers and practitioners with interests in developing and applying resilience-related concepts in the context of social-ecological sustainability. Its first published usage was by Nystrom and Folke (2001), but it has taken on a broader meaning in subsequent discussions. A comprehensive definition is offered in the first book-length treatment of spatial resilience (Cumming 2011):

"Spatial resilience" refers to the ways in which spatial variation in relevant variables, both inside and outside the system of interest, influences (and is influenced by) system resilience across multiple spatial and temporal scales. It has elements that are both internal and external to the system.

The primary internal elements of spatial resilience include the spatial arrangement of system components and interactions; spatially relevant system properties, such as system size, shape, and the number and nature of system boundaries (e.g., hard or soft, and whether temporally variable or fixed over time scales of interest); spatial variation in internal phases, such as the successional phase, that influence resilience; and unique system properties that are a function of location in space.

The primary external elements of spatial resilience include context (spatial surroundings, defined at the scale of analysis); connectivity (including spatial compartmentalisation or modularity); and resulting spatial dynamics, such as spatially-driven feedbacks and spatial subsidies.

Both internal and external elements must be considered in relation to other aspects of system resilience, including such things as the number and nature of components and interactions, the ability of the system to undergo change while maintaining its identity, system memory, and the potential inherent in the system for adaptation and learning".

In many social systems, system size is fundamental to overall resilience. The probability of extinction, or localised component loss, correlates with habitat and population size, with larger areas and populations usually being more resilient (Holt, 1992; Bruhl et al., 2003).

An example of the study of spatial resilience of Spanish regions is the paper by Angulo et al. (2014), which uses predictions from spatial panel data models to evaluate regional resilience to the last crisis that affected Spain using annual employment growth rates.

Thus, one future line of research will be to introduce geographical data into resilience analysis, to take into account this concept of spatial resilience, while extending the sample periods and broadening the scope of the analysis to include European regions.

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