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Tax collection efficiency in OECD countries improves via decentralization, simplification, digitalization and education

Yolanda Ubago Martínez
Institute for Advanced Research in Business and Economics (INARBE)
Department of Business Management
Public University of Navarre (UPNA)
(https://www.linkedin.com/in/yolanda-ubago-martinez-b39a8630/)
(yolanda.ubago@unavarra.es)

Pedro Pascual Arzoz
Institute for Advanced Research in Business and Economics (INARBE)
Department of Economics
University of Navarre (UPNA)
ORCID: 0000-0001-9561-6067
(ppascual@unavarra.es)

Idoia Zabaleta Arregui
Institute for Advanced Research in Business and Economics (INARBE)
Department of Economics
Public University of Navarre (UPNA)
https://www.linkedin.com/in/idoyazabaleta/
(idoia@unavarra.es)

Abstract

This paper offers an assessment of tax administration performance and provides evidence of the relationship between fiscal decentralization (and tax structure) and the technical efficiency of tax collection. The initial stage of the investigation consists of a data envelopment analysis (DEA) to obtain technical efficiency estimates for a sample of 28 OECD countries over the period 2004–2017. In a second stage, we explore how technical efficiency is affected by fiscal decentralization and tax structure variables. The results show how the degree of fiscal decentralization has a positive and significant impact on the technical efficiency of tax collection. They also reveal a relevant role of tax structure choices and the ratio of indirect to direct taxes, which can significantly affect tax collection efficiency. Finally, we extract some policy implications.

Keywords: efficiency, tax collection, decentralization.

JEL codes: H21, H26, H30, H83

1. INTRODUCTION

The global economic crisis has highlighted the persistence of the tax evasion problem. According to Capasso et al. (2021), solid fiscal institutions are essential to ensure a positive public attitude toward paying taxes. To achieve this, Tax Agencies (hereinafter, TA) need to acknowledge the scope of the problem. This has led to growing concern for the efficiency of the tax administration and / or the TAs in the various tax collection and management systems being implemented in different countries.

The literature describes various approaches to the analysis of tax collection efficiency. An early study (Bahl 1971) uses a regression model to estimate and compare fiscal effort across countries. More recently, Bird, Martínez-Vázquez, and Torgler (2008), shows the impact of demand factors, that is, corruption, voice and accountability, in addition to supply factors. Another approach uses the concept of 'compliance gap' (Gemmell and Hasseldine 2014). Collection efficiency rates are calculated for a variety of taxes, such as VAT, using the 'C-efficiency' indicator, which reveals the deviation between current efficiency and the perfect efficiency that would be achieved by imposing a uniform tax rate on all consumption (Keen, 2013).

Finally, other works study TA performance using the standard method of data envelopment analysis (DEA), the Malmquist Productivity Index, Free Disposal Hull (FDH), stochastic frontier analysis (SFA) among other similar or improved methodologies. Regarding the unit of analysis for this research, due to data limitations, most of the existing work on tax collection efficiency has tended to focus on TAs within the jurisdiction of a specific country. A sample of such works would include Moesen and Persoon (2002) for Belgium; Esteller-Moré (2003), Jiménez and Barrilao (2001), Barrilao-González and Villar-Rubio (2013), Cordero et al. (2021) and Belmonte-Martín, Ortiz and Polo (2021) for Spain; Barros (2005, 2007) for Portugal; Katharaki and Tsakas (2010) for Greece; and Førsund, Edvardsen, and Kittelsen (2015) for Norway.

Until recently, limited availability of comparable cross-country tax administration data has precluded the possibility of a comparative analysis of tax collection efficiency across TAs; hence the paucity of research on tax collection efficiency for a sample of countries. This data limitation issue has recently been overcome by a compilation of data by the Organization for Economic Cooperation and Development (OECD) on administrative performance in member countries. One exception to the general dearth of research is the work of Alm and Duncan (2014), who estimate the efficiency of tax agencies in 28 OECD countries for the years 2007-2011. Along similar lines, Savić et al. (2015), analyze TA performance and its effect on tax evasion in 13 European countries. More recently, Nguyen, Prior and Van Hemmen (2020) have expanded the existing literature seeking to shed light on the measurement of TA efficiency, by taking into account both input costs and tax compliance.

What is the level of TA performance in terms of relative tax collection efficiency in developed countries? Our objective is to delve further into the measurement and explanation of tax collection efficiency by TAs in a sample of 28 OECD countries. Taking a two-stage approach, we first choose a series of input and output variables for use in the DEA analysis to determine relative efficiency levels in tax system management and then apply the conditional order-m estimation method (Daraio and Simar 2005, 2007) to obtain an efficiency performance assessment of tax agencies across the sample countries. Our second-stage proposal is to use the relative efficiency results obtained to test two hypotheses that may help explain cross-country collection efficiency differentials. The first examines whether fiscal decentralization affects efficiency in tax collection and the second explores whether the structure of the tax system affects efficiency in tax collection.

An important tax administration issue attracting recent attention is the optimal level for potential decentralization. Should there be one central revenue administration or should each regional government have its own? Different countries have reached very different answers to this question (Bird 2015). Therefore, the multijurisdictional perspective of the administration of the tax system should be considered as an explanatory factor in the tax-collection efficiency of TAs.

What, therefore, is the most appropriate organizational design for the tax administration, and what are the determining factors that can improve the efficiency of a given model? As Martinez-Vázquez and Timofeev (2010) have pointed out, both centralized and multilevel tax administrations have their advantages and disadvantages. However, within fiscally-decentralized countries, where taxes and other sources of revenue need to be allocated to different levels of government, Vehorn and Amhad (1997) identify up to four tax administration models in fiscally decentralized countries.

Observation shows that taxation structures vary widely across different countries. The main idea to be drawn from this observation is that optimal tax enforcement critically depends on the underlying tax structure.

The article is organized as follows. Section 2 presents the literature review. Section 3 describes the data used in the empirical analysis, the DEA technique employed to obtain the measure of technical efficiency and the results obtained. Section 4 explains the econometric methodology used to regress the tax revenue efficiency estimates onto fiscal decentralization and tax structure measures and the estimation results. Finally, Section 5 provides the main conclusions and policy implications.

2. LITERATURE REVIEW

Two types of variables are used to measure tax collection efficiency; some relating to input; others to output. The input consists of the available tax management and collection resources; the output is the productivity obtained from those resources; a measure usually derived from the main tax figures.

The comparison of existing studies reveals differences in the econometric and statistical techniques used to calculate efficiency. Some researchers begin with a DEA (Data Envelopment Analysis) model (González and Miles, 2000; Moesen and Persoon, 2002, who combine it with Free Disposal Hull (FDH); Katharaki and Tsakas, 2010; Forsund et al., 2015; Fuentes and Lillo-Bañuls, 2015; Avellón and Prieto, 2017; Huang et al., 2017; who use a combination of DEA with the Russell directional distance function; Villar, Barrilao and Delgado, 2017). Others, such as Esteller (2003) and Barros (2005), use stochastic frontier analysis (SFA). Nguyen, Prior and Van Hemmen (2020), among others, use advanced frontier estimators, such as the semi-nonparametric StoNED, and

Alm and Duncan (2014) and Adam, Delis and Kammas (2014), among others, apply both techniques.

A second strand of the literature addresses the issues of goodness of fit of the estimates and identification of the explanatory factors of technical inefficiency.

The statistical accuracy of the selected analysis technique is approached in various ways. González and Miles (2000) use a Bootstrap technique (BA); while Alm and Duncan (2014) make input adjustments in the DEA, and Adam et al. (2014) tackle the issue with a sensitivity analysis. Meanwhile, Forsund, Edvardsen and Kittelsen (2015) use DEA to calculate the Malmquist productivity index and an output-oriented two-stage DEA with adjusted outputs enabled Villar, Barrilao and Delgado (2017) to identify 21 efficient tax offices out of a total sample of 47.

Various statistical methods have been used to explore the explanatory factors of inefficiency. The issue of sensitivity to outliers in exploratory data analysis, for example, is addressed by Moesen and Persoon (2002). Esteller (2003) estimates the tax collection function while also constructing an explanatory equation for inefficiency, which is an aspect whose determinants Katharaki and Tsakas (2010) identify by means of a Tobit (regression) model, while Fuentes and Lillo-Bañuls (2015) approach the issue by first calculating a Malmquist index using a smoothed bootstrap procedure and then performing a Mann Whitney U test to study the effect of certain variables on productivity.

A compilation of studies identifying the explanatory elements of inefficiency in tax administrations is provided in Table 1.

Table 1. Explanatory factors of tax office inefficiency.

Reference	**Country**	**Sample Years**	**Sample units**	**Explanatory variables of efficiency**
Moesen and Persoon (2002)	Belgium	1991	289 regional tax office	-Number of fines
				-Number of official assessments
				-Offices that benefit more from the services of the Central Tax Office
				-Office manager skills
				-Qualified civil servant
Esteller (2003)	Spain	1992	45 provincial tax office	-AEAT effort
		1995-1998		-Percentage of unconditional financing over total budgeted expenditure
				-Public deficit
				-Political color
				-Population
				-GDP
				-Percentage of State funding
				-Activity of the settlement offices (offices located in the CCAA)
Katharaki and Tsakas (2010)	Greece	2001-2006	27 tax office	-Population

				-Presence of the services sector
				-GDP
Fuentes and Lillo-Bañuls (2015)	Alicante (Spain)	2005-2006	30 local tax office	-Population and number of municipalities
				-Technology improvements
				-Resource management
Huang et al. (2017)	Taiwan	2013	20 local tax office	-Tax collection
				-Tax management
Avellón and Prieto (2017)	Spain	2014-2012	135 provincial tax office	-Household quality of life
				-National level of education
				-Number of crimes committed across regions
				-Political parties (other than that of the central govt.) in government across regions

Source: Author`s elaboration based on the literature reviewed

Also worth mentioning are two studies of Tax Office characteristics that were conducted without the use of statistical or econometric techniques, i.e., Gascón (2014) and Karatas and Ariti (2020) who describe a tax audit conducted in Turkey.

3. MEASURING TECHNICAL EFFICIENCY

Technical efficiency occurs when maximum output is obtained from a given input level, or minimum input is used to obtain a given output level.

Building on a previous study by Debreu (1951), Farrell (1957:254) introduces a measure of technical efficiency, which he defines as: "one minus the equi-proportional reduction in all inputs that still allows the production of given outputs". Farrell's method was generalized for multi-output contexts and reformulated by Charnes, Cooper and Rhodes (1978) as a mathematical programming problem, later termed DEA, which is the approach used in this paper to estimate the production frontier from which to evaluate the efficiency of each production unit[1]. DEA is very widely used to estimate production frontiers, as can be appreciated from the existing literature (Afonso and St. Aubyn 2005; Rayp and Van De Sijpe 2007; Adam, Delis and Kammas 2014; Wolszczak-Derlacz 2017). In this analysis, the performance of each Decision Making Unit (DMU) is measured relative to an envelopment surface (or efficient frontier) representing the current technology benchmark. DMUs enveloped within the frontier are classed as efficient; while those outside it are classed as inefficient. The closer the DMU is to the frontier, the greater its efficiency.

[1] The main advantages of this approach are the non-requirement of a specific parametric form for the production function; non-dependence on market structure or market imperfection assumptions; and usability in multi-output contexts. Its drawbacks are its sensitivity to measurement errors and outliers in the observations, and its non-statistical nature, which rules out statistical inferences.

This study is maximum-output-oriented under variable returns to scale because our object of observation is tax offices, where the aim will be to achieve maximum tax collection from the available resources[2]. The assumption of variable returns to scale (BCC model, proposed by Banker, Charnes and Cooper 1984) implies that each production unit has the optimum operating level for its input and output structure, and thus ensures that the model will evaluate pure technical efficiency, irrespective of scale considerations.

Thus, the output-maximization-oriented model under variable returns to scale for the case in hand can be written as follows:

$$
\begin{aligned}
&\text{Max } Z_0^0 = \phi_0 \\
&\text{s.t}: \\
&x_{ji0} - \sum_{i=1}^{n} x_{ji}\lambda_i \geq 0, \; j = 1,\ldots m \\
&-\phi_0 y_{ri0} + \sum_{i=1}^{n} y_{ri}\lambda_i \geq 0, \; r = 1,\ldots k \\
&\sum_{i=1}^{n} \lambda_i = 1, \; i = 1,\ldots n \\
&\lambda_i \geq 0, \forall \; i
\end{aligned}
$$

where ϕ_0 is the inefficiency index for each unit. This measure satisfies that $1 \leq \phi_0 \leq \infty$, and $\phi_0 - 1$ is the maximum proportional increase in outputs that is possible using the same quantity of inputs. The $1/\phi_0$ index defines the technical efficiency level, which ranges between 0 and 1. The variables in this problem include weights on the n DMUs, λ_i, which enable the construction of a composite unit, which, using $\sum_{i=1}^{n} x_{ji}\lambda_i$ input j (j=1, …m), produces $\sum_{i=n}^{n} y_{ri}\lambda_i$ of output r (r=1, …k), which is greater than or equal to the amount produced by unit i_0.

In addition, we calculate efficiency using another partial frontier approach, known as the order-m method (Nguyen, Prior and Van Hemmen 2020; Belmonte-Martín, Ortiz and Polo 2021). While both frameworks determine the production possibility frontiers, the order-m allows some decision-making units to lie outside the efficiency frontier

[2] Technical efficiency is measured in terms of the maximum proportional reduction in all inputs that is possible keeping output constant, but it can also be calculated as the maximum proportional increase in output that is possible keeping all inputs constant. Both measures provide the same results under constant returns to scale (CCR model), but not under variable returns to scale.

(super-efficient countries)[3]. While DEA is sensitive to outliers which can distort the reference frontier, the order-m approach mitigates this problem by allowing data points outside the frontier (see Lovell and Rouse 2003) which are labeled as "super-efficient."

In line with other cross-country analyses of the determinants of tax-collection efficiency, the variables selected for our study are as follows (Table 2):

As output variables we use: tax collection as a percentage of GDP (Alm and Duncan 2014; Avellón and Prieto 2017), and corporate, personal and goods and services tax revenue as a percentage of GDP (Esteller 2003; Katharaki and Tsakas 2010; Nguyen, Prior and Van Hemmen 2020).

As inputs, we include the percentage of audit, investigation and other verification staff in total tax administration (González and Miles 2000; Moesen and Persoon 2002; Katharaki and Tsakas 2010; Avellón and Prieto 2017; Nguyen, Prior and Van Hemmen 2020), total IT expenditure/total revenue body expenditure (%) (Alm and Duncan 2014; Nguyen, Prior and Van Hemmen 2020), tax audit costs/net revenue collected (%) (Moesen and Persoon 2002), tax administrator wages /aggregate administrative costs (%) (Alm and Duncan 2014; Nguyen, Prior and Van Hemmen 2020).

Table 2. Description of variables using in DEA and Order-m

	Variable	**Units and definition**	**Source**
Efficiency variables			
Inputs	Staff	Staff in audit, investigation and other verification in percent of the total tax administration	OECD
	Itcost	Total IT expenditure/total revenue body expenditure (%)	OECD
	Audit	Value of completed tax audit actions/net tax collections (%)	OECD
	Salary	Salary costs of tax administration employees/aggregate administrative cost (%)	OECD
Outputs	Tax collection	Tax collection as a percentage of GDP	OECD
	Businesses	Tax revenue from businesses as a % of GDP	OECD
	Individuals	Tax revenue from individuals as a % of GDP	OECD
	Goods	Tax revenue from goods and services as a % of GDP	OECD

Some data are taken from Tax Administration reports (OECD) which are available for a sample of 28 OECD countries for 2004, 2007, 2009, 2011 and from 2013 to 2017, which are the years for which the data for this study were drawn. There are two main reasons for the choice of study sample. The first is that there are very few country-level studies on tax collection efficiency (Alm and Duncan 2014; Nguyen, Prior and Van Hemmen 2020) and that most of the existing research is based on single-country data (Moesen and Persoon 2002; Katharaki and Tsakas 2010; Forsund, Edvardsen and Kittelsen 2015; Avellón and Prieto 2017; Huang et al. 2017). The second is that the

[3] Hence, the efficiency score in the order-m method can be greater than unity. Order-m scores greater than unity indicate inefficiency; those equal to unity indicate efficiency; and those below unity indicate super-efficiency.

relative developmental homogeneity of OECD countries circumvents the problem of having to deal with cross-country development gaps. Advanced economies show a marked tendency to converge in terms of aggregate productivity, technology growth and per capita income (Rodríguez-Pose and Ezcurra 2011). This economic convergence is also useful for correcting potential omitted-variable bias.

Tables 3 and 4 show technical efficiency scores for the 28 OECD countries.

Standing out in efficiency terms are the Nordic countries, such as Denmark, Norway and Sweden (Nguyen, Prior and Van Hemmen 2020), which maintain a score of 1 throughout the sample period, and other northern European countries such as Belgium and Poland. Those lying on the frontier are France, Greece and Italy.

Some countries that, while not maintaining a score of 1 during the entire period, could be considered efficient in tax collection management, include Hungary, Luxembourg or Switzerland (Nguyen, Prior and Van Hemmen 2020). The efficiency of Nordic countries, such as Denmark and Sweden; northern European countries such as Poland and Czech Republic, and others, such as France, Greece, Italy and New Zealand holds for the order-m method.

Table 3. Tax collection efficiency in OECD countries. DEA method

Country	**2004**	**2007**	**2009**	**2011**	**2013**	**2014**	**2015**	**2016**	**2017**	**Mean**
Australia	0,834	0,947	0,708	0,735	0,826	**1,000**	0,959	**1,000**	**1,000**	0,890
Austria	0,912	0,952	**1,000**	0,917	0,928	0,880	0,933	0,949	0,923	0,933
Belgium	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Canada	0,728	0,869	0,772	0,743	0,827	0,845	0,869	0,924	0,917	0,833
Czech Republic	0,773	0,901	**1,000**	0,880	**1,000**	**1,000**	**1,000**	**1,000**	1,000	0,950
Denmark	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	1,000	**1,000**
Finland	**1,000**	**1,000**	0,957	**1,000**	0,974	0,973	0,965	**1,000**	1,000	0,985
France	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Germany	0,824	0,908	0,908	0,872	0,828	0,830	0,836	0,997	1,000	0,889
Greece	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	1,000	**1,000**
Hungary	**1,000**	0,959	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	1,000	0,995
Ireland	0,784	0,780	0,748	0,706	0,698	0,715	0,629	0,798	0,834	0,744
Italy	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Japan	0,575	0,729	0,634	0,657	0,748	0,857	0,846	0,823	0,784	0,739
Luxembourg	0,895	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	0,988
Mexico	0,364	0,397	0,415	0,422	0,561	**1,000**	**1,000**	**1,000**	**1,000**	0,684
Netherlands	0,785	0,831	0,803	0,807	0,788	0,812	0,837	0,923	0,873	0,829
New Zealand	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Norway	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Poland	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Portugal	0,833	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	0,981
Slovak Republic	0,854	**1,000**	**1,000**	**1,000**	0,827	0,876	0,945	0,912	0,904	0,924
Spain	0,934	**1,000**	0,795	0,757	0,780	0,851	0,861	**1,000**	**1,000**	0,887
Sweden	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Switzerland	**1,000**	0,884	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	0,987
Turkey	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	0,893	**1,000**	**1,000**	**1,000**	0,988
United Kingdom	0,877	0,807	0,889	0,883	0,784	0,749	0,757	0,809	0,790	0,816

United States	0,583	0,856	0,879	0,781	0,572	0,580	0,610	0,706	0,622	0,688

Source: Authors' own calculations

Table 4. Tax collection efficiency in OECD countries. Order-m method

Country	**2004**	**2007**	**2009**	**2011**	**2013**	**2014**	**2015**	**2016**	**2017**	**Mean**
Australia	0,998	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	1,025	**1,000**	**1,000**	1,003
Austria	1,004	0,984	**1,000**	1,082	1,036	1,130	1,068	0,996	**1,000**	1,034
Belgium	**1,000**	**1,000**	0,985	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	0,998
Canada	0,992	0,994	**1,000**	**1,000**	0,988	**1,000**	0,998	0,997	**1,000**	0,996
Czech Republic	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Denmark	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Finland	**1,000**	**1,000**	0,993	0,996	0,997	1,007	1,021	**1,000**	**1,000**	1,002
France	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	0,997	**1,000**	**1,000**
Germany	**1,000**	0,997	0,993	**1,000**	1,072	**1,000**	**1,000**	**1,000**	**1,000**	1,007
Greece	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Hungary	**1,000**	0,950	**1,000**	**1,000**	**1,000**	0,997	**1,000**	0,983	**1,000**	0,992
Ireland	1,136	**1,000**	**1,000**	**1,000**	0,986	1,091	1,367	**1,000**	**1,000**	1,064
Italy	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Japan	1,676	**1,000**	**1,000**	**1,000**	1,214	**1,000**	**1,000**	**1,000**	**1,000**	1,099
Luxembourg	**1,000**	**1,000**	**1,000**	**1,000**	0,984	**1,000**	**1,000**	**1,000**	**1,000**	0,998
Mexico	**1,000**	1,421	1,375	2,129	0,999	**1,000**	**1,000**	**1,000**	**1,000**	1,214
Netherlands	**1,000**	**1,000**	**1,000**	**1,000**	1,059	**1,000**	**1,000**	0,991	**1,000**	1,006
New Zealand	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Norway	**1,000**	**1,000**	**1,000**	**1,000**	0,972	0,991	0,997	0,992	0,998	0,995
Poland	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Portugal	1,031	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	1,003
Slovak Republic	**1,000**	**1,000**	**1,000**	**1,000**	1,123	1,028	**1,000**	1,056	1,045	1,028
Spain	0,998	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Sweden	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Switzerland	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
Turkey	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
United Kingdom	**1,000**	**1,000**	**1,000**	**1,000**	0,999	**1,000**	1,150	0,999	0,999	1,016
United States	1,494	**1,000**	**1,000**	**1,000**	0,997	1,158	1,332	1,123	1,160	1,141

Source: Authors' own calculations.

4. ESTIMATION AND RESULTS OF THE SECOND-STAGE MODEL

In the second stage of this study, data obtained from the cross-country comparison of efficiency scores are used to test two hypotheses.

Hypothesis 1: Fiscal decentralization affects efficiency in tax collection.

The question to be addressed is whether a country's tax-collection efficiency is affected by its fiscal decentralization level. From the applied research perspective, cross-country comparisons reveal no optimal TA model, either in terms of good practice or organizational efficiency (Taliercio 2005). Qiao et al. (2008) draw attention to the importance of information on the impact of fiscal decentralization on economic growth and regional equity and their potential trade-offs for countries currently undergoing fiscal decentralization.

If a country is divided into sub-central jurisdictions, each with some degree of taxation autonomy, we will assume management efficiency gains to be possible. The plausibility of this assumption rests on the greater proximity of TA taxpayers facilitating effective monitoring of tax collection (Buehn, Lessmann and Markwardt 2013). As argued by Lago and Martínez-Vázquez (2015), the implementation of procedures for the coordination and exchange of tax information between administrations would enhance fiscal co-responsibility, by exposing sub-central taxation to closer scrutiny, thereby incentivizing management and promoting accountability.

Our approach is to use technical efficiency as the dependent variable in an econometric model written as follows:

$$TE_{it} = \alpha + \beta CVit + \gamma Decentralizationit + u_{it} \quad (1)$$

where TE_{it} denotes technical efficiency in country i in period t, $CVit$ denotes the control variables (GDP per capita, population density, the national level of education, public debt, control of corruption, productive structure and tax wedge). $Decentralization$ stands for the explanatory variable, fiscal decentralization of different countries; and u_{it} is the random error term.

Hypothesis 2: The structure of the tax system affects efficiency in tax collection

In other words, if tax revenue is predominantly generated by indirect taxes or fees, tax collection is more automatic, and the direct costs for the TA are lower, while collection efficiency is conceivably greater. However, if most of the collected revenue comes from direct taxes, the tax architecture will be more vulnerable to potential inefficiency due to the complexity of the collection system.

Specifically:

$$TE_{it} = \alpha + \beta CVit + \gamma FVit + u_{it} \quad (2)$$

where TE_{it} denotes the technical efficiency of the *i*th country in the *t*th period, $CVit$ denotes the control variables (GDP per capita, population density, national level of education, public debt, control of corruption, production structure and tax wedge) and $FVit$ represents the explanatory variables for this second hypothesis, namely, total tax and contribution rate, time to prepare and pay taxes and revenue from direct taxes and social security contributions. Table A1 in the appendix explains the variables used in the study.

Control variables

Real GDP per capita is used as a control for economic development. Countries with high GDP are expected to have more productive, and therefore more efficient, public and private sectors (Esteller 2003; Katharaki and Tsakas 2010; Ferede and Dahlby 2012).

With respect to *population density*, some research investigates the possible relationship between higher levels of efficiency and very high population density (Raab and Lichty 2002), a factor that is expected to generate economies of scale and thus increase efficiency (Adam, Delis and Kammas 2014).

The national *level of education*, like GDP pc, is another indicator of economic development, in that higher efficiency can be expected of a country with a more highly educated population endowed with a greater understanding of the necessity of taxation (Annabi 2017; Avellón and Prieto 2017).

The *public debt* variable is used to verify whether, in the face of an increase in public debt, a country reacts by trying to maximize its use of inputs in order to reduce its debt volume. This would entail strengthening its tax management effort (Esteller 2003; Ferede and Dahlby 2012; Nguyen, Prior and Van Hemmen 2020).

Control of corruption is an estimated variable which is used to capture public perception of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. This variable provides an indication of perceived government performance, that is, whether the public considers their government corrupt and, if so, to what extent. One of the factors that encourage taxpayers to contribute to the State is knowing where their taxes are destined. This requires public trust in the government's use of taxes. One of the principles of taxation is that taxpayers' perceptions influence their compliance with tax obligations. Thus, like Avellón and Prieto (2017), we assume that trust in the Government will reduce tax fraud.

We also include a variable for *productive specialization*, SI, based on the Herfindahl concentration index:

$$SI = \sum_{i=1}^{N} s_i^2$$

where s_i is the share of the i^{th} activity in total national GDP. The index covers agriculture, industry and services (Nguyen, Prior and Van Hemmen 2020) and has a theoretical range of close to zero to 1, with higher values indicating higher specialization (Katharaki and Tsakas 2010). The primary and tertiary sectors contain most of the self-employed, who are more difficult for the Tax Administration to control, since it is easier for them to conceal taxable income.

The *tax wedge* is personal income tax plus social security contributions as a percentage of total labor costs. It is a reflection of the effect of taxes on the incentive to work more or less and can distort the individual's work-life balance choice. It is an indicator of fiscal pressure on labor.

Explanatory variables

Decentralization is a complex concept which can be applied at different levels: fiscal, political or administrative; each with its own characteristics and implications. This paper focuses on fiscal decentralization, that is, the delegation of powers of taxation to lower tiers of government, using a measure of subnational tax revenue (as a share of general government revenue).

The notion of using fiscal decentralization as a means to increase technical efficiency is based on the first-generation theory of fiscal federalism, which originated in seminal papers by Tiebout (1956), Musgrave (1959), Oates (1972) and Brennan and Buchanan (1980)[4].

Our expectation is that fiscal decentralization will have a positive impact on tax collection efficiency, since the closer proximity of the tax administration will enable a more exhaustive control of compliance with tax obligations (Buehn, Lessmann and Markwardt 2013).

Profit tax is a variable representing the total tax and contribution rate as a percentage of profit, which we expect to have a negative sign; that is, the higher the tax rate, the lower the efficiency of tax collection.

Time tax, measured in hours per year, is the time taken to prepare, file, and pay (or withhold) three major types of taxes: corporate income tax, value added or sales tax, and labor taxes, including payroll taxes and social security contributions. It is a reflection of the complexity of the national tax system. The more complex the system, the longer the process, and the more likely it is to induce tax evasion (Mahangila 2017). The expected sign of this variable would thus be negative, thereby associating higher cost with lower efficiency.

Direct collection revenue is income collected in the form of direct taxes and social security contributions as percent of total taxation. Corporate gains tax, income tax, capital gains tax and value added tax are direct taxes, that is, they take into account individual taxpayer characteristics and play a role in individual economic decision-making. They also place a greater burden on Tax Offices, since personal income tax collection campaigns are more costly both in financial and administrative terms than indirect tax collection processes. Direct taxes also have their advantages, however. They can be beneficial in social equity terms by providing the basis for income redistribution under a progressive income tax rate system such as the Spanish one. Ideally, we would expect direct taxes as explanatory variables of tax collection efficiency to have a negative sign,in other words, the higher the percentage of direct taxes and social security contributions as a share of total tax collection, the greater the possibility of tax fraud, since the collection process is more difficult to control, and thus more prone to inefficiency.

The opposite applies in the case of indirect taxes, whose most notable features are immediacy of collection, ease of settlement and the fact that they account for an increasing share in the tax structures of developed countries with high consumption rates.

Our analysis uses panel data; first to estimate a random-effects GLS regression, the results of a Hausman test having suggested that the random effects framework might be appropriate for our model.

As a second step, we estimate a truncated regression with panel data and random effects, as proposed by Simar and Wilson (2007), but never, to the best of our knowledge, implemented for panel data (Adam, Delis, and Kammas 2014).

[4] These authors argue that fiscal decentralization can increase technical efficiency in several ways: by bringing government action closer to public preferences; promoting government accountability; and increasing competition between jurisdictions.

We also estimate a Tobit model, since technical efficiency takes values between 0 and 1 and is commonly found in second-stage DEA efficiency analyses (Panizza 1999; Afonso and St Aubyn 2006; Adam, Delis and Kammas 2014). The Tobit model uses random effects, thereby taking into account country data from several observation periods, while also breaking down the error term into two parts: a fixed term and country-specific random error term. This controls for individual heterogeneity, since each random error term can be interpreted as a set of country-specific factors not included in the regression (Greene 2003). The reason for using random instead of fixed effects is that DEA technical efficiency estimates (Table 3) show more cross-country than inter-temporal variation. Individual country efficiency scores vary little over time.

Table 5 shows the results from the three different models estimated using panel data and random effects with variable returns to scale for hypothesis 1.

Table 5. Estimation results of models with panel data (hypothesis 1)

	Random-effects GLS regression	**Truncated model with panel data**	**Tobit model with panel data**
GDP per capita	0,00001	0.00001	0,00001
	0,00001	0.00001	0,00001
Population density	-0,00006	-0.00018***	-0,00007
	0,00015	0.00007	0,00014
Level of education	0.00558***	0.00091	0.00542***
	0,00174	0.00140	0,00183
Public debt	-0.00122***	-0.00047*	-0.00118***
	0,00041	0.00026	0,00042
Control of corruption	-0.06112***	0.00342	-0.0588***
	0,0271	0.01784	0,02785
Production structure	0,00001	0.00001	0,00001
	0,00001	0.00001	0,00001
Tax wedge	0.00853***	0.00888***	0.00861***
	0,00228	0.00131	0,0022
Decentralization	0,10377	0.16277***	0,10864
	0,11032	0.05768	0,10669
Constant	0,49296	0.45306	0,48629
	0,15263	0.09741	0,14865

SD in parentheses.
*, ** and *** denote the levels of significance at 10%, 5% and 1%, respectively.

The results for the first hypothesis, show that the level of education and the tax wedge have positive signs and are significant in the random regression model, with respect to the level of efficiency. In other words, higher efficiency in tax collection is associated with a higher level of education (Avellón and Prieto 2017) and a wider tax wedge (Adam, Delis and Kammas 2014). The same sign is obtained for the degree of fiscal decentralization, the added variable in the truncated model.

According to the random-effects model, public debt and control of corruption emerge as explanatory variables with a negative and significant sign. Countries with lower public debt exhibit higher levels of tax collection efficiency.

Population density, another of the variables added to the truncated model, also shows significance, albeit negative, indicating that efficiency levels are higher in countries with lower population density. This may be due to the fact that taxpayer control is easier in low- than in high- density populations.

Potential correlation between fiscal decentralization measures and random disturbances advises caution in the interpretation of the results of the Tobit model discussed so far[5]. When working with panel data models affected by endogeneity, both fixed- and random-effects 2SLS methods can be used to obtain consistent estimates. Two options for the case in hand are: the Balestra and Varadharajan-Krishnakumar (1987) generalized 2SLS (G2SLS) or Baltagi (1981) error-component 2SLS (EC2SLS). The latter is the weighted average of the within and between 2SLS estimators, which is shown in Baltagi and Liu (2009) to have more instruments than G2SLS and to be more efficient in small samples. These advantages prompted us to use the EC2SLS estimator[6].

Following the literature, we use population as the instrumental variable for fiscal decentralization (Arikan 2004; Lessmann and Markwardt 2010). We have checked that this variable is positively correlated with fiscal decentralization, and assuming exogeneity of population and the random disturbance in our model (table 6).

Table 6. Estimation results of the EC2SLS model (hypothesis 1 and hypothesis 2)

	Hypothesis 1	Hypothesis 2
GDP per capita	0.000001***	-0.000001
	0.00001	0.00001
Population density	-0.00038***	0.00004
	0.0001	0.0001
Level of education	0.00321***	0.0023
	0.00176	0.0023
Public debt	0.00009	-0.0010***
	0.00035	0.0004
Control of corruption	0.02015	-0.0358
	0.02148	0.0275
Production structure	0.00001	-0.000001
	0.00001	0.00001
Tax wedge	0.01085***	0.0049***
	0.00163	0.0021
Profit tax	0.0014	0.0014

[5] There are at least two possible sources of correlation: 1) the omission of explanatory variables that are correlated with decentralization and determine the technical efficiency of the country; and 2) inverse causality; that is, the possibility that technical efficiency is what determines the degree of fiscal decentralization.

[6] See Baltagi and Liu (2009) for further details.

	0.0015	0.0015
Decentralization	0.63128***	
	0.14320	
Time taxes		-0.0003***
		0.0001
Direct collection		-0.0092***
		0.0033
Constant	-0.09892	13.251
	0.18766	0.2171

SD in parentheses.

*, ** and *** denote the levels of significance at 10%, 5% and 1%, respectively.

The results for the second hypothesis, that is, how the structure of the tax system affects tax collection efficiency, are given in Table 7.

Table 7. Estimation results of the panel-data models (hypothesis 2)

	Random-effects GLS regression	**Truncated model with panel data**	**Tobit model with panel data**
GDP per capita	-0,00001	-0,00001	-0,00001
	0,00001	0,00001	0,00001
Population density	0,00002	-0,00011	0,00001
	0,00015	0,00007	0,00011
Level of education	0,00301	-0,00306	0,00281
	0,00226	0,00166	0,00248
Public debt	-0.00111***	-0.00061***	-0.00108***
	0,00043	0,00029	0,00043
Control of corruption	-0,04183	0,01518	-0,03964
	0,02703	0,01804	0,0285
Production structure	-0,00001	-0,00001	-0,00001
	0,00001	0,00001	0,00001
Tax wedge	0.00543***	0.00546***	0.00544***
	0,00212	0,00127	0,00201
Profit tax	0,00173	0,00069	0,00168
	0,00148	0,00094	0,00144
Time taxes	-0.00027**	-0.00029***	-0.00027**
	0,00015	0,00014	0,00014
Direct collection	-0.00684***	-0.00675***	-0.0069***
	0,00296	0,00183	0,00284
Constant	1,13873	1,28039	1,14615
	0,17941	0,11563	0,17614

SD in parentheses.

*, ** and *** denote the levels of significance at 10%, 5% and 1%, respectively.

The tax wedge is significant and has a positive sign as predicted in hypothesis 1.

The variables public debt, time taxes and direct collection, have a negative sign with respect to efficiency. The results of the first read the same as in hypothesis 1. Time tax is significant and negative, which means that efficiency is higher when it takes taxpayers less time to comply with their tax obligations. This is logical if one thinks of tax administrations equipped with technology to ease form-filling for taxpayers.

Technological facilities should result in lower tax compliance costs. High tax compliance costs can be the reason for tax evasion (Savi´c et al. 2015). Moreover, Mahangila (2017) found that tax non-compliance increased significantly with increases in tax compliance costs, which his results suggest as possible cause of the unsatisfactory compliance levels shown by SME taxpayers.

Finally, higher tax collection efficiency is associated with lower direct to indirect tax ratios, which are characteristic of tax systems in which indirect taxation has more weight and can occur in those of more current design. In fact, Ferede and Dahlby (2012) show that a higher corporate income tax rate is associated with lower private investment and slower economic growth, while a sales tax that is harmonized with the federal value-added sales tax boosts provincial investment and growth. That is, tax collection is more efficient in more developed countries with higher GDPpc.

In the same line, Keen and Lockwood (2006) reveal that countries with indirect taxes such as VAT raise more revenue than those without. They conclude by saying that the evidence supports the greater effectiveness of VAT in raising revenue. In addition, some works show that direct taxes are those that generate the greatest incentives to move to the shadow economy (González-Fernández and González-Velasco 2015).

As when testing hypothesis 1, given the possibility of correlation, we estimate an EC2SLS model with instrumental variables. As can be observed in table 6, the results are consistent with those obtained in the previous estimates.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This paper aimed to fill a gap in the literature by estimating the relative technical efficiency of tax administration performance in 28 OECD countries over the period 2004–2017. Methodologically speaking, we took a two-stage approach beginning with the selection of a series of input and output variables with which to determine relative levels of efficiency in tax system management, first by means of DEA analysis, and then using a conditional order-m efficiency measure applicable to our comparative data, which were extracted primarily from the latest related database i.e., the OECD Tax Administration database, versions 2013, 2015, and 2017. While both frameworks determine the production possibility frontiers, the order-m allows for some decision-making units to be located outside the efficiency frontier (super-efficient countries). The findings reveal a high level of average performance in OECD countries when it comes to tax collection efficiency. Although both the DEA and order-m relative efficiency estimates are sensitive to the choice of inputs, outputs, and sample, we find that the country comparison scores are robust to various specifications.

In the second-stage, these results were used to test how technical efficiency is affected by fiscal decentralization and the structure of the tax system variables and, potentially, to account for cross-country heterogeneity in tax collection efficiency. We first estimated a random-effects GLS regression and then a truncated regression with panel data and random effects. We also estimated a Tobit model using random effects with panel data. Our empirical results from the three different models estimated using panel data and random effects with variable returns to scale, show how the degree of fiscal decentralization has a positive and significant impact on technical efficiency in tax collection. Meanwhile, the results from testing the second hypothesis reveal that tax structure choices and the ratio of indirect to direct taxes play a relevant role that can significantly affect tax collection efficiency. Thus, the results suggest an advantage in tax systems that prioritize indirect taxes over direct taxes as part of a strategy to increase tax compliance and improve collection efficiency.

Before concluding, we wish to highlight some important policy implications that can be drawn from our results. Efficient taxation can only be achieved through effective and efficient tax administration. Tax collection efficiency and the need for an understanding of its explanatory factors are matters of growing concern. The necessary policy choices, therefore, rely on complex and challenging decision making about how to improve tax collection efficiency and fiscal compliance without increasing the associated costs. This study focuses on testing two hypotheses with a view to identifying the top countries in terms of tax administration efficiency.

The result of the first hypothesis to be tested, i.e., that fiscal efficiency is improved by decentralization, is positive and statistically significant. This has several policy implications, the first of which is consistent with modern fiscal federalism theories, since our results reveal an association between higher fiscal decentralization and lower inefficiency, thus supporting the waves of reforms to devolve taxation power to lower tiers of government. Fiscal decentralization is shown to play a role in promoting efficient tax collection in OECD countries. Various tax administration models are found in combination with different subnational government funding systems among fiscally decentralized countries. It is likely that the decentralization of revenue raising will also increase collection and compliance costs, both for the public and private sectors. However, the implementation of a tax administration model enabling more efficient subnational government funding through greater accountability and fiscal responsibility could constitute an acceptable tax collection cost/efficiency trade off. This is one potential benefit of decentralization for tax collection efficiency. Another possibility is that closer proximity between the tax administration and the taxpayer, due to decentralization, (Buehn et al., 2013) could shrink the shadow economy. This would occur through two main channels: (1) decentralization enhancing public sector efficiency (efficiency effect), and (2) decentralization reducing the distance between bureaucrats and economic agents and facilitating the detection of shadow economic activities (deterrence effect).

It can be inferred from another of the findings that a higher national level of education has a positive impact on tax collection efficiency. Thus, a second implication is that the implementation of civic tax education policies and programs, particularly aimed at young adults and, specifically, taxpayer education programs could provide a viable channel for improving tax morale, that is, the intrinsic willingness to pay taxes. (OECD, 2021). Thus, taxpayer education is a key tool for transforming the tax culture and increasing voluntary compliance. In other words, by turning individuals and businesses into willing taxpayers, it can make a vital contribution to mobilizing tax revenues. The promotion of tax literacy can actively shape a country's tax culture by influencing public understanding of the everyday consequences of paying (or not paying) taxes, OECD (2021).

A third policy implication that emerges from our findings for H2 is the need to simplify taxation systems. The necessary fiscal reforms should be aimed at tax simplicity, neutrality and transparency, all of which would boost tax morale (Capasso, et al., 2021), while also minimizing litigation, cutting administrative costs and reducing the "time tax". The two main implications of tax complexity (Kopczuk, 2007) are, firstly, that it creates more incomeshield options, thereby increasing the overall cost of taxation; and, secondly, that it increases the likelihood of tax return errors. This can lead not only to a significant loss of tax revenue, as evidenced by some tax-gap calculations, but also to direct and opportunity costs for taxpayers, with possible consequences for economic activity. Thus, one way to increase tax collection technical efficiency would be through fiscal reforms oriented towards the simplification of the taxation system. The reduction of the "time tax" eases the indirect fiscal pressure on taxpayers and improves tax collection efficiency. A reasonable degree of simplification can also contribute more effectively than traditional methods to addressing the issues of tax avoidance and evasion. By reducing regulatory complexity, policy makers can influence taxpayers' responsiveness to changes in taxation. Many tax administrations could address these concerns by implementing policy actions to develop their educational initiatives and provide taxpayers with a wider range of practical assistance and support.

The fourth policy implication is that tax administrations should continue to accelerate their digital transformation with a view to increasing compliance. This will involve significant investment in the development of e-services and digital solutions and the use of existing opportunities to fast track digital transformation in order to improve services, reduce burdens, and improve tax compliance and tax collection efficiency. To make the most of the beneficial effects of fiscal digitization, they need to introduce innovations such as the use of new digital tools and services and take measures to assist taxpayers in using these technological advancements. In this way, digitization can help to smooth the tax authority/taxpayer relationship and raise the level of compliance. Artificial intelligence and machine learning, therefore, are means by which tax administrations can improve collection efficiency. Meanwhile, the use of big data, which is inherent to the digitization of the economy, will push tax administrations a step forward towards higher tax compliance through new modes of action. Data analysis in which machine learning algorithms are applied to taxpayers' past return experiences simplifies the process of selecting tax returns for verification and auditing, for example, thereby improving tax fraud detection (Stromme, 2018). Artificial intelligence also provides tax administrations with a mechanism with which to induce taxpayers to report their true liabilities, and thus ultimately reinforce tax compliance and collection efficiency.

A final policy implication indicated by our results is that, as well as being simplified, tax structures could be redesigned to improve collection efficiency by favoring indirect over direct taxes. This has to do with the fact that the administrative and management costs incurred in monitoring compliance are higher in the case of the latter, where there are more ways for taxpayers to devise tax planning strategies to gain tax deductions and direct tax credits, which are more difficult for tax agencies to control. Therefore, a better way to improve tax collection efficiency would be to increase the total tax revenue from indirect taxes.

In sum, our analysis identifies fiscal decentralization, the national level of education, structural reform and simplification of the taxation system as the four key drivers in the improvement of tax collection efficiency. In this regard, it is worth noting that tax compliance will also be improved if tax administrations rise to the challenge of implementing tax reforms and digitizing the taxation system. The arguments, findings and analysis contained in this paper also suggest that these issues are worth further research.

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8. APPENDIX

Table A1. Description of the input and output, control and explanatory variables

	Variable	**Units and definition**	**Source**
Efficiency variables			
Inputs	Staff	Staff in audit, investigation and other verification in percent of the total tax administration	OECD
	Itcost	Total IT expenditure/total revenue body expenditure (%)	OECD

	Audit	Value of completed actions of tax audit activities/net tax collections (%)	OECD
	Salary	Salary cost for tax administration functions/aggregate administrative cost (%)	OECD
Outputs	Tax collection	Tax collection as percentage of GDP	OECD
	Corporates	Tax revenue as % of GDP of taxes on corporates	OECD
	Individuals	Tax revenue as % of GDP of taxes on individuals	OECD
	Goods	Tax revenue as % of GDP of taxes on goods and services	OECD
Control variables			
	GDP per capita	Gross domestic productive/ population	World Bank
	Population density	Population density (people per sq. km of land area)	World Bank
	Educational level	Population with tertiary education 25-34 year-olds, % in same age group	OECD
	Public debt	General Government debt (% of GDP)	IMF
	Control of Corruption	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.	World Bank
	Production structure	Based on the Herfindahl concentration index	World Bank
	Tax wedge (% of labour cost)	The ratio between the amount of taxes paid by an average single worker (a single person at 100% of average earnings) without children and the corresponding total labour cost for the employer	OECD
Explicative variables	Decentralization	Tax revenue decentralization (share of general government)	IMF
	Profit tax	Total tax and contribution rate (% of profit)	World Bank
	Time taxes	Time to prepare and pay taxes is the time, in hours per year, it takes to prepare, file, and pay (or withhold) three major types of taxes: the corporate income tax, the value added or sales tax, and labor taxes, including payroll taxes and social security contributions.	World Bank
	Direct collection	Tax revenue of direct taxes and social security contributions as percent of total taxation	OECD

Source: Own elaboration based on the OECD Database (https://stats.oecd.org/) and the World Bank and IMF databases

Table A2. Descriptive Statistics

Variables		Mean	Standard deviation	Minimum	Maximum	N
Inputs	Staff	31,62	14,01	0,00	75,11	252
	Itcost	11,30	7,94	0,07	41,09	252

	Audit	3,66	3,39	0,00	23,30	252
	Salary	72,52	10,21	44,80	99,70	252
Outputs	Tax collection	34,34	7,45	11,56	48,53	252
	Corporates	3,03	1,39	1,15	10,84	252
	Individuals	8,72	4,34	2,08	26,25	252
	Goods	10,47	2,87	4,15	16,97	252
Control variables	GDP per capita	3791,57	15708,77	9,10	77451,98	222
	Population density	135,61	118,46	2,62	508,50	252
	Educational level	31,45	10,55	9,65	56,71	244
	Public debt	70,94	45,14	7,32	249,11	252
	Control of Corruption	1,31	0,85	-0,93	2,45	252
	Production structure	51,57	808,94	0,50	12842,16	252
	Tax wedge (% of labor cost)	37,78	9,35	15,30	56,09	252
Explicative variables	Decentralization	0,77	0,17	0,44	0,98	232
	Profit tax	43,33	11,89	19,80	75,30	215
	Time taxes	173,40	88,63	55,00	759,00	215
	Direct recaudation	61,59	5,87	45,40	73,30	252