Essays on Tax Administration

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de Barcelona

PhD in Economics | Luca Salvadori

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Chapter 1

Introduction

1. Tax Administration in Federal Systems

The literature on fiscal federalism has broadly investigated the consequences of decentralizing tax power. In the presence of mobile tax bases, sub-central government tax policies become interdependent because of the threat of losing tax bases (Brennan & Buchanan, 1980). This leads to a race to the bottom in tax rates, which results in the underprovision of public goods and services (Zodrow & Mieszkowski, 1986; Wilson, 1986). Tax interdependence might also be caused by a process of yardstick competition, when citizens start to assess the performance of their governments by comparing it with that of their neighbours (Besley & Case, 1995). As a result, politicians follow the tax policies of their neighbours so as to be re-elected and, ultimately, this process improves political accountability and may foster the diffusion of tax policy innovations (Rincke, 2009). These sources of interdependence have been extensively analysed with respect to the setting of statutory tax parameters (for a survey see *e.g.* Blöchliger & Pinero-Campos, 2011 and Wilson & Widalsin, 2004), but the theoretical literature is scarce regarding tax administration and there is also a lack of empirical research in this field.

Yet, in any tax system, tax administration clearly plays a crucial role. The existence of this authority is critical, since people are not intrinsically motivated to pay taxes, and so it has to enforce tax compliance. Following on from the seminal paper by Allingham & Sandmo (1972), very many papers have analysed this issue. Specifically, the level of evasion predicted by theory has emerged as being significantly higher than perceived and estimated rates of tax evasion obtained in empirical analyses. The literature has accounted for this discrepancy by claiming that not all taxpayers are equally liable to comply with their fiscal obligations. In this regard, a critical role is played by the degree of civic duty felt by taxpayers or the

level of their tax morale, which is argued to have a positive impact on individual tax compliance (for a survey, see Torgler, 2001). Moreover, the effectiveness of a tax enforcement policy largely depends on the way it is perceived by taxpayers. Thus, the tendency for individuals to give too much weight to the probability of being audited, even when fully informed about actual policy, provides an additional explanation for tax compliance (Alm, 2000). However, even a society with a high degree of tax morale and, hence with a high level of tax compliance still has to rely on the tax administration to manage minor administrative duties such as tracking the reporting of tax returns and detecting taxpayers' involuntary errors.

Thus, in general, it is important to analyse the nature of tax administration policies as they are central to an efficient tax system. Moreover, it is especially interesting to analyse the potential existence of externalities in such policies when the tax administration is decentralized at a sub-central level, as this should shed some light on alternative designs (centralized vs. decentralized) for tax administration within federal frameworks.

The three empirical studies presented in the following chapters are in this sense something of a novelty in the literature. The focus for the whole research line developed in this thesis is Spain, which provides a interesting federal framework for investigation. Indeed the regional governments of fifteen of the seventeen "common" regime autonomous communities have had the power to administer several wealth taxes since the mid-eighties and subsequent reforms, in 1997 and 2002, have conferred on them the normative power to make changes to certain statutory tax parameters (see Esteller, 2008, for further details on these reforms). The other two regions, the so-called "foral" autonomous communities (the Basque Country and Navarre), for historical reasons, administer almost all the taxes falling due within their territory – including VAT, personal income tax and corporate income tax – and they have the normative power to regulate most of them[1].

This setting provides me with the opportunity to explore different types of externalities that might impact tax administration policies. In Chapter 2 the presence of horizontal competition in tax enforcement is examined in the

[1] For more details on the differences between the "foral" and the "common" regimes see e.g. Garcia-Milà and McGuire 2007.

context of the common regime autonomous communities. Chapter 3 presents an analysis of the potential room for cooperation derived from misreported tax returns in this federal context. Chapter 4 estimates the externality effect on tax enforcement caused by the costs of terrorism in the foral autonomous communities. Chapter 5 describes the main contributions and the conclusions of the whole line of research.

The remaining part of this introduction is divided into three sections, each one presenting a summary of the three central chapters in this dissertation, including the contribution made by each study.

2. Horizontal Competition in Tax Enforcement

Tax enforcement undoubtedly represents the most important tax administration policy since it helps determine the level and distribution of effective tax rates (*e.g.* Johns & Slemrod, 2010; Traxler, 2012) and, hence, the total amount of tax revenues collected. The literature on tax interdependencies in tax enforcement is scarce and has only focused on the potential mobility of tax bases. The most relevant theoretical contribution in this sense is that of Cremer & Gahvari (2000) who investigate the consequences of tax evasion on tax competition and harmonization in an economic union. They show that in this framework tax evasion has the effect of provoking a race to the bottom that produces less than optimal equilibrium values of both tax and audit rates. Harmonization policies can avoid this problem but, according to the authors, tax audit policies are too opaque to result in an effective harmonization. Indeed, it is difficult for a country to enforce the effort that each other country employs in its policies. Thus, although tax harmonization is effective in avoiding sub-optimal tax rates it is not successful in circumventing the inefficient outcome of the audit rate.

The study presented in Chapter 2 analyses the presence of horizontal competition in tax enforcement for the case of the Spanish Inheritance and Gift Tax (IGT). After developing a simple theoretical framework, we examine the presence of this interaction by adopting a spatial econometric approach. We measure tax enforcement by using data on actual audits performed by regional governments extracted from the report “Informe

sobre la cesión de tributos a las Comunidades Autónomas" published every year jointly with the project of the general State budget. We employ a spatial panel autoregressive model and obtain results that corroborate the theory; specifically the coefficients for the spatial lag are compatible with the hypothesis of horizontal competition in tax enforcement. This is our main contribution, which is in line with Cremer and Gahvari's results (2000). We also find that once regional governments acquire legal power, the previously opaque competition in enforcement policies appears to switch in part to become a more transparent competition in statutory tax parameters.

3. Tax Cooperation among Sub-Central Administrations

The analysis presented in Chapter 3 investigates the incentives for sub-central tax authorities to cooperate in a decentralized context with the aim of identifying the determinants of that cooperation. In particular, we identify potential room for cooperation when, in the presence of different tax allocation principles (residence and territorial principles) corresponding to the three wealth taxes decentralized in Spain, unintentional errors on the part of uninformed taxpayers might arise. In such situations the regional tax authorities should report the misreported tax revenues to the competent autonomous community. However, there is casual evidence suggesting that this process is not always automatic. Indeed regional tax administrations face the trade-off between cooperating by transmitting the misreported tax revenues and not cooperating and retaining those revenues. In this context, cooperation is a farsighted strategy based on reciprocity, to the extent that if a region cooperates, it should foster cooperation from other regions in the future. On the other hand, not cooperating might be seen as short-sighted behaviour, driven in the main by budget constraints.

Our empirical analysis is based on a Tobit estimation strategy and data extracted from the report "Informe sobre la cesión de tributos a las Comunidades Autónomas" as in the previous Chapter. According to our results, the existence of reciprocity is critical for the transmission of misreported taxes, but there is sluggishness in this process, which is partly a result of tax authorities' short-sighted behaviour due to budget constraints. Hence, this is good news for the functioning of a decentralized tax

administration, as in the medium-long run the gains to be made from sharing tax information are achieved.

4. The impact of Terrorism on Tax Enforcement

Terrorism is a cost for the economies it affects (see e.g. Abadie and Gardeazabal, 2003) since it can have an impact on aggregate economic outputs as well as on specific sectors of activity. As a result, it might impact the setting of fiscal policies as any other idiosyncratic shock would or it might provoke an endogenous reaction by the tax authority to terrorist activity (Gupta et al. 2004). In this regard, the potential effects of terrorist activity on tax bases, tax collection and tax revenues have been largely overlooked. Chapter 4 contributes to this literature by analysing the presence of externalities in tax collection caused by terrorism. Specifically, we seek to analyze the impact of terrorism on tax enforcement policies focusing on the case of the Basque Country. In this framework, terrorism can distort the behaviour of the economic agents residing and operating in this region by inducing them to reduce their investment and consumption or to move their residence in order to avoid the costs of terrorism. In particular, a specific cluster of the population represented by entrepreneurs and liberal professionals has been the object of extortion as well as other targeted attacks by the terrorist organization ETA. For this reason, we believe that the tax enforcement policy could be a flexible, as well as an adaptable, instrument for intervening selectively to compensate this specific group of the population for the costs sustained. Indeed, casual evidence suggests that this might in fact happen. The objective of this paper, therefore, is to determine whether tax enforcement can be employed as an instrument for compensating the negative effects of terrorism on tax bases.

The presence of externalities in tax enforcement attributable to the costs of terrorism is investigated by undertaking a theoretical analysis and by deriving the reaction function of tax enforcement to the costs of terrorism. The findings are tested using Spanish data extracted from repeated surveys and other sources. Different measures of the costs produced by terrorist activity are employed and tax enforcement is measured using Spanish data

based on official surveys[2] where respondents are asked to express their opinion on the authorities' tax enforcement effort. By employing ordered response models, we find evidence of the negative impact of terrorism on tax enforcement as it is perceived by residents in the Basque Country and Navarre. In particular, this impact is found to be stronger for entrepreneurs and liberal professionals. No significant impact is found for individuals resident in the rest of Spain.

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Chapter 2

Empirical Evidence on Horizontal Competition in Tax Enforcement

1. Introduction

Enforcement strategies are crucial elements in the tax management process since they help determine the level and distribution of effective tax rates (*e.g.* Johns & Slemrod, 2010; Traxler, 2012) and, hence, the total amount of tax revenues collected. Moreover, these strategies are of particular interest to federal countries, as auditing policies can represent a second, additional, tax instrument in the hands of sub-central authorities (Besfamille *et al.*, 2013) – along with the setting of statutory tax parameters – on which they can interact. Yet, the possibility of tax enforcement interdependence has received limited attention in the literature (with notable exceptions being Janeba & Peters, 1999; Cremer & Gahvari, 2000 and, Stöwhase & Traxler, 2005) and, to the best of our knowledge, there are no empirical studies investigating the presence of these interactions, which might be due to an absence of data on auditing policies and/or the difficulties in finding an adequate measure to represent the level of "tax enforcement".

We aim to fill this gap in the literature by analysing the presence of horizontal tax interdependence between sub-central administrations in a federal context. In Spain, regional governments, the so-called "Comunidades Autónomas" (henceforth CAs), have had the power to administer several wealth taxes since the mid-eighties, first without any legal authority to modify the rule, though following reforms in 1997 and 2002 they did obtain the legislative power to modify significant tax parameters[3]. Here, we focus specifically on the Inheritance and Gift Tax (IGT), the main decentralized tax on wealth, which has recently become the

[3] More specifically, following the 1997 reform, CAs were permitted to modify their tax rate schedules in line with national schedules. Following the 2002 reform, CAs were granted complete legislative control over the tax rates ceded to them by the central government. For a more precise description of these reforms see Esteller-Moré (2008).

subject of considerable debate both in Spain and in other countries[4]. There is evidence that the decentralization of the IGT in federal countries can induce a race to the bottom in statutory tax parameters (see, for example, Bird, 1991, Conway & Rork, 2004; Brülhart & Parchet, 2011)[5]. The origin of this process is the mobility, or simply the threat of mobility, of tax bases[6]. A similar effect has been documented for the Spanish case (see Durán-Cabré & Esteller-Moré 2010; López-Casasnovas & Durán-Sindreu, 2008), provoking an academic and a more general debate[7]. The Spanish press headlines on these issues are symptomatic: "Cheaper Gifts and Inheritances"; "Regional Tax Competition"; "The Fiscal War among Regions Threatens the IGT"; "Regional Taxation and Voting with Feet"[8].

[4] Taxing wealth and wealth transfers is generally unpopular and has become the subject of debate in several OECD countries, including United States and Canada. In Europe, the UK case is highly illustrative: the IGT is popularly ostracized because it raises relatively little revenue, but it is characterized by an excessively high flat rate (40%). Likewise, it raises issues about double taxation as well as about the absence of effects on wealth distribution (Boadway *et al.*, 2010).

[5] Recently, the European Commission has shown interest in such issues and even though they might arise under different circumstances (*i.e.* cross-border discrimination and double taxation), it would seem to confirm that questions surrounding the inheritance tax are of growing concern to European citizens (European Commission, 2011).

[6] In a decentralized framework, when the principle of residence is applied, an individual finds it profitable to move his fiscal residence to the region with the lowest IGT rate so as to reduce the bequest tax burden.

[7] Spain's IGT is levied on all goods received from the deceased, valued in accordance with market criteria. As such, a progressive tax schedule subjects heirs (usually the spouse and the descendants) to a high tax liability if they have inherited valuable goods. For this reason, tax avoidance is especially attractive for these taxpayers. As the IGT is residence-based, the deceased's place of residence is key to determining where the inheritors pay the tax and how much they are required to pay. All in all, these circumstances encourage agents, in particular the wealthy elderly, to act strategically given the incentives to elude payment of this tax.

[8] The articles quoted are "Donaciones y sucesiones más baratas, y peajes por encima del IPC", ABC, 02/01/2008 (available at: http://goo.gl/douJz); "La competencia fiscal autonómica", El Periódico de Catalunya 24/10/2007; "La guerra fiscal entre comunidades amenaza el tributo sobre las herencias", El País 06/05/2007 (available at: http://goo.gl/Ekcdw) and "Imposición autonómica y voto con los pies", Expansion 22-03-2011 (available at: http://goo.gl/QCzwS). Among other articles see "Las Cámaras detectan 'fuga' de empresas de Cataluña por la competencia fiscal", El Mundo 21/07/2007 (available at: http://goo.gl/6DPP6); "Rosell advierte de que Cataluña puede salir perjudicada por la competencia fiscal con otras autonomias", El País 04/07/2006; "Madrid atrae herencias catalanas que buscan pagar menos impuestos", El Periódico de Catalunya 22/07/2007; (available at: http://goo.gl/Sr0Bd) and "Grandes bufetes eligen sitios fuera de Cataluña y Andalucía para sus clientes", Expansión 05/07/2007 (available at: http://goo.gl/i9Ojj).

These articles seem to corroborate the presence of mobility-based competition in the regional IGT statutory tax parameters[9]. Similarly, we hypothesize that the same type of competition between regions occurred even before the decentralization of legal power, in the form of opaque competition on tax enforcement since it is the effective tax rate that conditions mobility.

The objective of our paper, therefore, is to test the existence of interaction between decentralized administrations when setting their parameters. To achieve this, we develop a model of horizontal competition using the tax instrument of the audit rate, and empirically test its findings. The results of the theoretical framework are in line with the literature on tax rate competition: the threat of mobility tames the revenue maximizing administrations that compete in a race to the bottom over their tax instrument so as not to lose their tax bases[10]. We derive the slope of the administration's reaction function and obtain a positive sign. We proceed to test this result using a spatial econometric approach and estimating a spatial panel autoregressive model (see Anselin *et al.*, 2008). Our results validate the presence of horizontal interdependence between the regions and are coherent with the tax competition model. Moreover, we obtain an additional result: following the decentralization of legislative power on statutory tax parameters we observe a reduction of the competition in enforcement policies at the regional level. It seems that a substitution of instruments occurs: an opaque source of tax competition is partially substituted by a transparent one.

[9] This mobility can be real but also spurious or fictitious. This is confirmed by the results of a recent survey conducted among tax professionals working in Spain (see Durán-Cabré & Esteller-Moré, 2014). 65% of respondents agreed in part or fully with the statement that "Regional differences in the inheritance tax have provoked fictitious changes in people's fiscal residence". This impression is further confirmed by informal conversations that the authors have maintained with former directors of the regional tax authorities.

[10] As Brueckner notes: "It is important to realize that for strategic interaction (and thus the race to the bottom) to materialize, all that is required is a perception on the part of state governments that generous benefits attract welfare migrants" (Brueckner, 2000, p. 508). In our case, rather than generous benefits, it is lax tax auditing policies that can attract taxpayers (or disincentive them to leave), or at least it is perceived in this way by the tax administration.

The rest of the paper is organized as follows. In the next section, we provide a summary of the relevant literature, then the theoretical framework is developed and the empirical analysis performed. Finally, we conclude.

2. Literature review

This study is closely related to the vast literature on taxation policy interactions between governments and, in particular, to that research line that deals with horizontal tax competition (see Brennan & Buchanan, 1980; Zodrow & Mieszkosky, 1986; and Wilson, 1986). This approach analyses a decentralized framework in which local governments compete in a race to the bottom when fixing tax rates in order to gain or, at least not to lose, their tax bases. The mobility or simply the threat of mobility of capital and people reduces government discretion to set tax rates at an optimal level with the effect of tax revenue reductions[11].

This literature has offered limited attention to enforcement policies although they represent critical elements in the tax management process. The papers investigating these issues solely focused on the case of between-countries tax enforcement competition and the most relevant theoretical contribution in this sense is that of Cremer & Gahvari (2000). Using a welfare maximizing framework, they examine the implications of tax evasion for fiscal competition and tax harmonization policies in an economic union. The countries have the power to set both tax rates and tax audit policies. In a closed economy framework, allowing for tax evasion increases the marginal cost of public funds and reduces the level of public good provision. From our perspective the most interesting result of the paper concerns the economic union of two tax-evading countries. In this setting, the states engage in mobility-based competition that produces less than optimal equilibrium values of both tax and audit rates. Harmonization policies can theoretically circumvent this problem but, according to the

[11] The applied literature that tests these theoretical models from an empirical point of view is vast and takes a spatial econometric approach (see Anselin, 1988). Among others, see for example: Figlio *et al.* (1999) who examine the simultaneous setting of welfare benefits for the U.S. case; *Rork* (2003) who analyses competition involving five types of tax (*i.e.* taxes on cigarettes, gasoline, personal income, general sales and corporate income) for the U.S. case; Devereux *et al.* (2006) who focus on excise taxes, again for the U.S. case, Devereux *et al.* (2008) and Overesch & Rincke (2011) who examine corporate taxes for the U.S. and the European cases, respectively.

authors, coordinating audit strategies may be problematic because it is difficult for the government of one country to observe and verify the enforcement efforts of the other. For this reason, although a harmonization policy on tax rates is effective in circumventing tax rate sub-optimality, it is not sufficient for avoiding the inefficient outcome of the auditing rate: since member states are no longer allowed to compete over tax rates, they lower their effective rates by cutting their auditing probabilities.

A further contribution to this literature is provided by Stöwhase & Traxler (2005) who analyse the implications of different equalization systems on regional enforcement policies in a federal framework taking the statutory tax rates as being exogenously fixed at the central level. The benchmark framework presents no equalization scheme and is consistent with the results of Cremer & Gahvari (2000). Their most interesting result suggests that one way of partially circumventing the inefficient outcome of enforcement is to use a particular equalization scheme. By introducing a gross revenue sharing scheme, under which tax revenues are shared but auditing costs are borne fully by each region, an even more inefficient enforcement policy outcome is obtained. By considering instead a net revenue sharing scheme, under which both tax revenues and auditing costs are shared, the outcome is more efficient than both under the benchmark and the gross revenue sharing schemes.

Janeba & Peters (1999) analyse the taxation of interest income in an economic union of two countries in the presence of tax evasion. In their setting, the enforcement effort is proxied by the treatment of the non-residents' tax base. In fact, any state can decide whether to discriminate against the mobile tax base when setting the tax rate. The result is analogous to a prisoners' dilemma. The authors show that if a sequential structure of the game is considered and any country has initially to decide whether or not to discriminate and then to set the level of the tax rates, an equilibrium will always exist: both countries discriminate by offering a lower tax rate to non-resident's income with respect to that of the residents. In equilibrium this strategy will allow the mobile bases to evade taxation successfully. In this sense, a discrimination strategy is analogous to mobility-based competition in both enforcement policies and tax rates. If, by contrast, all countries harmonize their policies and decide not to

discriminate, tax competition will lead to a lower level of tax evasion. This strategy is dominated by the one in which both countries discriminate and so cannot be reached in equilibrium.

The literature on tax enforcement mobility-based competition, therefore, agrees on the impossibility of overcoming the inefficient outcome produced by audit policies by setting a harmonization policy, and, although some alternative strategies have been proposed, further research is needed in this field. In particular no empirical study has been conducted to test these models. Seen from this perspective, the case of wealth taxes seems to be particularly appropriate for investigation. Indeed the literature suggests that the cost of levying these taxes in federal systems is significantly increased by both vertical and horizontal tax competition (Bird, 1991). In Australia and Canada, for instance, the coexistence of a federal and a sub-central gift and estate tax led to the abolishment of the former (in 1978 and 1972 respectively). This favoured the disappearance of the regional gift and estate tax too which succumbed (in 1983 in Australia and in 1986 in Canada) to the pressures of horizontal tax competition (Duff, 2005). In the U.S. the wealth transfer taxes (i.e., estate, inheritance and gift taxes depending on the state) have been repealed in 33 of the 48 contiguous states and their elimination is under discussion in the remaining 15. Conway & Rork (2004), drawing on historical elderly migration data, show that this is the result of a mobility-based competition process. The same process has occurred in the majority of Swiss cantons since the early 1990s and tax competition was the main argument in the political debate regarding these reforms (Brülhart & Parchet, 2011).

The empirical evidence on wealth taxes confirms the presence of mobility-based competition in statutory tax parameters but the possibility that these interactions may also occur at the enforcement level has yet to be investigated. From this perspective, it is also useful to relate our analysis to the literature examining the determinants of tax administration. Although there is no agreement as to the objective function of a tax administration, the dominant approach sees it as a public agency that maximizes tax revenues (*e.g.* Shaw *et al.*, 2009; Slemrod & Yitzhaki, 2002, 1987). However, recent empirical papers suggest that political as well as budgetary variables play a role in determining a tax administration's enforcement

effort (see, for example, Young *et al.*, 2001; Baretti *et al.*, 2002; Esteller-Moré, 2005, 2011).

In order to gain a better understanding of the behaviour of sub-central administration we undertake an empirical analysis of the case of the IGT. We fulfil this objective by developing a simple theoretical framework that allows us to set up the basic hypotheses for empirical testing.

3. The theoretical framework: "mobility-based" competition in presence of tax evasion

Here, we consider mobility-based competition as a potential source of interdependence between sub-central tax administrations: we present a simple model of tax competition in the presence of tax evasion[12]. The framework is modelled as a federal state comprising two regions ($i = 1,2$) of equal size in which the total population is normalized to one. At the regional level there are two institutional agents: the government that sets the tax rate $t_i \in (0,1)$ and the tax administration that controls the auditing probability $\beta_i \in (0,1)$. Following the most common approach in the literature, we assume that the tax administration acts as a Leviathan and sets its audit policies so as to maximize total tax revenues. Since we are not interested in statutory tax parameter interactions we do not solve the government's problem and take tax rates as given. Taxpayers decide the share $\alpha \in (0,1)$ of wealth B to declare maximizing their utility. To ensure an interior solution, tax evasion is assumed to be costly for the individual. Moreover, taxpayers are neutral risk-averse in order to avoid any income effect. For the sake of simplicity, we do not develop the individual's problem but the results are in line with the standard literature (see Allingham & Sandmo 1972; Cremer & Gahvari, 2000). The model is developed in two stages and the solution is provided by backward induction:

1. Regional tax administrations set tax auditing policies.
2. Individuals decide in which region of the federation to locate by comparing their indirect utility function (based on their current tax

[12] The model is based on Cremer & Gahvari (2000).

burden) in the two regions. This stage is solved by exploiting the concept of "home attachment" (see Mansoorian & Myers, 1993 and 1997).

3.1 Stage 2: The decision as to which region to reside in

To model the concept of "home" we assume that taxpayers are indexed by $n \in (0,1)$ and are uniformly distributed between 0 and 1[13]. The preferences of taxpayer n with respect to his location are given by:

$$V(n) = \begin{cases} {U_1}^* + a \times (1-n) & \text{if } n \text{ lives in region 1} \\ {U_2}^* + a \times n & \text{if } n \text{ lives in region 2} \end{cases} \quad (1)$$

where ${U_i}^* = {U_i}^*(1-\alpha^*(t_i,\beta_i))$ represents the (pecuniary) indirect utility function of an individual residing in region $i = 1, 2$[14] and $n \in (0,1)$ indexes the individuals measuring the non-pecuniary (psychic) benefit they derive from living in region 2[15]. Thus, taxpayers indexed by $n \in \left(0, \frac{1}{2}\right)$ reside in region 1 while those identified by $n \in \left(\frac{1}{2}, 1\right)$ reside in region 2. The parameter $a \in (0, +\infty)$ measures the degree of individual mobility and its interpretation is crucial. We assume a to represent the cost incurred when moving from the home region[16]. The taxpayer's utility from living in his own region increases with the cost of mobility: if the costs are low (high) then the relative importance that the taxpayer assigns to the psychic part of the utility function, with respect to the pecuniary function, is low (high)[17]. The mobility equilibrium is characterized as:

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[13] See Appendix 1 for a generalisation of the model that makes this assumption about the population distribution.

[14] The direct utility function is defined as $U = B \times [1 - t_i \times [\alpha + (1-\alpha) \times \tau \times \beta_i] - g(1-\alpha)]$. where$(\tau - 1) > 0$ is the exogenous tax penalty per unit of tax evaded and the function $g(1-\alpha)$ represents the cost of tax evasion $(1-\alpha)$, such that $g'(1-\alpha) > 0$, $g''(1-\alpha) > 0$, $g(0) = 0, g(1) \to +\infty$.

[15] The psychic benefit from living in region 1is then expressed as $(1-n)$.

[16] Since mobility could be either real or fictitious, this could be interpreted as the cost of actual mobility or the cost of making apparent a fictitious movement.

[17] When the mobility cost is null $(a = 0)$ the tax bases become perfectly mobile: only the pecuniary part of the utility function matters in the taxpayer's migration decision. By contrast, when the mobility costs are extremely high $(a \to +\infty)$ the taxpayers are

$$U_1^* + a \times (1 - n_1) = U_2^* + a \times n_1$$
$$U_1^* + a \times (1 - n) > U_2^* + a \times n \quad \forall n < n_1$$
$$U_1^* + a \times (1 - n) < U_2^* + a \times n \quad \forall n > n_1 \qquad (2)$$

where $n = n_1$ represents the marginal individual indifferent between living in region 1 and region 2 and, since $\int_0^{n_1} dn = n_1$, it also represents the population in region 1 in the migration equilibrium:

$$n_1 = n_1(t_1, \beta_1, t_2, \beta_2; a) = \frac{1}{2} + \frac{U_1^* - U_2^*}{2a} =$$
$$= \frac{1}{2} + \frac{B \times [\theta_2 - \theta_1 + g_2 - g_1]}{2a} \qquad (3)$$

where $\theta_i \equiv t_i \times [\alpha + (1 - \alpha) \times \tau \times \beta_i]$ is defined as the effective tax rate for the region $i = 1,2$. For the sake of simplicity, the superscripts on the variables are omitted. The population in region 2 in the migration equilibrium is:

$$n_2 = \int_{n_1}^{1} dn = 1 - n_1 \qquad (4)$$

3.2 Stage 1: Regional administrations set tax audit policies

The problem is symmetric: the two administrations compete "à la Cournot" setting their tax policies. We develop the problem of administration 1. This administration faces the following problem given the governments' decisions regarding tax rates and anticipating the results of the last stage:

$$\underset{\beta_1}{Max}\ R_1(\beta_1, \beta_2; t_1, t_2, a) = n_1 \times r_1 =$$
$$= \left(\frac{1}{2} + \frac{B \times [\theta_2 - \theta_1 + g_2 - g_1]}{2a}\right) \times [B \times \theta_1 - d(\beta_1)]$$

---

perfectly immobile. This can be interpreted as a centralized economy case in which a sole federal planner sets tax policies. These two limit cases are excluded to allow for imperfect mobility of individuals.

where $d(\beta_i)$ represents the tax administration cost such that $d'(\beta_1) > 0, d(\beta_1)'' > 0$ and $r_i \equiv \frac{R_i}{n_i} = [B \times \theta_i - d(\beta_i)]$ is the unitary tax revenue.

Since the two regions are symmetric, we can show that a symmetric Nash equilibrium exists, satisfying the following condition obtained from the first order condition (FOC) of the administrations. Hence $t_1 = t_2 = t$, $\beta_1 = \beta_2 = \beta$ and:

$$\beta: \quad r'_\beta = -2n'_\beta \times r > 0 \tag{5}$$

The factor $-2n'_\beta$ represents the expected loss in the number of taxpayers due to an increase in β. So the right-hand side of equation (5) corresponds to the marginal mobility costs for the regional administration in terms of tax revenue losses due to an increase in β. The left-hand side represents the net marginal revenue due to an increase in β.

By developing condition (5) we find that $B \times \frac{\partial \theta}{\partial \beta} - d'(\beta) = r \times \frac{B \times \left(\frac{\partial \theta}{\partial \beta} + \frac{\partial g}{\partial \beta}\right)}{a}$. This shows us immediately that in the limit case of centralization ($a \to +\infty$), the marginal mobility costs are null and that $r'_\beta = 0$: we are at the bliss point of the Laffer curve. Since the marginal mobility costs are positive, under decentralization ($a \in (0, +\infty)$) the tax auditing implementation is more costly. In fact, the net marginal tax revenue is positive ($r'_\beta > 0$) and tax enforcement is less severe than under centralisation: the threat of the mobility of the tax base tames the administration. This result replicates that reported by Cremer and Ghavari (2000).

3.3 The slope of the reaction function and other comparative statics

Since the purpose of this paper is to test empirically the presence of regional interdependence in the setting of tax audit policies, we wish to examine the process by which regional administrations reach the equilibrium level of audit probability. In other words, we are interested in evaluating the slope of the reaction function $\beta_i(\beta_j)$. A non-null sign would highlight the presence of some kind of interaction between regions. It is

easy to show that[18]:

$$\frac{\partial \beta_1}{\partial \beta_2} = -\frac{R_{1_{\beta_1\beta_2}}(\beta_1, \beta_2; t_1, t_2, a)}{R_{1_{\beta_1\beta_1}}(\beta_1, \beta_2; t_1, t_2, a)} = -\frac{n_{1_{\beta_2}} \times r_{1_{\beta_1}}}{R_{1_{\beta_1\beta_1}}(\beta_1, \beta_2; t_1, t_2, a)} > 0 \qquad (6)$$

The first term in the numerator of equation (6) represents the derivative of the population in region 1 with respect to the enforcement of region 2 and is positive: once region 2 increases its audit probability, some residents in region 2 will move to region 1. The second factor in the numerator represents the marginal unitary tax revenue that is positive under the FOC. According to the second order condition (SOC) of the administration's problem the denominator of equation (6) is negative. The slope of the reaction function is then positive: the regional administrations set their audit strategies in a complementary fashion and so they are competing over this instrument in order to attract (or at least not to lose) their tax base. We test this result by means of econometric techniques. Our main research question can therefore be stated as follows: to what extent does the audit policy of each region depend on the enforcement strategies adopted by the other regions? Moreover, it is possible to show that $\frac{\partial\left(\frac{\partial \beta_1}{\partial \beta_2}\right)}{\partial a} < 0$ (see Appendix 2 for details). This means that the competition between regions weakens as the mobility costs rise. Since it seems reasonable to assume that mobility costs will be positively correlated with the distance between regions, two distant regions will compete less than two regions that lie closer together. We explicitly take this into consideration when choosing the econometric strategy.

A further result to emerge concerns the strategic relationship between β_1 and t_2:

$$\frac{\partial \beta_1}{\partial t_2} = -\frac{R_{1_{\beta_1 t_2}}(\beta_1, \beta_2; t_1, t_2, a)}{R_{1_{\beta_1\beta_1}}(\beta_1, \beta_2; t_1, t_2, a)} = -\frac{n_{1_{t_2}} \times r_{1_{\beta_1}}}{R_{1_{\beta_1\beta_1}}(\beta_1, \beta_2; t_1, t_2, a)} > 0 \qquad (7)$$

[18] For additional computations, please see Appendix 4 of the working paper version of this study (IEB Working Paper series 2012/005) downloadable at: http://www.ieb.ub.edu/en/2012022157/ieb/latest-publications#.UHQCbk26eyo.

Expression (7) indicates that β_1 and t_2 are strategic complements; thus, if the government in one region reduces its statutory tax rate t_2, *ceteris paribus*, the administration in the competing region will unambiguously react by setting a lower audit rate β_1 in order not to lose any of its tax base. We empirically test this result in the next section. As for the strategic relationship between the audit rate and the tax rate in the same region, it is not possible to establish unambiguously whether β_i and t_i are in fact strategic complements or strategic substitutes. We investigate this question in greater depth in our empirical analysis.

In our model we do not explicitly consider any technological restrictions that might limit the discretion of the regional tax authorities to react freely to any policy change implemented by the competing region. In designing our empirical strategy, however, we relax this assumption.

So far we have assumed the threat of tax base mobility to be the only source of interaction. In our empirical analysis we test an additional source of interdependence, namely the yardstick competition hypothesis (Besley & Case, 1995). This assumes that the interdependence in tax enforcement is the result of a mimicking process among neighbouring tax authorities aimed at seeking a larger share of votes, and hence ensuring re-election.

4. Empirical Analysis

In this section we provide a description of the database we have built to test the main hypotheses by means of an econometric model and finally we present and comment the main results emerging from the analysis.

4.1 The empirical framework

The theoretical framework presented in the previous section offers interesting insights that require empirical testing: the horizontal tax competition model suggests that revenue- maximizing administrations set their audit policies in a complementary fashion, interacting so as not to lose tax bases. This result can be derived from equation (6). To test it we estimate a spatial autoregressive panel model (see Anselin *et al.* 2008).

Information about regional tax enforcement policies is released annually in the report, *Informe sobre la cesión de tributos a las Comunidades*

Autónomas, published together with the Spanish National Budget, *Proyecto de Presupuestos Generales del Estado*. The report registers the number of audits performed each year by each region ($Audits_{it}$) together with the number of tax returns received (TR_{it}), information that is used to define our endogenous variable. The basic model to be estimated is the following:

$$log(\beta)_{it} = \gamma log(\beta)_{-it} + \xi Ded_{it} + \psi Ded_{-it-1} + \boldsymbol{X_{it}}\boldsymbol{\alpha} + \vartheta_i + \tau_t + \varepsilon_{it} \quad (8)$$

In order to make the dependent variable comparable across small and large regions we employ the audit rate defined as $\beta_{it} \equiv \frac{Audits_{it}}{TR_{it}}$. The term $log(\beta)_{-it} \equiv \sum_{j=1}^{N} w_{ij}\, log(\beta)_{jt}$ is the spatial lag of the endogenous variable and w_{ij} is the spatial weight that describes the relative interdependence of regions i and j in such a way that $w_{ij} \geq 0$ if $i \neq j$ and $w_{ij} = 0$ if $i = j$. Specifically, we employ a spatial matrix based on the inverse of the distance between regional capitals. The choice is made on the basis of the results of the theoretical model: when the distance between two regions – a proxy of mobility costs – increases we observe a lower level of competition in terms of their auditing policies[19]. More precisely in order to define w_{ij} for $i \neq j$ we use the inverse squared distance and we apply a spectral-normalization[20] to the weights (see Drukker, *et al.*, 2011). The standard practice in the literature is to adopt a "row standardization" to normalize the spatial matrix, meaning that the sums of the spatial weights in each row are standardized so that they add up to 1. This procedure is appropriate in most cases. However, applying this procedure with inverse distance based matrixes is more controversial. In fact, the explanatory role of distance could be weakened: row standardization makes the distances relative rather than absolute, *i.e.* within each row inverse distances are scaled to a row-specific scale of 0 to 1. Thus, row standardization does not change the relative weight that the CAs exert on other units within the same

[19] While the recent literature suggests that a change in the spatial matrix is not crucial (LeSage & Pace 2010), in our case the model can be assumed to be better specified than one based on a simple natural neighbours matrix because the Spanish state includes a number of islands, the presence of which makes the definition of neighbours arbitrary (see, for example, Costa-Font & Pons-Novell, 2007). However, to check robustness we also replicate the analysis employing alternative spatial matrixes.

[20] In a spectral-normalized matrix, the (i, j)th element of W becomes $w^*_{ij} = w_{ij}/v$, where v is the largest of the moduli of the eigenvalues of W.

row, but it does change it across rows with the result that the spatial lag coefficients may be biased (see *e.g.* Ghinamo *et al.*, 2010). For this reason we employ a spectral normalization technique which, by normalizing the spatial weights by the same scalar, preserves symmetry and basic model specifications such as the explanatory role of distance[21]. So the spatial lag term accounts for potential strategic competition in audit policies. According to the theoretical framework, eq. (6), we expect γ to be positive.

To account for the potential impact of modifications to the statutory tax parameters, we include a dummy (Ded_{it}) equal to one if the regional government i makes a marked deduction in favour of the most common heirs during the year t[22]. These modifications to the deduction regime substantially reduce the level of the effective tax rate and there is evidence that they induce a convergence process among regions compatible with a race to the bottom (Durán-Cabré & Esteller-Moré 2009, 2010). We can then interpret a Ded_{it} value equal to 1 as a modification to the corresponding regional statutory tax parameters that results in a less severe tax rate. As such this variable picks up the strategic interaction between the tax instruments controlled by the tax authority and the government of that same region, respectively. In line with what was previously stated a positive (negative) coefficient would indicate that these instruments are substitutes (complements). Finally, we control for Ded_{-it}, which represents the weighted average of the neighbours' deduction policies. In line with the above reasoning, an increase in this variable is compatible with a decrease in the weighted average of the neighbours' tax burden. Thus according to the theoretical model (equation (7)), we expect the coefficient of this variable to be negative: a higher Ded_{-it} would correspond to a decreasing audit rate.

Tax administration policies might also be sensitive to "technological",

[21] As an alternative we also employed a minmax-normalized matrix (see Drukker, *et al.*, 2011) where the (i, j)th element of W becomes $w^*_{ij} = w_{ij}/m$ and $m = \min(\max(r_i),\max(c_i))$, with $\max(r_i)$ being the largest row sum of W and $\max(c_i)$ being the largest column sum of W. We do not report the results because they are qualitatively unaffected but they are available on request.

[22] The main heirs are the spouse, descendants/ascendants who with this rule enjoy almost complete exemption. For details on the normative aspect of the exemption regime see Durán-Cabré and Esteller-Moré (2009, 2010).

"political" and "budgetary" effects (see *e.g.* Esteller-Moré, 2005, 2011 and Young, *et al.*, 2001), as well as to other elements for which we control. From the technological perspective, it is reasonable to assume that the number of inspections that has to be performed is established by the regional tax authorities conditional on its workload. We can define the workload as the ratio between the number of tax returns received (TR_{it}) and the number of inspectors employed in the office ($Inspectors_{it}$)[23]. As such, these variables express the technological restrictions a regional tax authority faces in terms of its size and structure [24]. We include TR_{it} and $Inspectors_{it}$ separately in our regression in order to incorporate the effect of workload changes in a flexible manner. These variables together with the endogenous variable are expressed in logs in order to evaluate directly the elasticity of β_{it} with respect to TR_{it} and $Inspectors_{it}$.

As for the political elements that might influence the tax administration we employ $Election\ year_{it}$, a dummy variable equal to one if there is an election in region i during the year t, in order to control for the electoral cycle. $Leftist\ government_{it}$ is another dummy equal to one if the party in office in a specific region and year is on the left of the political spectrum.

In the case of the economic or budgetary effects we employ three main variables. We use per capita GDP to control for the regional economic cycle and tax capacity. The per capita deficit and the total amount of transfers received from the central government divided by total regional expenditure are introduced to account for further relevant budgetary factors.

We control for any unobserved factors that might be correlated with the rest of the predetermined variables by including a set of fixed effects, ϑ_i. It would be recommendable to control for common shocks by means of time dummies, but this is not generally feasible in this model because it reduces

[23] The number of inspectors is also taken from the report *Informe sobre la cesión de tributos a las Comunidades Autónomas*. The variable $Inspectors_{it}$ is defined as "number of normalized inspectors": the number of staff members engaged in tax enforcement is conventionally calculated as the weighted sum of inspectors and sub-inspectors considered in function of the months effectively worked.

[24] More specifically TR_{it} is a measure of the size of the tax administration in terms of the amount of work it has to process while $Inspectors_{it}$ denotes the size of the regional tax authority in terms of the personnel employed in enforcement.

the identification of the spatial lag coefficient (see Devereux *et al.* (2008), p. 1224). By way of an alternative, we include individual time trends, τ_t. Finally, ε_{it} is the error term.

We enrich the model in order to gain a better understanding of the extent to which the reforms first implemented in Spain in the mid-nineties have affected the horizontal interdependence in tax auditing. More specifically in order to disentangle the role of either one of the two reforms that progressively gave greater tax legislative power to the regional governments, we employ a model in which we interact the spatial lag with a dummy associated with the first wave of decentralization ($d96\_01_{it}$) and another dummy that identifies the second reform (2002) ($post01_{it}$)[25].

$$\begin{aligned} log(\beta)_{it} = \gamma' log(\beta)_{-it} + \delta d96\_01_{it} \times log(\beta)_{-it} + \pi post01_{it} \\ \times log(\beta)_{-it} + \xi' Ded_{it} + \psi' Ded_{-it-1} + \boldsymbol{X_{it}\alpha'} + \rho d96\_01_{it} \\ + \sigma post01_{it} + \vartheta'_i + \tau'_t + \varepsilon'_{it} \end{aligned} \quad (9)$$

If δ and π, the coefficients of the interaction terms in equation (9), are found to be negative (positive), this would mean that following the reforms that gradually decentralized legislative power vis-à-vis statutory tax parameters, the regions began to compete less (more) regarding their auditing policies. The impact of the second reform on the consequent race to the bottom in statutory tax parameters was much more important than that one resulting from the first reform; hence, we expect this second reform to have a stronger influence on audit policies (*i.e.* we expect $|\delta| > |\pi|$).

4.2 Estimation strategy

As is well known, the spatial lag term is typically correlated with the disturbance terms and so must be treated as an endogenous variable and accurately estimated. It should be noted in this respect that OLS or within-group estimators are biased and inconsistent due to the simultaneity bias

[25] We also estimate two alternative models. In order to test whether the spatial lag is affected by the decentralization process as a whole, we interact the spatial lag with $post96_{it}$, a dummy equal to one for years posterior to the first IGT reform (1997). With the purpose of emphasizing the effects of the second IGT reform on the process of enforcement competition, we estimate one final model where the spatial lag is interacted solely with $post01_{it}$. The aim in this case is to emphasize the effects of the second IGT reform on the process of enforcement competition.

(see Anselin, 1988 p. 58). In order to deal with this problem, we employ the standard instrumental variable (IV) approach (see Kelejian & Robinson, 1993 and Kelejian & Prucha, 1998). While other techniques, such as the maximum likelihood (ML) approach, are available (see Brueckner, 2003, for details), IV estimation provides consistent estimates even in the presence of spatially correlated error terms (Kelejian and Prucha, 1998; Brueckner, 2003) and offers the advantage of computational ease. Thus, in line with the literature (see e.g. Figlio *et al*., 1999; Fredriksson & Millimet, 2002; Fredriksson *et al.,* 2004; Millimet & Rangaprasad 2007), we use a subset of the exogenous explanatory variables in equation (8) as instruments, employing the same weighting scheme for the instruments as that used for the spatial lag. We repeat this procedure with equation (9) instrumenting as above the interaction terms.

We opted for the generalized method of moments (GMM-IV) approach as our main estimation strategy since, according to Baum *et al.* (2003), it is more efficient than the two-stage least squares estimation (2SLS) in the presence of heteroskedastic errors. We also report jackknife two-stage least squares (JN2SLS) and Fuller (1977) estimators, which outperform the other options particularly in the presence of weak instruments and do not suffer from small sample biases (Hahn et al., 2004). Several diagnostic tests are reported to evaluate the reliability of the instruments employed. In order to test the instruments' validity we performed the Hansen (1982) test of overidentifying restrictions, and we also report the Kleibergen-Paap (2006) test for the underidentification of the equation and, finally, the Cragg-Donald Wald F statistic when testing the weakness of the instruments[26].

4.3 Data, sources and descriptive statistics

Our panel comprises information about the 15 Spanish "common regime" Autonomous Communities[27] for the period 1987-2009[28]. With the exception

[26] We also report the range of critical values for the Stock & Yogo (2005) weak identification test.

[27] The Communities of Navarre and the Basque Country form part of the Foral System, which grants them independence in their laws and tax administrations. For this reason information about them is not available and they are not included in the paper.

[28] We do not have any information about the administration policies of 1993, as in 1995 the budget had not been approved and data about ceded taxes is two-year lagged. Auditing information for the Madrid Community became available in 1996, the year in which it was granted this administrative power.

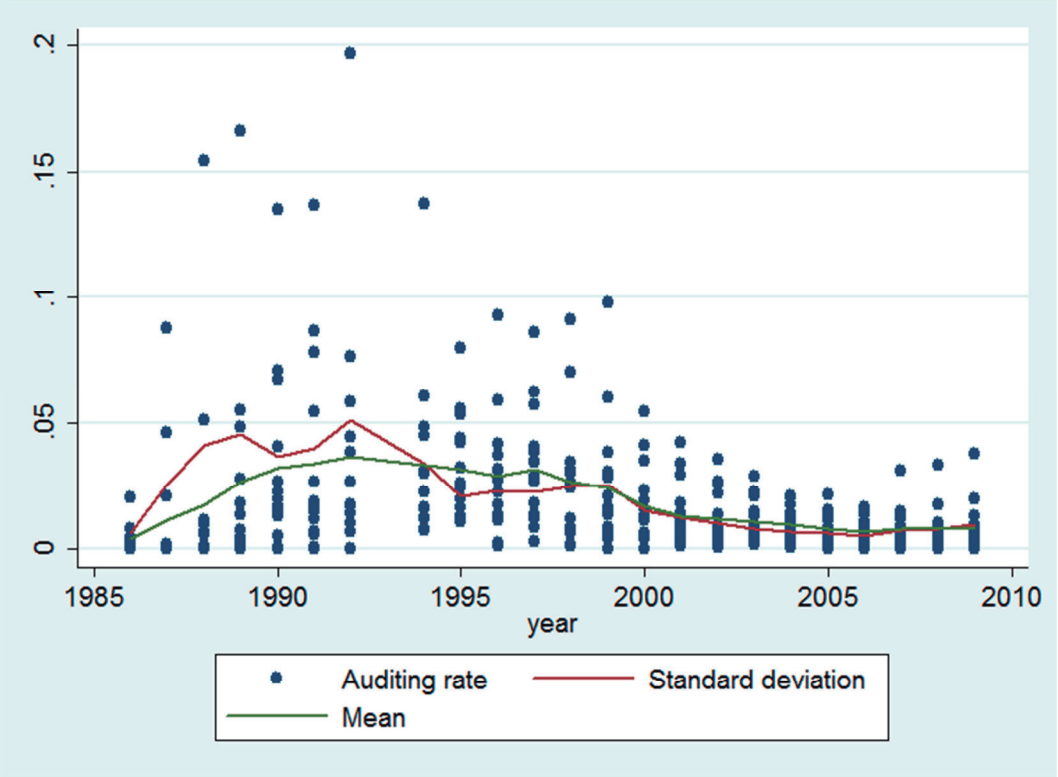
of the endogenous variable and the number of inspectors discussed above, the other variables are obtained from the following statistical sources. The $Per\text{-}Capita\ GDP_{it}$ is provided by the Spanish National Institute of Statistics (INE). The variable $Per\text{-}Capita\ Deficit_{it}$ is the deficit expected at the beginning of the fiscal year expressed in relation to population and it is extracted from the database maintained by the Ministry of Economy and Finance. The $Transfers/Expenditure_{it}$ is constructed as the ratio between the total amount of transfers received from the central government (extracted from the INE database) and the total regional expenditure (extracted from the Ministry of Economy and Finance database). The information on election years is obtained from the Interior Ministry's website (http://goo.gl/YCS3J) while the information about the political colour of each regional government, required to construct the dummy $Leftist\ government_{it}$, is obtained from Zarate's Political Collections website (http://zarate.eu/spain2.htm). The information used to construct the dummy Ded_{it}, which accounts for the introduction of IGT deductions, is taken from Durán-Cabré & Esteller-Moré (2009). In Table 1 we report a summary statistics.

Table 1: Summary statistics

Variable	Measurement unit	Obs.	Mean	Std. Dev.	Min	Max
β	audit rate	307	0.02	0.03	5×10^{-5}	0.20
TR	number of tax returns	308	21187	18234.62	1641	88528
Inspectors	number of inspectors	308	5.98	5.70	1×10^{-8}	32.80
Per Capita GDP	thousands of 2001 euro per capita	322	11.53	5.50	2.17	23.02
Per Capita Deficit	thousands of 2001 euro per capita	308	-0.03	0.08	-0.54	0.43
Transfers/Expenditure	share of expenditure financed by transfers	294	0.40	0.13	0.11	1.37
Election year	dummy for elections	322	0.25	0.44	0	1
Leftist government	dummy for leftist government	322	0.46	0.50	0	1
Deduction	dummy for deduction schemes	322	0.13	0.34	0	1

The statistics concerning the audit rate specifically state that the probability of an inspection ranges from a minimum of 0.005% to a maximum of 20% with a mean value of 2%. In Graph 1 we plot a scatter diagram of the IGT audit rate in the Spanish regions together with the evolution in the rate's mean and standard deviation. The data show a reduction in the dispersion and mean across regions during the period. Indeed, it seems that a convergence process takes place and that this in turn is coherent with the hypothesis of a race to the bottom in tax enforcement.

Graph 1: Dispersion of the audit rate



5. Main results

In Table 2 we report the results of the model expressed in equation (8). As discussed above, the model is estimated using four different estimation techniques, namely, GMM-IV, 2SLS, JN2SLS and the Fuller estimator. We also report by way of a baseline estimation a model without the spatial lag and a model in which the spatial lag is not instrumented. In all the models the spatial lag coefficient is positive and significant, which confirms that horizontal interactions between regional administrations do take place when audit policies are set. This, in turn, is consistent with the hypothesis of tax

competition adopted in the theoretical model and with the previous literature on tax competition.

As for the other variables, we find that $\log(TR)_{it}$ is significant and the correspondent coefficient is negative, *i.e.* that the elasticity of the audit rate with respect to the number of tax returns is negative. This means that *ceteris paribus* a variation of 1% in the number of tax returns corresponds to a variation of about -1.8% in the audit rate. Thus, for a given number of inspectors, an increase in their workload corresponds to a decrease in the auditing rate due to a lower share of audited tax returns. A further significant result is found with regard to the number of inspectors. The elasticity of β_{it} with respect to $Inspectors_{it}$ is positive indicating that *ceteris paribus* an increase of 1% in the number of inspectors corresponds to an increase of about 0.3% in the audit rate. This means that, for a given level of workload, increasing the number of inspectors results in higher tax enforcement. Thus, these two results suggest that the regional tax authorities are undersized and that the inspectors are overwhelmed by the quantity of work or it might be that it is not financially worthwhile expanding the activity of enforcement any further[29].

In the case of the control variables, we find a significant and negative effect of Ded_{it}on the audit probability: the introduction of a deduction scheme reduces the audit rate by about 0.5%. This result might indicate that once a region introduces a deduction scheme in favour of the main heirs (who as such enjoy virtual exemption from the tax), the need to enforce their tax returns decreases significantly. None of the other controls is found to be significant. More specifically, the signs of the estimates of the per-capita deficit and the transfers-expenditure ratio are as expected, but they are not statistically significant[30].

[29] The optimal size of the tax administration is not readily determined. The problem has been addressed by equating the marginal social benefit of reduced evasion to the marginal resource cost (Slemrod & Yitzhaki, 1987, 2002), which is calculated by assigning a shadow price to the work and time a tax inspector employs in selecting, processing and inspecting a tax return (Yitzhaki, & Vakneen, 1989).

[30] We performed further analyses (available on request) in order to test whether the relationship of the per-capita deficit and the transfers-expenditure ratio with the tax enforcement was nonlinear but the qualitative results remained unchanged.

Table 2: Tax audit interdependence. Spatial matrix: Inverse of the squared distance with spectral normalization

	(1)	(2)	(3)	(4)	(5)	(6)
Estimator	Within-FE Log(β)	Within-FE Log(β)	GMM-IV Log(β)	2SLS Log(β)	JN2SLS Log(β)	FULLER(4) Log(β)
Spatial Lag	-	0.635**	0.689***	0.724***	0.724**	0.732***
	-	(3.006)	(2.762)	(2.822)	(2.570)	(2.660)
Log(TR)	-1.108	-1.774**	-1.847**	-1.851**	-1.851**	-1.858**
	(-1.181)	(-2.254)	(-2.391)	(-2.324)	(-1.994)	(-2.315)
Log(Inspectors)	0.300**	0.302**	0.303***	0.304***	0.304	0.304***
	(2.310)	(2.597)	(3.086)	(3.090)	(0.424)	(3.092)
Per-Capita GDP	-0.096	0.031	0.063	0.054	0.054	0.056
	(-0.646)	(0.192)	(0.577)	(0.485)	(0.281)	(0.489)
Per-Capita Deficit	0.495	1.431	1.536	1.542	1.542	1.552
	(0.471)	(1.287)	(1.604)	(1.597)	(1.379)	(1.599)
Transfers/Expenditure	-1.950	-1.328	-1.022	-1.247	-1.247	-1.240
	(-1.284)	(-1.033)	(-1.184)	(-1.417)	(-1.071)	(-1.402)
Election year	-0.072	-0.104	-0.079	-0.105	-0.105	-0.105
	(-0.827)	(-1.041)	(-0.524)	(-0.689)	(-0.624)	(-0.690)
Leftist government	-0.395	-0.319	-0.439**	-0.315	-0.315	-0.314
	(-1.617)	(-1.279)	(-2.051)	(-1.372)	(-1.187)	(-1.369)
Deduction	-0.841***	-0.490**	-0.461*	-0.468*	-0.468	-0.466*
	(-3.061)	(-2.335)	(-1.814)	(-1.830)	(-1.562)	(-1.818)
WDeduction	-	0.247	0.352	0.414	0.414	0.428
	-	(0.311)	(0.583)	(0.667)	(0.587)	(0.664)
_cons	6.479	14.740*				
	(0.735)	(1.970)				
Observations	279	266	266	266	266	266
R^2	0.16	0.29	-	-	-	-
Shea's Partial R^2	-	-	0.18	0.18	0.18	0.18
Underidentification test *(H_0: equation underidentified)*						
Kleibergen-Paap rk LM statistic	-	-	36.762	36.762	36.762	36.762
(p-value)	-	-	0.000	0.000	0.000	0.000
Weak identification test *(H_0: instruments are weak)*						
Cragg-Donald Wald F statistic	-	-	8.803	8.803	8.803	8.803
Stock-Yogo weak ID test range of critical values	-	-	5.15-19.28	5.15-19.28	5.15-19.28	3.63-5.61
Validity test *(H_0: instruments are valid)*						
Hansen J statistic χ^2	-	-	5.222	5.222	5.222	5.204
(p-value)	-	-	0.389	0.389	0.389	0.391

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Fixed effects & time trends in all specifications.

Inspection of the diagnostic test performed to confirm the reliability of the instruments employed shows that our equation is never underidentified and that the instruments are valid, although there is some evidence that they have a weak explanatory power. For this reason we opted also to employ the Fuller estimator as this performs well even in the presence of weak instruments.

In Table 3 we perform various interactions so as to highlight the possible influence of the decentralization process on regional tax enforcement policies. In the first regression we interact the spatial lag with a dummy that captures the effect of the complete period of decentralization beginning in 1997 without differentiating between sub-periods. In column (2) we seek to disentangle the specific effect of each reform. As expected, the second reform has had a stronger impact on auditing competition. Indeed, both in models 2 and 3 the interaction term identifying the effect of the second reform on tax enforcement competition is negative and significant, while the effects of the first reform are statistically insignificant. For this reason, in column (3), we exclude the interaction with the period 1997-2001 (first reform). All in all, the second wave of decentralization of the normative power has attenuated enforcement competition, although there is still evidence of positive interdependence in this policy. Interestingly, it seems that after the second reform there has been a switch in the instruments over which regions compete.

Table 3: Tax audit interdependence – Interactions. Spatial matrix: Inverse of the squared distance with spectral normalization

	(1)	(2)	(3)
Estimator	GMM-IV Log(β)	GMM-IV Log(β)	GMM-IV Log(β)
Spatial Lag	0.917***	0.833***	0.829***
	(5.236)	(5.284)	(3.183)
Spatial Lag×Post96	-0.071	-	-
	(-0.741)	-	-
Spatial Lag×D97-01	-	0.001	-
	-	(0.005)	-
Spatial Lag×Post01	-	-0.191*	-0.262***
	-	(-1.855)	(-2.720)
Log(TR)	-2.020***	-1.917***	-2.051***
	(-2.594)	(-2.642)	(-2.775)
Log(Inspectors)	0.317***	0.311***	0.307***
	(3.252)	(3.254)	(3.162)
Per-Capita GDP	0.068	0.024	0.007
	(0.792)	(0.333)	(0.086)
Per-Capita Deficit	1.423	1.990**	1.848**
	(1.444)	(2.223)	(2.052)
Transfers/Expenditure	-0.818	-0.826	-0.735
	(-0.963)	(-1.049)	(-1.020)
Election year	-0.053	-0.017	0.038
	(-0.372)	(-0.130)	(0.274)
Leftist government	-0.373	-0.128	-0.108
	(-1.631)	(-0.586)	(-0.479)
Deduction	-0.437*	-0.312	-0.412
	(-1.701)	(-1.224)	(-1.600)
WDeduction	0.646	0.195	0.020
	(1.236)	(0.451)	(0.040)
Post96	-0.279	-	-
	(-0.640)	-	-
D97-01	-	-0.090	-
	-	(-0.206)	-
Post01	-	-1.227**	-1.538***
	-	(-2.216)	(-3.359)
Observations	266	266	266
Shea's Partial R^2 (Spatial Lag)	0.50	0.47	0.17
Shea's Partial R^2 (Spatial Lag×Post96)	0.93	-	-
Shea's Partial R^2 (Spatial Lag×D97-01)	-	0.94	-
Shea's Partial R^2 (Spatial Lag×Post01)	-	0.93	0.90

Table 3 continued

	(1)	(2)	(3)
Underidentification test *(H_0: equation underidentified)*			
Kleibergen-Paap rk LM statistic	67.835	64.453	30.056
(p-value)	0.000	0.000	0.000
Weak identification test *(H_0: instruments are weak)*			
Cragg-Donald Wald F statistic	18.201	10.580	4.710
Stock-Yogo weak ID test range of critical values	19.40-4.59	19.29-4.32	18.76-4.66
Validity test *(H_0: instruments are valid)*			
Hansen J statistic χ^2	9.762	21.148	6.289
(p-value)	0.462	0.132	0.615

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Fixed effects & time trends in all specifications.

6. Further results

6.1 Alternative weighting matrixes

In this section we perform an additional analysis and apply a different weighting scheme to the endogenous variable to define the spatial lag. Specifically, we apply two alternative weighting matrixes: a neighbours' matrix[31] and a uniform matrix in which we suppose that any one region interacts with any other region in the same way and so assign a weight equal to one to each CA. We then apply a spectral normalization to each region. We estimate equation (11) using a GMM-IV estimator. In Table 4 we present the results of this analysis. The first matrix (model 2) is an alternative way of defining the competition between regions, *i.e.* assuming that one region competes solely with its neighbours. The results of this model are qualitatively equivalent to those obtained when employing an inverse-of-the-squared-distance weighting matrix. Indeed, the spatial lag is still significant and positive corroborating the horizontal competition hypothesis. More specifically, we can also confirm previous findings concerning the control variables. The last model is underpinned by a hypothesis that is more general with respect to horizontal competition. In other words, what we seek to test is the presence of common intellectual trends as an additional source of interdependence likely to be found in conjunction with mobility-based competition. Here, we suppose that regional tax authorities might mimic each other's innovative procedures in

[31] As previously stated (see footnote 15), a simple, natural neighbours' matrix makes the definition of neighbours quite arbitrary in our case due to the presence of islands. Nevertheless, and due to their proximity, we assume the Balearic Islands to be neighbours of the Valencian CA and Catalonia and the Canary Islands to be neighbours of Andalucía.

the enforcement process. For this reason we employ a uniform matrix that should collect all kinds of interdependence as regards tax enforcement that occur between regions. We obtain a positive and significant coefficient for the spatial lag that supports the presence of alternative sources of interaction, such as common intellectual trends.

Table 4: Tax audit interdependence; Alternative weighting matrixes

	(1)	(2)	(3)
Spatial Matrix	Inverse of squared distance	Neighbours	Uniform
Estimator	GMM-IV Log(β)	GMM-IV Log(β)	GMM-IV Log(β)
Spatial Lag	0.689***	0.737***	0.969***
	(2.762)	(3.663)	(7.033)
Log(TR)	-1.847**	-1.330*	-2.252***
	(-2.391)	(-1.914)	(-3.363)
Log(Inspectors)	0.303***	0.288***	0.295***
	(3.086)	(3.119)	(3.425)
Per-Capita GDP	0.063	0.000	0.011
	(0.577)	(0.000)	(0.119)
Per-Capita Deficit	1.536	1.587*	2.083**
	(1.604)	(1.704)	(2.118)
Transfers/Expenditure	-1.022	-0.113	-0.351
	(-1.184)	(-0.133)	(-0.568)
Election year	-0.079	-0.076	-0.058
	(-0.524)	(-0.510)	(-0.482)
Leftist government	-0.439**	-0.415**	0.050
	(-2.051)	(-2.058)	(0.245)
Deduction	-0.461*	-0.296	0.052
	(-1.814)	(-1.086)	(0.206)
WDeduction	0.352	-0.131	-0.374
	(0.583)	(-0.230)	(-0.553)
Observations	266	266	266
Shea's Partial R^2	0.18	0.22	0.63
Underidentification test *(H_0: equation underidentified)*			
Kleibergen-Paap rk LM statistic	36.762	40.919	70.509
(p-value)	0.000	0.000	0.000
Weak identification test *(H_0: instruments are weak)*			
Cragg-Donald Wald F statistic	8.803	11.145	66.872
Stock-Yogo weak ID test range of critical values	5.15-19.28	5.15-19.28	5.15-19.28
Validity test *(H_0: instruments are valid)*			
Hansen J statistic χ^2	5.222	8.320	8.144
(p-value)	0.389	0.139	0.148

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Fixed effects & time trends in all specifications.

6.2 Testing the yardstick competition hypothesis

We test the yardstick competition hypothesis by employing a GMM-IV approach and the standard neighbours' matrix for the estimation of equation (11). As Bordignon *et al*. suggest: "the crucial point about testing yardstick competition theory is not about local tax setting behaviour as such, but in tax setting as linked to the incentives and constraints that are generated by the local electoral system" (Bordignon *et al*. 2004, p. 332). As for the identification strategy, Besley & Case's (1995) seminal paper proposes distinguishing local governments according to their eligibility to be re-elected. In the presence of term limits, governments that are not eligible for re-election are not expected to react to their neighbours' policy changes.

Unfortunately, this strategy is not available to us, since in Spain there are no term limits. However, other elements taken into account elsewhere in the literature have included the impact of the election year and the electoral margin (see e.g. Solé-Ollé, 2003; Bartolini & Santolini, 2012, or Esteller-Moré & Rizzo, 2014). In the presence of elections, the government's reaction to its neighbours' policy is expected to be greater; by contrast, an incumbent party with a large electoral margin is expected to show little reaction to its neighbours' policy. We use these two elements of the electoral system to test the yardstick competition hypothesis. As such, we interact the spatial lag alternatively with electoral dummies and the electoral margin (defined as the number of seats in the parliament obtained by the party/coalition in government minus the seats necessary to obtain the majority divided by the total seats in the parliament), respectively. The results of these analyses are reported in Table 5.

While the 'un-interacted' spatial lag coefficient is still significant and positive in all specifications, confirming the presence of interdependence, the coefficients of the interacted terms are not significantly different from zero. These results suggest that yardstick competition does not represent a relevant source of interaction for explaining IGT enforcement interdependence.

Table 5: Tax audit interdependence; Testing the yardstick competition hypothesis. Spatial matrix: Neighbours with spectral normalization

	(1)	(2)	(3)	(4)
Spatial Matrix	Neighbours	Neighbours	Neighbours	Neighbours
Estimator	GMM-IV	GMM-IV	GMM-IV	GMM-IV
Spatial Lag	0.737***	0.756***	0.577***	0.622***
	(3.663)	(4.055)	(3.009)	(3.614)
Spatial Lag× Election year	-	0.042	-	-
	-	(0.551)	-	-
Spatial Lag× Election year (-1)	-	-	-0.080	-
	-	-	(-1.035)	-
Spatial Lag× Electoral Margin	-	-	-	-0.000
	-	-	-	(-0.007)
Log(TR)	-1.330*	-1.736***	-1.400**	-1.341*
	(-1.914)	(-2.592)	(-2.279)	(-1.957)
Log(Inspectors)	0.288***	0.285***	0.317***	0.290***
	(3.119)	(3.095)	(3.071)	(3.347)
Per-Capita GDP	0.000	0.033	0.021	-0.017
	(0.000)	(0.340)	(0.205)	(-0.180)
Per-Capita Deficit	1.587*	1.447	1.638*	1.429
	(1.704)	(1.546)	(1.894)	(1.625)
Transfers/Expenditure	-0.113	-0.152	-0.873	-0.454
	(-0.133)	(-0.177)	(-1.108)	(-0.587)
Election year	-0.076	0.179	-	-
	(-0.510)	(0.501)	-	-
Leftist government	-	-	-0.342	-
	-	-	(-0.944)	-
Deduction	-0.415**	-0.296	-0.401*	-0.385**
	(-2.058)	(-1.455)	(-1.950)	(-2.000)
WDeduction	-0.296	-0.364	-0.293	-0.324
	(-1.086)	(-1.312)	(-1.127)	(-1.264)
	-0.131	-0.226	0.097	-0.312
	(-0.230)	(-0.395)	(0.192)	(-0.565)
Electoral Margin	-	-	-	-0.032
	-	-	-	(-1.553)
Observations	266	266	238	266
Shea's Partial R^2 (Spatial Lag)	0.22	0.28	0.44	0.32
Shea's Partial R^2 (Spatial Lag× Election year)	-	0.89	-	-
Shea's Partial R^2 (Spatial Lag× Election year -1)	-	-	0.91	-
Shea's Partial R^2 (Spatial Lag× Electoral Margin)	-	-	-	0.89

Table 5 continued

	(1)	(2)	(3)	(4)
Underidentification test *(H_0: equation underidentified)*				
Kleibergen-Paap rk LM statistic	40.919	31.507	51.304	54.387
(p-value)	0.000	0.000	0.000	0.000
Weak identification test *(H_0: instruments are weak)*				
Cragg-Donald Wald F statistic	11.145	7.919	13.997	9.662
Stock-Yogo weak ID test range of critical values	5.15-19.28	4.62-19.12	4.62-19.12	4.62-19.12
Validity test *(H_0: instruments are valid)*				
Hansen J statistic χ^2	8.320	13.927	10.654	13.504
(p-value)	0.139	0.125	0.300	0.141

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Fixed effects & time trends in all specifications.

7. Conclusions

In this paper we have analysed the presence of another level of tax interdependence that may occur in federal contexts: horizontal competition between regional administrations in their enforcement policies, which hitherto has not been empirically analysed in the literature. By applying a theoretical framework, we derive a regional audit reaction function that is positively sloped: regional administrations compete in their auditing policies. This result has been tested in the Spanish framework by means of spatial econometric techniques, whose outcomes corroborate the theory; specifically the coefficients for the spatial lag are compatible with the hypothesis of horizontal competition in tax enforcement. This is our main contribution, which is in line with Cremer and Gahvari's results (2000).

Our empirical evidence also suggests that if the decentralization process is gradually implemented and administrative responsibility is decentralized before the normative power, enforcement policy competition decreases when it becomes possible to compete in terms of more powerful instruments, *i.e.* the statutory tax parameters. Thus, a highly decentralized framework seems to provoke a switch from a situation of more opaque competition to one that is more transparent. A further interesting finding concerns the workload of the regional tax authorities. Our estimations suggest that the elasticity of the auditing rate with respect to the amount of work that has to be processed is negative, while the elasticity with respect to the number of inspectors is positive. This means that regional tax

authorities are undersized and that the inspectors are overwhelmed by the quantity of work, although it might hide the fact that it is not financially worthwhile expanding the activity of enforcement any further.

From a normative perspective, Cremer and Gahvari (2000) suggest that in the presence of horizontal competition, as auditing strategies are not easily observable, it might be difficult for the central government to intervene establishing a binding agreement between sub-central governments aimed at harmonizing their strategies. This makes it unfeasible to avoid sub-optimal levels in tax enforcement[32]. Therefore, although opaque competition in tax enforcement is difficult to evaluate, it seems that it is less desirable than a more transparent competition in statutory tax parameters. Moreover, although the problem of sub-optimal tax enforcement could in part be circumvented by a further decentralization of the normative power, having decentralized both instruments it might not be optimal because both forms of competition may lead to a race to the bottom and inefficiently low levels of tax instruments. Intuitively, the more instruments there are to compete with, the lower the tax revenues. In this framework it would be much easier to obtain a coordination agreement in order to harmonize the regional tax rates, but such a policy would implicitly restore the original context of opaque competition in tax enforcement. Hence it seems that, in our framework, imposing a coordination strategy is not the appropriate way to avoid the inefficiencies associated with horizontal externalities.

[32] Indeed, even if the policies were publicly observable (because, for instance, they were recorded in a publicly available report, as is the case in Spain), whether a specific region's enforcement effort is sufficient or not is not readily established. A low audit rate might be interpreted as being inefficient simply because it is low while it is actually low as a result of improvements that have ensured that the enforcement effort is much more precise and efficient.

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Appendix 1: Generalized results with non-uniform distribution of taxpayers

We assume that the distribution of taxpayers along the home attachment is not uniform, *i.e.* we assume that $n \epsilon (0,1) \sim f(n)$ where $f(n)$ represents a generic density function. The value $n_1(t_1, \beta_1, t_2, \beta_2; a) = \frac{1}{2} + \frac{{U_1}^* - {U_2}^*}{2a}$ represents the marginal individual indifferent to living in either region 1 or region 2. Below n_1 we have all the taxpayers that settle in region 1, while above n_1 there are all the taxpayers that live in region 2. The respective shares of each group are $F(n_1) = \int_0^{n_1} f(n)dn$ and $1 - F(n_1) = \int_{n_1}^{1} f(n)dn$.

At stage 1 the problem of the administration of region 1 becomes:

$$\underset{\beta_1}{Max}\ R_1 = F(n_1) \times r_1 = F(n_1) \times [B \times \theta_1 - d(\beta_1)]$$

The FOC of this problem is:

$${n_1}'_{\beta_1} \times f(n_1) \times r_1 + {r_1}'_{\beta_1} \times F(n_1) \equiv P(\beta_1, \beta_2; t_1, t_2, a) = 0 \qquad (9)$$

The SOC is:

$$P_{\beta_1}(\beta_1, \beta_2; t_1, t_2, a) < 0 \qquad (10)$$

The slope of the reaction function becomes:

$$\frac{\partial \beta_1}{\partial \beta_2} = -\frac{P_{\beta_2}(\beta_1, \beta_2; t_1, t_2, a)}{P_{\beta_1}(\beta_1, \beta_2; t_1, t_2, a)} \qquad (11)$$

This is positive as long as $f'(n_1) \leq 0$ [33].

[33] This condition is satisfied if the median of the population distribution (n_1) coincides with or is higher than the mode of the distribution. This condition can usually be satisfied.

Appendix 2: Comparative statics on a

It is possible to express $\frac{\partial \beta_1}{\partial \beta_2}$ as a function of a in order to perform a comparative statics analysis:

$$\frac{\partial \beta_1}{\partial \beta_2} = -\frac{N}{A + a \times \frac{\partial^2 r_1}{\partial {\beta_1}^2}} = -N \times \left(A + a \times \frac{\partial^2 r_1}{\partial {\beta_1}^2} \right)^{-1} \tag{12}$$

where:

$$\begin{aligned} A = -2B \times \left[\frac{\partial \theta_1}{\partial \beta_1} + \frac{\partial g_1}{\partial \beta_1} \right] \times \left[B \times \frac{\partial \theta_1}{\partial \beta_1} - d'(\beta_1) \right] + B \times [\theta_2 - \theta_1 + g_2 - g_1] \\ \times \left[B \times \frac{\partial^2 \theta_1}{\partial {\beta_1}^2} - d''(\beta_1) \right] - [B \times \theta_1 - d(\beta_1)] \times B \\ \times \left[\frac{\partial^2 \theta_2}{\partial {\beta_1}^2} + \frac{\partial^2 g_2}{\partial {\beta_1}^2} \right] \end{aligned} \tag{13}$$

And

$$N = B \times \left[\frac{\partial \theta_2}{\partial \beta_2} + \frac{\partial g_2}{\partial \beta_2} \right] \times \left[B \times \frac{\partial \theta_1}{\partial \beta_1} - d'(\beta_1) \right] \tag{14}$$

So under FOC and SOC, $N > 0$ and:

$$\frac{\partial \left(\frac{\partial \beta_1}{\partial \beta_2} \right)}{\partial a} = \frac{N}{\left(A + a \times \frac{\partial^2 r_1}{\partial {\beta_1}^2} \right)^2} \times \frac{\partial^2 r_1}{\partial {\beta_1}^2} < 0. \tag{15}$$

Chapter 3

Empirical Evidence on Tax Cooperation Between Sub-Central Administrations

1. Introduction

Tax administration policies are crucial in determining the final amount of revenues collected by tax authorities. Furthermore, be it in a federal context with decentralized tax administrations, or internationally with different national administrations, tax authorities are dependent on each other to enforce tax rules. Given these circumstances, investigating the determinants of such policies has become a key issue; yet, the literature on horizontal tax interdependencies pays limited attention to these matters.

We seek to investigate the potential for cooperation between sub-central tax authorities by carrying out an empirical analysis in a federal context. This represents something of a novelty in the literature and should serve to shed some light on alternative designs (centralized vs. decentralized) for tax administration within this context. In doing so, we analyse the determinants of information sharing between regional administrations based on the Spanish case, which is a good field for empirical research. Spanish regions (the so-called "Comunidades Autónomas", henceforth CAs) have had the power to administer several wealth taxes[34] since the mid-eighties and following reforms in 1997 and 2002 have also acquired the legislative power to modify significant statutory tax parameters[35]. Thus, this case study should serve as a benchmark for evaluating the information-sharing process in a decentralized framework and, more generally, for analysing the efficiency of a decentralized tax administration scheme.

[34] Namely the inheritance and gift tax (IGT), the annual wealth tax (AWT) and the tax on wealth transfers (TWT).
[35] For more details on these reforms, see Esteller-Moré (2008).

We focus our empirical analysis on a specific area of potential cooperation between the CAs, for which official data are available. In the case of wealth taxation, legal tax allocation principles (in Spanish, the so-called "puntos de conexión") indicate how tax revenues should be distributed among the CAs: the residence principle and the territorial (or source) principle, depending on the taxable event[36]. However, taxpayers are not necessarily aware of these and so might commit errors when reporting their tax returns, that is, a taxpayer might pay the tax to the wrong CA[37]. Thus, each CA should share their information on misreported taxes and transfer the corresponding revenue to the competent CA. This is supposedly an automatic practice, but in reality it does not always occur this way. Indeed, there is considerable casual evidence confirming that the information sharing process between CAs is far from automatic[38]. This situation might arise because every CA faces a trade-off between, on the one hand, cooperating by transmitting the information and the misreported tax revenues to other CAs, and, on the

[36] In the case of the IGT, three different circumstances may occur. The residence principle applies to all inheritances: the tax revenues are collected in the CA of residence of the deceased. This principle also applies for gifts of chattels but the relevant residence in this case is that of the donor. Finally, in the case of the gift of real estate, the territorial principle applies. The AWT is based on the residence principle while the TWT is mainly based on the territorial principle.

[37] Suppose, for example, that a company with its headquarters in Madrid sells a block of flats located in the CA of Andalusia and pays the TWT to the CA of Madrid. In this case an error has been incurred as the TWT is subject to the territorial principle and the tax return should be reported to the CA of Andalusia. Similarly, there is a mistake when a daughter living in the CA of Valencia receives an inheritance from her father, whose residence was in the CA of Catalonia, and she reports the IGT to the region in which she lives, rather than to Catalonia as she should have according to the allocation principle.

[38] Every year tax inspectors from the State review the way in which each region administers its ceded taxes and they report their findings in the "Informe sobre la cesión de tributos a las Comunidades Autónomas". For instance, in the 2006 report about Catalonia, inspectors from the State explain: "It should be noted that existing experiences show an unequal behaviour of the different CAs in their degree of compliance with the obligation to submit the information and the income due to the competent CA. The perception that the competent services of the Directorate General of Taxes of the Catalan government have on this issue is that certain CAs systematically and, in many cases, violate that obligation." (p. 39 of the report). Moreover, from informal conversations maintained with former directors of the Catalan tax authority we know that in some cases they chose not to transmit information to other CAs until the latter opted to do the same with their misreported taxes. This seems to suggest that 'reciprocity' might play a relevant role in determining the extent to which information is shared between CAs. Indeed, in the 2002 report about another CA, Castille y León, the inspectors from the State explain that this region would not return revenue due to the CA of Madrid until the latter transferred revenues due to it.

other, not cooperating and retaining the misreported tax revenues. The costs of cooperation are mainly administrative (being related directly to this information-sharing process) and financial (a loss of revenue yields). The benefits of cooperation are based on reciprocity: if a CA cooperates, it might foster other regions' cooperation in the future. For this reason, if a CA does not cooperate, there may be a cost, as the other CAs will opt not to exchange information in the future. In a repeated game, cooperative behaviour should produce mutual benefits for both CAs, since the benefits due to reciprocity should be higher than the administrative and financial costs in the short-run. Therefore, our main hypothesis is that a CA's cooperative behaviour is a matter of reciprocity, as it depends strictly on the potential cooperation of the other CAs in previous periods.

To test this hypothesis we estimate a Tobit random-effect model and also a dynamic version of this model to account for sluggish adjustment in transmitted tax revenues. Our results confirm the role played by reciprocity and indicate the presence of persistency in the strategic behaviour of the tax administration. In addition, in keeping with the short-run financial benefits of non-cooperation, we find that the impact of reciprocity is lower when the CAs face budget constraints picked up by the deficit. Thus, according to our analysis, in the medium-long run the regional administrations learn the advantages of cooperation thus providing elements that support the correct functioning of a decentralized tax administration.

The rest of the paper is organized as follows: section 2 provides a summary of the relevant literature, in section 3 we present our empirical strategy, section 4 presents the results, and we conclude in section 4.

2. Literature review

The literature has identified two main sources of interdependence at a tax administration level. On the one hand, Cremer & Gahvari (2000), examining the implications of tax evasion for fiscal competition and tax harmonization policies in an economic union, demonstrate the possibility of mobility-based competition in tax enforcement policies. They obtain sub-optimal equilibrium values for both tax and audit rates and show that tax harmonization alone is not sufficient to avoid strategic incentives to attract tax bases as there can be no commitment to audit policies. Durán-Cabré *et*

al. (2014) have tested this result for the Spanish decentralized framework and corroborate the presence of mobility-based competition in tax enforcement among regional administrations.

On the other hand, the incentive for sub-central tax authorities to collaborate by sharing relevant tax information has also been accounted for in the literature that has focused on the incentives for tax cooperation between countries to reduce evasion in an international mobile-capital framework (see Keen & Ligthart, 2006a, for a survey). In particular, the seminal study by Bacchetta & Espinosa (1995) identifies the strategic trade-off between competitive behaviour – lowering the tax rate to increase foreign investment – and cooperative behaviour – voluntarily sharing information to reduce international tax evasion. In equilibrium, the second effect may dominate the former resulting in partial information exchange. In a more recent study, Bacchetta & Espinosa (2000) further their previous analysis by modelling the choice of tax rates and information provision as an infinitely repeated game. A contribution in this same line is provided by Huizinga & Nielsen (2002) who model a repeated game in which tax authorities choose between withholding taxes and sharing information as alternatives for dealing with international capital income and profit taxation[39]. Both studies argue that potential cooperation in information sharing is a matter of reciprocity and, in particular, that it may be sustained if the process is viewed as an infinitely repeated game rather than as a single one. In this regard, the propensity of a country to cooperate directly depends on the potential cooperative behaviour of the other country in previous periods. Thus, in these models each country evaluates the trade-off between not providing information and obtaining a corresponding temporary gain (due to their attracting tax evading investors) versus suffering the costs of the non-cooperative behaviour of the other country (generally, more aggressive tax competition or the absence of information exchange or both) forever after.

Our empirical framework reflects existing theoretical models – given the existence of a trade-off between cooperative and non-cooperative behaviour – but applied to a federal context. The main differences between the two

[39] These contributions generated further research (*e.g.* Tanzi & Zee, 2001; Chisik & Davies, 2004, Keen & Ligthart, 2006b).

contexts lie in the tax authorities' motivation and incentive to cooperate. In an international framework with mobile capital, countries share fiscal information with the aim of avoiding, or of at least reducing, a race to the bottom in tax rates and the resulting negative effects on tax revenues. This kind of cooperation between countries reduces tax fraud.

Some empirical papers have tested these models in an international framework. In particular, Ligthart and Voget (2010) study the determinants of tax information sharing between Dutch and foreign tax authorities for income tax purposes. From our perspective, the most interesting result in this paper concerns reciprocity. The authors show that an increase in the amount of tax information provided by the Dutch tax authorities to their foreign counterparts significantly increases the amount of information received by the Dutch tax authorities. Elsayyad (2012) analyses recent treaty signings between tax havens and OECD countries as the outcome of a bargaining process over treaty form and focuses on the presence of an exchange of information clause. The paper shows that the likelihood of treaty-signing is mainly driven by a tax haven's bargaining power and good governance. Moreover, the author finds that it is easier for an OECD country to renegotiate an already existing treaty so as to incorporate an information exchange clause than to pressure countries to do so without an existing agreement. By interpreting the existence of a previous agreement between two countries as a measure of reciprocity, we have further confirmation that reciprocity matters in determining the level of information exchanged between two tax authorities.

In our federal framework, sub-central tax authorities should automatically cooperate in order to rectify any errors that might arise in the reporting of tax returns, but they have an incentive not to cooperate that is driven by the presence of administrative costs and the loss of financial revenue yields. In this context and according to our hypothesis, reciprocity not only reinforces the tax information exchange process, but it is the essential driving force promoting cooperation as it encourages tax authorities to switch from short- to far-sighted behaviour. This empirical analysis of a federal framework represents, we believe, a novelty and progress in the literature.

3. Empirical analysis

In this section, we present the dataset and define the empirical methodology employed in developing our analysis.

3.1 The empirical framework

Data on Spain's regional tax administrations are extracted from the report "Informe sobre la cesión de tributos a las Comunidades Autónomas" published every year jointly with the project of the general State budget. Specifically, we have access to data on the total number and total amount of transfers resulting from misreported tax returns ("Transferencias por aplicación de los puntos de conexión") collected (returned) by each CA from (to) any other region during the 1989-2009 period[40]. Hence, in contrast with previous analyses, our dataset allows us to identify both directions in the information-sharing process. Additionally, the availability of a time span allows us to adopt a dynamic approach and, thus, to test for the possibility that regional administrations learn the potential advantages of gradually sharing information.

Our endogenous variable is the amount of tax revenues transferred by each CA to every other CA in a given year and thus takes the form of a continuous random variable over strictly positive values, but it assumes the value zero with positive probability. Our dataset contains 43.02 percent zero-valued output. Thus, our endogenous variable may be censored at zero inasmuch as a zero value could alternatively indicate an actual absence of misreported taxes or that CAs choose not to share information on misreported taxes and claim to have zero tax revenues to transmit. Therefore, we maintain the random-effects Tobit corner-solution model as our main approach (see Wooldridge, 2002, pp. 518-549)[41], which is defined as follows:

[40] For instance, in 2000 the region of Andalusia transferred 828,192 euros to the region of Castile-La Mancha, corresponding to seven cases of misreported taxes. And the latter, for example, transferred 15,872.9 euros to the region of Valencia, corresponding to 33 cases.

[41] In a previous version of this paper we employed the number of cases of misreported taxes transmitted as our endogenous variable. Given that this is a count-data variable we used an estimation strategy based on Poisson regression models obtaining results that are congruent with those obtained through the current estimation strategy. These results are available upon request.

$$Trans\_Rev_{ijt} = \max\left[0, \alpha Rec\_Rev_{ijt-1} + \boldsymbol{Y_{ijt}\beta} + \boldsymbol{X_{it}\mu} + \tau_t + \vartheta_{ij} + \varepsilon_{ijt}\right]. \quad (1)$$

where $Trans\_Rev_{ijt}$ is the amount of misreported tax revenues transmitted by region *i* to region *j* during year *t*. We control for reciprocity through the misreported tax revenues received by region *i* from region *j* during the previous year, Rec_Rev_{ijt-1}. This is the key regressor, since our main hypothesis is that reciprocity fosters cooperation between regional tax authorities and then we expect α to be positive.

We introduce a series of control variables that account for both region pair-specific characteristics and unilateral determinants referring to region *i* that might influence the information-sharing process. The pair-specific variables are collected in vector $\boldsymbol{Y_{ijt}}$. In particular, N_{ijt} is the number of cases of misreported taxes transmitted from region *i* to region *j* in year *t*. According to Ligthart and Voget (2010), the distance between regions might reduce the flow of information between them. We therefore control for D_{ij}, the physical distance in kilometres between *i* and *j*. The political alignment between Spanish regions[42] is another variable that might have an impact on the tax administrations' willingness to cooperate. Thus, we introduce PA_{ijt}, a dummy identifying the political alignment between the two regions at time *t*. The relative GDP of the two regions at time *t*, $RGDP_{ijt}$, is also included in order to account for the relative economic power of the two regions, that is, as a measure of the relative bargaining position of region *i* with respect to region *j* (Elsayyad, 2012). A positive (negative) sign would indicate a favourable (unfavourable) bargaining position of region *i* with respect to region *j* due to a higher (lower) amount of revenues transmitted by region *i* to region *j*.

The vector $\boldsymbol{X_{it}}$ includes a constant term and the unilateral variables. According to the previous literature on the exchange of tax information (Bacchetta & Espinosa, 1995, 2000), the statutory tax parameters and the enforcement costs are crucial in determining the level of information exchange between tax authorities. These issues are also relevant in our

[42] Note this factor is specific for an analysis within a federal context.

context, albeit in a different way; thus, we control for $Tot\_Reg\_Tax\_Revenues_{it}$ and $Tot\_Reg\_Audit\_Revenues_{it}$ that account for total tax revenues and total tax auditing revenues collected by region i during year *t,* respectively. These variables are proxies of regional tax autonomy in raising revenues and they are expected to be associated with greater amounts of information being exchanged. Budgetary and political variables might also play a role in determining tax administration policies (see, e.g. Esteller-Moré 2005, 2011). In particular, we control for the deficit expected at the beginning of every fiscal period in order to account for the financial conditions of regional budgets and to measure indirectly the financial opportunity cost of cooperation of region i. We expect a higher deficit to negatively impact the transmission of misreported revenues. We return to this variable below. We include the total amount of transfers received from the central government divided by total regional expenditure to account for a further budgetary factor relevant in a federal framework, such as that operated in Spain. We expect this variable to have an income effect on the behaviour of the tax administrations. In particular, a higher transfer-expenditure ratio should force the administration to rely less on its own tax resources and to transfer more tax revenues to the other regions. We are not able to identify the impact of the administrative costs of cooperation, but reasonably suppose it to be constant over time. As such it will be picked up by the constant term; however, if it varies over time (and uniformly throughout the ACs) it will be picked up by the time effects. In the case of the political variables, we include a dummy equal to one, El_{it}, if there is a regional election in region i during the year t, to control for the potential impact of the electoral cycle on the incentives to share information. To account for modifications to the statutory tax parameters, we include a dummy, Ded_{it}, equal to one if the regional government i introduces a deduction in (at least) one tax during the year[43]. $Left_{it}$ is a dummy variable equal to one if the party in office in a specific region and year is to the left of the political spectrum. Pop_{it} is the total population and

[43] In our framework – in contrast with the hypothesis proposed by Bachetta and Espinosa (1995) – it is unlikely that a CA behaves strategically and lowers the tax burden via tax rate cuts, so as to induce, to a certain measure, taxpayers to err in their tax returns: taxpayers would pay less and the CA would collect more tax revenues. All the same, in our case it is difficult to identify such behaviour since the information on the misreported tax revenues transmitted is available at an aggregated level and not tax by tax.

accounts for regional size. We finally include a set of time dummies τ_t, while ϑ_{ij} is an unobserved pair-specific disturbance that is constant over time and ε_{ijt} is an idiosyncratic error that varies across time and pair of regions[44]. The parameters of Eq. (1) are estimated by maximum likelihood.

In order to have a better understanding of the determinants of the tax information sharing process, we extend this model in a dynamic fashion allowing for sluggish adjustment in the endogenous variable. It might take time for the regional tax authorities to process all the misreported tax revenues, and so inertia might play a role in this process. Thus, following Wooldridge (2002, pp. 542-543), we also estimate a dynamic Tobit model with unobserved effects:

$$Trans\_Rev_{ijt} = \max\left[0, \gamma g\left(Trans\_Rev_{ijt-1}\right) + \delta Rec\_Rev_{ijt-1} + \boldsymbol{Y_{ijt}\varphi} + \boldsymbol{X_{it}\rho} + \tau_t + c_{ij} + \epsilon_{ijt}\right]. \quad (2)$$

As in Eq. (1), we expect reciprocity to positively impact the cooperative behaviour of the regional tax authorities, and then expect δ to be positive. In addition, we test the persistency hypothesis. In this regard, the function $g(.)$ allows $Trans\_Rev_{ijt-1}$ to appear in a variety of ways. We employ two alternative specifications:

(i) $g\left(Trans\_Rev_{ijt-1}\right) = Trans\_Rev_{ijt-1}$; and

(ii) $g\left(Trans\_Rev_{ijt-1}\right) = \left\{1\left[Trans\_Rev_{ijt-1} = 0\right]; 1\left[Trans\_Rev_{ijt-1} > 0\right] \times Trans\_Rev_{ijt-1}\right\}$, where $1[.]$ is the indicator function.

The first approach is the standard dynamic model and in this case we expect γ to be positive, that is, cooperative behaviour in the previous period is expected to foster present cooperation. The second approach allows the effect of the lagged endogenous variable to be different depending on whether the previous response was a corner solution (zero) or strictly positive; then, in this case, γ is a vector 2×1 (see Wooldridge 2002, pp. 542-543). Specifically in this case we expect to find a persistent behaviour

[44] In particular, $\vartheta_{ij} \sim N(0, \sigma_\vartheta)$ and $\varepsilon_{ijt} \sim N(0, \sigma_\varepsilon)$.

over time so that zero-valued transmitted misreported revenue in $t - 1$ is expected to negatively impact the cooperative behaviour while the component $1[Trans\_Rev_{ijt-1} > 0] \times Trans\_Rev_{ijt-1}$ is expected to be positively related to the propensity to cooperate at time *t*.

In dynamic Tobit models with unobserved effects, the treatment of the initial observations is a key issue[45]. Wooldridge (2005) proposes a fairly general and tractable solution to this econometric issue. This approach consists in specifying a distribution for the unobserved effect, c_{ij}, given the initial value, TR_{i0}, and the exogenous variables in all time periods. This leads to a fairly straightforward procedure that is no different from the standard static random-effects Tobit model. For practical purposes, the only difference between the exogenous initial values assumption and Wooldridge's approach is that the latter includes the initial values of the endogenous variable as additional explanatory variables in the regression[46].

In our framework, the main incentives for a CA not to cooperate are the administrative costs as well as the financial costs of losing the financial yield of undue tax revenues. Thus, we suspect that a CA with relatively short-term budget constraints will decide to reduce cooperation. In order to identify the role of financial/budget constraints in influencing reciprocity we interact Rec_Rev_{ijt-1} with $1[Def_{it}]$, a dummy equal to one if region *i* expects a deficit in period *t*. We perform this interaction for both the static and the dynamic models. Then, Eq. (2) is modified as follows:

$$Trans\_Rev_{ijt} = \max[0, \gamma g(Trans\_Rev_{ijt-1}) + \delta_1 Rec\_Rev_{ijt-1} + \delta_2 Rec\_Rev_{ijt-1} \times 1[Def_{it}] + \boldsymbol{Y_{ijt}\varphi} + \boldsymbol{X'_{it}\rho} + \tau_t + c_{ij} + \epsilon_{ijt}]. \quad (3)$$

[45] The ideal case would be that the observed panel dataset starts together with the stochastic process. In this case the initial values are known constants. If data are not collected at the beginning of the process, assuming that the initial values are exogenous might lead to bias and inconsistency in the estimators (Heckman, 1981; Hyslop, 1999; Honore, 2002). The first period in our dataset is 1989 but the decentralization of the relevant taxes began in the mid-eighties, thus there are a few years for which these data are missing. Although the assumption of exogenous initial values might not be too strong because the missing years are relatively few in comparison to the extent of the dataset, the most appropriate approach is to assume that the initial values are endogenous. For a formal discussion of this issue see e.g. Akay (2009).

[46] For a formal discussion of these issues and a formal derivation of this model, see Wooldridge (2002, pp. 542-543; 2005).

Eq. (1) is also modified in a similar fashion. We expect δ_2 to be negative.

3.2 Data and sources

The data on the cases of misreported taxes and their corresponding revenues, in addition to the regional tax and audit revenues and the dummy Ded_{it}, are extracted from the report entitled "Informe sobre la cesión de tributos a las Comunidades Autónomas". The other variables are obtained from the following statistical sources. The distance between two CAs is the Euclidean distance between their capitals and is calculated using their geographical coordinates and is expressed in kilometres. The political alignment is defined using the information on the political colour of the governments in office, which we also employ for the definition of the variable $Left_{it}$. This information is obtained from Zarate's Political Collections website (http://zarate.eu/spain2.htm). The relative GDP is based on data from the Spanish National Institute of Statistics (INE). The transfers-expenditure ratio is constructed as the ratio between the total amount of transfers received from the central government (extracted from the INE database) and the total regional expenditure (extracted from the Ministry of Economy and Finance database). The deficit is that expected at the beginning of the fiscal year and is extracted from the database of the Ministry of Economy and Finance. The information on election years is obtained from the Ministry of the Interior's website (http://goo.gl/YCS3J). In Table 1, we report the summary statistics.

Table 1: Summary statistics

Variable	Measurement unit	Obs.	Mean	Std. Dev.	Min	Max
Transmitted Tax Revenues	thousands of 2001 euro	4,203	144.87	1,179.61	0	37,111.18
Received Tax Revenues	thousands of 2001 euro	4,206	114.30	954.11	0	38,900.90
Cases of Transmitted misreported taxes	number of cases	4,410	22.53	196.28	0	10,533
Cases of Received misreported taxes	number of cases	4,410	36.13	505.42	0	22,944
Distance	Kilometres	4,410	630.73	512.75	31	2204
Political Alignment	Dummy	4,410	0.51	0.50	0	1
Relative GDP	Ratio	4,410	1.04	0.29	0.46	2.15
Tot_Reg_Tax_Revenues	millions of 2001 euros	4,410	72.51	104.64	1.73	775.02
Tot_Reg_Audit_Revenues	millions of 2001 euros	3,990	3.59	6.69	0	49.85
Deficit	thousands of 2001 euro	4,200	-68,860	271,390	-2,478,177	1,270,978
1[Deficit]	Dummy	4,200	0.38	0.49	0	1
Transfers/Expenditure	share of expenditure financed by transfers	4,410	0.35	0.17	-0.04	1.37
Leftist Government	Dummy	4,410	0.44	0.50	0	1
Election Year	Dummy	4,410	0.24	0.43	0	1
Deduction	Dummy	4,410	0.15	0.35	0	1
Population	thousands of people	4,410	2,542.28	2,168.17	261.34	8,150.47

4. Results

In Table 2, we present the results of the estimation of Eq. (1), that is, the static model. We report a GLS random-effects specification in column (1), a standard Tobit model in column (2), and column (3) reports the random-effects Tobit model, which is our preferred estimation strategy. The amount of misreported tax revenues transmitted by CA *i* to CA *j* positively depends on reciprocity, which is proxied by the time-lagged tax revenues received by CA *i* from CA *j*. This result is robust to the different specifications.

According to the random effects Tobit model reported in column (3), a one euro increase in the tax revenues received by CA *i* from CA *j* in year *t-1* results in an increase of 0.385 euros of tax revenues being transmitted from CA *i* to CA *j* in year *t,* holding all other variables constant. Clearly, the amount of misreported revenues increases as the number of cases of transmitted misreported taxes grows. Specifically, according to model (3), one additional case of misreported taxes leads to an increase in transmitted revenues of almost 6.5 thousand euros, keeping constant all the other variables. The estimate of the distance between regions is significant and robust to the two different Tobit specifications presenting negative coefficients: two distant regions share less misreported revenues than is the case between two closer CAs. This corroborates previous results in the literature. Furthermore, we find that the deficit negatively impacts the cooperative behaviour of the tax administration. Those CAs with a higher expected deficit at the beginning of the year are less willing to transfer misreported tax revenues. As for the control variables, we find that regional size, proxied by population, is positively associated with the transfer of misreported tax revenues. None of the remaining covariates is found to be significant, but they are jointly statistically significant according to a Wald test.

In Table 3, we present the results of the estimation of the alternative specifications of Eq. (2). In columns (1) and (2) we set $g(Trans\_Rev_{ijt-1}) = Trans\_Rev_{ijt-1}$. In columns (3) and (4) we assume $g(Trans\_Rev_{ijt-1}) = \{1[Trans\_Rev_{ijt-1} = 0]; 1[Trans\_Rev_{ijt-1} > 0] \times Trans\_Rev_{ijt-1}\}$. The dynamic Tobit models in columns (2) and (4) are estimated by employing Wooldridge's (2005) approach, while the models in columns (1) and (3) are estimated by assuming exogenous initial values. The results suggest that there is a sluggish adjustment in the process of transmission of misreported tax revenues. In models (1) and (2) the coefficients of $Trans\_Rev_{ijt-1}$ suggest that a one euro increase in misreported tax revenues transmitted by CA *i* to CA *j* in the previous year leads to an increase of almost 0.235 euros in the transmitted misreported revenues in the current year. Moreover, the results obtained by means of the estimation of models (3) and (4) corroborate our hypothesis of congruency in the behaviour of the regional tax authorities. The CAs that did not

transmit revenues in *t – 1* tend to transmit less revenues in *t,* while the CAs that had transmitted revenues in *t – 1* transfer on average 0.023 euros more in *t* for any additional euro transmitted in *t*–1. The initial value of the transmitted misreported revenues does not turn out to be significant, suggesting that there is no correlation between the unobserved heterogeneity and the initial condition. This is probably due to the fact that the first period in our panel dataset coincides mostly with the true starting point generating the process. Although Wooldridge's method is the most appropriate for the estimation of this process, this result indicates that the bias in the estimation of $g(Trans\_Rev_{ijt-1})$ under the exogenous initial values assumption is not severe as confirmed by the magnitudes of the coefficients obtained through the two methodologies that are almost equal. Taking inertia into account, though, does not modify the main results obtained when estimating Eq. (1). In particular, reciprocity remains a driving force of the process.

In Table 4 we report the results of the estimation when we interact Rec_Rev_{ijt-1} with a dummy identifying periods of expected budget in deficit (Eq. 3). Both in the static and in the dynamic approach, we still find reciprocity to be positively associated with the revenue transmission process, but this relationship is weaker during the periods in which CA *i* faces relatively more binding budget constraints. In the absence of deficit, the CAs transmit according to the different specifications at around 0.80 – 0.84 of every 1 euro received, while in the presence of (an expected) deficit they transmit less than half that amount, 0.29 – 0.35 of every 1 euro received.

Table 2: Determinants of the information sharing process. TOBIT-RE and alternative specifications

	(1)	(2)	(3)
Estimator	GLS-RE	TOBIT	TOBIT-RE
L.Received Tax Revenues	0.467***	0.438***	0.385***
	(10.456)	(7.351)	(6.311)
Cases of Transmitted misreported taxes	5.891***	6.892***	6.478***
	(23.516)	(20.554)	(17.874)
Distance	-0.017	-0.288***	-0.299***
	(-0.562)	(-5.850)	(-4.603)
Political Alignment	-64.845**	-61.081	-45.212
	(-2.094)	(-1.293)	(-0.880)
Relative GDP	-36.360	-4.180	14.190
	(-0.587)	(-0.043)	(0.113)
Tot_Reg_Tax_Revenues	11.970	1.062	8.352
	(0.717)	(0.042)	(0.295)
Tot_Reg_Audit_Revenues	-0.648	-1.219	-1.158
	(-0.777)	(-1.008)	(-0.908)
Deficit	-0.000*	-0.000**	-0.000*
	(-1.848)	(-2.052)	(-1.768)
Transfers/Expenditure	161.385	396.833	366.767
	(1.037)	(1.580)	(1.400)
Election Year	-2.153	-73.051	-74.340
	(-0.061)	(-1.340)	(-1.212)
Deduction	-8.960	9.324	0.885
	(-0.162)	(0.116)	(0.011)
Leftist Government	-12.665	-113.368	-89.040
	(-0.180)	(-1.126)	(-0.846)
Population	0.006	0.065***	0.069***
	(0.765)	(5.545)	(4.401)
_cons	48.804	-184.113	-220.779
	(0.346)	(-0.851)	(-0.915)
Observations	3,446	3,446	3,446
Censored Observations	1,504	1,504	1,504
Number of groups (couple of regions)	210	210	210
R^2	0.244	-	-
Log likelihood	-	-17,134.759	-17,112.908
Wald chi2	1100.793	1036.608	785.558
p-value	0.0000	0.0000	0.0000

Notes: *t* statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. For all specifications, we report χ^2 statistics and p-values for the Wald test of joint significance. Time effects and regional dummies are included in all specifications.

Table 3: Determinants of the information sharing process Dynamic TOBIT-RE: alternative specifications

Estimator	(1) TOBIT-RE Exogenous initial values	(2) TOBIT-RE Wooldridge method	(3) TOBIT-RE Exogenous initial values	(4) TOBIT-RE Wooldridge Method
L.Transmitted Tax Revenues	0.234***	0.235***	-	-
	(9.438)	(9.456)		
1[L.Transmitted Tax Revenues = 0]	-	-	-712.641***	-712.263***
			(-13.257)	(-13.168)
1[L.Transmitted Tax Revenues> 0]×L.Transmitted Tax Revenues	-	-	0.023***	0.023***
			(9.394)	(9.393)
L.Received Tax Revenues	0.327***	0.327***	0.378***	0.378***
	(5.440)	(5.442)	(6.393)	(6.393)
Transmitted Tax Revenues$_{t=1989}$	-	1.791	-	0.058
		(1.512)		(0.063)
Cases of Misreported Taxes	5.926***	5.930***	5.848***	5.848***
	(16.620)	(16.634)	(17.365)	(17.364)
Distance	-0.283***	-0.271***	-0.188***	-0.187***
	(-4.718)	(-4.482)	(-3.745)	(-3.709)
Political Alignment	-33.301	-32.097	-66.883	-66.807
	(-0.664)	(-0.640)	(-1.403)	(-1.401)
Relative GDP	10.889	17.485	-27.411	-27.191
	(0.093)	(0.149)	(-0.280)	(-0.278)

Table 3 continued

Tot_Reg_Tax_Revenues	18.989	18.371	15.238	15.199
	(0.665)	(0.644)	(0.576)	(0.574)
Tot_IGT_Audit_Revenues	-1.600	-1.470	-1.248	-1.242
	(-1.280)	(-1.174)	(-1.032)	(-1.024)
Deficit	-0.000	-0.000	-0.000	-0.000
	(-1.485)	(-1.459)	(-1.502)	(-1.500)
Transfers/Expenditure	446.910*	434.541*	376.867	376.357
	(1.700)	(1.652)	(1.463)	(1.461)
Election Year	-49.016	-51.271	-40.768	-40.883
	(-0.824)	(-0.862)	(-0.739)	(-0.741)
Deduction	-2.659	-3.200	-13.971	-13.994
	(-0.033)	(-0.040)	(-0.172)	(-0.173)
Leftist Government	-96.980	-98.314	-77.896	-77.954
	(-0.944)	(-0.957)	(-0.777)	(-0.778)
Population	0.065***	0.061***	0.038***	0.038***
	(4.468)	(4.175)	(3.193)	(3.147)
_cons	-340.952	-351.172	-96.233	-96.555
	(-1.442)	(-1.485)	(-0.434)	(-0.436)
Observations	3,405	3,405	3,405	3,405
Censored Observations	1,490	1,490.000	1,490	1,490
Number of groups (couple of regions)	210	210	210	210
Log likelihood	-16,845.972	-16,844.828	-16,769.765	-16,769.763
Wald chi2	923.174	927.285	1,276.899	1,276.878
p-value	0.0000	0.0000	0.0000	0.0000

Notes: *t* statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. For all specifications, we report χ^2 statistics and p-values for the Wald test of joint significance. Time effects and regional dummies are included in all specifications.

Table 4: Determinants of the information sharing process. Interactions.

Estimator	(1) TOBIT-RE	(2) TOBIT-RE Wooldridge Method	(3) TOBIT-RE Wooldridge Method
L.Transmitted Tax Revenues	-	0.238*** (9.585)	-
1[L.Transmitted Tax Revenues = 0]	-	-	- 704.264*** (-13.022)
1[L.Transmitted Tax Revenues> 0]×L.Transmitted Tax Revenues	-	-	0.023*** (9.482)
L.Received Tax Revenues	0.798*** (3.939)	0.816*** (4.113)	0.836*** (4.312)
L.Received Tax Revenues×1[Deficit]	-0.442** (-2.125)	-0.525** (-2.570)	-0.495** (-2.474)
Transmitted Tax Revenues$_{t=1989}$	-	1.600 (1.372)	-0.090 (-0.098)
Cases of Misreported Taxes	6.492*** (17.969)	5.933*** (16.726)	5.829*** (17.329)
Distance	-0.296*** (-4.602)	-0.268*** (-4.497)	-0.185*** (-3.675)
Political Alignment	-47.302 (-0.923)	-34.418 (-0.689)	-67.460 (-1.417)
Relative GDP	25.821 (0.207)	30.349 (0.263)	-15.383 (-0.157)
Tot_Reg_Tax_Revenues	4.904 (0.173)	14.925 (0.525)	12.763 (0.482)
Tot_IGT_Audit_Revenues	-1.257 (-0.988)	-1.607 (-1.287)	-1.376 (-1.134)
1[Deficit]	74.688 (1.176)	77.504 (1.239)	54.397 (0.862)
Deficit	-0.000* (-1.764)	-0.000 (-1.448)	-0.000 (-1.294)
Transfer/Expenditure	301.820 (1.134)	371.018 (1.393)	333.402 (1.275)
Left	-73.329 (-1.197)	-50.600 (-0.854)	-41.794 (-0.756)
Election	3.812 (0.047)	0.536 (0.007)	-10.327 (-0.128)
Deduction	-70.078 (-0.662)	-78.229 (-0.758)	-62.124 (-0.614)
Population	0.069*** (4.400)	0.061*** (4.200)	0.038*** (3.158)
_cons	-256.972 (-1.065)	-392.334* (-1.660)	-133.715 (-0.600)

Table 4 continued

Linear Combinations			
L.Received Tax Revenues +L.Received Tax Revenues× 1[Deficit]	0.355***	0.291***	0.341***
	(5.65)	(4.69)	(5.59)
Observations	3,446	3,405	3,405
Censored Observations	1,504	1,490	1,490
Number of groups (couple of regions)	210	210	210
Log likelihood	-17,110.207	-16,841.078	-16,766.540
Wald chi2	796.081	944.918	1,285.733
p-value	0.0000	0.0000	0.0000

Notes: *t* statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. For all specifications, we report χ^2 statistics and p-values for the Wald test of joint significance. Time effects and regional dummies are included in all specifications.

5. Conclusions

We have analysed an area of horizontal tax interdependence that may occur in federal contexts, namely, the transmission of misreported tax revenues between sub-central tax administrations. We have obtained some evidence of the determinants of cooperation between the Spanish regional tax authorities. Our analysis, based on a Tobit estimation strategy, suggests that cooperation is a matter of reciprocity and so we corroborate the results of the relevant theoretical literature. More specifically, the amount of tax revenues transmitted from one region to another positively depends on the revenues received from the latter in the previous period. This is the main result of the paper and it is significant and robust to different specifications. Furthermore, we have found that the reciprocity link existing between two CAs becomes weaker when budget constraints are binding, *i.e.* in the presence of an expected deficit. In addition, the estimation of a dynamic Tobit model suggests that there is a sluggish adjustment in the setting of this process.

Therefore, once tax administrations engage in cooperative behaviour, it is maintained, fostering even closer cooperation between them. This is a crucial point because it suggests that once regional tax administrations become aware of the potential benefits of cooperation, they do not deviate from this equilibrium. In this regard, we can conclude that the correct functioning of the decentralized tax administration in Spain is hindered by the existence of administrative, financial and transaction costs and, as such,

cooperation is reached only in the medium-long run. This is, in part at least, good news for the functioning of a decentralized tax administration.

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Chapter 4

Does Tax Enforcement Counteract the Negative Effects of Terrorism? A Case Study of the Basque Country

1. Introduction

Terrorism can impact aggregate economic outputs (Abadie and Gardeazabal, 2003) as well as specific sectors of activity (for a survey, see, e.g., Llussá and Tavares, 2007a and 2007b), representing more generally a cost for the economy of the affected countries (see, e.g., Enders and Olson, 2012). Besides personal and material damages, terrorist activity induces a change in the risk perception of economic agents, leading to a permanent reduction in productive investments and consumption of goods (Abadie and Gardeazabal, 2008; Eckstein and Tsiddon, 2004). Additionally, the terrorists' predatory financing system may also impact the economy and its agents. In this regard, one of the main forms of funding used by terrorist groups is that of extortion – the so-called "revolutionary tax" paid by entrepreneurs and liberal professionals[47]. As a result of its impact on economic activity and on the behaviour of economic agents, terrorism may also influence the design of fiscal and monetary policies, either as any other unpredictable shock would or as part of the policy makers' endogenous reaction to terrorist activity. As the previous literature suggests (see Gupta et al., 2004), terrorism can affect the fiscal accounts through three main potential channels: by disrupting real economic activity (GDP); by distorting the composition of government spending; and by affecting the tax bases with negative consequences for tax revenues. While the evidence confirms the negative effect of terrorism on GDP growth and demonstrates an increase in public spending to cover additional security needs (see, e.g.,

[47] This is the practice of several nationalist and separatist terrorist organizations including "Euskadi Ta Askatasuna" (Basque Homeland and Freedom) – ETA in the Basque Country (Buesa and Baumert, 2013); the Provisional Irish Republican Army – IRA (Silke, 1998), and the National Liberation Front of Corsica – FCLN (Sanchez, 2008).

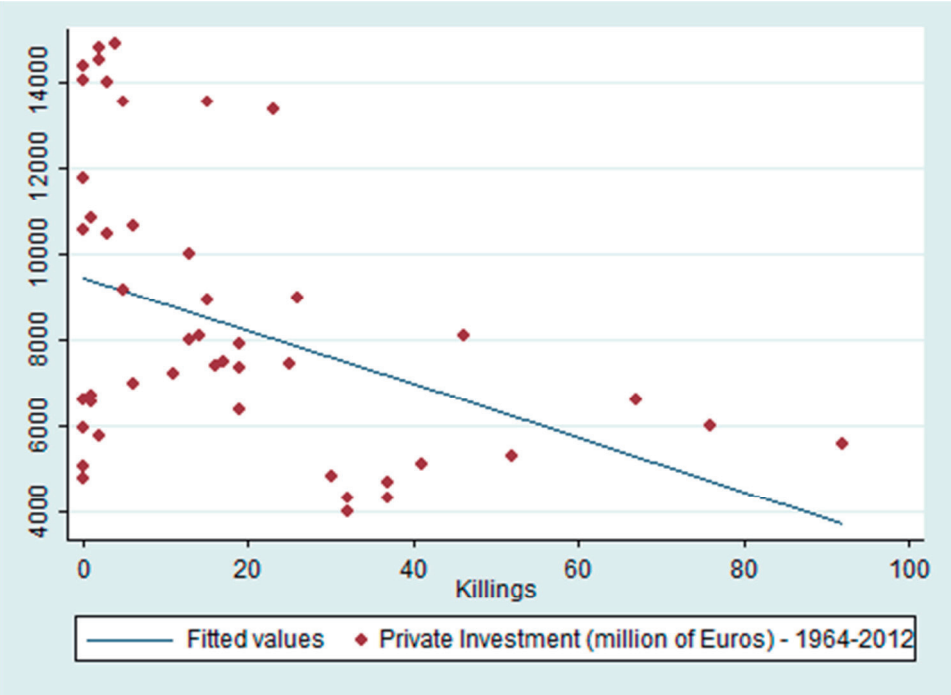
Hobjin, 2002 and Gupta et al., 2004) with its negative impact on the budget deficit (see, e.g., Eichenbaum and Fisher, 2004; Wildasin, 2002), very little has been said about the potential effects of terrorist activity on tax bases, tax collection and tax revenues.

The present paper contributes to this literature by analysing the presence of externalities in tax collection due to terrorism. Specifically, I use the Basque Country[48] as a case study for testing the impact of terrorism on tax enforcement policies. Terrorism can distort the behaviour of the economic agents residing and operating there by inducing them to reduce their investment and consumption or to move their residence in order to avoid the costs of terrorism[49]. Graph 1 shows the presence of a negative correlation between aggregate investment in the Basque Country and Navarre and the level of activity of the terrorist organization ETA in terms of killings per year. This provides casual evidence of the negative impact of terrorism on the economic activity in these regions.

[48] Here I refer to the Basque Country in a wider sense to include Spain's so-called foral autonomous communities of the Basque Country and Navarre. The foral community of the Basque Country comprises three provinces (Alava, Guipuzcoa and Vizcaya) while the foral community of Navarre coincides with the homonym province. These provinces have a high level of tax autonomy while the remaining Spanish provinces are mainly administered by a central tax agency. See Appendix 1 for a detailed description of the ETA-Basque framework.

[49] According to Buesa (2011) the so-called "Basque Democratic Diaspora" began in the mid-seventies and involved mainly businessmen and the self-employed, which make up the group most badly affected by the costs of terrorism in the form of extortion, but from the mid-nineties onwards the phenomenon began to affect the rest of the population.

Graph 1: Relationship between investmens and terrorist activity in the Basque Country and Navarre (1964-2012)



Source: own calculations from IVIE and BBVA stock capital database (available at http://goo.gl/fbmGmG) and the Interior Ministry's database on terrorism.

Given the costs of terrorism, the regional tax authorities might have an incentive to counteract these costs by alleviating tax pressure so as not to lose their tax bases. Due to the pressures of terrorist extortion and the direct damage to their businesses caused by terrorist attacks, entrepreneurs and liberal professionals constitute a cluster within the population that is especially exposed to these costs. Tax enforcement policy is a flexible, adaptable instrument for selective intervention, which can be used to compensate this specific cluster of the population for the costs incurred[50]. In this regard, there is casual evidence that at least one Basque tax authority has reacted to ETA's extortions by tolerating its fiscal deductibility as a

[50] Enforcement policies are important determinants of the level and distribution of effective tax rates (see e.g. Johns and Slemrod, 2010) and, hence, they influence the total amount of tax revenues collected by governments. Previous literature on tax externalities has demonstrated the possibility of horizontal tax externalities in tax enforcement (see Cremer & Gahvari, 2000; Durán-Cabré *et al.*, 2014).

cost and by exempting the tax returns of the affected entrepreneurs from fiscal inspections. An investigation conducted in 2004 by the Spanish anticorruption prosecution agency, reported by Buesa (2011) and by the national press[51], reported that the tax authority of the Basque province of Vizcaya formally exempted from being audited the tax returns of a group of entrepreneurs and liberal professionals that had treated payments to the terrorist organization as deductions in their tax forms. The consequent fiscal opacity might further distort the taxpayers' incentives to resist extortion, particularly "if the payments to terrorists are mentally accounted for as an additional tax and, furthermore, if you are confident of obtaining a tax deduction from the tax authorities" (Barbería, 2004).

The objective of this paper, therefore, is to determine whether tax enforcement can be employed as an instrument for compensating the negative effect of terrorism on tax bases. To do so, I develop a theoretical model and empirically test it using a dataset based on survey results and other sources. The results of the theoretical analysis confirm the presence of externalities in tax enforcement due to the threat of the mobility of tax bases attributed to terrorism. I derive the reaction function of tax enforcement to the costs of terrorism and obtain a negative sign. As explained in detail in section 4.1, in order to corroborate this result I use Spanish data based on surveys, in which respondents are asked to express their opinion about the authorities' tax enforcement effort and I employ alternative measures of the costs produced by ETA's terrorist activity. By estimating ordered response models, I find a significant and negative impact of terrorism on tax enforcement as perceived by individuals who reside in the Basque Country and Navarre. In particular, this impact is found to be stronger for entrepreneurs and liberal professionals, while no significant impact is found for individuals resident in the rest of Spain.

[51] See e.g. Korta J.M., "Las Haciendas vascas crean un fichero especial para los chantajeados por ETA" ["The Basque tax authorities create a special file for those blackmailed by ETA"] in *El Mundo* (22nd January, 2004) and Bornstein, F. "¿Deduce el impuesto revolucionario?" ["Do you deduct the revolutionary tax?"], in *Nueva Economia – El Mundo* (8th February, 2004).

The rest of the paper is organized as follows. Section 2 provides a summary of the relevant literature, section 3 presents the theoretical framework, section 4 presents the empirical strategy while section 5 presents the results. Finally, I conclude in section 6 with some remarks.

2. Literature Review

The literature on the economics of terrorism is vast and can be usefully classified in different areas of study, including the analysis of the impact of terrorism on aggregate economic output and on specific sectors of activity as well as the effect of terrorism on economic policies. In particular, an increasing number of papers focuses on the economic output consequences of terrorist activity (see, e.g., Abadie and Gardeazabal, 2003; Eckstein and Tsiddon, 2004; Eldor and Melnick, 2004). The main conclusion of these articles is that terrorism represents a cost for the economies affected and that terrorist activities do reduce economic growth, particularly if they are concentrated in specific regions (see, e.g., Abadie and Gardeazabal, 2003; World Bank, 2002, 2003). That terrorism represents an economic cost is confirmed by the literature analysing the effect of terrorism on specific economic sectors. In this regard, several articles show that terrorist attacks may be considered as idiosyncratic shocks associated with noticeable decreases in consumption and investment (see, e.g., Eckstein and Tsiddon, 2004; Blomberg et al., 2004), as well as in capital flows and trade across borders (see, e.g., Abadie and Gardeazabal, 2008; Nitsch and Schumacher, 2004), tourism (see, e.g., Enders and Sandler, 1991, 1996; Buckley and Klemm, 1993) and airline demand (see, e.g., Ito and Lee, 2004).

Yet, the possibility that terrorist activity might have fiscal and monetary consequences has received only limited attention in the literature, although, as Wildasin (2002) notes, terrorist "attacks are likely to trigger a complex series of simultaneous adjustments that reverberate throughout *the* entire system of private and public decision-making"[52]. In a similar vein is the study undertaken by Gupta et al. (2004) that analyses the fiscal effects of armed conflicts and terrorism on 20 low- and middle-income countries.

[52] Wildasin, 2002, p.3. Italics are mine.

These authors empirically corroborate that terrorism negatively affects GDP growth and changes the composition of government spending by increasing military expenditure in response to additional security needs, accompanied by a negative effect on social public expenditure (health and education) and on the level of the public deficit. On the revenue side, they show that the fiscal accounts are affected only in terms of a reduction in real economic activity, but they do not show any significant effect of terrorism on the government revenue-to-GDP ratio.

Further contributions to this literature are made by various papers that deal with the fiscal and economic policy consequences of the terrorist attacks of 11 September 2001. Hobjin (2002) estimates that the economic impact of the 9/11 terrorist attacks in terms of U.S. security policies are relatively small (0.35 % of GDP in 2003) and they are unlikely to have major effects on the fiscal discipline of the government or on productivity in the private sector. Eichenbaum and Fisher (2004) and Wildasin (2002) argue that the large increase in military expenditures in the aftermath of 9/11 is not sufficient to justify the rise in the government deficit and the large fall in labour and capital tax rates. Thus, these papers suggest that isolated terrorist events, such as the 9/11 attacks, have a significant but limited effect on fiscal policies.

Further research is needed in this field and, seen from this perspective, the analysis of the impact of terrorism on fiscal policies in the Basque Country is particularly appropriate. Since this particular case is characterized by persistent terrorist violence over a long period of time, the potential impact of terrorism on fiscal policies might extend beyond the simple spending reaction to an unexpected but isolated economic shock. As a consequence, I expect to find a clear endogenous response on the part of the tax authorities in terms of their tax collection policy.

Given the case under study here, it is useful to refer to the literature that analyzes the economic impact of terrorism in the Basque Country from a range of different perspectives. On the output side, the economic

consequences of ETA terrorism have been accurately analysed by Abadie and Gardeazabal (2003). On the one hand, the authors estimate the macroeconomic impact of terrorism in the Basque Country using a synthetic Spanish region with the characteristics of the Basque Country but in the absence of terrorism. Based on this comparison, the authors find a 10-percent average gap between Basque per capita GDP and the per capita GDP of a comparable synthetic region without terrorism. On the other hand, the authors use ETA's 1998-1999 truce as a natural experiment to estimate the impact of terrorism on the stock markets and find that the stocks of firms with a significant share of their business activity in the Basque Country showed a positive relative performance during the truce period, and a relative negative performance when the truce ended. Abadie and Gardeazabal's (2003) results suggest that terrorism may have further externality effects on tax bases and, consequently, on Basque fiscal policies. This paper aims at filling this gap in the literature.

Buesa and Baumert (2013) describe ETA's financing system and its complex structural and economic network, but also illustrate the direct/indirect economic costs that ETA's terrorist activity has on the Basque economy. Again, their study clearly indicates that when terrorism is persistent in the Basque Country and Navarre the negative economic impact is substantial.

Finally, note this paper shares some of the features of the literature on the economic-policy impact of mafia-type organized crime (see in particular Alexeev et al., 2003; 2004). The theoretical framework presented in these papers is particularly appropriate for describing the context analysed here because of the similarities between mafia-type organizations and the terrorist organization ETA, particularly with regard to the extorting of regular payments from businessmen and firms, but more generally in that they represent a constant threat to the economic stability of the affected regions. This literature has emphasised the role of the mafia as an alternative tax collector and provider of public goods, such as protection and other services that facilitate a firm's underground activities, thus

demonstrating the existence of externalities between the government and the mafia in the tax collection process[53].

In section 3, I introduce elements from the models developed in this literature into my framework based on Durán-Cabré *et al.*, 2014.

3. The Theoretical Framework

Here I seek to identify the possible externality in tax administration due to terrorist activity. I develop a simple framework consisting of a federal state comprising two regions $(i = 1,2)$ of equal size in which the total population is normalized to one. Region 1 is subject to the permanent threat of terrorist activity, while the other one is not. I consider two players: the regional tax authorities and the terrorist organization. Adhering to the most common approach in the literature (see, e.g., Shaw *et al.*, 2009; Slemrod & Yitzhaki, 2002, 1987), I design the tax administrations as revenue maximizing agencies that set the tax enforcement rate $\beta_i \in (0,1)$ in their regions. Here I focus on the potential externality effect of terrorism on tax enforcement policies, and so I restrict my attention to one tax instrument, β_i, while assuming the tax rates in the two regions to be exogenously set. In line with the literature on extortion by mafia-type criminal organizations (see, e.g., Alexeev et al., 2003; 2004), I design the terrorist organization as a competing, revenue-maximizing tax collector that finances its violent activity in region 1 through the extortion of regular payments from its population. Individuals face an income tax on an exogenously fixed and normalized-to-one tax base and decide the share $\alpha \in (0,1)$ of income to declare maximizing their utility. To ensure an interior solution, tax evasion

[53] In particular, Alexeev et al. (2004) argue that the presence of the mafia can actually benefit the revenue-maximizing government as long as public goods do not play a significant role in determining whether the firms operate above or underground. Although this literature has generally assumed that the mafia can tax only underground activities, Alexeev et al. (2003) suppose that if the official government is sufficiently weak the mafia can and does tax above ground activities too. These authors show that when the demand for the firms' output is inelastic and the mafia is not too strong, the revenue-raising capacity of the state is not affected by the mafia, while when the demand is elastic the government's revenues decline as the mafia grows stronger.

is assumed to be costly for the individual. Since the effectiveness of a tax enforcement policy largely depends on the way it is perceived by taxpayers[54], I assume the enforcement rate to enter into the individual's objective function through his perceived probability of being audited ${\beta_i}^e(\beta_i, X)$[55]. For sake of simplicity, the individual's problem is not explicitly developed here, and I assume the results of the standard literature (see Allingham & Sandmo 1972; Kahneman & Tversky, 1979; Alm, 2000). Then, the model consists of three stages. At the first stage, the terrorist organization sets $E \in (0,1)$, the amount of the extortion[56]. At stage 2 the regional tax authorities set the regional tax enforcement rate β_i and at the third stage individuals choose their region of residence. The solution is provided by backward induction, but I will not solve stage 1, as the focus of our empirical analysis is stage 2.

This model has elements of both vertical and horizontal tax competition. Vertically, the tax authority in region 1 and the terrorist organization compete because they co-occupy the same normalized-to-one tax base.

[54] In this sense there is vast evidence from psychology that individuals tend to overestimate the probability of their being audited even when fully informed about actual policy (Kahneman and Tversky, 1979). This "may therefore provide an additional explanation for tax compliance. If taxpayers give more weight to the probability of an audit than they ought to (at least relative to an expected utility model), then compliance will be greater than the level predicted by the standard economics approach." (Alm, 2000, p. 748).

[55] Where $\frac{\partial {\beta_i}^e}{\partial \beta_i} > 0$, $\frac{\partial^2 {\beta_i}^e}{\partial {\beta_i}^2} > 0$ and X is a variable exogenously collecting information about the individual and situational characteristics as well as the social context that might have an impact on the individual's perceived enforcement (see e.g. Alm, 2000). Following Kahneman and Tversky (1979) I assume ${\beta_i}^e(\beta_i, X) \geq \beta_i$.

[56] Since the tax bases are normalized to one, it is possible to alternatively interpret E as an extortion rate or as a lump-sum payment and even more generally as a linear cost. The model takes into consideration just one component of the total cost of terrorism but its broad interpretation allows us to easily generalize its effects on tax administration. Indeed I am assuming that the entire population in region 1 is the victim of extortion by the terrorist organization. This is compatible with assuming that terrorism is a cost borne by all the regional population, which seems to be a reasonable assumption. A possible extension to the model would be to consider that the terrorist organization also decides the share of population in region 1 to be extorted $\gamma \in (0,1)$ in addition to E. This would lead to the same result since the only change would be the way in which the total amount of extortion is collected through variables E and γ.

There is also horizontal competition because the tax authorities in the two regions compete in a race to the bottom in tax enforcement rates in order not to lose the mobile tax bases. Moreover, and unlike the previous literature (see Cremer & Gahvari, 2000; Durán-Cabré *et al.*, 2014), horizontal competition is not fair in this model because of the presence of the externality produced by the terrorist organization in region 1 that reduces the tax authorities' ability to set β_1.

I employ the notion of "home attachment" (see Mansoorian & Myers, 1993 and 1997) to model the problem at stage 3. At this stage, individuals compare their indirect utility function in the two regions in order to decide where they wish to reside. Assuming that $n \in (0, 1)$ indexes the individuals by measuring the non-pecuniary (psychic) benefit they derive from living in region 2 and that individuals are uniformly distributed between 0 and 1[57] I can describe the preferences of individuals n with respect to location in this way:

$$V(n) = \begin{cases} {U_1}^* + a \times (1 - n) - E & \text{if } n \text{ lives in region 1} \\ {U_2}^* + a \times n & \text{if } n \text{ lives in region 2} \end{cases} \quad (1)$$

where ${U_i}^* = {U_i}^*(1 - \alpha^*(\beta_i;\ t_i))$ represents the (pecuniary) indirect utility function of an individual residing in region $i = 1, 2$[58], t_i is the tax rate exogenously fixed in region i, and $a \in (0, +\infty)$ is a parameter representing the cost sustained by an individual when moving away from their home region. In equilibrium, the marginal individual, that is, the one indifferent to residing in either region 1 or 2 is identified by $n = n_1$ such that:

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[57] Thus individuals indexed by $n \in \left(0, \frac{1}{2}\right)$ reside in region 1 while those identified by $n \in \left(\frac{1}{2}, 1\right)$ reside in region 2.

[58] The direct utility function is defined as $U = [1 - t_i \times [\alpha + (1 - \alpha) \times \tau \times {\beta_i}^e(\beta_i, X)] - g(1 - \alpha)]$ where $(\tau - 1) > 0$ is the exogenous tax penalty per unit of tax evaded such that $\tau \times {\beta_i}^e(\beta_i, X) < 1$ and the function $g(1 - \alpha)$ represents the cost of tax evasion $(1 - \alpha)$, such that $g'(1 - \alpha) > 0, g''(1 - \alpha) > 0,\ g(0) = 0, g(1) \to +\infty$.

$$U_1^* + a \times (1 - n_1) - E = U_2^* + a \times n_1. \quad (2)$$

Since $\int_0^{n_1} dn = n_1$, n_1 also represents the population resident in region 1 in equilibrium:

$$n_1 = n_1(\beta_1, E; a, t_1, t_2, \beta_2) = \frac{1}{2} + \frac{U_1^* - U_2^* - E}{2a}. \quad (3)$$

The population in region 2 in the migration equilibrium is:

$$n_2 = \int_{n_1}^{1} dn = 1 - n_1 \quad (4)$$

At stage 2, the regional tax authorities simultaneously set the tax enforcement rate by anticipating the optimal level of E set by the terrorist organization and by maximizing their objective function. The problem of tax authority in region 1 is then:

$$\underset{\beta_1}{Max}\ R_1(\beta_1, E\ ; a, t_1, t_2, \beta_2) = n_1 \times r_1$$

$$= \left(\frac{1}{2} + \frac{[\theta_2 - \theta_1 + g_2 - g_1] - E}{2a}\right) \times [\theta_1 - d(\beta_1)],$$

where $\theta_1 \equiv t_1 \times [\alpha + (1-\alpha) \times \tau \times \beta_1]$ is defined as the effective tax rate in region 1[59], $d(\beta_1)$ represents the tax administration cost such that $d'(\beta_1) > 0, d(\beta_1)'' > 0$ and $r_1 \equiv \frac{R_1}{n_1} = [B \times \theta_1 - d(\beta_1)\,]$ is the unitary tax revenue. Tax authority in region 2 faces the symmetric problem. The FOCs of these problems are then:

$$\frac{\partial r_1}{\partial \beta_1} = -\frac{2a}{U_1^{\,*} - U_2^{\,*} - E + a} \times {n_1}'_{\beta_1} \times r_1 > 0 \tag{5}$$

and

$$\frac{\partial r_2}{\partial \beta_2} = \frac{2a}{U_2^{\,*} - U_1^{\,*} + E + a} \times {n_1}'_{\beta_2} \times r_2 > 0 \tag{6}$$

The left hand side of both Eq. 5 and Eq. 6 represents, for each region, the marginal benefit of increasing β_i, while the right hand side represents the corresponding marginal cost. In particular, since ${n_1}'_{\beta_1} < 0$ and ${n_1}'_{\beta_2} > 0$, the marginal cost is positive in both cases. If we examine the denominator on the right hand side of both equations, it can be seen that the presence of costs related to terrorism (*E*), by affecting n_1 and n_2, increases the marginal cost of tax enforcement in region one while relaxing it in region 2. Consequently, the optimal level of β_1 (β_2) turns out to be lower (higher) than in the absence of terrorism. In other words, at this stage, given the exogenous level of a, t_1 and t_2, the tax administration of region 1 has to compensate for the costs of terrorism by relaxing its enforcement of existing tax legislation.

Multiple equilibria are possible and for sake of simplicity I assume that $t_1 = t_2 = t$. It is possible to show that in equilibrium $\beta_1 < \beta_2$ then,

[59] The effective tax rate is defined between 0 and 1; I limit the attention to the case where $t_1 + E \leq 1$ since the case $t_1 + E > 1$ clearly cannot represent a sub-game perfect equilibrium.

depending on the capacity of the tax authority in region 1 to maintain the individuals indifferent to living in either region 1 or 2, and given the optimal level of E it is possible to describe the equilibrium in this way:

$$\begin{matrix} n_1 < \frac{1}{2} < n_2 & \text{if } {U_1}^* < {U_2}^* + E \\ n_1 = n_1 = \frac{1}{2} & \text{if } {U_1}^* = {U_2}^* + E \end{matrix} . \quad (7)$$

Applying the inverse function theorem to Eq. (5), I derive the reaction function of β_1 with respect to E in order to determine the nature of the externalities in tax administration due to the cost of terrorism:

$$\frac{\partial \beta_1}{\partial E} = -\frac{{n_1}_E \times {r_1}_{\beta_1}}{{R_1}_{\beta_1\beta_1}(\beta_1, E; a, t_1, t_2, \beta_2)} = -\frac{-\frac{1}{2a} \times {r_1}_{\beta_1}}{{R_1}_{\beta_1\beta_1}(\beta_1, E; a, t_1, t_2, \beta_2)} < 0 \quad (8)$$

The first term of the numerator is the marginal loss of population in region 1 due to the costs of terrorism and it is negative; the term ${r_1}_{\beta_1}$ is the marginal unitary tax revenue that is positive under the FOC. According to the second order condition of the administration's problem, the denominator of Eq. 8 is negative. The slope of the reaction function is then negative. Thus, Eq. 8 shows that the activity of extortion practiced by the terrorist organization causes a negative externality on tax enforcement set by the regional administration representing its strategic substitute.

The individual perceived enforcement ${\beta_i}^e(\beta_i, X)$ positively depends on the actual tax enforcement rate and, consequently, it follows that the costs of terrorism also reduce the individual's perceived level of enforcement:

$$\frac{\partial {\beta_1}^e}{\partial E} = -\frac{n_{1_E} \times r_{1_{\beta_1}}}{R_{1_{\beta_1\beta_1}}(\beta_1, E; a, t_1, t_2, \beta_2)} \times \frac{\partial {\beta_1}^e}{\partial \beta_1}$$

$$= -\frac{-\frac{1}{2a} \times r_{1_{\beta_1}}}{R_{1_{\beta_1\beta_1}}(\beta_1, E; a, t_1, t_2, \beta_2)} \times \frac{\partial {\beta_1}^e}{\partial \beta_1} < 0 \qquad (9)$$

I empirically test this result in the next section.

4. The Empirical Analysis

In this section, I present the empirical framework used in order to test my main hypothesis, provide a description of the dataset and finally comment on the results of the analysis.

4.1 The empirical framework

The theoretical model developed in the previous section advances an interesting result that requires empirical investigation. Terrorism operates as a negative externality on tax administration by constraining the tax authority's ability to enforce existing tax legislation: because of individual mobility, the tax authority reacts to the higher costs of terrorism being borne by taxpayers by reducing the level of tax enforcement so as not to lose tax bases (Eq. 8). By impacting the actual policy, the costs of terrorism also have effects on tax enforcement as it is perceived by individuals, being lower in the presence of costs related to terrorism (Eq. 9). Here I test this hypothesis by means of econometric techniques. In order to perform my analysis, I construct a dataset based on the information provided by surveys and data from different Spanish sources.

Specifically, I use data from the 1994-2013 waves of the survey "Public opinion and fiscal policy"[60], conducted annually and released by the Spanish Centre of Sociological Research (*Centro de Investigaciones Sociológicas* in Spanish, CIS henceforth). This repeated cross-section survey reports information on subjective perceptions of the fiscal policies, public provided goods and services, and other aspects of the tax system in Spain. Socio-economic information about the respondents and their province of residence is also included in the survey data. In order to define my endogenous variable I employ the following question: "Do you think that the tax administration is currently taking many/quite a few/a few/very few steps in its efforts to fight tax evasion?"[61], which remains unchanged over the 1994-2013 period. For any respondent *i* in province *j* in survey year *t*, I code the answer to this question into the variable $\beta^{e}{}_{ijt}$ which is scaled from very low (1) to very high (4) according to the answer. Thus, by defining $\beta^{e}{}_{ijt}$ as an ordinal dependent variable measuring the latent perceived tax enforcement of individuals $\left(\beta^{e*}{}_{ijt}\right)$, I can design an ordered response model (see e.g. Wooldridge, 2002, pp. 504-509) to test the hypothesis raised in Eq. 9 in this way[62]:

[60] All annually released surveys are based on personal interviews conducted with a representative sample of 2500 Spaniards over the age of 18. The complete contents of the survey are available at the CIS website (http://www.cis.es).

[61] The original question in Spanish is "¿Cree Ud. que, en la actualidad. la Administración hace muchos, bastantes, pocos o muy pocos esfuerzos para luchar contra el fraude fiscal?" (see e.g. question n. 21 of the survey n. 2994 released in 2013).

[62] In this case, since the dependent variable is defined as an ordinal discrete ranking, the most appropriate estimation strategy is that of employing an ordered response model. Indeed as Greene (2002) states "although the outcome is discrete, the multinomial logit or probit model would fail to account for the ordinal nature of the dependent variable. Ordinary regression analysis would err in the opposite direction, however. Take the outcome of an opinion survey. If the responses are coded 0, 1, 2, 3, or 4, then linear regression would treat the difference between a 4 and a 3 the same as that between a 3 and a 2, whereas in fact they are only a ranking." (see Greene, 2002, p. 736).

$$\beta^{e*}_{ijt} = \mu T + \pi T \times Foral_{ijt} + \rho Foral_{ijt} + \boldsymbol{Y_{ijt}\psi} + \boldsymbol{X_{it}\alpha} + \vartheta_j + \tau_t + \varepsilon_{ijt}$$

$$\beta^{e}_{ijt} = \begin{cases} 1 & \text{if } \beta^{e*}_{ijt} \leq \omega_1 \\ 2 & \text{if } \omega_1 \leq \beta^{e*}_{ijt} \leq \omega_2 \\ 3 & \text{if } \omega_2 \leq \beta^{e*}_{ijt} \leq \omega_3 \\ 4 & \text{if } \beta^{e*}_{ijt} \geq \omega_3 \end{cases} \quad (10)$$

I estimate the coefficients as well as the cut-points in Eq. 10 through an ordered probit model by means of maximum likelihood technique. The variable T measures the costs generated by ETA's terrorist activity. In order to identify this, I employ five alternative proxies[63]. The first approach is standard in the literature (see, e.g., Abadie and Gardeazabal, 2003), and is based on the use of information about ETA's truces and ceasefires: I construct a dummy variable equal to one for the years in which a truce was announced by ETA[64]. This variable indirectly measures the costs of ETA's activity, while the other variables employed directly measure the costs of terrorism. Specifically, I employ two measures of the aggregate costs attributable to ETA's activity. They refer to the pecuniary compensation for the damage caused by terrorism and provided respectively by the Spanish Ministry of the Interior[65] and by the Insurance Compensation Consortium ("Consorcio de Compensacion de Seguros" in Spanish, IC henceforth)[66] on

[63] Depending on the measure employed, T varies over time or alternatively both over time and across provinces. For this reason I omit subscripts.

[64] Information on truces is extracted from the dataset of the Spanish Ministry of the Interior. Specifically I define $Truce_t$ as being equal to one if a ceasefire was announced and implemented by ETA during the survey year *t*, i.e. during a period of time within the 12 months previous to the implementation of the survey.

[65] The Ministry's compensations include personal as well as any kind of material damages. These data are extracted from the Spanish Ministry of the Interior's annually released statistical report (for the report of 2013 see http://goo.gl/GEwg2R).

[66] The IC is a public corporate entity attached to the Spanish Ministry of the Economy. It is a guarantee fund that aims at providing insurance cover for a series of extraordinary risks such as terrorism and natural catastrophes. The data are extracted from the IC's report "Extraordinary risk statistics 1971-2012" (http://goo.gl/5ND1n0).

a national and annual basis[67]. Both variables are defined at the national level, as are the proxies of the ETA terrorist costs for the affected economy. Alternatively, I measure ETA's level of activity by employing a variable collecting information on the number of fatalities attributed to ETA in any Spanish province and, thus, directly identify the costs generated by ETA in terms of the threat to personal security and provincial stability[68]. According to the theoretical model, terrorism should negatively impact tax enforcement and its perception in the areas most affected by terrorist activity in Spain, namely, the four provinces belonging to the foral autonomous communities of the Basque Country and Navarre. Thus, I employ an interaction term between the measure of terrorism costs and $Foral_{ijt}$, a dummy variable equal to one for residents in the foral provinces and I expect the linear combination between the interacted and the un-interacted terms to be negative[69].

As a final measure of the costs of terrorism, I employ an estimation of the total revenues obtained by ETA through the "revolutionary tax" in the foral communities of the Basque Country and Navarre. This variable is extracted from Buesa and Baumert (2013). These authors estimate the total amount of extortion required by ETA on an annual basis in the Basque Country and Navarre by employing documents seized from the terrorist group by Spain's anticorruption prosecution agency; thus, this variable is incomplete and

[67] These data are aggregated at the national level and do not distinguish between the compensation paid out to the victims of ETA from that paid out to the victims of other terrorist organizations. Nevertheless, I was able to exclude data referring to the 2004 Islamic terrorist attack on Madrid and as 96.5% of the fatalities of terrorism in Spain are attributable to ETA (in common with almost the totality of all other classes of injury due to terrorism), it seems that these measures provide a reasonable approximation of the damages caused by ETA's activity.

[68] This frequently used indicator has been criticized since it tends to underestimate the degree of terrorist activity (Frey *et al*., 2007). Nevertheless, in this framework, the possibility of expressing this variable at a provincial level is of particular interest for the analysis since in the territories belonging to the foral regime the tax authorities are appointed to operate at this level of government. The variable is also defined considering the survey year and not the current one and the information on fatalities is also extracted from the Spanish Ministry of the Interior's dataset.

[69] Since the variable $Truce_t$ is indirectly related to the level of terrorist activity, its coefficient is expected to be positive and significant.

measured with error. This variable is set as being equal to zero for the rest of the country and, consequently, no interaction term is calculated.

According to the assumption of the theoretical model, perceived tax enforcement is a function of the information on the actual enforcement policy that individuals have. In particular, I expect actual tax enforcement and the individuals' perception of it to be positively related. In order to disentangle the changes in perceived tax enforcement due to the externality produced by terrorism in the setting of the actual tax enforcement from those changes determined by other factors that may alter the real tax enforcement, I include in vector $\boldsymbol{X_{jt}}$ information on political and budgetary variables that directly affect the setting of the enforcement policy. Specifically, I include dummies for elections and rightist governments. I also control for provincial per-capita GDP and population.

In the theoretical model, I have also assumed perceived tax enforcement to be a function of individual personal characteristics and the social context. For this reason, I control in Eq. 10 for the vector of variables $\boldsymbol{Y_{ijt}}$ collecting information on relevant personal and social characteristics that are likely to influence the individual's perception of the risk of being audited. These variables are also extracted from the survey "Public opinion and fiscal policy". Specifically I control for sex, age, level of education, civil status, job market status, the industry in which respondents work, their political views (including dummies for leftist voter and nationalist voter) and I include a dummy equal to one for individuals that are heads of household and a dummy equal to one if the respondent to the survey declares themselves as being an entrepreneur or liberal professional. Finally, I include provincial fixed effects and time trends, while ε_{ijt} is the error term.

As emphasized in the introduction, Basque and Navarrese entrepreneurs and professionals constitute the cluster of individuals that are most affected by the costs of terrorism, as a result of their exposure to blackmailing. This makes these self-employed workers a specific target for potential tax

enforcement cutbacks by the foral tax authorities. Therefore, I suspect that the costs of terrorism may impact the perceived tax enforcement of self-employed workers resident in the Basque Country and Navarre more strongly. For this reason, I further interact the term $T \times Foral_{ijt}$ with the dummy SE_{ijt}. Thus, I define in a similar fashion the following model:

$$\beta^{e*}{}_{ijt} = \gamma T + \xi T \times Foral_{ijt} +_t \eta T \times Foral_{ijt} \times SE_{ijt} + \varphi SE_{ijt} + \boldsymbol{\lambda} Foral_{ijt} + \boldsymbol{Y'_{ijt}\sigma} + \boldsymbol{X'_{it}\alpha} + \vartheta'_j + \tau'_t + \epsilon_{ijt}$$

$$\beta^{e}{}_{jit} = \begin{cases} 1 & \text{if } \beta^{e*}{}_{jit} \leq w_1 \\ 2 & \text{if } w_1 \leq \beta^{e*}{}_{jit} \leq w_2 \\ 3 & \text{if } w_2 \leq \beta^{e*}{}_{jit} \leq w_3 \\ 4 & \text{if } \beta^{e*}{}_{jit} \geq w_3 \end{cases} \quad (11)$$

4.2 Data, sources and descriptive statistics

With the exception of the endogenous variable, the proxies of the costs of terrorism and of the individual personal characteristics discussed above, the other variables are obtained from the following statistical sources. The provincial per-capita GDP and the provincial population are provided by the Spanish National Institute of Statistics (INE). The dummies identifying rightist government in office and elections are based on information extracted from the electoral database of the Spanish Ministry of the Interior. In Table 1, I report the summary statistics[70].

[70] I do not present descriptive statistics for the branch of industry in which respondents work in the interest of space as they are a large number of dummies. These descriptive statistics are available upon request.

Table 1: Summary Statistics

Variable	Measurement Unit	Observations	Mean	Std. Dev.	Min	Max
Key variables						
Perceived Enforcement	Ranking 1 to 4	40913	2.37	0.81	1	4
Truce	Dummy	49656	0.60	0.49	0	1
Killings_prov	Units	49656	0.28	0.99	0	8
Total_Extortion(BC)	Millions of Euros	48513	0.14	0.85	0	10.42
Int_Min_Compensation_Terr	Millions of Euros	49656	4.37	30.07	0	12.92
CCS_Compensation_Terr	Millions of Euros	49656	10.97	10.32	0	40.08
Individual Characteristics						
Female	Dummy	49656	0.51	0.50	0	1
Age	Years	49625	46.03	18.14	18	99
Schooly	Years	49493	8.20	4.93	0	17
Civil Status	Dummy	49656	0.36	0.48	0	1
Household head	Dummy	49656	0.45	0.50	0	1
Worker	Dummy	49656	0.45	0.50	0	1
Self_Employed	Dummy	49656	0.19	0.39	0	1
Nationalist	Dummy	49656	0.06	0.23	0	1
Left	Dummy	49656	0.52	0.50	0	1
Social context characteristics						
Rigth	Dummy	49656	0.40	0.49	0	1
Per_Capita_GDP	Thousands of Euros	49656	21823.88	26790.88	0.00	267471.90
Population	Thousands of People	49656	2054.46	2007.99	79.90	6461.97
Foral	Dummy	49656	0.07	0.25	0	1

Before the multivariate analysis, I perform a test for the equality of the means of the subsample of the individuals residing in the foral provinces and the rest of the population concerning their perceived tax enforcement. The results of this analysis are reported in Table 2.

According to this analysis (model 1), I can reject the hypothesis of equality of the means of the two subsamples, in particular the perceived tax enforcement mean in the foral regime subsample is significantly lower than that in the common regime subsample. In order to obtain a clearer picture of the distribution of the perceived tax enforcement in the two subsamples, I construct four dummy variables equal to one corresponding to the four values assumed by $\beta^{e}{}_{jit}$ and I replicate the analysis of subsample means for these variables (models 2 to 5). The results go in the same direction, suggesting that the distribution of the perceived tax enforcement in the foral regime is more skewed to the right with respect to the corresponding distribution in the common regime subsample. This may depend in part on differences in the risk perception of the population in the two Spanish areas, but it may also be the result of substantial differences in the policy strategies set by the competent tax authorities in the two territories. In particular part of the potential differences in the policy strategies might be due to the externality that terrorism has on tax enforcement in the foral territories. To gain an initial insight into this issue I replicate the analysis performed in model 1 for the two sub-periods identified by the dummy Truce (models 6 and 7). According to this analysis, the difference in means is mainly driven by the effects of terrorism but there is a residual part that is still explained by other potential factors. In the next section I report the results of the main analysis presented in section 4.1.

Table 2: Subsamples Means Estimation: Foral vs. Common regimes

	(1) Perceived Enforcement	(2) Dummy Perc_Enf=4	(3) Dummy Perc_Enf=3	(4) Dummy Perc_Enf=2	(5) Dummy Perc_Enf=1	(6) Perceived Enforcement Truce=0	(7) Perceived Enforcement Truce=1
Common Regime (Foral = 0)	2.381***	0.071***	0.378***	0.414***	0.138***	2.389***	2.374***
	(575.718)	(53.796)	(152.132)	(164.215)	(78.100)	(395.753)	(418.210)
Foral Regime (Foral = 1)	2.227***	0.057***	0.296***	0.465***	0.182***	2.154***	2.295***
	(144.690)	(12.859)	(34.071)	(48.943)	(24.803)	(99.819)	(105.525)
Linear Combination (Foral_Regime – Common_Regime)	-0.154***	-0.014**	-0.081***	0.051***	0.045***	-0.235***	-0.079***
	(-9.65)	(-3.04)	(-9.00)	(5.16)	(5.89)	(-10.48)	(-3.51)
Observations	40913	40913	40913	40913	40913	40913	40913
Common regime	37615	37615	37615	37615	37615	37615	37615
Foral regime	3298	3298	3298	3298	3298	3298	3298
Equality of the means							
(H_0: means of subsamples are equal)							
Wald F statistic	93.08	9.22	80.92	26.65	34.70	109.81	12.31
p-value	0.0000	0.0024	0.0000	0.0000	0.0000	0.0000	0.0005

Note*: t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5. Results

In Table 3, I report the results of the estimation of alternative models expressed in Eq. 10[71]. As discussed above, I employ five alternative measures of the costs of terrorism that are reflected respectively in models 1 to 5. Using the interpretation I have given to the latent variable, it is possible to interpret the estimated coefficients in terms of the marginal effects of the regressors on the latent perceived tax enforcement $\beta^{e*}{}_{jit}$[72]. In most of the models, the costs of terrorism significantly impact the individuals' perceived tax enforcement in a way that is consistent with the theory. In particular, it has a significant negative impact on the perceived tax enforcement of individuals residing in the foral provinces – the interacted terms $T \times Foral_{ijt}$ and the corresponding linear combination with T are significant in most of the specifications and present the expected signs – but it does not have any effect on the tax enforcement perceived by the rest of the individuals interviewed (the un-interacted terms T are not significantly different from zero). Thus, this result suggests that while terrorism represents an externality in the tax-enforcement-setting process for the foral tax authorities, it does not impact at all on the setting of auditing policies in the provinces belonging to the common tax regime, which are administered by a central agency. Furthermore, I find that the dummy variable $Foral_{ijt}$ is negative and significant confirming what the analysis of sub-samples means previously indicated. This result may well be evidence of the competitive behaviour of the foral provinces but it might also, in part, collect the residual effect of terrorism on tax enforcement that is not fully identified by the measures of terrorism employed.

[71] The complete results for the covariates have been omitted for reasons of space but are available upon request.

[72] The coefficients can always be interpreted as the marginal effects of the regressors on the latent variable, which is particularly useful in contexts such as the one analyzed here, where the latent variable can be given some easily interpretable meaning and it is not a mere modeling device (see e.g. Wooldridge 2002).

Table3: Impact of terrorism on perceived tax enforcement. Ordered Probit Models (1994-2013). Interaction Foral.

	(1)	(2)	(3)	(4)	(5)
Truce	-0.010	-	-	-	-
	(-0.522)				
Truce×Foral	0.196***	-	-	-	-
	(4.180)				
Comp_Terr_IM	-	-0.002	-	-	-
		(-0.551)			
Comp_Terr_IM×Foral	-	-0.018**	-	-	-
		(-2.499)			
Comp_Terr_IC	-	-	0.001	-	-
			(0.972)		
Comp_Terr_IC×Foral	-	-	-0.001	-	-
			(-0.509)		
Annual_Killings_province	-	-	-	0.002	-
				(0.286)	
Annual_Killings_province×Foral	-	-	-	-0.054***	-
				(-3.951)	
Extortion (in Foral Provinces)	-	-	-	-	-0.009
					(-0.941)
Foral	-0.352***	-0.158***	-0.313***	-0.182***	-0.266***
	(-8.913)	(-2.799)	(-8.694)	(-3.448)	(-5.003)
Linear Combinations					
Truce +Truce×Foral	0.186*** (3.85)				
Comp_Terr_IM +Comp_Terr_IM×Foral		-0.019** (-2.69)			
Comp_Terr_IC +Comp_Terr_IC×Foral			0.000 (0.07)		
Annual_Killings_province +Annual_Killings_province×Foral				-0.052*** (-4.37)	

Table 3 continued

	(1)	(2)	(3)	(4)	(5)
Observations	40755	40755	40755	40755	39751
Log likelihood	-47128.840	-47127.195	-47142.276	-47065.466	-46281.486
Wald chi2 (All variables)	5089.247	5126.426	3021.360	25984.423	3865.418
p-value	0.000	0.000	0.000	0.000	0.000
Test for the equality of the cut-points (H_0: w_1=w_2)					
Wald chi2	23269.54	23268.69	23366.97	23261.66	22618.57
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Test for the equality of the cut-points (H_0: w_2=w_3)					
Wald chi2	18917.36	18910.21	19485.56	18924.38	18732.64
p-value	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The endogenous variable is the perceived tax enforcement in any specification. Each model includes Individual Characteristics, Contextual-level characteristics, Provincial fixed effects and Time Trends. In particular Individual Characteristics include sex, age, level of education , civil status, dummy variable for head of household, job market status, dummy for self-employed, branch of activity and political views (leftist voter and nationalist voter dummies). Contextual-level characteristics include dummy for right government, per-capita GDP, population.

In Table 4, I present the results of the estimation of alternative specifications of Eq. 11. The impact of ETA's terrorist activity on the perceived tax enforcement of the residents in the foral provinces is even stronger for the cluster of entrepreneurs and liberal professionals, as the interacted terms and linear combinations of interacted and un-interacted coefficients show. The entrepreneurs and liberal professionals are found to report a higher perceived tax enforcement than that reported by the rest of the population[73], which makes sense because their probability of being audited is higher as they have more opportunities to evade taxes.

Thus, the results of the analysis performed here show that in the presence of more intense terrorist activity, individuals residing in the foral territories perceive a lower level of tax enforcement. This confirms that the costs of terrorism do represent a negative externality for the foral communities. In particular, the impact of the cost of terrorism is, most of the time, significantly stronger for self-employed people confirming that the foral tax authorities might react to the externalities attributable to terrorism by reducing tax enforcement in particular for this group of people.

As a robustness check, I perform an ordered logit estimation of the models presented above obtaining results congruent with the main analysis. The results are reported in Appendix 2.

[73] Even if not shown in Table 3, this result is present also in the absence of the interaction $T \times Foral_{ijt} \times SE_{ijt}$.

Table 4: Impact of terrorism on perceived tax enforcement. Ordered Probit Models (1994-2013). Interaction Foral & Self Employed

	(1)	(2)	(3)	(4)	(5)
Truce	-0.011 (-0.549)				
Truce×Foral	0.169*** (3.463)				
Truce×Foral×SE	0.179* (1.799)				
Comp_Terr_IM		-0.002 (-0.558)			
Comp_Terr_IM×Foral		-0.013* (-1.783)			
Comp_Terr_IM×Foral×SE		-0.030*** (-2.613)			
Comp_Terr_IC			0.001 (1.055)		
Comp_Terr_IC×Foral			0.002 (0.804)		
Comp_Terr_IC×Foral×SE			-0.018*** (-4.618)		
Killings_province				0.002 (0.289)	
Killings_province×Foral				-0.052*** (-3.632)	
Killings_province×Foral×SE				-0.009 (-0.334)	
Extortion (in Foral)					-0.008 (-0.793)
Extortion (in Foral)×SE					-0.046 (-1.506)
Foral	-0.158*** (-2.804)	-0.152*** (-2.689)	-0.310*** (-8.607)	-0.183*** (-3.449)	-0.264*** (-4.981)
SE	0.088*** (5.777)	0.085*** (5.633)	0.092*** (6.091)	0.087*** (5.794)	0.070** (2.496)

Table 4 continued

	(1)	(2)	(3)	(4)	(5)
Linear Combinations					
Truce+Truce×Foral+Truce×Foral×SE	0.337***				
	(3.44)				
Comp_Terr_IM+Comp_Terr_IM×Foral+Comp_Terr_IM×Foral×SE		-0.044***			
		(-3.64)			
Comp_Terr_IC+Comp_Terr_IC×Foral+Comp_Terr_IC×Foral×SE			-0.015***		
			(-3.67)		
Killings_province + Killings_province×Foral +Killings_province×Foral×SE				-0.059**	
				(-2.31)	
Extortion (in Foral)+ Extortion (in Foral)×SE					-0.054*
					(-1.75)
Observations	40755	40755	40755	40755	39751
Log likelihood	-47123.183	-47124.686	-47131.584	-47065.412	-46280.616
Wald chi2 (All variables)	5015.030	5046.874	3042.743	25830.262	3846.938
p-value	0.000	0.000	0.000	0.000	0.000
Test for the equality of the cut-points (H_0: w_1=w_2)					
Wald chi2	23267.18	23271.72	23364.28	23261.94	22618.50
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Test for the equality of the cut-points (H_0: w_2=w_3)					
Wald chi2	18917.59	18907.54	19484.87	18924.13	18731.97
p-value	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The endogenous variable is the perceived tax enforcement in any specification. Each model includes Individual Characteristics, Contextual-level characteristics, Provincial fixed effects and Time Trends. In particular Individual Characteristics include sex, age, level of education , civil status, dummy variable for head of household, job market status, dummy for self-employed, branch of activity and political views (leftist voter and nationalist voter dummies). Contextual-level characteristics include dummy for right government, per-capita GDP, population.

6. Conclusions

In this paper, I have analysed the impact of externalities due to terrorism on fiscal policy, in particular, on tax enforcement. By altering individuals' incentives to reside in their home region, terrorism constrains the tax authority's ability to set tax enforcement policies in the affected region. As a result, the tax authority decreases the tax pressure by reducing the audit rate so as not to lose tax bases. This hypothesis has been tested for the Basque Country and Navarre: by employing a dataset based on surveys as well as on data extracted from other statistical sources, I estimated ordered response models whose outcomes corroborate the theory.

The costs of terrorism have been found to impact negatively and significantly the perceived tax enforcement of individuals residing in the provinces belonging to the Basque Country and Navarre, with a more marked effect on self-employed workers. This is the main contribution of the paper. No significant effect is reported for the residents in common-regime provinces, where the main taxes are administered by the central government. ETA's terrorist activity acts then as a negative externality on the setting of tax enforcement policies only in the territories where terrorism represents a substantial and persistent cost that might significantly affect the residents' incentives to move. We can conclude, therefore, that in the Basque Country and Navarre the tax administration uses tax enforcement as an instrument to counteract the negative effect of terrorism on its tax bases, tax revenues and definitely on the economy. Abadie and Gardeazabal's (2003) results are implicitly calculated net of this effect, and so they could be considered as a lower bound of the impact of terrorism on the Basque economy.

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Appendix 1: Framework background: The Basque Country and ETA

The four provinces belonging to the Spanish autonomous communities of Navarre and the Basque Country represent the main part of the historical Basque territories: they share common cultural roots including a common second language, "Euskera", which in those regions is co-official with Spanish. They are two of the richest regions in Spain, the Basque Country being the first and Navarra the third in terms of per capita GDP among the Spanish autonomous communities according to the data of the Spanish National Institute of Statistics (INE). From a tax management perspective, the Basque Country and Navarra enjoy a special (so-called "foral") tax regime granting them an almost full autonomy in the setting and collecting of all the taxes which grants them complete jurisdiction in determining tax law and tax administration. The foral tax authorities are appointed at the provincial level and thus the four foral provinces levy all the taxes that elsewhere are levied by the central government (including personal income tax and corporate tax). In return both autonomous communities pay an annual quota for the common public services provided by the central government (such as defense), which is agreed between the two parties on a periodical basis. An important aspect of this system is that there is no effective mechanism of equalization between the foral communities and the common regime communities[74]. In Figure 1 I highlight the foral communities of Navarre and the Basque Country within the Spanish national confines.

[74] For more information on the differences between the foral and the common regimes see e.g. Garcia-Milà and McGuire 2007.

Figure 1: The foral autonomous communities of Navarre and the Basque Country

In this context in 1959 a group of Basque students founded the extreme left-wing terrorist organization ETA (*Euskadi Ta Askatasuna*, Basque acronym for "Basque Homeland and Freedom") with the political objective of achieving the establishment of an independent Basque state[75]. ETA carried out its first terrorist attack in 1968 and since then its violent and paramilitary activity has claimed more than 800 lives and many more victims in Spain until the allegedly definitive cessation of its armed activity declared on 20 October 2011. In Figure 2, I report the distribution of killings due to ETA's attacks by Spanish provinces. The picture shows that the majority of attacks were perpetrated in the Basque and Navarrese provinces but that also Madrid and Barcelona have been frequent targets.

[75] Among others monographic works on ETA see e.g. Clark; 1984, Domínguez 1998 and Mees 2003.

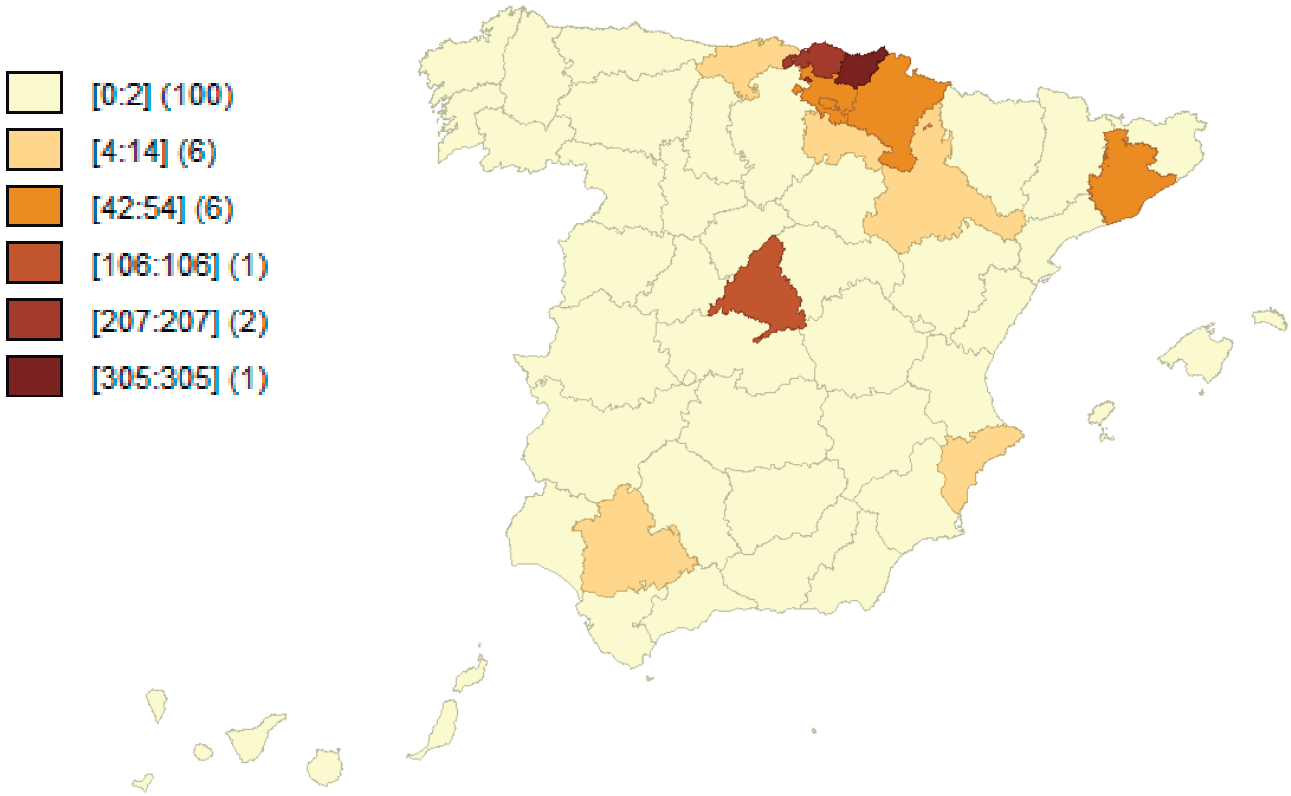

Figure 2: ETA's killings by province

In particular Basque entrepreneurs and liberal professionals were specific targets of violence including assassinations, robberies, extortion and kidnappings-for-ransom. In this regard Buesa and Baumert (2013) show that the revolutionary tax extorted from this cluster of the population was one of the main sources of income for ETA from the 1970s onwards, after substituting the previously more important activities of bank robberies and thefts. These authors estimated that during the three decades that range from 1978 to 2008, ETA obtained more than 115 million euros through its extortion activity. This value has to be considered a minimum, since the information employed is mostly obtained from documents seized from the terrorist group and, as such, is incomplete. In the same line, Juan Miguel Liñan Macias – former representative of the Spanish Ministry of Defense – declared that "ETA is funded mainly from one source: the money it collects through extortion of small and medium-sized businessmen, charging them the so-called "revolutionary tax". At present the amounts required are

between 35,000 and 400,000 euros. The annual budget the terrorist organization needs for the maintenance of its structures is estimated at around 10 million euros."[76]. Thus the effect of terrorism is responsible at least in part for the economic downturn suffered by the Basque Country during ETA's period of activity (see Abadie and Gardaebazal, 2003; Enders and Sandler 1991, 1996).

Finally ETA holds a central role within the Basque national liberation movement (MLNV), a composite aggregation of multiple organizations (both legal and illegal), which are united by the aforementioned common ideological objective but not always by any actual formal links. In the past decades, several judicial rulings have made illegal many, but not all, of the MLNV entities due to their connections with ETA. Some of the entities that are part of the MLNV are responsible for street terrorism, which represents a further threat to the stability of businesses based in the Basque Country and Navarre[77].

[76] (Text extracted from: "Counterterrorism: An Example of Co-operation", speech pronounced at the Seminar on The role of the Euro-Atlantic Partnership Council in combating terrorism, Feb. 22nd, 2002).

[77] For a detailed investigation of ETA's network and its financing system see Buesa (2011) and Buesa and Baumert (2013).

Appendix 2: Alternative estimation strategies

Table A1: Impact of terrorism on perceived tax enforcement. Ordered Logit Models (1994-2013). Interaction Foral.

	(1) Perceived Enforcement	(2) Perceived Enforcement	(3) Perceived Enforcement	(4) Perceived Enforcement	(5) Perceived Enforcement
Truce	-0.031	-	-	-	-
	(-0.909)				
Truce×Foral	0.330***	-	-	-	-
	(4.098)				
Comp_Terr_IM	-	-0.000	-	-	-
		(-0.057)			
Comp_Terr_IM×Foral	-	-0.032***	-	-	-
		(-2.593)			
Comp_Terr_IC	-	-	0.003	-	-
			(1.443)		
Comp_Terr_IC×Foral	-	-	-0.002	-	-
			(-0.539)		
Annual_Killings_province	-	-	-	0.001	-
				(0.056)	
Annual_Killings_province×Foral	-	-	-	-0.085***	-
				(-3.605)	
Extortion (in Foral Provinces)	-	-	-	-	-0.007
					(-0.442)
Foral	-0.602***	-0.243**	-0.549***	-0.292***	-0.496***
	(-8.832)	(-2.554)	(-8.894)	(-3.279)	(-5.386)

Table A1 continued

	(1)	(2)	(3)	(4)	(5)
Linear Combinations					
Truce +Truce×Foral	0.299***				
	(3.60)				
Comp_Terr_IM +Comp_Terr_IM×Foral		-0.032**			
		(-2.60)			
Comp_Terr_IC +Comp_Terr_IC×Foral			0.001		
			(0.29)		
Annual_Killings_province +Annual_Killings_province×Foral				-0.084***	
				(-4.17)	
Observations	40755	40755	40755	40755	39751
Log likelihood	-47049.353	-47045.678	-47063.462	-46984.323	-46219.275
Wald chi2 (All variables)	4627.979	4672.693	3178.987	11816.392	3318.701
p-value	0.000	0.000	0.000	0.000	0.000
Test for the equality of the cut-points (H_0: w_1=w_2)					
Wald chi2	20425.65	20421.68	20456.51	20404.18	19955.87
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Test for the equality of the cut-points (H_0: w_2=w_3)					
Wald chi2	15595.64	15580.12	15819.36	15588.18	15348.47
p-value	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each model includes Individual Characteristics, Contextual-level characteristics, Provincial fixed effects and Time Trends. Individual Characteristics include sex, age, level of education , civil status, dummy variable for head of household, job market status, dummy for self-employed, branch of activity and political views (leftist voter and nationalist voter dummies). Contextual-level characteristics include dummy for right government, per-capita GDP, population.

Table A2: Impact of terrorism on perceived tax enforcement. Ordered Logit Models (1994-2013). Interaction Foral & Self Employed.

	(1)	(2)	(3)	(4)	(5)
	Perceived Enforcement	Perceived Enforcement	Perceived Enforcement	Perceived Enforcement	Perceived Enforcement
Truce	-0.032 (-0.931)				
Truce×Foral	0.282*** (3.383)				
Truce×Foral×SE	0.327* (1.933)				
Comp_Terr_IM		-0.000 (-0.065)			
Comp_Terr_IM×Foral		-0.024* (-1.909)			
Comp_Terr_IM×Foral×SE		-0.051** (-2.526)			
Comp_Terr_IC			0.003 (1.506)		
Comp_Terr_IC×Foral			0.002 (0.635)		
Comp_Terr_IC×Foral×SE			-0.031*** (-4.354)		
Killings_province				0.001 (0.058)	
Killings_province×Foral				-0.081*** (-3.308)	
Killings_province×Foral×SE				-0.017 (-0.355)	
Extortion (in Foral)					-0.005 (-0.276)
Extortion (in Foral)×SE					-0.080 (-1.597)
Foral	-0.603*** (-8.844)	-0.243** (-2.550)	-0.543*** (-8.782)	-0.292*** (-3.280)	-0.495*** (-5.380)
SE	0.129*** (4.916)	0.147*** (5.580)	0.153*** (5.862)	0.146*** (5.596)	0.109** (2.239)

Table A2 continued

	(1)	(2)	(3)	(4)	(5)
Linear Combinations					
Truce+Truce×Foral+Truce×Foral×SE	0.577***				
	(3.42)				
Comp_Terr_IM+Comp_Terr_IM×Foral+Comp_Terr_IM×Foral×SE		-0.075***			
		(-3.49)			
Comp_Terr_IC+Comp_Terr_IC×Foral+Comp_Terr_IC×Foral×SE			-0.025***		
			(-3.41)		
Killings_province + Killings_province×Foral +Killings_province×Foral×SE				-0.097**	
				(-2.21)	
Extortion (in Foral)+ Extortion (in Foral)×SE					-0.084*
					(-1.69)
Observations	40755	40755	40755	40755	39751
Log likelihood	-47047.518	-47041.857	-47053.861	-46984.262	-46218.347
Wald chi2 (All variables)	4682.104	4573.557	3198.190	11804.676	3302.779
p-value	0.000	0.000	0.000	0.000	0.000
Test for the equality of the cut-points (H_0: w_1=w_2)					
Wald chi2	20421.22	20428.67	20454.69	20404.63	19956.17
p-value	0.0000	0.0000	0.0000	0.0000	0.0000
Test for the equality of the cut-points (H_0: w_2=w_3)					
Wald chi2	15597.57	15578.72	15819.91	15587.94	15348.21
p-value	0.0000	0.0000	0.0000	0.0000	0.0000

Note: *t* statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each model includes Individual Characteristics, Contextual-level characteristics, Provincial fixed effects and Time Trends. Individual Characteristics include sex, age, level of education , civil status, dummy variable for head of household, job market status, dummy for self-employed, branch of activity and political views (leftist voter and nationalist voter dummies). Contextual-level characteristics include dummy for right government, per-capita GDP, population.

Chapter 5

Concluding Remarks

In a federal framework analysing the determinants of the decentralized tax administration acquires great relevance. In this context, the existence of potential interactions between sub-central tax authorities, resulting from the mobility of tax bases, and, more generally, the existence of other tax externalities, potentially impacting the efficient functioning of such institutions, need to be taken into account when setting policies. Clearly, tax administration is a key institution in any tax system, being the enforcement of the existing tax legislation its main responsibility. In this sense, there can be little doubt that the tax audit policy represents its most important, as well as its most powerful instrument, for enhancing tax compliance. Having said this, however, other tax policies designed to increase efficiency in the tax management process – e.g. by reducing errors in the tax reporting process – are as equally crucial. The three studies that constitute this dissertation have examined the incentives that lead to the existence of three different forms of externalities in tax administration in a federal context and their corresponding consequences. This concluding chapter summarizes the main findings of the three studies and discusses their contributions to the literature.

Chapter 2 analyses the presence of horizontal competition in tax enforcement. After developing a simple theoretical model in order to formulate a working hypothesis, we test its outcomes for the Spanish IGT by employing a spatial panel autoregressive model and by measuring tax enforcement via the actual tax audit rate. Our results confirm the presence of interaction. Specifically, the coefficients for the spatial lag are coherent with the hypothesis of mobility-based competition in tax enforcement adopted in the theoretical model and with the previous literature on tax competition. As such, this study represents the first empirical contribution to this branch of research. Our empirical evidence also suggests that after the decentralization of the normative power a partial switch occurs from a

more opaque competition in tax audit rates to a more transparent competition in statutory tax rates, partially circumventing the problem of sub-optimal tax enforcement. Nevertheless, decentralizing both the tax and the audit rates might not be optimal as it could provoke a race to the bottom in both instruments with consequent inefficient outcomes. Thus, in line with Cremer & Gahvari's (2000) conclusion, it seems that in our framework harmonization policies are not the most appropriate instrument to employ to avoid the inefficiencies caused by mobility-based competition, since they would only circumvent inefficiencies in the setting of tax rates and restore the initial situation of opaque competition in tax enforcement.

Before concluding that a decentralized tax administration will only result inefficiency, we sought to investigate whether there is room for potential cooperation between sub-central tax administrations. Chapter 3 aims at analysing this issue by examining the application of the different tax allocation principles corresponding to the whole set of wealth taxes administered by Spain's common-regime regions. In this regard, this study is similar to the previous one. Specifically, we investigate the conditions under which sub-central tax authorities do cooperate when managing taxpayers' errors in reporting their tax returns. Our results, based on a Tobit estimation strategy, show that the essential condition for cooperation is the existence of a reciprocity linkage between regions. More precisely, the amount of misreported tax revenues that one tax administration transmits to another positively depends on the misreported tax revenues received from the latter in the previous period. This is the main contribution of the study. We also find that reciprocity is significantly reduced by the existence of budget constraints due to expected deficit. Finally, by employing a dynamic approach we find that there is a degree of sluggishness in this process. This point is critical in the sense that it indicates that short-sighted, uncooperative behaviour, driven by administrative, financial and transaction costs as well as by budget constraints, is replaced in the medium-long run by a more farsighted behaviour that leads to cooperation. In conclusion, this study shows that once regional tax administrations recognize the potential benefits of cooperation they do not deviate from this equilibrium. This is, in part, good news for the functioning of Spain's decentralized tax administration.

Chapters 2 and 3 analyse the tax externalities that might arise when sub-central tax administrations set their policies, by highlighting how the strategies of these institutions are mutually interdependent. In Chapter 4 we take this analysis one step further by identifying the existence of externalities in tax administration policies caused by the specific external shock of terrorism. More specifically the question evaluated in Chapter 4 is "Does tax administration employ tax enforcement with the aim of counteracting the negative economic effects of terrorism?". We analyse the case of the Basque Country where terrorism represents a permanent threat. In this context, economic agents, and in particular self-employed workers, threatened by extortion as well as by other targeted terrorist attacks, have the incentive to shift their residence in order to avoid the costs of terrorism. By altering individuals' incentives to reside in their home region, terrorism constrains the tax authority's ability to set tax enforcement policies in the affected region. We describe this framework through a simple theoretical model and test its findings employing survey data on perceived tax enforcement and different measures of the costs of terrorism. The outcomes of the empirical analysis based on ordered response models corroborate the theory. In particular, the costs of terrorism have been found to negatively influence the perceived tax enforcement of individuals, in particular self-employed workers, residing in the provinces of the Basque Country and Navarre. No significant impact is reported for the residents of the common-regime provinces, where the main taxes are administered by the central government. In conclusion, this study provides evidence of the fact that the tax administrations of the Basque Country and Navarre employ tax enforcement as an instrument to counter the negative impact that ETA's terrorist activity has on tax bases, tax revenues and, in short, on the economy as a whole. Recalling the results of Abadie & Gardeazabal (2003), the impact of terrorism on the Basque economy is estimated at around 10 percent in terms of per capita GDP. Our results suggest that this effect is implicitly calculated net of the impact of terrorism on tax administration and, thus, it could be considered as a lower bound of the impact of terrorism on the Basque economy.

The three central chapters of this thesis represent something of a novelty in the literature as they are the first empirical studies on externalities in tax administration policies. The whole research line shows that in a federal

framework these policies are employed by tax authorities as strategic instruments, demonstrating that decentralizing tax administration gives regional governments additional degrees of tax autonomy. In particular, Chapters 2 and 4 show that tax enforcement policies can be used by tax authorities in order to counter the loss of revenues due to the potential mobility of tax bases. In both studies, tax administrations are found to lower the tax burden by cutting the tax audit rate in order to retain mobile tax bases, where the taxpayers' incentive to move is based solely on classic horizontal tax competition or, alternatively, on an external shock such as terrorism. In the context of horizontal tax competition presented in Chapter 2, the mutual strategic reaction of tax authorities generates inefficiency in the setting of enforcement policies. Although this problem is partially reduced by the subsequent decentralization of normative power, the further inefficiencies that arise open the door for future research in this field so as to identify means, other than harmonization, that might circumvent this issue. Chapter 4 allows us to conclude that part of the shock due to terrorism is internalized by the tax administration and, thus, further research is needed in order to disentangle the actual impact of terrorism in terms of economic costs for the region. Chapter 3 shows that potential cooperation in tax management is possible when tax administration is decentralized at a sub-central level although it is partially undermined by short-sighted incentives caused by administrative, transaction and financial costs.

This thesis has a number of policy implications. Not least it has shown that decentralizing tax administration entails conceding to sub-central governments a further strategic tool corresponding to additional tax autonomy and, thus, this process needs to be designed by identifying and circumventing all potential inefficiencies. This study also indicates that the decentralization process is compatible with good functioning of tax administration. Furthermore, it can be concluded that tax administration policies are critical elements in the whole tax management process. Thus, in the literature on the analysis of tax systems, policies should consider the adoption of endogenous decision-making instruments that are much more than mere technical tools.

A number of questions related to this field of analysis have been left for further research. Clearly, the first research question that arises concerns the optimal size of tax administration in a decentralized framework.

Specifically, it would be interesting to determine whether the perceived tax enforcement and, hence, the level of tax compliance depend on the structure of the tax administration (e.g., in terms of the number of tax agencies and tax inspectors). Finally, given that all the findings reported herein have been obtained by analysing the Spanish framework, further research is needed in order to investigate these issues in other federal contexts.

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