Decentralization and Environment: An Application to Water Policies

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Summary

By means of a two-jurisdictional model, this paper analyses the optimal division of environmental policymaking functions among the different government levels, identifying the most appropriate level of decentralization in each case. The paper focuses on water resources policies, with an application to Spanish regions during the 1996-2001 period. The estimation of an environmental quality-consumption transformation function allows the implementation of a simulation to find the most efficient policies in the context of water resources.

Keywords: Fiscal federalism, Environmental policies, Water resources

JEL Classification: H77, Q25, Q28

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WHAT LEVEL OF DECENTRALIZATION IS BETTER IN AN ENVIRONMENTAL CONTEXT? AN APPLICATION TO WATER RESOURCES IN SPAIN

1. - Introduction

The relation between the intergovernmental structure of a country and various environment outcomes is currently the subject of research and debate (Oates, 2002). What degree of centralization is better suited for environmental objectives? The degree of decentralization that can be most effective in achieving specific environmental objectives, such as improved water quality and service provision, remains an unresolved issue. In particular, the impact of fiscal competition on social welfare remains a controversial issue.

Some of the advantages of decentralized environmental policies are based on technical characteristics that are unique to each jurisdiction or region, while others rely on heterogeneity of tastes among jurisdictions' population. It is well-known, for example, that the per-household cost of treating drinking water varies among communities depending on the size and other characteristics of water distribution and sewerage systems. Likewise, there are significant differences regarding preferences for environmental protection. Some populations are willing to sacrifice some economic growth for a cleaner environment, while others prefer the opposite. So, in that context, subcentral governments are more likely to choose efficient policies for water resources.

From the opposite perspective, it is possible that some subcentral governments would fail to choose efficient policies in the absence of central regulation. Centralization might be preferred if one jurisdiction's environmental policies generate unchecked externalities on other jurisdictions or maybe on future generations. Moreover, centralized environmental policies could guarantee a minimum protection for all population.

In this research, we analyze the consequences of different levels of centralization, in the context of water resources in Spain. We will see that those resources have not been shared out in a homogeneous way, and there have been strong differences in consumption across regions and periods. At times, some regional deficits have had to be covered with other regions´ resources; thus, the potencial overuse in some regions can lead to consequences in other jurisdictions. The main objective of the paper is to evaluate what level of government might manage water resources in the most efficient way. This naturally is at the core of the current debate of what is the optimal level of centralization for the management of natural resources.

The structure of the paper is as follows. First, we review the main contributions in the field of environmental federalism. Next, we propose a simple model to evaluate the performance of different levels of government centralization. The theoretical model captures the impact on the regions´ welfare of several features, such as preferences or the way by which private consumption deteriorate water resources. The empirical application uses panel data for Spanish regions in the period 1996-2001, to identify a water pressure-consumption transformation function. The most recent wave of the

World Value Survey (1999-2001) have allowed us to get information about Spanish population's preferences between environment and economic grown. Based on the main parameter of the model calculated previously, a simulation exercise has been implemented. Finally, we conclude with some thoughts and suggestions for further research.

2. - Decentralization and environment: a brief review

The advantages and disadvantages associated with decentralization have been long debated in the literature. It has been argued that if there is heterogeneity among jurisdictions, centralization is suboptimal (Peltzman and Tideman, 1972; Oates and Schwab, 1996). This is because strong differences in preferences among governments could lead to important efficiency losses for small-size jurisdictions (Burtraw and Porter, 1991; Dinan et *al*., 1999). In such cases, decentralization is a preferable alternative in order to take into account local circumstances. On the other hand, decentralization could result in a severe reduction of environmental quality, as a consequence of 'destructive interjurisdictional competition' (Cumberland, 1979, 1981). The so-called 'race to the bottom' could lead to excessively lax environmental standards.

With respect to environmental policy overall, the literature is not overwhelmingly in one side or the other of the decentralization issue. Some studies have stressed the advantages of decentralization, because fiscal competition does not result in excessive pollution, and it can make possible efficiency improvements (Oates and Schwab, 1988; 1991; 1996). List and Mason (2001), develop a model based on game theory in a context of asymmetric information and strategic behaviors. They conclude that decentralization can dominate centralization when there are significant differences among jurisdictions and initial pollution conditions are not very high.

We must note that the conclusions of some of those studies are excessively dependent upon stringent assumptions, involving technological characteristics, the size of jurisdictions, the existence of strategic behavior among jurisdictions or the objectives of local governments[1]. If some of those initial assumptions are relaxed, it is possible to find a series of papers, which have concluded that competition among jurisdictions can lead to welfare losses. Those include models which assume that local governments cannot use all kind of fiscal instruments to implement environmental policies (Zodrow and Mieszkowski, 1986; Wilson, 1986; Wildasin, 1989). These studies show that, in decentralized settings public goods will be underprovided bellow optimum levels, and that decentralization may result in excessively lax environmental standards.

More recently, Markusen et *al*. (1993, 1995) developed a model under the assumption of increasing returns to scale and shipping costs between regions. They concluded that pollution taxes affect firm's decisions and through some numerical examples they show how tax competition results in more plants and pollution. As Levinson (1997) pointed out, an example can help us to clarify the distinction between Oates and Schwab's framework and Markusen's model. Oates and Schwab develop a model applicable to many small jurisdictions that are competing for attracting investments to examine the effects of decentralization level on welfare. Markusen et *al*. show that regional governments establish their taxes in order to attract foreign plants. In

[1] For example, Oates and Schwab (1988) showed that, under the hypothesis of a revenue-maximizing government, there is a trend to lax environmental standards in order to increase the tax base.

such context, the regions are looking for getting economics rents that would otherwise be earned elsewhere, and by competing, the regions decrease their ability to exploit rents and to regulate efficiently the levels of pollution. Levinson (1997) attempts to conciliate both kinds of models in a theoretical framework. He concludes that the consequences of decentralization on efficiency depend on monopoly profits and tax exporting, not the nature of the pollution externality or environmental federalism. Finally, Fredriksson and Gaston (2000) find that centralized and decentralized governments could have similar effects. They show, for example, that sometimes, environmental standards are independent of institutional design. They also find that decentralized policies are efficient as long as either or neither lobby groups are organized.

The presence of externalities is an argument that leads to justify central government intervention, or in general more centralized institutional frameworks. It has been argued that if the environmental policy of one jurisdiction affects others jurisdictions, it is desirable to allow central government to set (not necessarily uniform) standards (Oates, 2002). Shapiro and Petchey (1997) show a bundle of conditions which characterize interjurisdictional cooperation as an efficient solution, without the need for centralized policies[2].

[2] Those conditions are the following: a) States have sufficient trust in one another's morality, b) States are fully informed about the policy choices of their treaty partners and c) The benefits of cooperation are sufficiently high relative to the rewards of defection. As Braden et *al*. (1997) pointed out, these conditions are hard to find in real situations, but it is possible to conclude that the existence of interjurisdictional externalities is not sufficient condition for central government intervention in an environmental context.

From an empirical point of view, some studies have focused on analyzing the consequences of decentralization in an environmental context (Dinan et *al*., 1999; List and Gerking, 2000; Fredriksson and Millimet, 2002; Millimet, 2003; Millimet and List, 2003; Fomby and Lin, 2003). Most of these studies fail to find empirical evidence of the 'race to the bottom' effect. Hence these studies support a decentralization approach, because centralized policies can impose large welfare losses on some jurisdictions[3]. Sometimes, and as it has been predicted by some theoretical models (Glazer 1999), the opposite effect has been observed, the so-called 'race to the top' (Milllimet, 2003). It is not possible to find the 'race to the bottom' phenomenon (Fredriksson, 2000), but instead stringent regulations (Glazer, 1999). Fredriksson and Millimet (2002) find that decentralized governments set higher levels of abatement spending when neighboring jurisdictions establish more stringent rules, but there appears to be no effect on a government's spending when the regulation is lax.

Summarizing, the majority of empirical contributions in this context have been focused on testing the "race to the bottom" phenomenon. However, although there are some theoretical studies which have analyzed the impact that different decentralization levels have on jurisdiction's welfare (Shapiro, 1996; Mueller and Oates, 1996), we can not find empirical studies which analyze this topic. We consider that this is an important issue, so, in the following sections we will develop an empirical example which helps to cover the scarcity of studies in this field.

[3] Dinan et *al*. (1999) analyzed the effects of centralized standards of water quality on households' welfare. They found that decentralizing standards process could allow governments to establish standards that better reflect their individual costs and benefits.

3. - The theoretical model: comparing alternatives

In this section, we present a two-jurisdiction model, following Shapiro (1996).Jurisdictions (regions) are denoted by the sub-index *i,* so $i = 1, 2$. In each region there are two kinds of citizens, capital owners, denoted by k, and "greens", citizens that value environmental quality, denoted by g. The type of individual is denoted by j, where j = k, g. So the population of each group in each state is denoted by n_{ij}. We assume that the majority of population in region 1 is composed by capital owners, while in region 2 the majority of citizens has a higher preference for environmental conservation. The utility function of a representative citizen is the following:

$$U_{ij} = Qc_{ij}^{g_j} \tag{1}$$

Thus citizens' care for environmental preservation, Q, which is defined as an index of the natural resource's quality and availability, and c_{ij} is defined for the private consumption of the *j-th* individual in the *i-th* jurisdiction. We only consider one parameter, g, to account for differences in preferences. Moreover, we know that $g_k > g_g$. In addition, we model the presence of externalities in consumption as:

$$Q = \sum_{i=1,2} Q_i \tag{2}$$

This means that the more one jurisdiction consumes environmental quality, there could be less available for the second jurisdiction. If we think about water resources in several regions of a country, we can find that some regions consume more intensively than others and higher levels of economic activity can lead to an overuse and quality deterioration of water resources. This overuse and deterioration can generate water transfers from some regions to others, which can be costly from an economic point of view[4].

Hence, the relationship between water pressure and private consumption needs to be modeled accurately by recognizing natural resource deterioration as an inevitable byproduct of the productive process. This process can be formalized through a transformation function as:

$$Q_i = a - bC_i + dZ_i \tag{3}$$

Where water resources quality and availability depends on regional total consumption, C_i, and on a bundle of exogenous factors, denoted by Z_i. As we will see, some parameters of that transformation function are significant in order to deciding which level of decentralization is preferred from a welfare point of view. From (2) and (3), we can find an explicit expression for *Q*:

$$Q = 2a - bn_1c_1 - bn_2c_2 + dZ_1 + dZ_2 \tag{4}$$

Where c_i is the per capita consumption in the *i-th* region. We can obtain the optimal solution for several scenarios[5]. Firstly, following Shapiro (1996), we can

[4] In Spain, for example, the contrasts between regions in terms of the natural availability of water have led to a policy of diverting water between basins. The National Water Plan, which aimed to improving the water supply in regions in the south of Spain on the Mediterranean coast, had an estimated cost of around 3.78 billion euro. This Plan was abandoned by the new government in 2004, which supports conservation policies and desalinization plants in Southeastern Spain as an alternative.

[5] For more details, see Shapiro (1996).

consider a decentralized context (A), in which each region maximizes the utility of a representative citizen in (1) subject to the externality revealed in (4). In this context, we assume the rules of majority and anonymity. This means that subcentral governments take decisions based on majority preferences, and they do not know about individual preferences (governments are not able to distinguish between capital owners and "greens").

Next, we can look at two centralized scenarios, with a central government which maximizes total welfare, leading to the national sum of the marginal rates of substitution between water quality/availability and consumption equals the marginal cost of water quality/availability[6] (B1), or maximizing majority's welfare, (B2). Table 1 presents the optimal levels of private per capita consumption for each region in each one of these scenarios.

TABLE 1
Optimal *per capita* consumption under several scenarios

	DECENTRALIZATION	CENTRALIZATION	
	A	**B1 (efficient)**	**B2 (majority)**
c_1^*	$\frac{f g_k}{b n_1 (1 + g_k + g_g)}$	$\frac{f g_k g_g}{g_k (n_{1k} + n_{2k}) + g_g (n_{1g} + n_{2g})}$	$\frac{f g_m}{b n (g_k + g_g)}$
c_2^*	$\frac{f g_g}{b n_2 (1 + g_k + g_g)}$	$\frac{f g_k g_g}{g_k (n_{1k} + n_{2k}) + g_g (n_{1g} + n_{2g})}$	$\frac{f g_m}{b n (g_k + g_g)}$

Total country population is denoted by $n = n_1 + n_2$; $f = 2a + d n_1 z_1 + d n_2 z_2$
National majority's preferences parameter is denoted by g_m

[6] Notice that the optimization program leads to $\frac{n_1 c_1}{g_1 Q} + \frac{n_2 c_2}{g_2 Q} = \frac{1}{b}$

Substituting c_1^* and c_2^* in expressions (4) and (1), it is possible to obtain the optimal values of Q and U_i. We can observe that, in order to decide the optimal level of decentralization, it is necessary to find out how intense the relationship between consumption and environmental quality is. In the next section, we have estimated a transformation function for environmental quality-consumption, considering another factors which can have an influence on environment, such as the efforts of firms and public sector to protect the environment.

4. - Empirical application: the Spanish case

To estimate equation (4), we employ a panel dataset for 17 Spanish Autonomous Regions for the period 1996-2001. The information source is the Spanish Institute of Statistics (INE). We analyze the relationship between water resources pressure and economic activity controlling for exogenous factors that have influence in water resources quality and quantity. Standard static panel data models, *between-groups*, *within-groups* and *random-effects*, are estimated.

Regarding the dependent variable, it is difficult to find some disaggregated index of water quality/availability. In this study, we use the inverse of *per capita* sewage water as the measurement of (Q). With this indicator, we are showing two features. On the one hand, it is a proxy of the level of pressure which is exerting on water resources, because there is a direct relationship between water consumption and sewage water. On the other hand, sewage water is quality deteriorated water by consumptive uses, so it could be interpreted as a proxy of water quality resources.

Two main independent variables are used: an index of economic activity in the region and a proxy for the firms' effort to improve water quality and availability. For the former, it has been considered the gross domestic product (GDP). For the latter, we have considered the one-period lagged capital expenditures on environmental protection, considering both public and private investments[7](KEXP-1). The descriptive statistics of those variables are shown in Table 2:

TABLE 2
Descriptive statistics

VARIABLE		MEAN	STD. DEV.	MIN	MAX
Q	overall	0.0209357	0.0097724	0.0088952	0.0498132
	between		0.0082827	0.0098243	0.0366965
	within		0.0055188	0.0000757	0.0362643
GDP(*)	overall	34494.260	32225.62	4103.721	119784.5
	between		32860.54	4522.92	110832.4
	within		3483.115	21884.83	46258.68
KEXP-1(*)	overall	129.387	124.9564	11.24784	548.4302
	between		105.4608	17.08475	367.1494
	within		73.83352	-108.8347	437.1828

Monetary variables (*) *are expressed in millions of euros*

The estimates are presented in Tables 3. Such as can be deduced of Hausman´s test results, in both cases the *fixed-effects* model estimation is preferred. The null hypothesis of not systematic differences in coefficients is rejected. Moreover, under this approach, all the variables are significant.

[7] There are several reasons why private firms provided environmental protection. Public subsidies and fiscal incentives or consumers' preferences are some arguments which have been pointed out. For a recent survey, see, among others, Segerson and Li (1999), Knanna (2001) or Lyon and Maxwell (2002).

TABLE 3
Transformation function: estimates

	VARIABLE	COEF.	STD. ERR.
BETWEEN-GROUPS	**GDP**	0.15986	0.18809
	KEXP-1	18.15203	57.3696
	Constant	0.02371***	0.00317
WITHIN-GROUPS	**GDP**	-0.63678***	0.18361
	KEXP-1	22.38638**	8.82186
	Constant	0.04106***	0.00635
RAMDOM-EFFECTS	**GDP**	-0. 21004***	0.06634
	KEXP-1	17.55551**	8.70131
	Constant	0.02563***	0.00287
Hausman test	Prob> c^2(2)= 0.0040 (11.05)		

Dependent variable:*Q. For the estimations, monetary variables are expressed in euros/1,000,000,000,000*
*** Significance at 1% level ** Significance at 5% level * Significance at 10% level

In general, it is noticeable the negative relationship between economic activity and the index of water quality/pressure. Moreover, it is possible to see the positive and significant impact that private and public efforts have on water resources conservation. Total capital expenditures in protecting environment have been a control variable which has allowed isolating the net effect of productive process on water quality.

From the previous results, it is possible to show a numerical example in order to get an idea about utility levels under each scenario. To do that, we have considered information relative to an Autonomous Region located in the East of Spain, Valencia (Area 1) and three Autonomous Regions located in the North, Aragon, Navarra and La Rioja (Area 2). This division is explained because those regions are the main jurisdictions included in the Jucar and Ebro River Basins. Area 1 has problems of water resources quality and availability, due to the strong environmental impact of tourism agricultural and industrial activities. The past administration national water plan called for a water transfer from Area 2 to Area 1. The data used in the simulations, which are based on estimates of the *within-groups* model in Table 3, are the following:

TABLE 4
Data used in the simulation

PARAMETER/VARIABLE	UNITS	VALUES
Z_1	*Billions euros*	0.0000608
Z_2	*Billions euros*	0.0001294
f	---	0.04106
b	---	0.63678
n_{1k}	*inhabitants*	2,947,344
n_{1g}	*inhabitants*	961,082
n_{2k}	*inhabitants*	1,010,371
n_{2g}	*inhabitants*	1,016,045

Regarding population data, we have obtained the information from the 4th wave of the *World Value Survey* (1999-2001). That survey includes political and socio-economic data about 1209 individuals from different Spanish regions. So, in Area 1, our sample population are mainly capital owners (75.41% of total population) while in Area 2 there is a higher proportion of green people[8] (50.14% of total population). The remaining data are referred to 2001 year. Under those data, we can obtain the next results:

[8] In the *World Value Survey*, individuals are asked about their preferences about economic growth and environment. The question is: “Here are two statements people sometimes make when discussing the environment and economic growth. Which of them comes closer to your own point of view?”

Table 5. A comparison: *per head* consumption (*), environmental quality and total utility

γ_g	γ_k	1			1.25			1.5			1.75			2		
		A	B1 (efficient)	B2 (majority)	A	B1 (efficient)	B2 (majority)	A	B1 (efficient)	B2 (majority)	A	B1 (efficient)	B2 (majority)	A	B1 (efficient)	B2 (majority)
0.10	c_1^*	0.0165	0.0021	0.0208	0.0185	0.0021	0.0212	0.0200	0.0021	0.0214	0.0213	0.0021	0.0216	0.0224	0.0021	0.0218
	c_2^*	0.0032	0.0021	0.0208	0.0028	0.0021	0.0212	0.0026	0.0021	0.0214	0.0023	0.0021	0.0216	0.0022	0.0021	0.0218
	Q^*	0.0411	0.0785	0.0079	0.0368	0.0784	0.0064	0.0332	0.0784	0.0054	0.0303	0.0784	0.0047	0.0279	0.0783	0.0041
	U_{tot}	51881420.4	84357023.0	11184292.8	45240773.9	83850081.7	8807162.1	40469898.6	83739967.0	7334628.4	36737946.0	83715553.7	6313671.6	33679145.2	83709716.0	5553672.9
0.25	c_1^*	0.0154	0.0049	0.0183	0.0174	0.0050	0.0190	0.0189	0.0050	0.0196	0.0202	0.0051	0.0200	0.0214	0.0051	0.0203
	c_2^*	0.0074	0.0049	0.0183	0.0067	0.0050	0.0190	0.0061	0.0050	0.0196	0.0056	0.0051	0.0200	0.0051	0.0051	0.0203
	Q^*	0.0384	0.0680	0.0173	0.0345	0.0676	0.0144	0.0314	0.0673	0.0123	0.0288	0.0671	0.0108	0.0266	0.0670	0.0096
	U_{tot}	26489974.2	36809080.5	13809340.4	22800553.1	35836706.2	10976542.3	20366173.7	35563431.9	9260892.6	18527604.6	35480381.7	8072834.7	17034177.8	35450239.9	7179283.6
0.50	c_1^*	0.0139	0.0087	0.0152	0.0158	0.0091	0.0163	0.0174	0.0094	0.0171	0.0187	0.0095	0.0178	0.0198	0.0097	0.0183
	c_2^*	0.0134	0.0087	0.0152	0.0122	0.0091	0.0163	0.0112	0.0094	0.0171	0.0103	0.0095	0.0178	0.0096	0.0097	0.0183
	Q^*	0.0345	0.0534	0.0288	0.0314	0.0520	0.0247	0.0288	0.0510	0.0216	0.0266	0.0503	0.0192	0.0247	0.0497	0.0173
	U_{tot}	9854812.4	11705562.6	8762723.7	7957728.9	10383287.0	6804069.9	6963074.8	9939276.3	5781367.4	6314807.3	9773480.2	5125423.7	5822855.8	9699225.5	4641166.2
0.75	c_1^*	0.0126	0.0119	0.0131	0.0145	0.0126	0.0143	0.0160	0.0131	0.0152	0.0174	0.0135	0.0160	0.0185	0.0138	0.0166
	c_2^*	0.0183	0.0119	0.0131	0.0167	0.0126	0.0143	0.0154	0.0131	0.0152	0.0143	0.0135	0.0160	0.0134	0.0138	0.0166
	Q^*	0.0314	0.0414	0.0370	0.0288	0.0388	0.0324	0.0266	0.0369	0.0288	0.0247	0.0354	0.0259	0.0230	0.0343	0.0236
	U_{tot}	4469083.7	4898434.0	4740823.8	3115522.3	3529937.5	3279079.5	2543526.5	3041566.5	2682986.1	2248366.3	2845793.4	2378421.6	2059322.9	2752156.7	2181790.9

(*) consumption levels are expressed in millions euros.

U_{tot} is calculated aggregating individual utility levels, basing on population data of Table 4.

As we can observe in the previous table, the centralized efficient context dominates the remaining alternatives, due to the higher water quality and availability levels. However, if we compare the decentralized context with a more realistic centralized context (B2), the final conclusion depends on the heterogeneity of preferences. A higher gap between preferences' parameters g_k and g_g leads to chose decentralized alternatives. This fact is according with some theoretical and empirical findings[9].

So under the hypothesis that incumbents search to satisfy minority and mayority social interests, or under majority maximization of homogenous preferences, the results favor some degree of centralization in the water resources field. Actually, some European Union environmental policies have been oriented in this way. Recently, the European Framework D2000/60/EC establishes a common guide for members to improve water quality and quantity aspects. The basic objective of the European regulation is to improve water quality and to achieve a rational use of water resources, in order to reduce pressure on those resources. The UE is enforcing country members to apply this framework it in the following years. The Spanish central government will have to adapt its regulation to the European Framework. So, it is expected that this will re-centralize water resource management in Spain also and lead to improved social welfare in the UE regions.

5. - Conclusions

[9] See section 2 for some references.

Fiscal decentralization in an environmental context is a controversial topic which has to be analyzed carefully. We have reviewed the main contributions in this field, showing the advantages and disadvantages of decentralized policies. In this paper we have focused on some features that have an important influence in order on the choice of the better option in the context of water resource policies. From a theoretical point of view, we have shown the relevant factors for this choice by means of a two-region model. Next, we developed an empirical application in Spanish regions using a panel data base during the period 1996-2001.

We estimate a water quality-consumption transformation function, finding statistically significant coefficients and the expected signs. Our results suggest that economic activity has a negative impact in water quality and availability in Spain, while capital spending to conserve environmental quality is positively correlated with water quality and availability.

Finally, a simulation based on estimates has been shown, in order to guide the degree of decentralization of future public policies in the water field. Under some assumptions, centralized policies are shown to be superior, because they generate higher utility levels and upper water quality and availability than decentralized option. So, if the administrative costs of centralization were not very important and there is not very strong heterogeneity in preferences, centralized solution would be the best alternative from a welfare point of view.

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(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003

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