EMPIRICAL EVIDENCE ON COOPERATION BETWEEN SUB-CENTRAL TAX ADMINISTRATIONS

José María Durán-Cabré, Alejandro Esteller-Moré[1] *and Luca Salvadori*[2]

Abstract

The literature on horizontal tax interdependence pays limited attention to interactions in administrative policies, although they can play a large role in determining the amount of tax revenues collected. We investigate the incentives for sub-central tax authority cooperation in a decentralised context, with the aim of identifying the determinants of that cooperation. Our results are congruent with standard theory; in particular, the existence of reciprocity is essential for sharing tax information, but there is sluggishness in this process, which is partly the result of the short-sighted behaviour of tax authorities influenced by budget constraints. Hence, this is good news for the functioning of a decentralised tax administration as, in the medium to long run, the gains to be made from sharing tax information are achieved.[3]

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 decentralised tax administrations, or internationally with different national administrations, tax authorities are dependent on each other to enforce tax rules. For example, starting from January 2017, all EU member states will have to automatically exchange information on tax rulings given to companies with cross-border operations. The aim is to provide national authorities with insight into aggressive tax planning in order to protect their tax bases; consequently, cooperation will be essential. In general, improving tax enforcement in the global economy has translated into a proliferation of bilateral and multilateral treaties between national tax administrations and tax havens. Given these circumstances, investigating the determinants of cooperation between tax administrations has

[1] Universitat de Barcelona & Institut d'Economia de Barcelona (IEB).
[2] Universitat Autonòma de Barcelona, IEB & Tax Administration Research Centre (TARC). Corresponding author: Department d'Economia i d'Història Econòmica, Unitat de Fonaments de l'Anàlisi Econòmica (UFAE), Edifici B – Campus Universitari s/n, 08193 Bellaterra (Barcelona), Spain; e-mail: luca.salvadori@uab.cat.
[3] ACKNOWLEDGMENTS. We would like to thank participants at the ZEW 2014 Public Finance Conference, at the "XXI Encuentro de Economía Pública" (University of Girona), at the ERSA 2013 congress, at the ERSA 2012 Summer School, at the SIEP 2012 conference, and at the PhD seminars of the IEB, CREIP (University of Tarragona) and Max Planck Institute for Tax Law and Public Finance (Munich) for their helpful comments. We are also very grateful to Nadja Dwenger, Salmai Qari, Federico Revelli, Lionel Védrine and two anonymous reviewers for their useful suggestions. The funding from the Generalitat de Catalunya (2009SGR102) and from the Ministerio de Ciencia e Innovación (ECO2012-37873) are gratefully acknowledged. Durán-Cabré also thanks the funding from the Institut d'Estudis Autonòmics. Usual disclaimers apply.

become a key issue; yet, the literature on horizontal tax interdependencies pays limited attention to these matters.[4]

We seek to investigate the potential for cooperation in tax administration policies 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 (centralised vs. decentralised) 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[5] since the mid-1980s and, following reforms in 1997 and 2002, have also acquired the legislative power to modify significant statutory tax parameters.[6] Thus, this case study should serve as a benchmark for evaluating the information-sharing process in a decentralised framework and, more generally, for analysing the efficiency of a decentralised tax administration scheme.

We focus our empirical analysis on a specific area of potential cooperation between the CAs, the only one for which official data is 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.[7] 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.[8] 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.[9]

---

[4] The effectiveness of these cooperative policies at an international level has been highly questioned by recent empirical literature (e.g. Johannesen & Zucman, 2014). As we will make clear though, our approach is different, as we focus on the administrative incentives to cooperate within a federation.

[5] Namely the inheritance and gift tax (IGT), the annual wealth tax (AWT) and the tax on wealth transfers (TWT).

[6] For more details on these reforms, see Esteller-Moré (2008).

[7] 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.

[8] 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 occurred, 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.

[9] 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

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 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 to long run, the regional administrations learn the advantages of cooperation, thus providing elements that support the correct functioning of a decentralised tax administration.

The rest of the paper is organised 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 5.

LITERATURE REVIEW

The literature has identified two main sources of horizontal interdependence at a tax administration level.[10] On the one hand, Cremer and Gahvari (2000), examining the implications of tax evasion for fiscal competition and tax harmonisation 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 harmonisation alone is not sufficient to avoid strategic incentives to attract tax bases, as there can be no commitment to audit policies. Durán-Cabré, Esteller-Moré and Salvadori (2015) have tested this result for the Spanish decentralised 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 focussed on the incentives for tax cooperation between countries to reduce evasion in an international mobile-capital framework

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, Castile and León, the inspectors from the State explain that this region would not return revenues due to the CA of Madrid until the latter transferred revenues due to it.

[10] More generally, recent literature has also identified the incentives for vertical transmission of information between central and local governments in a federal framework. Dreher, Gehring, Kotsogiannis and Marchesi (2014) explore the role of this information transmission process in explaining the optimal degree of decentralisation across countries.

(see Keen & Ligthart (2006a) for a survey). In particular, the seminal study by Bacchetta and 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 and 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 and 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.[11]

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 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. In our federal context, we focus on the potential existence of cooperation in tax administration between sub-central authorities. This is probably more related to tax-management policies than to strategic behaviours of the regional tax authorities.[12] In a federal framework, a decentralised tax administration might enhance efficiency due to a greater ability of sub-central authorities to exploit informational advantages on local tax bases (see, for example, Martinez-Vazquez & Timofeev, 2010). Nonetheless, this is conditional upon the existence of cooperation among sub-central tax authorities. That is why it is so important to test for the existence of administrative cooperation.

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 focusses on the presence of an exchange of information

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

[12] Note that cooperation by sharing information on misreported taxes should not have implications concerning taxpayers' compliance.

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 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, CAs are required to cooperate by law in support to the good organisation of the federal tax administration system. To this aim, sub-central tax authorities should automatically rectify any errors that might arise in the reporting of tax returns, but they have an incentive not to cooperate due to the presence of administrative costs and to the loss of financial revenue yields. In this context, and according to our hypothesis, reciprocity should reinforce the tax information exchange process by being an important driving force in the promotion of cooperation and the enhancement of the functioning of the decentralised tax administration. This empirical analysis of a federal framework represents, we believe, a novelty and progress in the literature.

EMPIRICAL ANALYSIS

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

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.[13] 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.

[13] 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.

Therefore, we maintain the random-effects Tobit corner-solution model as our main approach (see Wooldridge, 2002, pp. 518-549)[14], which is defined as follows:[15]

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

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. More precisely, if α is equal to zero, receiving tax revenues from CA *j* does not encourage a transmission of revenues by CA *i*. This could mean that CA *i* does not have any case of misreported taxes to transmit or that it does not have incentives to do it. Instead, a strictly positive α surely indicates that there are cases of misreported taxes and, most importantly, that CA *i* has some incentives to transmit the corresponding misreported tax revenues.

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. Indeed, this variable accounts for both higher transaction costs and lower cultural proximity, which are relevant issues in a federal framework.[16] Therefore, we control for D_{ij} the physical distance in kilometres between *i* and *j*. The political alignment between Spanish regions[17] 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

[14] 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.

[15] A limit of our database is intrinsic in the absence of a counterfactual: we are not able to disentangle a priori if a zero valued number of cases of misreported taxes is due to an actual absence of cases of misreported taxes or to a strategic uncooperative behaviour. Nevertheless, the methodology we employ appropriately takes this shortcoming into account.

[16] On the one hand, since we analyse a long period of time, including many years before the "internet era", this variable is relevant in measuring larger operational costs due to a longer distance between two regions. On the other hand, the distance between regions in the same federal country might also be relevant in representing the level of cultural affinity.

[17] Please note: this factor is specific for an analysis within a federal context.

exchange between tax authorities. These issues are also relevant in our 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, for example, 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 CAs) 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 i CA 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[18]. $Left_{it}$ 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 accounts for regional size. At the same time, when regions acquired some tax power to modify those taxes ceded by the central government (in 1997 and 2002), a formal forum of interaction between each regional tax administration and the central one (bilateral nature), but also one of multilateral nature, was set up. This might have had an impact on the cooperation among regional tax administrations. However, it is not possible to identify its effect due to the absence of qualitative or quantitative information on the activity of these forums. Nevertheless, we implicitly account for this effect by including a set of time dummies, τ_t. We finally introduce fixed effects (ϑ_{ij}) to account for unobserved heterogeneity among CAs[19], while ε_{ijt} is an idiosyncratic error that varies across time and pair of regions.[20] The parameters of Eq. (1) are estimated by maximum likelihood.

[18] 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.

[19] The "quality of the tax administration" would be an interesting control variable, as rightly suggested by a reviewer. However, this cannot be identified from our data, so we cannot identify its impact. The fixed effects should control for it as long as we suppose administrative quality does not vary much over time.

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

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, 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 over time, so that zero-valued transmitted misreported revenue in $t - 1$ is expected to negatively impact the cooperative behaviour while the component $1\left[Trans\_Rev_{ijt-1} > 0\right] \times Trans\_Rev_{ijt-1}$ 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.[21] 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.[22]

[21] 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 is not collected at the beginning of the process, assuming that the initial values are exogenous, this 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 decentralisation of the relevant taxes began in the mid-1980s, thus there are a few years for which this data is 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, for example, Akay (2009).

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

In our framework, the main incentives for a CA not to cooperate are the administrative costs and 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. Eq. (2) is then modified as follows:

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

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

To conclude our empirical analysis, we investigate two additional and potentially important dimensions of heterogeneity in the effect of reciprocity on cooperation. First, we consider differences in the size across different regions by interacting Rec_Rev_{ijt-1} with $1[Pop_{it}]$, a dummy equal to one if region *i* has a population higher than the average. Thus Eq. (2) is modified in this way:

$$Trans\_Rev_{ijt} = \max\big[0, \gamma g\big(Trans\_Rev_{ijt-1}\big) + \pi_1 Rec\_Rev_{ijt-1} + \pi_2 Rec\_Rev_{ijt-1} \times 1[Pop_{it}] + \boldsymbol{Y_{ijt}\varphi} + \boldsymbol{X'_{it}\rho} + \tau_t + c_{ij} + \epsilon_{ijt}\big]\,. \quad (4)$$

Again, Eq. (1) changes in a similar way. We expect the reciprocity linkage to be weaker for bigger regions, since they have less to gain from reciprocity and thus we expect π_2 to be negative. Indeed, the size of the aggregate tax base, which is proxied by population, influences regional behaviour in a similar way to the one presented in the asymmetric competition literature (see, for example, Bucovetsky, 1991; Wilson, 1991). Namely, since bigger regions have a larger aggregate tax base and corresponding revenues, they obtain a smaller marginal benefit from reciprocal cooperation. We will test for this source of heterogeneity.

The second source of heterogeneity we want to investigate relates to the electoral cycle. We think that, in electoral years, tax authorities might want to end the administrative period with few pending information-sharing processes given the potential change of the executive. Thus, we expect the reciprocity linkage to be stronger in electoral years. Then, we interact Rec_Rev_{ijt-1} with El_{it} and Eq. (2) is modified in this way:

$$Trans\_Rev_{ijt} = \max\big[0, \gamma g\big(Trans\_Rev_{ijt-1}\big) + \mu_1 Rec\_Rev_{ijt-1} + \mu_2 Rec\_Rev_{ijt-1} \times El_{it} + \boldsymbol{Y_{ijt}\varphi} + \boldsymbol{X'_{it}\rho} + \tau_t + c_{ij} + \epsilon_{ijt}\big]\,. \quad (5)$$

Eq. (1) changes in a similar way. We expect μ_2 to be positive.

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, 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	-68,860.48	27,1390.3	-24,78177	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

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, as we saw in the literature review. 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.

Table 2. Determinants of the Information-Sharing Process: TOBIT-RE and Alternative Specifications

Estimator	(1) GLS-RE	(2) TOBIT	(3) 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.

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 the Wald test.

In Table 3, we present the results of the estimation of the alternative specifications of Eq. (2) that we use to test the persistency hypothesis. In columns (1) and (2), we employ specification (i), while in columns (3) and (4) we use specification (ii).[23] 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.

[23] Specifically in columns (1) and (2) we set $g(Trans\_Rev_{ijt-1}) = Trans\_Rev_{ijt-1}$, while in columns (3) and (4) we assume $g(Trans\_Rev_{ijt-1}) = \{1[Trans\_Rev_{ijt-1} = 0]; 1[Trans\_Rev_{ijt-1} > 0] \times Trans\_Rev_{ijt-1}\}$.

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)
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.

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 4. Determinants of the Information-Sharing Process: Interactions with High Deficit.

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

Table 5 reports the results of the estimation of Eq. (4). By considering heterogeneity in regional size, we find that the reciprocity linkage is significantly weaker for more populated regions. In particular, smaller regions transmit 1.86 – 2.12 of every 1 euro received, while bigger regions transmit on average about one tenth of that amount (0.19 – 0.24 of every 1 euro received).

As a final exercise, we try to understand how the electoral cycle interacts with the reciprocity (Table 6). By interacting Rec_Rev_{ijt-1} with the electoral dummy, we find that reciprocity linkages are stronger in electoral years. In presence of elections, tax administrations transmit 2.41 – 2.52 of every 1 euro received while otherwise they transmit 0.27 – 0.33 of every 1 euro received.

Table 5. Determinants of the Information-Sharing Process: Interactions with High Population.

Estimator	(1) TOBIT-RE	(2) TOBIT-RE Wooldridge method	(3) TOBIT-RE Wooldridge method
L.Transmitted Tax Revenues	-	0.204***	-
		(8.244)	
1[L.Transmitted Tax Revenues = 0]	-	-	-682.449***
			(-12.844)
1[L.Transmitted Tax Revenues> 0]×L.Transmitted Tax Revenues	-	-	0.020***
			(8.163)
L.Received Tax Revenues	2.126***	1.871***	1.863***
	(11.969)	(10.536)	(10.771)
L.Received Tax Revenues×1[HPop]	-1.902***	-1.677***	-1.620***
	(-10.357)	(-9.174)	(-9.096)
Transmitted Tax Revenues$_{t=1989}$	-	1.326	-0.236
		(1.178)	(-0.261)
Cases of Misreported Taxes	6.025***	5.600***	5.494***
	(17.050)	(16.050)	(16.524)
Distance	-0.272***	-0.252***	-0.168***
	(-4.401)	(-4.346)	(-3.364)
Political Alignment	-43.665	-32.574	-64.862
	(-0.878)	(-0.667)	(-1.387)
Relative GDP	8.674	10.505	-23.210
	(0.073)	(0.094)	(-0.241)
Tot_Reg_Tax_Revenues	23.738	32.390	27.615
	(0.867)	(1.167)	(1.063)
Tot_IGT_Audit_Revenues	-0.747	-1.124	-0.938
	(-0.604)	(-0.921)	(-0.789)
Deficit	-0.000	-0.000	-0.000
	(-0.660)	(-0.547)	(-0.543)
Transfer/Expenditure	348.880	429.546*	374.739
	(1.372)	(1.674)	(1.484)
Left	-83.175	-62.253	-45.212
	(-1.374)	(-1.050)	(-0.808)
Election	-26.256	-26.948	-37.095
	(-0.335)	(-0.344)	(-0.467)
Deduction	-23.766	-41.642	-21.093
	(-0.232)	(-0.414)	(-0.214)
Population	0.098***	0.088***	0.049**
	(3.520)	(3.331)	(2.177)
1[HPop]	-89.429	-77.344	9.864
	(-0.723)	(-0.662)	(0.098)
_cons	-421.474*	-518.854**	-268.564
	(-1.805)	(-2.253)	(-1.232)
Linear Combinations			
L.Received Tax Revenues +L.Received Tax Revenues× 1[HPop]	0.224***	0.194**	0.244***
	(3.64)	(3.20)	(4.08)
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	-17060.233	-16803.221	-16729.211
Wald chi2	940.659	1060.800	1393.584
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 6: Determinants of the Information-Sharing Process: Interactions with Electoral Year.

	(1)	(2)	(3)
Estimator	TOBIT-RE	TOBIT-RE Wooldridge method	TOBIT-RE Wooldridge method
L.Transmitted Tax Revenues	-	0.242***	-
		(9.937)	
1[L.Transmitted Tax Revenues = 0]	-	-	-684.458***
			(-12.918)
1[L.Transmitted Tax Revenues> 0]×L.Transmitted Tax Revenues	-	-	0.023***
			(9.809)
L.Received Tax Revenues	0.333***	0.230***	0.274***
	(5.595)	(3.847)	(4.654)
L.Received Tax Revenues×1[Election]	2.191***	2.196***	2.141***
	(9.158)	(9.353)	(9.084)
Transmitted Tax Revenues$_{t=1989}$	-	1.553	-0.095
		(1.360)	(-0.106)
Cases of Misreported Taxes	7.039***	6.114***	5.995***
	(21.383)	(17.574)	(18.155)
Distance	-0.268***	-0.250***	-0.171***
	(-5.553)	(-4.288)	(-3.457)
Political Alignment	-63.746	-36.057	-68.385
	(-1.376)	(-0.737)	(-1.465)
Relative GDP	18.785	40.040	-2.340
	(0.198)	(0.354)	(-0.024)
Tot_Reg_Tax_Revenues	-14.103	-0.673	-1.610
	(-0.563)	(-0.024)	(-0.062)
Tot_IGT_Audit_Revenues	-1.519	-1.729	-1.544
	(-1.279)	(-1.411)	(-1.297)
Deficit	-0.000*	-0.000	-0.000
	(-1.780)	(-1.211)	(-1.207)
Transfer/Expenditure	291.006	307.052	262.837
	(1.179)	(1.192)	(1.039)
Left	-88.218*	-68.656	-57.191
	(-1.650)	(-1.184)	(-1.058)
Election	54.503	44.437	33.057
	(0.687)	(0.568)	(0.416)
Deduction	-117.021	-107.937	-83.278
	(-1.185)	(-1.076)	(-0.848)
Population	0.056***	0.052***	0.030**
	(4.869)	(3.665)	(2.556)
_cons	-117.984	-261.440	-29.716
	(-0.555)	(-1.134)	(-0.137)
Linear Combinations			
L.Received Tax Revenues +L.Received Tax Revenues× 1[Election]	2.524***	2.426***	2.415***
	(10.74)	(10.47)	(10.44)
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	-17093.838	-16802.281	-16729.673
Wald chi2	1134.267	1061.395	1397.541
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.

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 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.

According to our results, the existence of a reciprocity linkage between CAs is crucial in determining their level of cooperation in managing misreporting of taxes. The robustness of this result suggests, even in absence of a counterfactual, that regional tax authorities behave strategically and do, under certain conditions, cooperate with each other in dealing with this problem. Namely, we have identified two main barriers that might reduce the sub-central tax administrations' incentives to cooperate. The existence of administrative and transaction costs directly related to the information-sharing process may induce a regional tax administration not to cooperate. Similarly, cooperation implies a financial cost due to the loss of revenue yields, which we find particularly important for the CAs that face budget constraints measured in terms of high deficit. However, our results suggest that. Typically, both barriers to cooperation act in the short-run, causing a delay in the transmission of relevant information. Indeed, the estimation of a dynamic model suggests that there is a sluggish adjustment in the setting of this process. We have explored different types of heterogeneity in the effect of reciprocity on the endogenous variable, finding that regional size reduces this effect on cooperation while the presence of electoral years tends to enhance it. 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. This confirms the presence of barriers to cooperation due to the existence of financial costs.

Therefore, although a decentralised tax administration might entail some inefficiency costs due to a lack of incentives to collaborate across administrations, we prove that once they engage in cooperative behaviour, this 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, the central government could play a role in promoting the advantages of cooperation. All in all, this is good news for the functioning of a decentralised tax administration as, in this context, strategic considerations regarding tax base attraction might not be an issue. Further research, though, should be carried out to analyse other aspects of the functioning of tax administration in a federal context.

REFERENCES

Akay, A. (2009). The Wooldridge Method for the Initial Values Problem Is Simple: What About Performance? IZA DP No. 3943.

Bacchetta, P., & Espinosa, M. P. (1995). Information Sharing and Tax Competition Among Governments. *Journal of International Economics,* 39, 103–121.

Bacchetta, P., & Espinosa, M. P. (2000). Exchange-of-Information Clauses in International Tax Treaties. *International Tax and Public Finance*, 7, 275–293.

Bucovetsky, S. (1991). Asymmetric Tax Competition. *Journal of Urban Economics*, 30, 167-181.

Chisik, R., & Davies, R. B. (2004). Asymmetric FDI and tax-treaty bargaining: theory and evidence. *Journal of Public Economics*, 88, 1119-1148.

Cremer, H., & Gahvari, F. (2000). Tax evasion, fiscal competition and economic integration. *European Economic Review*, 44, 1633-1657.

Dreher, A., Gehring, K., Kotsogiannis, C., & Marchesi S. (2014). Information transmission within federal fiscal architectures: Theory and evidence. CESifo Working Paper No. 4400.

Durán-Cabré J. M., Esteller-Moré, A., & Salvadori, L. (2015). Empirical evidence on horizontal competition in tax enforcement. *International Tax and Public Finance*, *22*(5), 834-860.

Esteller-Moré, A. (2005). Is There a Connection Between the Tax Administration and The Political Power? *International Tax and Public Finance*, 12, 639-63.

Esteller-Moré, A. (2008). Tax Administration in Spain: A Description and Analysis of the current institutional organization and some proposals of reform. In N. Bosch & J.M. Durán-Cabré (Eds.) *Fiscal Federalism and Political Decentralization: Lessons from Spain, Germany and Canada*, (pp. 209-247). Edward Elgar Publishing.

Esteller-Moré, A. (2011). Is the Tax Administration Just a Money Machine? Empirical Evidence on Redistributive Politics. *Economics of Governance*, 12, 275-299.

Elsayyad, M. (2012). Bargaining over tax information exchange. Max Planck Institute for Tax Law and Public Finance Working Paper No. 2012-02.

Heckman, J.J. (1981). The Incidental Parameters Problem and the Problem of Initial Conditions in Estimating a Discrete Time - Discrete Data Stochastic Process. In C. Manski and D. McFadden (Eds.) *Structural Analysis of Discrete Panel Data with Econometric Applications* (pp. 179-195). Cambridge, Mass: MIT Press.

Hyslop, D.R. (1999). State Dependence, Serial Correlation and Heterogeneity in Intertemporal Labor Force Participation of Married Women. *Econometrica*, 67, 1255-1294.

Honore, B. (2002). Nonlinear Models with Panel Data. *Portuguese Economic Journal,* 1, 163–179.

Huizinga H., & Nielsen, S.B., (2002). Withholding Taxes or Information Exchange: The Taxation of International Interest Flows. *Journal of Public Economics,* 87, 39–72.

Johannesen, N., & Zucman, G. (2014). The End of Bank Secrecy? An Evaluation of the G20 Tax Haven Crackdown. *American Economic Journal: Economic Policy*, *6* (1): 65-91.

Keen, M., & Ligthart, J.E. (2006a). Information sharing and international taxation: A primer. *International Tax and Public Finance*, 13, 81-110.

Keen, M., & Ligthart, J.E. (2006b). Incentives and Information Exchange in International Taxation, *International Tax and Public Finance*, 13, 163-180.

Ligthart J.E., & Voget, J. (2010). The determinants of Cross-Border Tax Information Sharing, mimeo.

Martinez-Vazquez, J., & Timofeev, A. (2010) Choosing between centralized and decentralized models of tax administration. *International Journal of Public Administration*, 33, 601-619.

Tanzi, V., & Zee, H.H. (2001). Can Information Exchange be Effective in Taxing Cross-Border Income Flows? In K. Andersson, P. Melz and C. Silfverberg (Eds.), *Modern Issues in the Law of International Taxation* (pp. 259-268). Stockholm: Kluwer Law International.

Wilson, J. (1991). Tax Competition with Interregional Differences in Factor Endowments. *Regional Science and Urban Economics*, 21, 423-451.

Wooldridge, J.M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Mass: MIT Press.

Wooldridge, J.M. (2005). Simple solutions to the initial conditions problem in dynamic, nonlinear panel-data models with unobserved heterogeneity. *Journal of Applied Econometrics*, 20, 39-54.