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Tax Systems Analysis

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

***MAIN RESULT:** The essential condition for cooperation is the existence of a reciprocity linkage between regions. More precisely, the amount of misreported tax revenues that one regional tax administration transmits to another positively depends on the misreported tax revenues received from the latter in the previous period. This reciprocity is significantly reduced by the existence of budget constraints due to expected deficit. Finally, the presence of sluggishness in this process indicates that short-sighted, uncooperative behaviour, driven by administrative, financial and transaction costs as well as by budget constraints, is replaced in the medium-long run by a more farsighted behaviour that leads to cooperation.*

JEL Codes: H71, H77, H83

Keywords: Tax information sharing, reciprocity, fiscal federalism

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1. Introduction

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

We seek to investigate the potential for cooperation between sub-central tax authorities by carrying out an empirical analysis in a federal context. This represents something of a novelty in the literature and should serve to shed some light on alternative designs (centralized vs. decentralized) for tax administration within this context. In doing so, we analyse the determinants of information sharing between regional administrations based on the Spanish case, which is a good field for empirical research. Spanish regions (the so-called "Comunidades Autónomas", henceforth CAs) have had the power to administer several wealth taxes[1] since the mid-eighties and following reforms in 1997 and 2002 have also acquired the legislative power to modify significant statutory tax parameters[2]. Thus, this case study should serve as a benchmark for evaluating the information-sharing process in a decentralized framework and, more generally, for analysing the efficiency of a decentralized tax administration scheme.

We focus our empirical analysis on a specific area of potential cooperation between the CAs, for which official data are available. In the case of wealth taxation, legal tax allocation principles (in Spanish, the so-called "puntos de conexión") indicate how tax revenues should be distributed among the CAs: the residence principle and the territorial (or source) principle, depending on the taxable event[3]. However, taxpayers are not necessarily aware of these and so might commit errors when reporting their tax returns, that is, a taxpayer

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

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

[3] 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.

might pay the tax to the wrong CA[4]. 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[5]. 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

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

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

reciprocity is lower when the CAs face budget constraints picked up by the deficit. Thus, according to our analysis, in the medium-long run the regional administrations learn the advantages of cooperation thus providing elements that support the correct functioning of a decentralized tax administration.

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

2. Literature review

The literature has identified two main sources of interdependence at a tax administration level. On the one hand, Cremer & Gahvari (2000), examining the implications of tax evasion for fiscal competition and tax harmonization policies in an economic union, demonstrate the possibility of mobility-based competition in tax enforcement policies. They obtain sub-optimal equilibrium values for both tax and audit rates and show that tax harmonization alone is not sufficient to avoid strategic incentives to attract tax bases as there can be no commitment to audit policies. Durán-Cabré *et al.* (2014) have tested this result for the Spanish decentralized framework and corroborate the presence of mobility-based competition in tax enforcement among regional administrations.

On the other hand, the incentive for sub-central tax authorities to collaborate by sharing relevant tax information has also been accounted for in the literature that has focused on the incentives for tax cooperation between countries to reduce evasion in an international mobile-capital framework (see Keen & Ligthart, 2006a, for a survey). In particular, the seminal study by Bacchetta & Espinosa (1995) identifies the strategic trade-off between competitive behaviour – lowering the tax rate to increase foreign investment – and cooperative behaviour – voluntarily sharing information to reduce international tax evasion. In equilibrium, the second effect may dominate the former resulting in partial information exchange. In a more recent study, Bacchetta & Espinosa (2000) further their previous analysis by modelling the choice of tax rates and information provision as an infinitely repeated game. A contribution in this same line is provided by Huizinga & Nielsen (2002) who model a repeated game in which tax authorities choose between withholding taxes and sharing information as alternatives for dealing with international capital income and

profit taxation[6]. 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.

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

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

countries as a measure of reciprocity, we have further confirmation that reciprocity matters in determining the level of information exchanged between two tax authorities.

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

3. Empirical analysis

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

3.1 The empirical framework

Data on Spain's regional tax administrations are extracted from the report "Informe sobre la cesión de tributos a las Comunidades Autónomas" published every year jointly with the project of the general State budget. Specifically, we have access to data on the total number and total amount of transfers resulting from misreported tax returns ("Transferencias por aplicación de los puntos de conexión") collected (returned) by each CA from (to) any other region during the 1989-2009 period[7]. 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.

[7] 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.

Our endogenous variable is the amount of tax revenues transferred by each CA to every other CA in a given year and thus takes the form of a continuous random variable over strictly positive values, but it assumes the value zero with positive probability. Our dataset contains 43.02 percent zero-valued output. Thus, our endogenous variable may be censored at zero inasmuch as a zero value could alternatively indicate an actual absence of misreported taxes or that CAs choose not to share information on misreported taxes and claim to have zero tax revenues to transmit. Therefore, we maintain the random-effects Tobit corner-solution model as our main approach (see Wooldridge, 2002, pp. 518-549)[8], which is defined as follows:

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

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

We introduce a series of control variables that account for both region pair-specific characteristics and unilateral determinants referring to region *i* that might influence the information-sharing process. The pair-specific variables are collected in vector $\boldsymbol{Y_{ijt}}$. In particular, N_{ijt} is the number of cases of misreported taxes transmitted from region *i* to region *j* in year *t*. According to Ligthart and Voget (2010), the distance between regions might reduce the flow of information between them. We therefore control for D_{ij}, the physical distance in kilometres between *i* and *j*. The political alignment between Spanish regions[9] 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

[8] 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.

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

regions, that is, as a measure of the relative bargaining position of region *i* with respect to region *j* (Elsayyad, 2012). A positive (negative) sign would indicate a favourable (unfavourable) bargaining position of region *i* with respect to region *j* due to a higher (lower) amount of revenues transmitted by region *i* to region *j*.

The vector $\boldsymbol{X_{it}}$ includes a constant term and the unilateral variables. According to the previous literature on the exchange of tax information (Bacchetta & Espinosa, 1995, 2000), the statutory tax parameters and the enforcement costs are crucial in determining the level of information exchange between tax authorities. These issues are also relevant in our context, albeit in a different way; thus, we control for $Tot\_Reg\_Tax\_Revenues_{it}$ and $Tot\_Reg\_Audit\_Revenues_{it}$ that account for total tax revenues and total tax auditing revenues collected by region *i* during year *t*, respectively. These variables are proxies of regional tax autonomy in raising revenues and they are expected to be associated with greater amounts of information being exchanged. Budgetary and political variables might also play a role in determining tax administration policies (see, e.g. Esteller-Moré 2005, 2011). In particular, we control for the deficit expected at the beginning of every fiscal period in order to account for the financial conditions of regional budgets and to measure indirectly the financial opportunity cost of cooperation of region *i*. We expect a higher deficit to negatively impact the transmission of misreported revenues. We return to this variable below. We include the total amount of transfers received from the central government divided by total regional expenditure to account for a further budgetary factor relevant in a federal framework, such as that operated in Spain. We expect this variable to have an income effect on the behaviour of the tax administrations. In particular, a higher transfer-expenditure ratio should force the administration to rely less on its own tax resources and to transfer more tax revenues to the other regions. We are not able to identify the impact of the administrative costs of cooperation, but reasonably suppose it to be constant over time. As such it will be picked up by the constant term; however, if it varies over time (and uniformly throughout the ACs) it will be picked up by the time effects. In the case of the political variables, we include a dummy equal to one, El_{it}, if there is a regional election in region i during the year t, to control for the potential impact of the electoral cycle on the incentives to share information. To account for modifications to the statutory tax parameters, we include a dummy, Ded_{it}, equal to one if the regional government i introduces a deduction in (at least) one tax during

the year[10]. $Left_{it}$ 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. We finally include a set of time dummies τ_t, while ϑ_{ij} is an unobserved pair-specific disturbance that is constant over time and ε_{ijt} is an idiosyncratic error that varies across time and pair of regions[11]. The parameters of Eq. (1) are estimated by maximum likelihood.

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

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

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) $g\big(Trans\_Rev_{ijt-1}\big) = Trans\_Rev_{ijt-1}$; and

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

[10] 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.

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

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 $1[Trans\_Rev_{ijt-1} > 0] \times Trans\_Rev_{ijt-1}$ is expected to be positively related to the propensity to cooperate at time *t*.

In dynamic Tobit models with unobserved effects, the treatment of the initial observations is a key issue[12]. 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[13].

In our framework, the main incentives for a CA not to cooperate are the administrative costs as well as the financial costs of losing the financial yield of undue tax revenues. Thus, we suspect that a CA with relatively short-term budget constraints will decide to reduce cooperation. In order to identify the role of financial/budget constraints in influencing reciprocity we interact Rec_Rev_{ijt-1} with $1[Def_{it}]$, a dummy

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

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

equal to one if region *i* expects a deficit in period *t*. We perform this interaction for both the static and the dynamic models. Then, Eq. (2) is modified as follows:

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

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

3.2 Data and sources

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

[TABLE 1]

4. Results

In Table 2, we present the results of the estimation of Eq. (1), that is, the static model. We report a GLS random-effects specification in column (1), a standard Tobit model in column (2), and column (3) reports the random-effects Tobit model, which is our preferred estimation strategy. The amount of misreported tax revenues transmitted by CA *i* to CA *j* positively depends on reciprocity, which is proxied by the time-lagged tax revenues received by CA *i* from CA *j*. This result is robust to the different specifications. According to the random effects Tobit model reported in column (3), a one euro increase in the tax revenues received by CA *i* from CA *j* in year *t-1* results in an increase of 0.385 euros of tax revenues being transmitted from CA *i* to CA *j* in year *t*, holding all other variables constant. Clearly, the amount of misreported revenues increases as the number of cases of transmitted misreported taxes grows. Specifically, according to model (3), one additional case of misreported taxes leads to an increase in transmitted revenues of almost 6.5 thousand euros, keeping constant all the other variables. The estimate of the distance between regions is significant and robust to the two different Tobit specifications presenting negative coefficients: two distant regions share less misreported revenues than is the case between two closer CAs. This corroborates previous results in the literature. Furthermore, we find that the deficit negatively impacts the cooperative behaviour of the tax administration. Those CAs with a higher expected deficit at the beginning of the year are less willing to transfer misreported tax revenues. As for the control variables, we find that regional size, proxied by population, is positively associated with the transfer of misreported tax revenues. None of the remaining covariates is found to be significant, but they are jointly statistically significant according to a Wald test.

[TABLE 2]

In Table 3, we present the results of the estimation of the alternative specifications of Eq. (2). In columns (1) and (2) we set $g(Trans\_Rev_{ijt-1}) = Trans\_Rev_{ijt-1}$, while in columns (3) and (4) we assume $g(Trans\_Rev_{ijt-1}) = \{1[Trans\_Rev_{ijt-1} = 0]; 1[Trans\_Rev_{ijt-1} > 0] \times Trans\_Rev_{ijt-1}\}$. 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.

[TABLE 3]

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]

5. Conclusions

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

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

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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

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

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

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

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

Estimator	(1) TOBIT-RE Exogenous initial values	(2) TOBIT-RE Wooldridge method	(3) TOBIT-RE Exogenous initial values	(4) TOBIT-RE Wooldridge method
L.Transmitted Tax Revenues	0.234***	0.235***	-	-
	(9.438)	(9.456)		
1[L.Transmitted Tax Revenues = 0]	-	-	-712.641***	-712.263***
			(-13.257)	(-13.168)
1[L.Transmitted Tax Revenues> 0]×L.Transmitted Tax Revenues	-	-	0.023***	0.023***
			(9.394)	(9.393)
L.Received Tax Revenues	0.327***	0.327***	0.378***	0.378***
	(5.440)	(5.442)	(6.393)	(6.393)
Transmitted Tax Revenues$_{t=1989}$	-	1.791	-	0.058
		(1.512)		(0.063)
Cases of Misreported Taxes	5.926***	5.930***	5.848***	5.848***
	(16.620)	(16.634)	(17.365)	(17.364)
Distance	-0.283***	-0.271***	-0.188***	-0.187***
	(-4.718)	(-4.482)	(-3.745)	(-3.709)
Political Alignment	-33.301	-32.097	-66.883	-66.807
	(-0.664)	(-0.640)	(-1.403)	(-1.401)
Relative GDP	10.889	17.485	-27.411	-27.191
	(0.093)	(0.149)	(-0.280)	(-0.278)
Tot_Reg_Tax_Revenues	18.989	18.371	15.238	15.199
	(0.665)	(0.644)	(0.576)	(0.574)
Tot_IGT_Audit_Revenues	-1.600	-1.470	-1.248	-1.242
	(-1.280)	(-1.174)	(-1.032)	(-1.024)
Deficit	-0.000	-0.000	-0.000	-0.000
	(-1.485)	(-1.459)	(-1.502)	(-1.500)
Transfers/Expenditure	446.910*	434.541*	376.867	376.357
	(1.700)	(1.652)	(1.463)	(1.461)
Election Year	-49.016	-51.271	-40.768	-40.883
	(-0.824)	(-0.862)	(-0.739)	(-0.741)
Deduction	-2.659	-3.200	-13.971	-13.994
	(-0.033)	(-0.040)	(-0.172)	(-0.173)
Leftist Government	-96.980	-98.314	-77.896	-77.954
	(-0.944)	(-0.957)	(-0.777)	(-0.778)
Population	0.065***	0.061***	0.038***	0.038***
	(4.468)	(4.175)	(3.193)	(3.147)
_cons	-340.952	-351.172	-96.233	-96.555
	(-1.442)	(-1.485)	(-0.434)	(-0.436)
Observations	3,405	3,405	3,405	3,405
Censored Observations	1,490	1,490.000	1,490	1,490
Number of groups (couple of regions)	210	210	210	210
Log likelihood	-16,845.972	-16,844.828	-16,769.765	-16,769.763
Wald chi2	923.174	927.285	1,276.899	1,276.878
p-value	0.0000	0.0000	0.0000	0.0000

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

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

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