Empirical evidence on horizontal competition in tax enforcement

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Abstract Tax auditing parameters have been largely overlooked by the literature as policy-making instruments of any relevance; however, enforcement strategies are critical elements of the tax burden. In this paper, we show that, in a federal framework, tax auditing policies can serve as additional tools for regional interaction. We examine the presence of this interaction by adopting a spatial econometric approach. We employ a spatial panel autoregressive model and obtain results that are congruent with standard theory, corroborating the presence of horizontal competition between regions in their tax auditing policies. We also find that once regional governments acquire legal power, the opaque competition in enforcement policies appears to switch in part to a more transparent competition in statutory tax parameters.

Keywords Tax administration and auditing · Fiscal competition · Fiscal federalism

JEL Classification H71 · H77 · H83
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 and 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 and Peters 1999; Cremer and Gahvari 2000; Stöwhase and 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.1 Here, we focus specifically on the inheritance and gift tax (IGT), the main decentralized tax on wealth, which has recently become the subject of considerable debate both in Spain and in other countries.2 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 and Rork 2004; Brülhart and Parchet 2011).3 The origin of this process is the mobility, or simply the threat of mobility, of tax bases.4 A similar effect has been documented for the Spanish case (see Durán-Cabré and Esteller-Moré 2010; López-Casasnovas and Durán-Sindreu Buxadé 2008), provoking an academic and a more general debate.5 The Spanish press headlines on these issues are symp-

1 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).

2 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).

3 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).

4 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.

5 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
tomatic: “Cheaper Gifts and Inheritances”; “Regional Tax Competition”; “The Fiscal War among Regions Threatens the IGT”; “Regional Taxation and Voting with Feet”. These articles seem to corroborate the presence of mobility-based competition in the regional IGT statutory tax parameters. 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. 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.

Footnote 5 continued

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.

6 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/Ekdw) 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 autonomías”, 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/9Ojji).

7 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-Cabrè and 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.

8 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 and Buchanan 1980; Zodrow and Mieszkowski 1986; 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.9

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 and 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 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 and 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 and Gahvari (2000). Their most interesting

9 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 and Rincke (2011) who examine corporate taxes for the U.S. and the European cases, respectively.
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 and 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, then 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, then 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 and 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 and 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 and 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; Esteller-Moré 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. 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 and Sandmo 1972; Cremer and 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 burden) in the two regions. This stage is solved by exploiting the concept of “home attachment” (see Mansoorian and Myers 1993, 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. The preferences of taxpayer \(n\) with respect to his location are given by

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10 The model is based on Cremer and Gahvari (2000).
11 See Appendix 1 for a generalisation of the model that makes this assumption about the population distribution.
\[ V(n) = \begin{cases} U_1^* + a \times (1 - n) & \text{if } n \text{ lives in region 1,} \\ U_2^* + a \times n & \text{if } n \text{ lives in region 2,} \end{cases} \]  

where \( U_i^* = U_i^*(1 - \alpha^*(t_i, \beta_i)) \) represents the (pecuniary) indirect utility function of an individual residing in region \( i = 1, 2 \) \( ^{12} \) and \( n \in (0, 1) \) indexes the individuals measuring the non-pecuniary (psychic) benefit they derive from living in region 2. \( ^{13} \) Thus, taxpayers indexed by \( n \in (0, \frac{1}{2}) \) reside in region 1 while those identified by \( n \in (\frac{1}{2}, 1) \) 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. \( ^{14} \) 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). \( ^{15} \) The mobility equilibrium is characterized as

\[
\begin{align*}
U_1^* + a \times (1 - n_1) &= U_2^* + a \times n_1 \\
U_1^* + a \times (1 - n) &> U_2^* + a \times n \quad \forall n < n_1 \\
U_1^* + a \times (1 - n) &< U_2^* + a \times n \quad \forall n > n_1,
\end{align*}
\]  

where \( n = n_1 \) represents the marginal individual indifferent between living in region 1 and region 2 and, since \( \int_{n_1}^{n_2} dn = n_1 \), it also represents the population in region 1 in the migration equilibrium:

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

where \( \theta_i = t_i \times [\alpha + (1 - \alpha) \times \tau \times \beta_i] \) 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

\[
n_2 = \int_{n_1}^{1} dn = 1 - n_1. \tag{4}
\]

\( ^{12} \) 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 \( g'(1 - \alpha) > 0, g''(1 - \alpha) > 0, g(0) = 0, g(1) \rightarrow +\infty. \)

\( ^{13} \) The psychic benefit from living in region 1 is then expressed as \( (1 - n). \)

\( ^{14} \) 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.

\( ^{15} \) 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 \( (a \rightarrow +\infty) \), the taxpayers are 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.
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:

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

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

$$\beta : r'_\beta = -2n'_\beta \times r > 0. \quad (5)$$

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

By developing condition (5), we find that $B \times \frac{\partial \theta}{\partial \beta} - d'(\beta) = r \times \frac{B \times (\frac{\partial \theta}{\partial \beta} + \frac{g_2}{\theta})}{a}$. 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 Gahvari (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

\[16\] 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.
The first term in the numerator of Eq. (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 Eq. (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 $\frac{\partial (\frac{\partial \beta_1}{\partial \beta_2})}{\partial a} < 0$ (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 is the strategic relationship between $\beta_1$ and $t_2$:

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

Expression (7) indicates that $\beta_1$ and $t_2$ are strategic complements; thus, if the government in one region reduces its statutory tax rate $t_2$, ceteris paribus, then the administration in the competing region will unambiguously react by setting a lower audit rate $\beta_1$ 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 $\beta_i$ 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 and 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 Eq. (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:

\[
\log(\beta)_{it} = \gamma \log(\beta)_{-it} + \xi \text{Ded}_{it} + \psi \text{Ded}_{-it-1} + X_{it}\alpha + \vartheta_{i} + \tau_{t} + \varepsilon_{it}. \quad (8)
\]

In order to make the dependent variable comparable across small and large regions, we employ the audit rate defined as \(\beta_{it} \equiv \frac{\text{Audits}_{it}}{\text{TR}_{it}}\). 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.\(^{17}\) More precisely in order to define \(w_{ij}\) for \(i \neq j\), we use the inverse squared distance and we apply a spectral normalization\(^{18}\) 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

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\(^{17}\) While the recent literature suggests that a change in the spatial matrix is not crucial (LeSage and 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 and Pons-Novell 2007). However, to check robustness, we also replicate the analysis employing alternative spatial matrixes.

\(^{18}\) 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 \(W\).
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 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. So the spatial lag term accounts for potential strategic competition in audit policies. According to the theoretical framework, Eq. (6), we expect $\gamma$ to be positive.

To account for the potential impact of modifications to the statutory tax parameters, we include a dummy ($\text{Ded}_{it}$) equal to one if the regional government $i$ makes a marked deduction in favour of the most common heirs during the year $t$. 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 and Esteller-Moré 2009, 2010). We can then interpret a $\text{Ded}_{it}$ value equal to 1 as a modification to the corresponding regional statutory tax parameters that result 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 $\text{Ded}_{-it}$, 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 (Eq. 7), we expect the coefficient of this variable to be negative: a higher $\text{Ded}_{-it}$ would correspond to a decreasing audit rate.

Tax administration policies might also be sensitive to “technological”, “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 have 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 ($\text{TR}_{it}$) and the number of inspectors employed in the office ($\text{Inspectors}_{it}$). As such, these variables express the technological restrictions, a regional tax authority faces in terms of its size.

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19 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 $m = \min(\max(r_i), \max(c_j))$, with $\max(r_i)$ being the largest row sum of $W$ and $\max(c_j)$ being the largest column sum of $W$. We do not report the results because they are qualitatively unaffected but they are available on request.

20 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).

21 The number of inspectors is also taken from the report Informe sobre la cesión de tributos a las Comunidades Autónomas. The variable $\text{Inspectors}_{it}$ 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.
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and structure.\textsuperscript{22} 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 $\beta_{it}$ with respect to $TR_{it}$ and $Inspectors_{it}$.

As for the political elements that might influence the tax administration, we employ $\text{Election\_year}_{it}$, 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. $\text{Leftist\_government}_{it}$ 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, $\vartheta_{i}$. 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 the identification of the spatial lag coefficient (see Devereux et al. 2008, p. 1224). By the way of an alternative, we include individual time trends, $\tau_{t}$. Finally, $\epsilon_{it}$ 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) ($\text{post01}_{it}$).\textsuperscript{23}

\begin{equation}
\log(\beta)_{it} = \gamma'\log(\beta)_{-it} + \delta d96\_01_{it} \times \log(\beta)_{-it} + \pi \text{post01}_{it} \times \log(\beta)_{-it} \\
+ \xi'\text{Ded}_{it} + \psi'\text{Ded}_{-it-1} + X_{it}\alpha' + \rho d96\_01_{it} + \sigma \text{post01}_{it} + \vartheta_{i} + \tau_{t} + \epsilon_{it}.
\end{equation}

(9)

If $\delta$ and $\pi$, the coefficients of the interaction terms in Eq. (9), are found to be negative (positive), then this would mean that following the reforms that progressively gave greater tax 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

\textsuperscript{22} 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.

\textsuperscript{23} 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.
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 (see Anselin 1988, p. 58). In order to deal with this problem, we employ the standard instrumental variable (IV) approach (see Kelejian and Robinso 1993; Kelejian and 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 and Millimet 2002; Fredriksson et al. 2004; Millimet and Rangaprasad 2007), we use a subset of the exogenous explanatory variables in Eq. (8) as instruments, employing the same weighting scheme for the instruments as that used for the spatial lag. We repeat this procedure with Eq. (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 and Paap (2006) test for the underidentification of the equation and, finally, the Cragg–Donald Wald F statistic when testing the weakness of the instruments.24

4.3 Data, sources and descriptive statistics

Our panel comprises information about the 15 Spanish “common regime” Autonomous Communities25 for the period 1987–2009.26 With the exception of the endogenous variable and the number of inspectors discussed above, the other variables are obtained

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24 We also report the range of critical values for the Stock and Yogo (2005) weak identification test.

25 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.

26 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 are two-year lagged. Auditing information for the Madrid Community became available in 1996, the year in which it was granted this administrative power.
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Table 1 Summary statistics

| Variable            | Measurement unit          | Obs. | Mean   | SD    | Min      | Max    |
|---------------------|---------------------------|------|--------|-------|----------|--------|
| β                   | Audit rate                | 307  | 0.02   | 0.03  | $5 \times 10^{-5}$ | 0.20   |
| TR                  | Number of tax returns     | 308  | 21187  | 18234.62 | 1641 | 88528 |
| Inspectors          | Number of inspectors      | 308  | 5.98   | 5.70  | $1 \times 10^{-8}$ | 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     |

Graph 1 Dispersion of the audit rate

from the following statistical sources. The Per-Capita GDP$_{it}$ is provided by the Spanish National Institute of Statistics (INE). The variable Per-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, is obtained from Zarate’s Political Collections website (http://zarate.eu/spain2.htm). The information used to construct the dummy $\text{Ded}_{it}$, which accounts for the introduction of IGT deductions, is taken from Durán-Cabrè and Esteller-Moré (2009). In Table 1, we report a summary statistics.

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.

5 Main results

In Table 2, we report the results of the model expressed in Eq. (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 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 $\beta_{it}$ 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.27

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

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27 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 and 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 and Vakneen 1989).
Table 2 Tax audit interdependence. Spatial matrix: inverse of the squared distance with spectral normalization

| Estimator | (1) | (2) | (3) | (4) | (5) | (6) |
|-----------|-----|-----|-----|-----|-----|-----|
|           | Within-FE | Within-FE | GMM-IV | 2SLS | JN2SLS | FULLER(4) |
| Log(β)    | Log(β) | Log(β) | Log(β) | Log(β) | Log(β) | Log(β) |
| Estimator |       |       |       |       |       |       |
| 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* | 6.479 | 14.740* | 6.479 | 14.740* |
|           | (0.735) | (1.970) | (0.735) | (1.970) | (0.735) | (1.970) |

Observations 279 266 266 266 266 266
R² 0.16 0.29 0.18 0.18 0.18 0.18
Shea’s Partial R² – – 0.18 0.18 0.18 0.18

Underidentification test (H₀ : equation underidentified).
Kleibergen–Paap rk LM statistic (p value)
– – 36.762 36.762 36.762 36.762
– – 0.000 0.000 0.000 0.000

Weak identification test (H₀ : instruments are weak).
Cragg–Donald Wald F statistic
– – 8.803 8.803 8.803 8.803
– – 5.15–19.28 5.15–19.28 5.15–19.28 3.63–5.61

Stock–Yogo weak ID test range of critical values
– – 5.222 5.222 5.222 5.204
– – 0.389 0.389 0.389 0.391

Validity test (H₀ : instruments are valid).
Hansen J statistic χ² (p-value)
– – 5.222 5.222 5.222 5.204
– – 0.389 0.389 0.389 0.391

t statistics in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01; Fixed effects and time trends in all specifications.
Table 3  Tax audit interdependence—interactions. Spatial matrix: inverse of the squared distance with spectral normalization

| Estimator                        | (1) GMM-IV Log(β) | (2) GMM-IV Log(β) | (3) 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)          | −                  | −                  |
| 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             |
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Table 3 continued

| Estimator                        | (1) GMM-IV Log(β) | (2) GMM-IV Log(β) | (3) GMM-IV Log(β) |
|----------------------------------|-------------------|-------------------|-------------------|
| 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 $\chi^2$     | 9.762             | 21.148            | 6.289             |
| $p$ value                        | 0.462             | 0.132             | 0.615             |

$t$ statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Fixed effects and time trends in all specifications

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.28

Inspection of the diagnostic test performed to confirm that 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.

28 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.
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 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 Eq. (12) 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 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.

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 Eq. (12). 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 and Case (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

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29 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.
### Table 4  Tax audit interdependence: alternative weighting matrixes

| Spatial matrix estimator | (1) Inverse of squared distance GMM-IV Log(β) | (2) Neighbours GMM-IV Log(β) | (3) Uniform GMM-IV Log(β) |
|-------------------------|-----------------------------------------------|-----------------------------|--------------------------|
| Spatial Lag             | 0.689*** (2.762)                             | 0.737*** (3.663)            | 0.969*** (7.033)         |
| Log(TR)                 | −1.847** (−2.391)                            | −1.330* (−1.914)            | −2.252*** (−3.363)       |
| Log(inspectors)         | 0.303*** (3.086)                             | 0.288*** (3.119)            | 0.295*** (3.425)         |
| Per-Capita GDP          | 0.063 (0.577)                                | 0.000 (0.000)               | 0.011 (0.119)            |
| Per-Capita deficit      | 1.536 (1.604)                                | 1.587* (1.704)              | 2.083*** (2.118)         |
| Transfers/expenditure   | −1.022 (−1.184)                              | −0.113 (−0.133)             | −0.351 (−0.568)          |
| Election year           | −0.079 (−0.524)                              | −0.076 (−0.510)             | −0.058 (−0.482)          |
| Leftist government      | −0.439*** (−2.051)                           | −0.415*** (−2.058)          | 0.050 (0.245)            |
| Deduction               | −0.461* (−1.814)                             | −0.296 (−1.086)             | 0.052 (0.206)            |
| WDeduction              | 0.352 (0.583)                                | −0.131 (−0.230)             | −0.374 (−0.553)          |
| Observations            | 266                                           | 266                         | 266                      |
| Shea’s Partial R²       | 0.18                                          | 0.22                        | 0.63                     |
| Underidentification test (H₀: equation underidentified) | Kleiberge-Paap rk LM statistic | 36.762 | 40.919 | 70.509 |
| (p value)               | 0.000                                         | 0.000                       | 0.000                    |
| Weak identification test (H₀: 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 (H₀: instruments are valid) | Hansen J statistic χ² | 5.222 | 8.320 | 8.144 |
| (p value)               | 0.389                                         | 0.139                       | 0.148                    |

\(t\) statistics in parentheses; * \(p < 0.10\), ** \(p < 0.05\), *** \(p < 0.01\); Fixed effects and time trends in all specifications.

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...
Table 5 Tax audit interdependence: testing the yardstick competition hypothesis. Spatial matrix: neighbours with spectral normalization

| Estimator                              | (1) Neighbours | (2) Neighbours | (3) Neighbours | (4) Neighbours |
|----------------------------------------|---------------|---------------|---------------|---------------|
| Spatial Lag                            | 0.737*** (3.663) | 0.756*** (4.055) | 0.577*** (3.009) | 0.622*** (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* (−1.914) | −1.736*** (−2.592) | −1.400** (−2.279) | −1.341* (−1.957) |
| Log(inspectors)                        | 0.288*** (3.119) | 0.285*** (3.095) | 0.317*** (3.071) | 0.290*** (3.347) |
| Per-Capita GDP                         | 0.000 (0.000)  | 0.033 (0.340)  | 0.021 (0.205)  | −0.017 (−0.180) |
| Per-Capita deficit                     | 1.587* (1.704) | 1.447 (1.546)  | 1.638* (1.894) | 1.429 (1.625)  |
| Transfers/expenditure                  | −0.113 (−0.133) | −0.152 (−0.177) | −0.873 (−1.108) | −0.454 (−0.587) |
| Election year                          | −0.076 (−0.510) | 0.179 (0.501)  | –             | –             |
| Leftist government                     | –             | –             | −0.342 (−0.944) | –             |
| Deduction                              | −0.415** (−2.058) | −0.296 (−1.455) | −0.401* (−1.950) | −0.385** (−2.000) |
| WDeduction                             | −0.296 (−1.086) | −0.364 (−1.312) | −0.293 (−1.127) | −0.324 (−1.264) |
| Electoral margin                       | –             | –             | 0.097 (0.192)  | −0.312 (−0.565) |
|                                       |               |               |               | −0.032 (−1.553) |
Table 5 continued

| Spatial matrix | (1) Neighbours | (2) Neighbours | (3) Neighbours | (4) Neighbours |
|----------------|----------------|----------------|----------------|----------------|
| Estimator      | GMM-IV         | GMM-IV         | GMM-IV         | GMM-IV         |
| 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 $\times$ Election year) | – | 0.89 | – | – |
| Shea’s Partial $R^2$ (Spatial Lag $\times$ Election year $-1$) | – | – | 0.91 | – |
| Shea’s partial $R^2$ (Spatial Lag $\times$ Electoral margin) | – | – | – | 0.89 |
| 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 $\chi^2$ | 8.320 | 13.927 | 10.654 | 13.504 |
| (p value)      | 0.139          | 0.125          | 0.300          | 0.141          |

$t$ statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; Fixed effects and time trends in all specifications
yardstick competition does not represent a relevant source of interaction for explaining IGT enforcement interdependence.

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. 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 the 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

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30 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 which have ensured that the enforcement effort is much more precise and efficient.
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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.

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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 \( n \in (0, 1) \sim f(n) \) where \( f(n) \) represents a generic density function.

The value \( n_1(t_1, \beta_1, t_2, \beta_2; a) = \frac{1}{\tau} + \frac{U^*_1 - U^*_2}{2a} \) 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

\[
\max_{\beta_1} R_1 = F(n_1) \times r_1 = F(n_1) \times [B \times \theta_1 - d(\beta_1)].
\]

The FOC of this problem is

\[
n'_1 \times f(n_1) \times r_1 + r'_1 \times F(n_1) \equiv P(\beta_1, \beta_2; t_1, t_2, a) = 0. \tag{10}
\]

The SOC is

\[P_{\beta_1}(\beta_1, \beta_2; t_1, t_2, a) < 0. \tag{11}\]

The slope of the reaction function becomes

\[
\frac{\partial \beta_1}{\partial \beta_2} = -\frac{P_{\beta_2}(\beta_1, \beta_2; t_1, t_2, a)}{P_{\beta_1}(\beta_1, \beta_2; t_1, t_2, a)} \tag{12}
\]

This is positive as long as \( f'(n_1) \leq 0 \).\(^{31}\)

\(^{31}\) 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:

$$\frac{\partial \beta_1}{\partial \beta_2} = -\frac{N}{A + a \times \frac{\partial^2 r_1}{\partial \beta_1^2}} = -N \times \left( A + a \times \frac{\partial^2 r_1}{\partial \beta_1^2} \right)^{-1}, \quad (13)$$

where

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

$$\times \left[ B \times \frac{\partial^2 \theta_1}{\partial \beta_1^2} - d''(\beta_1) \right] - [B \times \theta_1 - d(\beta_1)] \times B \times \left[ \frac{\partial^2 \theta_2}{\partial \beta_2^2} + \frac{\partial^2 g_2}{\partial \beta_2^2} \right], \quad (14)$$

and

$$N = B \times \left[ \frac{\partial \theta_2}{\partial \beta_2} + \frac{\partial g_2}{\partial \beta_2} \right] \times \left[ B \times \frac{\partial \theta_1}{\partial \beta_1} - d'(\beta_1) \right]. \quad (15)$$

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

$$\frac{\partial}{\partial a} \frac{\beta_1}{\beta_2} = \frac{N}{(A + a \times \frac{\partial^2 r_1}{\partial \beta_1^2})^2} \times \frac{\partial^2 r_1}{\partial \beta_1^2} < 0. \quad (16)$$

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