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Luisito Bertinelli, DEM, Université du Luxembourg, LU
Arnaud Bourgain, DEM, Université du Luxembourg, LU
Seydi Ababacar Dieng, Université Cheikh Anta Diop, Dakar, SN
Jean-Paul Diagne, Université Cheikh Anta Diop, Dakar, SN

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For editorial correspondence, please contact: dem@uni.lu
University of Luxembourg
Faculty of Law, Economics and Finance
6, Rue Richard Coudenhove-Kalergi
L-1359 Luxembourg

Corporate taxation in Senegal: Reform and tax avoidance

Luisito Bertinelli, Arnaud Bourgain[1] (University of Luxembourg)

Seydi Ababacar Dieng, Jean-Paul Diagne (University Cheikh Anta Diop, Dakar)

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Abstract

Based on a very large number of Senegalese companies representing the quasi-universe of the formal sector, this study identifies the main drivers of the effective tax rates (ETR) at the firm level, which is a standard way to assess the extent of tax avoidance. We mainly find that ETR tends to decline with firm size and that the 2013 reform generated a general increase of ETR but a ETR reduction for large firms. This result is robust even after accounting for a few unobservable time, industry and firm characteristics.

Keywords: Effective Tax Rate; Tax avoidance; Corporate income Tax; Taxation in Sub-Saharan Africa; Tax exemption.

JEL classification: H25, O17, O55

1. Introduction

In Sub-Saharan Africa (SSA), increasing tax mobilization and in particular direct tax ratios has been recognized as a major condition to economic development in a context of fiscal transition characterized by a decline in customs revenues. The objective of this study is to scrutinize the determinants of one particular, but prominent fiscal instrument, namely the corporate income tax. We exploit information collected from financial statements and balance sheets of a large number of Senegalese enterprises representing the quasi-universe of the formal sector to calculate the tax burden through the Effective Tax Rates (ETR).

With a Tax/GDP ratio of approximately 18%,[2] Senegal is slightly (i.e., 2 points) above the African average. However, as in other SSA countries, the tax base, especially for corporate taxes, is considered overly narrow. This is partly attributable to the prevalence of the informal sector, but the issue is exacerbated by the extensive use of tax derogations, exemptions, and other forms of tax expenditures, as frequently highlighted in reports by international organizations.

[1] Corresponding author: arnaud.bourgain@uni.lu

[2] IMF- Government Finance Statistics (GFS) database (2019)

Senegal's tax structure closely reflects that of sub-Saharan African economies, making it an interesting case study. Senegal is identified by the IMF (2018, p.45) as a country that has experienced periods of significant increases in domestic resource mobilization and more specifically as a "country engaged in policies to reduce base narrowing exemptions by voiding or suspending certain tax exemptions, revising investment codes" alongside Mozambique, Rwanda and Tanzania.

A major tax reform was implemented in Senegal in 2013, with the objective of increasing revenue mobilization. This reform falls within the analysis period of this study (2008–2019), adding further relevance to the examination of Senegal's fiscal strategies. Subsequently, in 2014, the government launched an ambitious program, the *Plan Sénégal Émergent* (PSE), aimed at fostering investment in infrastructure and the private sector. This initiative was accompanied by structural reforms, including the modernization and strengthening of tax collection systems.

Studies relying on SSA enterprises microdata are very few, not the least due to the scarcity and availability of reliable data. The work of Mascagni and Mengistu (2019, 2022) on Effective Tax Rates in Ethiopia constitutes a notable exception.

Even though the share of the formal sector in Senegal is extremely modest in total employment (10%) and to a lesser extent in total added value (53%)[3], it accounts for a very large proportion of the domestic resource mobilization. Senegal has introduced a one-off contribution on the turnover of very small units in the informal sector, but its revenues are negligible (around 0.1% of corporate income tax revenues in 2020)[4]. As shown in Auriol and Walters' (2005) model, the large size of the informal sector can be explained by a public policy characterized by entry barriers in the formal sector and allowing the government to concentrate taxation on this latter sector.

Empirical papers on taxation and development highlight the importance of corporate taxation hampered by multiple reductions and exemptions. Keen and Mansour (2010) consider that "the core Corporate Income Tax (CIT) challenge that SSA faces is in stemming, and reversing, the proliferation of incentives whose effectiveness is, at best, unclear" (p. 587). By calculating effective tax rates applied to various kinds of assets evolution in developing countries based on country data, Abramovsky et al (2014) unearth quite high distortive effects of special reductions and tax holidays. Tax exemptions could be a policy instrument to encourage investment and innovation. However, the multiple exemptions, which characterize the corporate tax system of developing countries, are commonly criticized. For instance, Tanzi and Zee (2001) highlight the distortions generated by exemptions: deadweight effect, incentive for tax avoidance, attraction of short-term projects, lack of transparency, to name a few. Moore (2013) and Balh (2014) note that exemption practices in low-income countries

[3] ANSD Data (2018)

[4] Authors' calculations based on data from the Direction Générale des Impôts et des Domaines (DGID), Senegal, provided by Faye et al. (2022)

have clearly a political motivation. On this point, international institutions have exerted strong pressure in favor of publicizing tax expenditures.

In the present study, we analyze in detail the effective corporate income taxation in Senegal, on a large panel of enterprises during 12 years (2008-2019) just before the Covid shock, and in particular, before and after the major reform of 2013. We identify the main drivers of the effective tax rates at the firm level, thereby assessing the extent of tax avoidance. We show that ETR tends to decline with firm size and that the 2013 reform generated a decreasing ETR for large firms. These results remain qualitatively unchanged, even after taking account on a battery of observable and unobservable confounders.

This paper is organized as follows. Section 2 discusses the concept of effective tax rate and reviews its main determinants. Section 3 briefly summarizes the taxation of Senegalese companies and its reform. Section 4 describes the data used and the research method. And section 5 reports the econometric results, while we conclude in section 6.

2. Effective tax rate and firm size

Our study focuses on firm-level average effective tax rate (ETR) as a measure of the tax burden relying on retrospective data. This *ex-post or backward-looking* indicator is defined as the ratio of corporate tax expenses to a pre-tax income observed at the firm level.[5] The tax and accounting literature (Janský 2023) has produced a proliferation of ETR ratios, using different measures of income on the denominator; see in particular Fullerton (1984), Omer et al. (1991), Callihan (1994), Plesko (2003), Dwenger and Steiner (2012), Hoopes et al. (2012). While a few variants exist, the fundamental principle is that the denominator should be a measure of the economic profit before taxation, focusing on the company's ability to generate earnings from current operations. The aim is not to mimic the exact taxable base to verify tax payment. In this regard, the EBIT (Earnings before interest and tax) indicator is most commonly used. By construction, ETR and corporate statutory tax rate (STR) are not equal. The difference between ETR and STR, in addition to financial incomes and expenses, is that STR includes tax reduction, exemptions, favorite rate, special deduction, various exceptions, and other forms of incentives. This explains why the ETR can be considered as an indicator of tax avoidance (Janský 2023).

Papers dedicated to ascertaining the determinants of the ETR almost never focus on developing countries, but rather on developed and sometimes emerging economies. Many of them use data from listed companies or from referenced firms in large international databases, and thus, unlike the present study, do not rely on the universe of formal firms in a country.

[5] The term of "effective" is also used in the context of measuring the tax burden on new investment, but *ex ante* or *forward-looking*.

Firm size is the main variable of interest in empirical work on corporate ETR. The expected relationship between size and ETR is, however, ambiguous. In his seminal paper, Zimmerman (1983) argues that larger firms incur a "political cost" due to their greater visibility. They are more exposed to the government scrutiny and face therefore higher tax levies and tax audits. This logic is in line with the theoretical model of Auriol and Walters (2005) who consider that the formal sector in developing countries is in the grip of the government. Conversely, the relationship between size and ETR would be negative if we consider that large firms have greater scope for tax planning (Richardson and Lanis, 2007). In a recent paper based on a panel of German firms, Behr and Schiwy (2024) found that companies with major shareholders tend to have lower tax rates. In the same vein, large firms can be able to manipulate the political process in their favor to benefit from exemptions and advantages. This argument may be particularly relevant for SSA countries, with weaker institutional controls.

Based on a panel of about 200 Malaysian firms listed at the Stock Exchange, Derashid and Zhang (2003) find a negative and significant relationship between size and several measures of ETR. In a more recent paper, Fernandez-Rodriguez et al. (2014) analyze the size effect on ETR of four emerging economies. In line with the government control hypothesis, the authors obtain a positive and significant coefficient for Brazil and China, while an opposite relationship is found for Russia, suggesting a greater lobbying or a greater fiscal planning by larger firms. The coefficient is not significant for India.

Among the very scarce papers relying on SSA data, we can identify the studies of Gauthier and Gersovitz (1997), and Gauthier and Reinikka (2006), who investigate corporate tax exemptions respectively in Cameroon and in Uganda on smaller sample size though. In both surveys, their results put forward the fact that larger firms benefit disproportionately from higher tax exemptions. They compute also a tax burden but, unlike the literature on ETR, they consider all kinds of taxes and not only corporate tax. Finally, in a more recent study, Mascagni and Mengistu (2016) investigate the case of Ethiopia. The authors rely on a large firm-level dataset from the tax authorities, and they obtain a U-shaped relation between ETR and firm size. The tax burden decreases to a minimum for medium-sized enterprises.

3. Corporate income tax in Senegal and its reform

In Senegal, the share of corporate income tax (CIT) is 14% of total revenue and VAT represents 32% (2019). As in other SSA countries, the burden is concentrated on high-contributing branches. Even if its share is still low, direct taxation on companies is, alongside VAT, an essential pillar of the "fiscal transition" strategy, which consists of maintaining or even increasing the level of tax resources in a context of trade openness and, consequently, lower customs revenues.

Before the major reform of 2013, Senegal's corporate taxation system was judged to be complex and distortive.[6] The distribution of tax incentives was often considered opaque and discriminatory to the benefit of certain large, often foreign, companies and to the detriment of Senegalese SMEs. This situation was not favorable to tax compliance. In 2010, IMF[7] recommended to draw up an action plan to suppress tax expenditures, with a significant budgetary impact, that are ineffective or inefficient. In the explanatory memorandum on the law amending the tax code,[8] the legislator argues that the tax system is characterized by the existence of a multitude of derogatory regimes scattered through multiple texts (Mining Code, Petroleum Code, Investment Code, free trade regimes, etc.). In addition to the problem of readability and coherence that it poses, this legislation is the source of a number of factors that distort economic competition. Senegal's first reports on tax expenditure (in 2008 and 2009) also revealed the "exorbitant" cost of tax exemptions to the government budget. In terms of corporate taxation policy, the primary objectives are to enhance the yield of ICT, expand the tax base, and make incentives transparent.

In 2013, the reform introduced a new tax code.[9] The corporate income tax rate has been increased from 25% to 30%, which corresponds to a harmonization with other West African Economic and Monetary Union (WAEMU) countries. For very small entities (less than F.CFA 5,000,000 in turnover, i.e. about 7,600€) a flat minimum tax rate is calculated as a proportion of turnover. Additionally, changes have been also made to the determination of the taxable base in accordance with WAEMU guidelines, as well as a rationalization of tax expenditures.[10] The complexity and lack of transparency in the old system make it impossible to pinpoint exactly which types of companies or sectors experienced the removal of tax reductions or exemptions. In contrast, the remaining or reinforced incentives primarily encourage investment and benefit exporting companies. Among other measures favorable to exporting companies, the standard ICT rate of 30% is reduced to 15% for companies exporting more than 80% of their production.

In addition to other tax benefits, including exemption from customs duties, firms based in Special Economic Zones also benefit from a reduced CIT of 15% instead of 30% if they generate 50% of their turnover from exports. The tax reform also concerned the investment code,[11] introducing additional tax incentives for new or expanding businesses. For example, companies benefit from several tax exemptions for a period of up to 15 years, depending on the type of project and its location.

For the modernization component, the tax administration has implemented a single tax identifier common to taxes, customs, and the Treasury, allowing better visibility of activities

[6] Senegal: IMF Staff Report for the 2012 Article IV Consultation, December 19.
[7] Senegal: IMF Staff Report for the 2010 Article IV Consultation, June 10.
[8] Loi no 2012-31 du 31 décembre 2012 portant Code général des impôts, exposé des motifs.
[9] Direction Générale des Impôts (Sénégal), Code des Impôts 2013.
[10] Ministère des Finances et du Budget, Evaluation des dépenses fiscales, Rapport 2013, Rapport 2019.
[11] Code des investissements, Loi n°2004-06 du 6 février 2004, modifiée par la loi n°2012-32 du 31 décembre 2012.

and reducing tax fraud. In addition, the 2013 tax reform aims to reduce the effect of transfer pricing by incorporating profits transferred to subsidiaries through intra-group pricing systems.[12]

This reform encompasses a package of policies that seem to be moving toward a better collection of the CIT and broadening the tax base. The diversity of the measures undertaken by the 2013 reform prevents us from summarizing them in a quantitative indicator. We will therefore rely on a dummy variable, identifying the period of the reform.

4. Data, variables' definition and empirical method

Data

The individual firm data used in this analysis is gathered from income statements and balance sheets provided by the *Agence Nationale de la Statistique et de la Démographie* (ANSD), in an anonymized format. The database includes all formal firms reporting their accounting information to ANSD over the period 2008-2019. The panel is not balanced, but contains 15796 companies in 2019, across 96 industries. We have cross-checked the accuracy of our data, by taking the ratio of the sum of corporate tax paid by all the firms and the aggregate amount of corporate income tax provided by the Ministry of Finance and found a rate of 90 %. Since very small firms (annual turnover lower than 5,000,000 FCFA about 7,600€) benefit from a flat tax and their accounting is probably less reliable, we prefer to exclude them from our empirical estimates.

Variables

In Table 1, we provide descriptive statistics of all variables of interest. Our dependent variable is the effective tax rate *(ETR)*. To determine the ETR, for the numerator, the most traditional indicator is the corporate income tax payment, while various profit measures can be considered on the denominator. Given our data availability constraints, we mainly focus on the Earnings Before Income Tax (EBIT). Therefore, the ETR used throughout our estimations is the ratio "corporate income tax" / "earnings before interest and tax (EBIT)".

To avoid serious distortions, and similarly to other studies, we exclude firms declaring losses or a negative ETR. Firms with an ETR exceeding one are also eliminated. On average, ETR is 26 percent across our sample.

[12] Direction Générale des Impôts (Sénégal), Code des Impôts 2013, p. 19.

Table 1 : Descriptive statistics

VARIABLES	(1) N	(2) mean	(3) std. dev	(4) min	(5) max
ETR	27,353	0.259	0.155	$5.88 \cdot 10^{-5}$	1
Fixed Assets	27,353	0.318	0.296	-1.243	11.25
dum_{2013}	27,353	0.751	.433	0	1
Assets	27,353	$3.33 \cdot 10^{9}$	$2.73 \cdot 10^{10}$	$-8.25 \cdot 10^{6}$	$9.68 \cdot 10^{11}$
Size	27,353	$2.74 \cdot 10^{9}$	$1.82 \cdot 10^{10}$	$5.03 \cdot 10^{6}$	$5.63 \cdot 10^{11}$
LnSize	27,353	19.38	1.891	15.43	27.06
PTI	27,353	0.226	3.691	-4.336	219.1

Since our sample includes a large number of small enterprises, hence leading to a very skewed distribution, we measure the firm *size* variable as the logarithm of the firm's turnover *(LnSize)*. We also use the log of total asset as an alternative robustness check *(LnAsset)*. The correlation between these 2 variables is 0.84. To take into account the firms' asset mix, *capital intensity (Fixed Assets)* is defined as tangible fixed assets divided by total assets. For the measure of tax expenses, we were not able to consider the deferred tax expenses, but we add a variable controlling the net pre-tax income of the previous period *(PTI_{t-1})*.

We add Industry fixed effects (*Industry FE*) to account for the different sectors (96 sectors in total; see appendix) in the sample and take account of sectoral specific unobservable effects. Additionally, we define a category of *tradable* sectors.[13] A dummy variable for the year 2013 (*dum_{2013}*), which takes the value 1 from the year of the tax reform (2013) and onwards, is introduced to account for the impact of the reform; 75 percent of our observations are treated, as can be retrieved from Table 1. Alternatively, we also introduce time fixed effects as a control for time specific macroeconomic chocs.

Empirical method and implementation

In the sequel, we regress the following reduced form specification:

$$ETR = \alpha + \beta \cdot dum_{2013} + \delta \cdot LnSize + \gamma \cdot y2013 \times LnSize + X'\delta + I_t + I_s + \varepsilon \qquad (1)$$

where *$0 \leq ETR \leq 1$* is the effective tax rate as defined above, *Size* refers to the logarithm of firm turnover (or alternatively to the logarithm of *Assets*), *X* are a number of control variables, I_t and I_s are year (or the 2013 dummy) and sector fixed effects, and ε is the disturbance term.

[13] "Tradable" industries: Hydrocarbons and mining Extraction; Activities related to mining; Peanut farming, Fish and fish products production.

Our dependent variable, ETR, is measured as a ratio bounded between zero and one. Hence, standard linear models do not provide an accurate measure of the effects of the independent variables on ETR throughout the entire distribution of the respective independent variables. The relationship must be bounded, otherwise ETR are eventually predicted to be greater than one, or smaller than zero. We therefore rely on a fractional response estimator that fits models on continuous zero-to-one data using logit regression. Generalized linear models, using maximum likelihood are implemented in order to take account of exactly zero and one outcomes on the dependent variable. In the present case, we rely on Papke and Wooldridge (1996)'s fractional logit model, which allows to take account of 0 and 1's and has been shown to be appropriate for continuous dependent variables bounded by these 2 values. More specifically, we model *ETR* as:

$$E(ETR/X) = g\{X'\beta\} \quad (2)$$

where $ETR \epsilon (0,1)$, X is the set of our explanatory variables. $g(.)$ is a known function, also referred to as the link function, satisfying $0 \leq g(.) \leq 1$. Following Papke and Wooldridge (1996), we use the logistic transformation $g(.)=exp(.)/[1+exp(.)]$, which will map the predicted values of *ETR* to the $(0,1)$ interval. We rely on robust standard errors to take account of a possibly mis specified distribution family and provide valid estimators of the asymptotic variance of β resulting from the maximization of the Bernoulli *log*-likelihood. The stochastic error term ϵ, captures unobserved explanatory factors, as well as measurement errors in our data.

Our identification strategy relies on a difference-in-difference framework (henceforth DiD) with continuous treatment (Callaway et al., 2024). We compare the effective tax rate before and after a treatment, given by the fiscal policy change in 2013. In our case, the treatment group is not binary, but is related to the size of the firms, which is a continuous variable. Since firm size is continuous, our specification can be understood as a continuous treatment DiD. The key idea is that instead of simply comparing treated and non-treated groups, we are examining how the treatment effect (i.e. the change in fiscal policy) depends on the firm size. Further discussion on identification is provided towards the end of Section 5.

5. Econometric results

Baseline regressions are shown in Table 2. It displays variants of equation (1). In the first column, we only add our variables of interest (i.e. dum_{2013} and *LnSize*) in the regression, while in the second column we control for lagged pre-tax income and fixed assets. The third column displays the interaction term between dum_{2013} and *LnSize*, and in the last column, we replace the dum_{2013} with a year fixed effect (which absorbs dum_{2013}). All four specifications control for industry fixed effects.

Our main variable of interest, *Size* (measured as the logarithm of turnover), displays a negative and significant coefficient (except for column (3) displaying an insignificant coefficient, while the interaction term is however negative and significant). In these specifications, the ETR thus appears decreasing with the size of the firms. These first results

would indicate that large firms are better tooled to optimize their taxation and that they possibly benefit more from various reductions and exemptions.

Table 2 : Econometric results

Dep. Var.	ETR (1)	ETR (2)	ETR (3)	ETR (4)
LnSize	-0.0137***	-0.0139***	-0.0031	-0.0138***
	(0.0027)	(0.0031)	(0.0052)	(0.0031)
dum_{2013}	-0.0219**	-0.0237**	0.2584**	
	(0.0096)	(0.0111)	(0.1132)	
dum_{2013}·LnSize			-0.0146**	
			(0.0058)	
PTI_{t-1}		0.0044***	0.0043***	0.0044***
		(0.0007)	(0.0006)	(0.0007)
Fixed Assets		-0.2280***	-0.2293***	-0.2282***
		(0.0221)	(0.0221)	(0.0221)
Constant	-0.3311**	-0.2800	-0.4903**	-0.2802
	(0.1557)	(0.2019)	(0.2153)	(0.2026)
Industry FE	Yes	Yes	Yes	Yes
Pseudo R-squared	0.00409	0.00486	0.00488	0.00488
Time FE	No	No	No	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	35,378	27,353	27,353	27,353

Coefficients obtained from fractional logit estimator; Standard errors in parentheses;
***p<0.01, ** p<0.05, * p<0.1

In all the baseline regressions, the coefficient on the dummy variable dum_{2013} is negative (except column (3) where we introduce an interaction term including dum_{2013}). The post-tax reform period thus appears less favorable for tax collection as measured by the ETR. The control variables are significant, with the expected sign. The net profitability of the previous year (PTI_{t-1}) has a positive effect on the ETR and the share of fixed assets highlights a negative effect. Results in column (4) are similar to column (2), with the addition of time fixed effects (hence we have to drop the 2013 dummy).

Interestingly, in column (3), the size effect interacted with the post-reform 2013 dummy appears significantly negative, while in general, the coefficient on the post-reform dummy variable becomes positive. This points towards the fact that the size effect mainly affected firms after the tax reform in 2013 and is consistent with the reform aimed at improving revenue mobilization, while granting reductions that would benefit more to large firms.

In order to check the robustness of our results, we, following Hoopes et al (2012), use variants of the effective tax rate as alternative dependent variables in Table 3, and replicate our preferred specification (3) on these alternative ETR measures. In particular, we compute moving averages of our ETR variable; as noted by Hoopes et al (2012), long-run average ETR

mitigates the impact of temporary fluctuations in cash taxes paid or pretax income, such as those caused by timing differences, extraordinary events, or other short-term anomalies. By averaging tax outcomes over a longer period, this measure offers a more consistent and reliable indicator of a firm's tax planning strategies and overall tax avoidance behavior; this stability makes it particularly useful in our context as we are interested to understand corporate tax practices without being misled by year-to-year volatility. In Table 3, we present three moving average variants, over 2 (ETR1_avg2), 3 (ETR1_avg3) and 4 (ETR1_avg4) years; column (1) replicates columns (3) of Table 2, for ease of comparison. Results are consistent with Table 2, with size negatively affecting ETR after the 2013 reform in all three cases. Note that the number of observations is decreasing as we lose observations at the end of the period when computing the averages.

Table 3 : Variants of ETR

	ETR1	ETR1_avg2	ETR1_avg3	ETR1_avg4
	(1)	(2)	(3)	(4)
LnSize	-0.0031	-0.0034	-0.0051	-0.0110*
	(0.0052)	(0.0053)	(0.0056)	(0.0057)
dum_{2013}	0.2584**	0.3669***	0.3854***	0.2986**
	(0.1132)	(0.1184)	(0.1267)	(0.1347)
dum_{2013}·LnSize	-0.0146**	-0.0177***	-0.0176***	-0.0127*
	(0.0058)	(0.0061)	(0.0065)	(0.0068)
$PTIt_{-1}$	0.0043***	0.0031***	0.0031***	0.0028***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Fixed Assets	-0.2293***	-0.2365***	-0.2494***	-0.2592***
	(0.0221)	(0.0265)	(0.0292)	(0.0363)
Constant	-0.4903**	-0.4060*	-0.3492	-0.3037
	(0.2153)	(0.2120)	(0.2393)	(0.2130)
Industry FE	Yes	Yes	Yes	Yes
Pseudo R-squared	0.00488	0.00542	0.00577	0.00629
Observations	27,353	22,152	17,963	14,365

Coefficients obtained from fractional logit estimator; Standard errors in parentheses;
***p<0.01, ** p<0.05, * p<0.1

In Table 4, we test several further specifications. In column (1), we explore possible non-linearities between size and taxation. We are unable to highlight a U-shaped curve (as in Mascagni and Mengistu, 2019) nor an inverted U-shaped curve, when relying on a degree 2 polynomial for size. The results of regressions (2) and (3) corroborate the negative effect on ETR for large firms after the tax reform. Indeed, in column (2) where the regression is based on firms smaller than the median of the sample, the effect of the reform appears positive (though not significant) on the ETR. By contrast, in column (3), the 2013 dummy variable is significantly negative for the subsample of large firms. In column (4), a variable indicating exporting industries (tradable dummy) highlights a significantly negative coefficient. This result confirms that tax benefits granted to exporting firms reduce their contribution, other factors being taken into account.

Given the very large share that commerce represents in the overall activities (about 36 percent), we run separate regression only on firms not in the commercial sector (column 5). In column (6), we exclude hydrocarbon extraction due to the quite specific characteristics of this sector. In both cases, the results are very consistent with our previous specifications.

Last, in column (7), we explore an alternative measure for size by using the logarithm of assets rather than the logarithm of turnover. While we prefer measuring size with turnover, which is a more reliable indicator for small firms, relying instead on the logarithm of asset provides qualitatively the same results, although the variable dummy 2013 is no longer significant anymore.[14]

Table 4: Robustness checks

	LnSIZE²	< Me $2.02x10^8$ CFA	> Me $2.02x10^8$ CFA	Tradable dummy	Excluding Commerce	Excluding Hydrocar. Exctract.	Size: Asset
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
LnSize	-0.0090	-0.0977***	-0.0406***	-0.0190***	0.0015	-0.0031	
	(0.0474)	(0.0094)	(0.0056)	(0.0051)	(0.0059)	(0.0052)	
LnSize²	-0.0001						
	(0.0012)						
dum_{2013}	-0.0237**	0.0089	-0.0635***	0.2578**	0.3325***	0.2585**	0.1445
	(0.0111)	(0.0158)	(0.0155)	(0.1165)	(0.1262)	(0.1132)	(0.1035)
dum_{2013}·LnSize				-0.0143**	-0.0187***	-0.0146**	
				(0.0060)	(0.0065)	(0.0058)	
LnAssets							-0.0253***
							(0.0048)
dum_{2013}·LnAssets							-0.0091*
							(0.0054)
PTI_{t-1}	0.0044***	2.0464***	0.0060***	0.0051***	0.0042***	0.0043***	0.0058***
	(0.0007)	(0.6564)	(0.0008)	(0.0006)	(0.0006)	(0.0006)	(0.0008)
Fixed Assets	-0.2280***	-0.1391***	-0.3688***	-0.2323***	-0.2498***	-0.2293***	-0.2199***
	(0.0221)	(0.0267)	(0.0337)	(0.0193)	(0.0243)	(0.0221)	(0.0218)
Dum.Tradable				-0.1958***			
				(0.0370)			
Constant	-0.3276	0.6950	0.5029**	-0.5941***	-0.5687**	-0.4903**	-0.3237
	(0.5116)	(0.5438)	(0.2272)	(0.0997)	(0.2213)	(0.2153)	(0.2160)
Industry FE	Yes	Yes	Yes	No	Yes	Yes	Yes
Pseudo R-squared	0.00486	0.00502	0.00978	0.00136	0.00648	0.00485	0.00542
Observations	27,353	13,675	13,678	27,353	20,125	27,351	27,550

Coefficients obtained from fractional logit estimator; Standard errors in parentheses, ***p<0.01, ** p<0.05, * p<0.1

[14] For the sake of completeness, we present, in Appendix 3, a Table where we interact all control variables, sequentially and then jointly, with the dum_{2013} variable. As can be seen, his does not affect our results;

Finally, in Table 5, we present results that address potential endogeneity issues, not addressed through our identification strategy displayed above. More specifically, there may be two related identification threats: one comes from a possible simultaneity relation between ETR and Size. Taxes reduce potential amounts that can be re-invested into firms, and thereby reduce turnover, i.e. if corporate taxes are lowered, the firm might reinvest the tax savings into expansion efforts, leading to increased turnover.

In order to address this issue, we would ideally have to come up with a credible instrument, affecting the size of a firm while being neutral vis-à-vis ETR. Given the difficulty of coming up with a credible external instrument, we undertake a slightly different avenue: we rely on internal instruments to circumvent the issues enumerated above. In particular, we estimate our specification relying on (i) Lewbel (2012)'s heteroskedasticity estimator and Arellano and Bonds (1991)'s generalized method of moments estimator.[15]

Results are displayed in columns (1) and (2) of Table 5. As can be retrieved from the results, the size effect remains negative (although insignificant in the first case), but the interaction term of Size and the 2013 dummy are negative and significant as in the previous results. Note however that the size of the coefficients cannot be compared with results from the previous tables, as both estimators are linear, while the fractional logit estimator is non-linear.

Table 5: Tackling endogeneity

	Lewbel	Dynamic Panel GMM	Firm FE
	(1)	(2)	(3)
LnSize	-0.001	$-0.002 \cdot 10^{-9}$***	-0.0022
	(0.001)	(0.000)	(0.0141)
dum_{2013}	0.047**	$0.017 \cdot 10^{-8}$***	0.1047
	(0.021)	(0.000)	(0.0714)
$dum_{2013} \cdot$LnSize	-0.003**	$0.004 \cdot 10^{-10}$**	-0.0075**
	(0.001)	(0.000)	(0.0037)
PTI_{t-1}	0.001***	$-0.002 \cdot 10^{-10}$***	0.0086***
	(0.000)	(0.000)	(0.0024)
Fixed Assets	-0.042***	$0.039 \cdot 10^{-10}$	0.0004
	(0.005)	(0.267)	(0.0261)
Constant	0.306***	$0.68 \cdot 10^{-8}$	-1.1503***
	(0.021)	(0.000)	(0.3497)
Industry FE	Yes	Yes	Yes
Pseudo R-squared	0.0433	/	0.0828
Wald chi^2 (joint sign.)	/	2134,9***	/
Observations	27,353	27,349	27,353

Standard errors in parentheses : *** p<0.01, ** p<0.05, * p<0.1

[15] A brief description of both these estimators is provided in the appendix.

In the last column of Table 5, we address another potential source of endogeneity, namely the problem of omitted variables, which might potentially bias our estimation. To do so, we add firm-specific fixed effects in our regressions, which allow us to take account of time invariant firm characteristics, that we do not observe but which potentially could affect our outcome. Again, the results are consistent with those displayed in Table 3. The coefficient on the size of the firm is still negative, while the interaction term is negative and significant.

6. Conclusion

Relying on a unique twelve-year database of all formal firms in Senegal, we explore the potential determinants of the ETR, considered as the main indicator of profit tax burden and tax avoidance. This type of study is scarce for sub-Saharan African countries and yet very relevant in a context of fiscal transition in which the focus is moving from (reduced) custom taxes to corporate taxes and VAT.

Focussing on the relation between size of firms and taxation, with a major tax reform in 2013, we highlight that larger firms do benefit from a lower ETR. While the tax reform has helped to improve overall corporate income tax collection, the interaction between the reform and firm size has a negative effect on their ETR. This result is robust to various specifications.

In terms of external validity, we must take our results with precaution, as (i) our database is not balanced, with lower numbers of firms at the beginning of the period; furthermore (ii) while we rely on the continuous variable LnSize as a continuous treatment, we do not have a dichotomous a control group that would have allowed for a much more rigorous evaluation of the tax reform.

Despite these reservations, our analysis contributes to better understanding the enforcement of tax policies in a sub-Saharan country committed to tax reform. Our results may be of interest to other SSA countries that are also engaged in reforms to better mobilize domestic revenues. This policy of broadening the tax base, including the reduction of tax reliefs and exemptions that have mainly benefited large companies in the past, is recommended. However, an important lesson from the Senegalese experience highlights the challenges in achieving this objective when strong tax incentives are simultaneously provided to exporting companies, which also tend to be large firms.

7. References

Abramovsky L., Klemm A., Phillips D., 2014, Corporate Tax in Developing Countries: Current Trends and Design Issues, *Fiscal Studies*, 35(4): 559–588.

Arellano, M, Bond, S., 1991, Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations, *Review of Economic Studies*, 58 (2): 277

Auriol E., Warlters M., 2005, Taxation base in developing countries, *Journal of Public Economics*, 89: 625–646.

Ba A., Diagne S., 2016, Evaluation du Potentiel fiscal du Sénégal, ministère des Finances et du Budget, Document d'Etude n°34, Sept.

Bahl R., 2014, A retrospective on taxation in developing countries: Will the weakest link be strengthened? in: Bird R.M. and Martinez-Vasquez J. (eds.), *Taxation and Development: The weakest link?*, Edward Elgar Publishing.

Behr A., Schiwy Ch., 2024, Determinants of German firm's adjusted effective tax rate, *Applied Economics*, DOI: 10.1080/00036846.2024.2397147.

Bertinelli L., Bourgain A., 2016, Tax Mobilization in Sub-Saharan Africa: The Impact of Tax and Business Law Reforms, *Economics Bulletin*, 36(3): 1805-1810.

Callaway B., Goodman-Bacon A., Sant'Anna PHC, 2024, Difference-in-Differences with a Continuous Treatment, NBER WP #32117.

Callihan D.S., 1994, Corporate Effective Tax Rates: A Synthesis of Literature, *Journal of Accounting Literature,* 13(1): 1–43.

Derashid C, Zhang H., 2003, Effective tax rates and the "industrial policy" hypothesis: evidence from Malaysia, *Journal of International Accounting, Auditing and Taxation,* 12: 45–62.

Direction Générale des Impôts (Sénégal), 2013, Code des Impôts 2013.

Dwenger N., Steiner V., 2012, Effective Profit Taxation and the Elasticity of the Corporate Income Tax Base: Evidence from German Corporate Tax Return Data, *National Tax Journal*, 65 (1): 117–150.

Faye I., Sow A., Yade S., 2022, Evaluation du Potentiel Fiscal du secteur informel au Sénégal, Document d'études No 47, Direction des prévisions et des études économiques, ministère de l'Économie, Sénégal.

Fernández-Rodríguez E., Martínez-Arias A., 2014, Determinants of the Effective Tax Rate in the BRIC Countries, *Emerging Markets Finance & Trade*, 50(3): 214–228, Supplement.

Fullerton D., 1984, Which Effective Tax Rate? *National Tax Journal,* 37, 1: 23–41.

Gauthier B., Gersovitz M., 1997. Revenue erosion through exemption and evasion in Cameroon, 1993. *Journal of Public Economics,* 64: 407–424.

Gauthier B., Reinikka R., 2006, Shifting Tax Burdens through Exemptions and Evasion: an Empirical Investigation of Uganda, *Journal of African Economies,* 15(3): 373–398.

Hoopes J.L., Mescall D., Pittman J.A., 2012, Do IRS Audits Deter Corporate Tax Avoidance?, American Accounting Association, 87(5), 1603-1639.

IMF, 2018, *Regional economic outlook. Sub-Saharan Africa*. Domestic Revenue Mobilization and Private Investment, April.

Janský P., 2023, Corporate Effective Tax Rates for Research and Policy, *Public Finance Review*, 51(2) 171–205.

Keen M., Mansour M., 2010, Revenue Mobilisation in Sub-Saharan Africa: Challenges from Globalisation II – Corporate Taxation, *Development Policy Review*, 28(5): 573-596.

Lewbel A., 2012, Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models, *Journal of Business and Economic Statistics*, 30: 67–80.

Mascagni G., Mengistu, A. (2019), Effective tax rates and firm size in Ethiopia, *Development Policy Review*, 37 (S2): O248–73.

Mengistu A., Molla K.G., Mascagni G., 2022, Trade Tax Evasion and the Tax Rate: Evidence from Transaction-level Trade Data, *Journal of African Economies,* 31, Issue 1, January, 94–122.

Ministère des Finances et du Budget (Sénégal), 2020, Rapport d'évaluation budgétaire des dépenses fiscales.

Moore M., 2013, Obstacles to Increasing Tax Revenues in Low Income Countries, Working Paper 15, International Centre for Tax and Development (ICTD).

Papke L. E., Wooldridge J., 1996, Econometric methods for fractional response variables with an application to 401(k) plan participation rates, *Journal of Applied Econometrics,* 11: 619–632.

Plesko G.A. 2003, An Evaluation of Alternative Measures of Corporate Tax Rates, *Journal of Accounting and Economics,* 35(2): 201–226.

Richardson G., Lanis R., 2007, Determinants of the Variability in Corporate Effective Tax Rates and Tax Reform: Evidence from Australia, *Journal of Accounting and Public Policy,* 26, 6: 689–704.

Tanzi V., Zee H.H., 2001, Tax Policy for Developing Countries, *Economic Issues 27*, International Monetary Fund.

Zimmerman J.L., 1983, Taxes and Firm Size, *Journal of Accounting and Economics,* 5(1): 119–149.

Appendix 1: Sectoral Statistics

ACTIVITES	ETR1	dum2013	TI (·10^5)	LnSIZE	PTI	ASSET·(10^5)	LnASSET	FIX_ASSETS
ACTIVITES ANNEXES A L'EXTRACTION MINIERE	0.336	0.789	17800	20.701	0.335	67800	20.985	0.419
ACTIVITES INFORMATIQUES	0.302	0.797	5320	18.929	0.037	4530	18.488	0.227
ACTIVITES POUR LA SANTE DES HOMMES	0.221	0.714	2280	18.140	0.019	1990	17.968	0.469
ACTIVITES RECREATIVES, CULTURELLES ET SPORTIVES	0.172	0.797	67100	19.617	0.228	47500	19.466	0.471
ACTIVITES VETERINAIRES	0.189	0.649	1250	18.395	0.003	724	17.789	0.329
ADMINISTRATION GENERALE, ECONOMIQUE ET SOCIALE	0.172	1.000	441	17.166	0.017	45600	22.231	0.223
ASSAINISSEMENT, VOIRIE ET GESTION DES DECHETS	0.261	0.797	12700	20.163	0.041	160000	19.987	0.475
ASSURANCE (SAUF SECURITE SOCIALE)	0.291	0.667	9750	19.688	0.240	31600	20.163	0.303
AURES ELEVAGES	0.109	1.000	1140	18.547	0.005	401	17.506	0.981
AUTRES COMMERCES	0.253	0.748	16700	19.613	0.035	9770	18.888	0.189
AUTRES CORPS GRAS	0.246	0.875	59900	21.916	0.189	75900	22.099	0.443
AUTRES CULTURES INDUSTRIELLES	0.224	0.675	18200	18.837	0.053	18300	18.909	0.542
AUTRES PECHES ET AQUACULTURE	0.238	0.760	5990	19.221	0.022	4310	18.867	0.482
AUTRES SERVICES IMMOBILIERS	0.278	0.736	2160	18.085	0.042	10400	19.411	0.580
AUXILLIAIRES FINANCIERS ET D'ASSURANCES	0.324	0.777	3450	18.401	0.036	8570	18.354	0.217
BARS ET RESTAURANTS	0.239	0.772	7710	19.036	0.031	4280	18.363	0.408
CAPTAGE, EPURATION ET DISTRIBUTION D'EAU	0.269	0.704	362000	22.932	1.880	420000	23.122	0.150
COMMERCE DE PRODUITS AGRICOLES BRUTS ET D'ANIMAUX VIVANTS	0.277	0.783	19200	20.075	0.134	9150	19.010	0.285
COMMERCE DE VEHICULES, D'ACCESSOIRES ET DE CARBURANT	0.265	0.738	170000	21.180	0.376	78100	20.600	0.240
CULTURE CEREALIERE	0.157	0.644	7760	19.683	0.013	7750	19.463	0.432
CULTURE D'ARACHIDE D'HUILERIE	0.006	1.000	128000	23.253	0.200	169000	23.530	0.263
CULTURE D'AUTRES PRODUITS ET L'AGRICUTURE VIVRIERE	0.251	0.820	3140	18.757	0.010	2230	18.365	0.516
CULTURE DE FRUITS	0.168	0.737	18900	21.014	0.101	30900	21.403	0.256
CULTURE DE LEGUMES	0.222	0.750	51200	21.489	0.397	51600	21.565	0.607
EDITION, IMPRIMERIE, REPRODUCTION	0.262	0.761	5260	19.067	0.025	7040	18.966	0.313
EDUCATION	0.280	0.748	3600	18.857	0.050	3930	18.412	0.496

ELEVAGE BOVIN	0.333	1.000	399	17.501	0.002	50	15.424	0.828
ELEVAGE DE VOLAILLE	0.236	0.789	45100	20.992	0.118	33000	20.263	0.540
ENTRETIEN ET REPARATION DE VEHICULES AUTOMOBILES	0.254	0.759	2230	18.364	0.009	2020	17.977	0.338
EXPLOITATION FORESTIERE	0.150	1.000	2040	18.861	0.020	7640	18.560	0.330
EXTRACTION D'AUTRES PRODUITS	0.230	0.757	173000	22.374	3.088	361000	22.544	0.456
EXTRACTION D'HYDROCARBURES	0.575	1.000	16100	21.098	0.868	230000	23.858	0.435
FABRICATION D'APPAREILS ELECTRIQUES	0.170	0.810	123000	22.442	0.469	125000	22.603	0.275
FABRICATION D'ARTICLES EN BOIS ASSEMBLES	0.249	0.900	2680	18.667	0.008	2490	18.594	0.426
FABRICATION D'AUTRES BOISSONS ALCOOLISEES	0.217	0.636	95100	22.615	0.109	88300	22.338	0.176
FABRICATION D'AUTRES MATERIELS DE TRANSPORT	0.200	0.750	35200	21.142	0.233	26300	20.717	0.404
FABRICATION D'AUTRES PRODUITS ALIMENTAIRES	0.252	0.725	97600	20.553	0.311	82600	20.251	0.382
FABRICATION D'AUTRES PRODUITS MINERAUX NON METALLIQUES	0.185	1.000	5410	20.100	0.034	4370	19.677	0.274
FABRICATION D'INSTRUMENTS MEDICAUX, D'OPTIQUE ET D'HORLOGERI	0.313	0.723	2590	18.889	0.030	1750	18.645	0.271
FABRICATION DE BOISSONS NON ALCOOLISEES ET D'EAUX MINERALES	0.208	0.733	71800	21.411	0.402	78400	21.688	0.452
FABRICATION DE MACHINES ET D'EQUIPEMENTS	0.310	0.636	18300	21.050	0.108	46200	21.940	0.052
FABRICATION DE MATIERES PLASTIQUES	0.199	0.710	33500	21.056	0.083	36800	21.025	0.335
FABRICATION DE MEUBLES	0.286	0.810	998	18.185	-0.021	546	17.637	0.186
FABRICATION DE PAINS, DE BISCUITS ET DE PATISSERIE	0.230	0.758	3790	18.737	0.010	2360	17.863	0.360
FABRICATION DE PATES ALIMENTAIRES	0.246	0.636	81100	22.794	0.605	46600	22.255	0.582
FABRICATION DE PRODUITS A BASE DE FRUITS ET LEGUMES	0.180	0.667	47000	21.318	0.671	33900	21.381	0.301
FABRICATION DE PRODUITS AGRO-CHIMIQUES	0.290	0.636	33700	21.896	0.326	42500	22.143	0.081
FABRICATION DE PRODUITS MINERAUX POUR LA CONSTRUCTION	0.292	0.642	50900	20.186	0.961	54700	20.135	0.277
FABRICATION DE SAVONS, DE DETERGENTS ET DE PDTS D'ENTRETIEN	0.251	0.690	51900	20.792	0.153	35300	20.527	0.253
FABRICATION DE SUCRE	0.168	0.778	438000	22.810	5.378	1050000	23.380	0.411
FABRICATION DE VEHICULES ROUTIERS	0.005	1.000	31700	21.876	0.612	111000	23.132	0.442
FABRICATION DU CUIR ET D'ARTICLES EN CUIR	0.181	1.000	12200	20.443	0.034	11000	20.813	0.168
FABRICATIONS D'AUTRES PRODUITS CHIMIQUES	0.221	0.774	33800	20.712	0.102	53500	21.064	0.117
HOTELS	0.250	0.687	10600	19.206	0.106	18800	19.252	0.617
HUILES BRUTES ET TOURTEAUX	0.374	0.833	138	16.288	0.002	295	16.792	0.324
INDUSTRIES CHIMIQUES DE BASE	0.127	1.000	655	17.998	0.003	1290	18.678	0.056
INDUSTRIES DE L'ABILLEMENT	0.339	0.657	891	17.237	0.005	924	16.046	0.322

INDUSTRIES DIVERSES	0.234	0.871	9570	19.708	0.001	12800	19.407	0.410
INDUSTRIES DU CAOUTCHOUC	0.130	0.529	94300	22.057	0.517	43200	21.527	0.174
INDUSTRIES DU PAPIER ET CARTON	0.225	0.758	65800	21.454	0.123	60300	21.481	0.325
INDUSTRIES DU TABAC	0.258	0.636	344000	24.233	1.732	262000	23.952	0.110
INDUSTRIES LAITIERES	0.177	0.656	82500	22.315	0.334	90900	22.176	0.419
INDUSTRIES PHARMACEUTIQUES	0.388	0.610	34400	20.775	0.171	29600	20.562	0.259
INDUSTRIES TEXTILES	0.352	0.667	34000	21.621	0.256	43000	21.555	0.235
LOCATIONS DE BIENS IMMOBILIERS	0.165	0.707	19700	20.350	0.182	96900	21.773	0.380
LOCATIONS SANS OPERATIONS	0.250	0.744	23000	19.981	0.432	328000	20.125	0.506
METALLURGIE	0.190	0.759	122000	21.229	0.098	125000	20.989	0.429
PECHE DE POISSONS	0.203	0.733	40600	21.375	0.306	35000	20.769	0.338
POSTES	0.272	0.750	11100	18.483	0.138	11400	18.153	0.430
PRODUCTION AUDIO ET VIDEO	0.337	0.832	18700	18.927	0.122	11700	18.503	0.311
PRODUCTION DE GLACE HYDRIQUE - SUPPORT ENERGETIQUE	0.175	0.750	1710	18.792	0.007	1750	18.227	0.738
PRODUCTION DE POISSONS ET DE PRODUITS A BASE DE POISSONS	0.167	0.756	34400	21.170	0.115	11000	20.052	0.405
PRODUCTION DE VIANDE ET DE PRODUITS A BASE DE VIANDE	0.307	1.000	1980	19.087	0.004	1150	18.503	0.273
PRODUCTION ET DISTRIBUTION DE GAZ	0.247	0.658	199000	21.957	0.163	132000	22.181	0.415
PRODUCTION, TRANSPORT ET DISTRIBUTION D'ELECTRICITE	0.176	0.826	655000	21.344	5.057	1440000	21.540	0.445
RAFFINAGE DE PETROLE	0.128	0.619	2470000	25.541	2.054	1490000	25.146	0.066
REPARATONS DE BIENS PERSONNELS ET DOMESTIQUES	0.294	1.000	16600	19.121	0.122	8450	18.258	0.100
REPARAT° DE SITES ET CONST. D'OUVRAGES DE BAT. OU GEN. CIVIL	0.242	0.763	25100	19.657	0.145	42700	19.418	0.316
SCILLAGE, RABOTAGE ET IMPREGNATION DU BOIS	0.371	1.000	6770	20.268	0.019	3880	19.622	0.144
SERVICE D'INTERMEDIATION FINANCIERE INDIRECTEMENT MESURE	0.345	1.000	2220	19.220	0.049	1060	18.477	0.232
SERVICE DE PREROGATIVE PUBLIQUE	0.331	0.691	3590	19.254	0.110	48400	20.659	0.083
SERVICES ANNEXES A L'AGRICULTURE ET A L'ELEVAGE	0.309	0.700	17900	21.285	0.042	11400	20.667	0.072
SERVICES ANNEXES ET AUXILLIAIRES DE TRANSPORT	0.257	0.744	18800	19.076	0.537	39300	19.341	0.335
SERVICES D'INTERMEDIATION FINANCIERE	0.201	0.879	20200	19.164	0.327	74900	20.443	0.453
SERVICES PERSONNELS	0.289	0.724	669	17.582	0.005	1250	17.567	0.337
SERVICES RENDUS PRINCIPALEMENT AUX ENTREPRISES	0.290	0.782	5600	18.702	0.050	6860	18.204	0.273
SYLVICULTURE	0.310	1.000	1050	18.452	0.002	750	17.803	0.399
TELECOMMUNICATIONS	0.262	0.748	258000	20.656	7.829	437000	20.434	0.287

TRANSFORMATION DU CACAO	0.153	0.778	398	17.494	0.003	338	17.331	0.651
TRANSFORMATION DU CAFE	0.296	1.000	3600	19.431	0.008	1700	18.558	0.408
TRANSPORTS AERIENS	0.243	0.660	16800	20.254	0.257	646000	21.767	0.379
TRANSPORTS PAR EAU	0.319	0.809	11200	19.883	0.069	23000	19.883	0.267
TRANSPORTS ROUTIERS ; TRANSPORT PAR CONDUITE	0.252	0.746	12700	19.713	0.089	17600	19.559	0.555
TRAVAIL DES GRAINS ET FABRICATION DE PRODUITS AMYLACES	0.269	0.591	314000	23.494	2.561	199000	23.231	0.318
TRAVAIL DES METAUX	0.248	0.709	34200	19.701	0.063	27100	19.593	0.293
TRAVAUX D'INSTALLATIONS ET DE FINITION	0.281	0.720	8460	19.535	0.069	8670	19.185	0.215

Appendix 2 : Lewel (2012)'s and Arellano and Bond (1991)'s estimators

Lewel heteroscedasticity based estimator

The Lewbel estimator is an instrumental variable (IV) approach designed to address endogeneity in cases where traditional instruments are not available or suitable. Specifically, it leverages higher-order moments—such as variance—of the data to construct instruments from within the model. In the context of your model, the Lewbel estimator uses the variability in our data to generate instruments that are uncorrelated with the error term but correlated with the endogenous regressor, *LnSize*. This approach is particularly useful in our case, where exogenous, external instruments are difficult to identify, yet heteroskedasticity in the data is present. By utilizing this strategy, the Lewbel estimator can provide consistent estimates for the effects of LnSize on ETR1, while also controlling for any potential bias that may arise from endogeneity.

Arellano–Bond's dynamic Panel Data estimator

As Lebel's estimator, the Arellano and Bond estimator is based on internal instruments. However, it was originally designed to estimate models with dynamic relationships, it can also addresses potential endogeneity—where explanatory variables may be correlated with past errors—by using lagged values of endogenous variables, such as LnSIZE, as instruments. By specifying LnSIZE as endogenous, the model treats firm size as potentially correlated with unobserved factors, which could bias results. The inclusion of one lag allows our model to generate valid internal instruments, effectively controlling for this endogeneity and ensuring more reliable coefficient estimates.

Appendix 3: Interaction terms

	ETR1	ETR1	ETR1	ETR1
	(1)	(2)	(3)	(4)
LnSize	-0.0031	-0.0139***	-0.0140***	-0.0019
	(0.0052)	(0.0031)	(0.0031)	(0.0053)
dum_{2013}	0.2584**	-0.0238**	0.0010	0.3193***
	(0.1132)	(0.0111)	(0.0167)	(0.1176)
dum_{2013}·LnSize	-0.0146**			-0.016***
	0.0058			0.0060
PTI_{t-1}	0.0043***	0.0043***	0.0044***	0.0026***
	(0.0006)	(0.0009)	(0.0007)	(0.0009)
dum_{2013}·PTI_{t-1}		0.0001		0.0021*
		(0.0011)		(0.0011)
Fixed Assets	-0.2293***	-0.2280***	-0.1663***	-0.160***
	(0.0221)	(0.0221)	(0.0364)	(0.0366)
dum_{2013}·Fixed Assets			-0.0808*	-0.0901**
			(0.0418)	(0.0420)
Constant	-0.4903**	-0.2801	-0.2960	-0.5344**
	(0.2153)	(0.2019)	(0.2014)	(0.2160)
Industry FE	Yes	Yes	Yes	Yes
Pseudo R-squared	0.00488	0.0333	0.00628	0.00464
Observations	27,353	16,170	22,693	27,317

Coefficients obtained from fractional logit estimator; Standard errors in parentheses;
***p<0.01, ** p<0.05, * p<0.1