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The tax burden on mobile network operators in Africa

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Abstract

We estimate the tax burden on the mobile telecommunication sector in twenty-five African countries. This tax burden encompasses not only standard and particular taxes under the control of the Ministry of Finance (MoF), but also fees raised by national telecommunication Regulatory Agency (RA). Given the lack of financial data at the country level, we build a representative mobile network operator, named TELCO, using the GSMA Intelligence database. We compute the Average Effective Tax Rate (AETR) for this firm considering general and special taxes and fees levied only on the telecommunication sector. We develop a web application (https://data.cerdi.uca.fr/telecom/), which allows the reader to replicate our analysis or to modify TELCO and tax parameters. The AETR varies significantly across countries, ranging from 33 percent in Ethiopia to 118 percent in Niger. Special taxes and fees represent a large share of the AETR illustrating some taxation by regulation and a potential tax competition (a race to the top) between the MoF and the RA. We compare the AETR of TELCO to this of a representative gold mining plant and a standard firm with similar gross return. The tax burden of the telecommunication sector is higher than this of the mining sector in 15 countries out of the 19 countries for which we have data on the gold mining sector.

Keywords: Taxation; Telecommunication sector; Project analysis; Developing countries.
JEL: H25 ; L96 ; O22 ; O55.

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1 Introduction

The tax on internet voice calls such as WhatsApp, Skype and Viber triggered massive protests in Lebanon, which bring down the government. Several other countries especially in Sub Saharan Africa (Uganda, Zambia, Kenya) raised or tried to raise (Benin[1]) similar taxes. These experiments illustrate not only governments' efforts to tax new bases, but also the politically sensitivity of some bases and the poor design of these taxes, which often take the form of a specific excise.[2] Such taxes add up to a lot of others, which are particular to the telecommunication sector. This sector is yet one of the most dynamic economic sectors in sub-Saharan African countries. It participates to the economic development of this region by improving market efficiency (Aker and Mbiti, 2010). It has still a substantial capacity to grow further given that unique subscriber penetration remains low, at around 45 percent on average in Africa compared to more than 60 percent in other developing countries in 2017 (GSMA intelligence, 2018).

Despite the globalization process, the telecommunication markets remain highly fragmented with heterogeneous national regulations and tax systems. Several studies (e.g. Noll, 2000; Li, and Xu, 2004; Howard and Mazaheri, 2009; Faccio and Zingales, 2017) focus on the role of privatization, competition and regulation of the telecommunication sector in developing countries. In particular, Howard and Mazaheri (2009) consider internet use and mobile phone adoption in 154 countries over the period 1990-2007.[3] They conclude that the independence of the Regulatory Agency (RA) reduces the "digital divide" in access to information and communication technologies. Bur, the full depoliticization and deregulation of the telecommunication sector have a negative effect. Beyond the studied regulation reforms (privatization, market liberalization, the independence of RA and its depoliticization), we stress here the role of taxation of this sector, which is particularly complex given the variety of special taxes and regulatory fees raised not only by the Ministry of Finance (MoF), but also by the Telecommunication RA. These two institutions may even compete in taxing the same base: the activity of Mobile Network Operators (MNOs). Such a tax competition can trigger a

[1] The Decree 218-34 of July 25, 2018 raised a tax on the use of social media at a rate of 5 FCFA or equivalently USD 0.009 per megabyte. Online and street protests push the government to cancel this tax a few month later.
[2] The tax is specific when its base is a quantity (e.g. minutes, megabyte…).
[3] In line with Henisz et al. (2005), they consider four policy reforms of the telecommunication sectors: the privatization of the national telecommunication provider, the market liberalization allowing some competition among Mobile Network Operators (MNOs), the creation of an independent RA, and the depoliticization of the latter.

race to the top (an excessive taxation) as described by Berkowitz and Wei (2000) in the context of Russia and China or Keen and Kostiogiannis (2002) in federal States.

Our analysis participates to the debate regarding the adequate level of taxation that should apply to the sector. On one hand, some authors such as Matheson and Petit (2020) consider that mobile phone companies extract rents from operating their exclusive licenses. The tax regime applied to telecommunication sector should therefore follow a similar logic to the one applied to the extractive industries. On the other hand, others authors advocate on the merits of telecommunication firms to bridge the digital divide. They justify potential tax incentives, such as exemptions or reduced rates, which aim at improving the affordability of mobile phone devices and services (Mistry, 2005; GSMA, 2017). This debate is not particular to the telecommunication sector and reflects a well-known trade-off, prominent in developing countries, between fostering an economic activity through tax incentives and collecting tax revenues for public funding purposes. Our approach completes previous studies on the taxation of telecommunication, in particular these provided by GSMA Intelligence (Pedros and Sivakumaran, 2019) and the International Telecommunication Union (ITU, 2013). These works study the affordability of the mobile phone services especially in developing countries. Consequently, they focus mainly on indirect taxation such as Value Added Tax, excise, and special mobile networks taxes, such as fees or surtax on SMS, Sim cards, and international incoming calls. In contrast, we consider here all the taxes a firm has to pay to operate its mobile network license. These include direct taxation such as Corporate Income Tax (CIT) and some indirect taxes, which increase unambiguously the production cost of mobile phone services.

We estimate the tax burden borne by mobile phone companies in some African countries. We compute the Average Effective Tax Rate (AETR), which summarizes the main taxes and fees paid by a MNO over the length of a telecommunication license (15 years by assumption). Our methodology follows the standard approach of forward-looking AETR through a representative firm (see Devereux and Griffith, 1998; Djankov *et al.*, 2010; Steinmüller *et al.*, 2019 for general economic activity; Daniel *et al.*, 2010 for the extractive industry). Given the lack of public firms' financial data, we build TELCO, a representative mobile phone company, using the GSMA Intelligence database. The financial data and economic activities of TELCO are expressed in terms of percentage of final consumption or

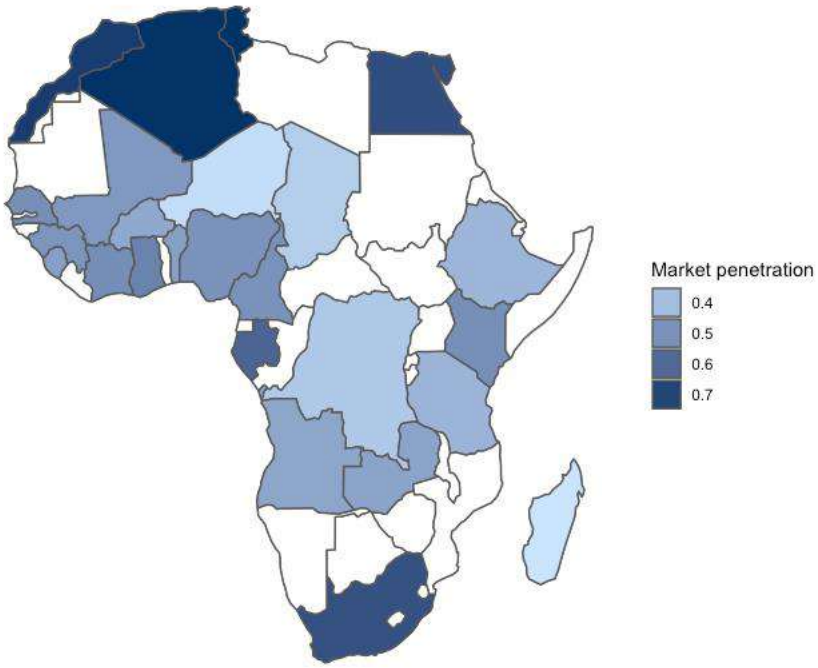
subscribers for each country. We consider the tax regime relevant in fiscal year 2018 over the length of a typical license period (15 years by assumption). Another assumption concerns the evolution of final consumption and mobile subscribers in each country over the 15 years license length. We choose to use observed data, rather than projected estimates. In other words, we consider the applicable tax regime for 2018 but use actual mobile market data from 2003 to 2018.[4] Such assumptions allow us to determine the AETR given observed national mobile phone progress since 2003. We develop a web application (https://data.cerdi.uca.fr/telecom/) allowing not only the replication of our analysis, but also any modification of the parameters of TELCO or the studied national tax systems.

We study 25 African countries: Algeria, Angola, Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, DRC, Egypt, Ethiopia, Kenya, Gabon, Ghana, Guinea, Madagascar, Mali, Morocco, Niger, Nigeria, Senegal, Sierra Leone, South Africa, Tanzania, Tunisia, and Zambia. These countries represent 60 percent of Africa's total GDP, 79 percent of the total population, and 81 percent of African unique subscribers in 2018. They differ in the development of their respective telecommunication sector.[5] For instance, the 3G network coverage in 2018 varies from 31.6 percent in Mali to 99.2 percent in South Africa and the market penetration of mobile phone from 30.9 percent in Madagascar to 75.4 percent in Tunisia (see Figure 1).

[4] TaxpayerCo has a constant activity expressed in terms of Gross National Income (GNI) per capita over the five years period. The Fiscal Analysis of Resource Industries (FARI) model of the International Monetary Fund (IMF) considers a production plan, which can result from actual feasibility studies or an average estimation of extraction process. However, a weakness of this approach is the predicted commodity prices over a very long period (20 to 40 years), which are assumed to be constant or increase at a given rate.

[5] Appendix A displays some characteristics of these countries.

Figure 1: Market penetration (unique subscribers in 2018) of the studied countries.



Source: Authors.

The AETR varies significantly across these countries from 33 percent in Ethiopia or 37 percent in Morocco to 97 percent in DRC and even 118 percent in Niger with an average at 64 percent. Ethiopia may appear as an outlier of our sample since the liberalization of its telecommunication sector remains to be done (see Table A in Appendix).

We break down the AETR in two components: the Average Special Tax Rate (AESTR) summarizes all special taxes and fees raised on mobile companies; the Average General Tax Rate (AEGTR) captures "standard" taxes, which apply to all firms in the country. We observe that special taxation represents the larger share of the final tax burden in 14 countries: The AEGTR is on average 26 percent, while the AESTR is 38 percent over our sample. We compute also the AETR of CIT only for a standard firm and a MNO. Our results are close to Steinmüller et al. (2019) with an average CIT AETR of 27.9 percent. We observe also that the CIT ATER of TELCO is lower than the CIT AETR of a standard firm since several special telecommunication taxes and fees are deductible from the CIT base.

For each country, we compare the AETR of TELCO to the AETR of a standard firm and a representative gold mining plant, which both have the same gross return of 60 percent. The standard firm supports only general taxation, while the mining firm has to pay some specific

sectoral taxes such as mining royalties, surface taxes and other fees.[6] Unambiguously, the AETR of TELCO is higher than that of the other two sectors in all countries except Angola, Chad, Kenya, and South Africa. Telecommunication is more taxed than mining.

The rest of the paper is organized as following: Section 2 presents our AETR computation methodology, results, and some comparisons with the mining and the standard sector; Section 3 presents the results; and Section 4 concludes and presents some correlations between the computed AETRs and market penetrations or GNI per capita in 2018.

2 The AETR approach

We consider a representative MNO, named TELCO. This firm exploits a telecommunication license over 15 years. It generates cash flows (revenue minus expenses), which are shared between the investor (the owner of TELCO) and the government and other regulatory authorities, which tax TELCO. The AETR captures this distribution of cash flows by measuring the effective tax burden on the telecommunication sector.

We take into account the general taxation system such as the Corporate Income Tax (CIT), capital income tax, and custom duties and the telecommunication special taxation such as taxes on international or national traffic. Our analysis also integrates quasi-tax levies[7] such as the pre-shipment inspection fees and contributions to the RA. However, we do not consider indirect taxation such as VAT, excises, and Personal Income Tax (PIT), which are collected by the firm, but are due either by the customer or by the employee of the firm.

Our approach follows previous analyses computing AETR for a general economic sector or a specific one such as the extractive industries. For instance, Djankov et al. (2010) study the effect of corporate taxes on investment and entrepreneurship. The authors build a five-year business plan of a representative firm, named TaxpayerCo, which produces and sells ceramic pots. The World Bank Doing Business survey uses this fictitious firm to rank countries every year. Blake and Roberts (2006), Daniel et al. (2010), Luca and Mesa Puyo (2016), and Diouf and Laporte (2017) apply the AETR approach to the extractive industry (mining and petroleum). Daniel et al. (2010) and Luca and Mesa Puyo (2016) present the Fiscal Analysis of Resources Industries (FARI) model, which the International Monetary Fund (IMF) used

[6] We use the FERDI online database and its mining industries simulation tool (https://fiscalite-miniere.ferdi.fr/en).
[7] Quasi-taxes are not raised by the tax administration nor the customs one.

extensively to simulate tax policy reform in the mining and petroleum upstream sectors.

The cash flows sharing model is based on Net Present Values (NPV). The AETR is given by:

$$AETR = \frac{\sum_{t=1}^{15} \frac{T_t}{(1+d)^t}}{\sum_{t=1}^{15} \frac{R_t - C_t - K_t}{(1+d)^t}}, \qquad (eq.1)$$

where T_t denotes total tax revenues in year t, R_t total turnover, C_t total OPEX, K_t total CAPEX, and d is the discount rate. A rate of 50 percent would mean that tax payment is 50 percent of before-tax cash flows over the license life length.

2.1 TELCO's accounting data

Given data availability and the diversity of market structures, we build TELCO, a standard representative MNO, which obtains its exploitation license in 2018 for a 15 year period. We model TELCO's financial statements during its license exploitation period using the GSMA Intelligence database, which covers 237 countries and territories. This database encompasses market data (e.g., market shares, numbers of subscribers, market penetration, etc.), financial data (e.g., turnover, OPEX, CAPEX, and their decompositions, etc.), and communications volumes (e.g., outbound and inbound national and international minutes, SMS and data volumes).

To design the profile of TELCO, we consider all firms that were granted a mobile operating license in Africa over the period 2000-2017 in order to have a scalable profile. We assume that the turnover and other data for each firm depend on its market penetration rate. We first define TELCO's turnover in each country as a share of the national final consumption. We consider national final consumption instead of Gross Domestic Product (GDP) since the former approximates better national demand for goods and services. This will allow us to take into account market diversity by building different cash flows profiles depending on national demands. Final consumption data come from the World Development Indicators (WDI) of the World Bank. We express total OPEX and CAPEX as a proportion of this turnover. We also consider the ratio of personnel and equipment costs over total OPEX. We determine national and international voice traffic in terms of inbound and outbound minutes per unique subscribers.[8] We then compute the weighted average of each variable for each year over the

[8] The use of the number of subscribers allows us to take into account market size, which may vary across countries. Since our considered initial year is 2018, we consider the variation of the two variables (final consumption and unique subscribers) over the last 15 years to determine TELCO data.

length of the license to obtain TELCO's data. The weight is the individual market penetration rate. Each variable, denoted by $\bar{x}_t$, is then given by the following formula:

$$\overline{x_t} = \sum_{i=1}^{n} \frac{MP_{it} * x_{it}}{\sum_{i=1}^{n} MP_{it}}, \qquad \text{(eq. 2)}$$

where MP_{it} and x_{it}represent respectively firm i's market penetration rate at time t and firm i's considered financial variable at time t. TELCO's pre-tax Internal Rate of Return (IIRR) is on average 60 percent across studied countries. Our web application allows to modify the profile of TELCO and to apply the profile of actual Mobile Network Operators.

2.2 Assumptions

We make several assumptions regarding the details of TELCO's accounting and financial data (see the online Appendix O.I). First, we assume a straight-line depreciation rule, which determines CAPEX depreciation charges.[9] Second, we assume that TELCO finances its activity by combining debt and equity and consider a debt to capital ratio of 60 percent with a repayment period of 5 years. These borrowings are subject to a 10 percent interest rate, the same rate used to discount annual cash flows.[10] We also make a sensitivity analysis by considering a lower interest rate of 6 percent.

We consider that the upfront license cost is part of tax revenue since it is paid by the investor to the government.[11] An alternative approach would be to consider the license cost as a market entry cost, a necessary investment to operate a mobile phone network.[12] To define employer costs such as social security contributions, we assume that wages and salaries represent 70 percent of labor cost. For professional or business licensing taxes, we consider that the rental value of business property corresponds to 5 percent of the total OPEX excluding cost of personnel and equipment.

While our approach is close to this developed by the IMF for the extractive sector's rent sharing,[13] it differs significantly in its price structure assumptions. Actually, oil and most mineral resources have a well-established world price, which depends on global demand and

[9] We consider that tangible CAPEX represents 95 percent of total CAPEX.
[10] For comparison purpose, these parameters are chosen in line with Ferdi's gold mining representative firm borrowing parameters.
[11] We consider a one-off license payment at the beginning of exploitation.
[12] The cost of the license would then be integrated in the denominator in deduction of the gross cash flows.
[13] Fiscal Analysis of Resource industries: www.imf.org/external/np/fad/fari/.

supply variations. Commodity prices are then an exogenous parameter for any particular mining or petroleum project, independent of its size. In other words, the extractive firm is price taker and its production has no impact on the global price.[14] The definition of prices is more complex in the telecommunication sector, since markets are national and oligopolistic (see Faccio and Zingales, 2017). Telecommunications firms set their prices depending on the demand and the behavior of their competitors at the national level. At the supply side, interactions may take the form of a pure price or price-quality competition, which can significantly reduce firms' profits.[15] Many developments in industrial economics aim to study the competition structure of a market and its impact on prices and consumer surplus. We use historical data to determine the profile of turnover of TELCO during the exploitation of its license. We express this turnover in terms of national final consumption (see the online Appendix).

The discount rate captures the opportunity cost of invested capital in TELCO on the investor side. But, the discount rate is also the preference for present of the government. This may explain a difference among investors' discount rate and the State one. They can then vary across countries depending on risks and stakeholders' preferences. For example, we can expect higher discount rates for developing countries given the short-term liquidity preference of their governments. However, choosing the right discount rate is not an easy task given the divergence of preference between governments and investors. Several analyses discuss factors such as the level of uncertainty, capital expenditures valuation, and other risk factors in the discount rate determination (Boadway and Bruce, 1984; Fane, 1987; Bonds and Devereux, 1995). For simplicity, we consider the same discount rate of 10 percent for both investors and governments.[16] We propose a sensitivity analysis by setting the discount rate to 0, 5 and 12 percent in the online Appendix O.IV.

Following Chennells and Griffith (1997) we take into account exchange rates and inflation in the AETR computation. We convert all tax variables in Euro, which is the currency of the GSMA database. Using data in nominal or real terms will not affect the AETR results, as the

[14] This hypothesis can be discussed for some minerals such as uranium or some mining deposits such as Simandou's in Guinea for iron. The production capacity of the latter would represent a significant volume of the worldwide production.
[15] A classical result in the economic literature is the equivalence between the Bertrand's duopoly equilibrium and the pure and perfect competition one. In both equilibrium, price equals the marginal cost and profits are zero.
[16] Chennells and Griffith (1997), Djankov et al. (2010), Luca and Mesa Puyo (2016), and Diouf and Laporte (2017) consider a discount rate of 10 percent. However, Luca and Mesa Puyo (2016) differentiate their discount rate for government (10 percent) and for contractor (12.5 percent).

conversion rate will be the same for the numerator and the denominator of the AETR expression. The potentially substantial upfront license payment takes place on Year 0 and is not impacted by inflationary concerns. We then choose to keep the data in nominal term as expressed in the GSMA database.

2.3 Tax data

The study considers the tax regimes applicable in 2018 to MNOs in 25 African countries. General taxation applies to all firms operating in the country. Tax and Customs Codes, Laws and Acts define the standard tax regime. Some special laws such as Investment Code and other legal sources (act, decree, ministerial ruling, etc.) may provide tax incentives by reducing tax rates or the taxable base (see Appendix B). General taxation includes direct and indirect taxation, as well as tariff duties collected at the borders.

Direct taxation includes CIT, a Minimum tax usually based on turnover, employer contributions on wages, and professional taxes based on rental value or some fixed asset value (see Table 1). CIT rates vary from 20 percent in Madagascar to 40 percent in Zambia. Three counties: Cote d'Ivoire, Tunisia and Zambia raise a higher CIT rate on MNOs than the standard rate. Moreover, Algeria, Ghana, Nigeria, and Tunisia have also an additional ad valorem tax applied on benefits. Many African countries have an alternative mechanism for CIT purpose, which taxes turnover. This mechanism called Minimum tax has a rate, which varies from 0.2 percent in Tunisia to 3 percent in Kenya. Employer contributions rates raised on wages range from 0.5 percent in Gabon to 20 percent in Chad. Cote d'Ivoire and Niger for example distinguish between the rate applied to local workers and foreigners. Professional tax has two components in Burkina Faso, Guinea, and Niger: a fixed lump sum from 279 Euro in Guinea to at least 4,573 Euro in Niger;[17] and a proportional one based on the rental value of business property from 8 percent in Burkina Faso to 15 percent in Guinea. In the other countries, it is expressed as a percentage of turnover (Algeria and Senegal for example) or assets value. Niger has also a commercial tax on advertising based on the number and types of billboards and advertising activities. Finally, Cote d'Ivoire, Gabon, Nigeria, and Tanzania have ad valorem taxes based on the turnover of MNOs, which aim to finance some activities such as artistic creation, tertiary education or local services.

Appendix B presents tax advantages, which apply to MNOs operating in the studied

[17] In Niger, the fixed lump sum is determined depending to the value of the turnover going from 4,573 Euro to 45,734 Euro.

countries. Several countries such as Egypt, Ethiopia, Ghana, Senegal and South Africa apply standard CIT rate. On the opposite, Tunisia displays a very generous mechanism by providing 10 years of CIT exemption and a reduced rate by half for the next ten years. Losses carry-forward increases significantly the effective length of CIT exemptions. Almost all countries have reduced or zero rate of customs duties for equipment and capital goods.

We consider some indirect taxes only, which increase the cost of production of TELCO (see Table 2).[18] These taxes are customs duties, non-deductible VAT on oil products, and the different levies associated to import operations. VAT rates vary from 5 percent in Nigeria to 20 percent in Madagascar and Morocco. Custom duties range from zero to 30 percent.[19] We consider also some particular fees or levies collected at the border. Customs unions such as the Eastern African Community (EAC) or the Western African Economic and Monetary Union (WAEMU) for instance raise fees or quasi-tax for the budget of their respective Commissions. Several African countries use also private firms to assist their own customs administration through Pre-Shipment Inspection (PSI) programs. These firms provide additional information on the value of imported goods. The importers have to pay this service through a fee, which is equivalent to a quasi-tariff on importations (see Dequiedt et al., 2012).

Special taxation on the telecommunication sector results from particular laws and decrees, which regulate this sector (see Table 3). We consider the following taxes and fees: taxes on national and international traffic, telecommunication network access tax, numbering fees, Universal Service Fund, research and development fund, RA levy and particular fees. These taxes may be ad valorem (based on turnover) or specific (nominal amount based on some activity measures such as minutes, data and SMS). This special taxation is similar to excise duties, which are collected by firms but legally due by consumers. However, given the incidence of this mobile-specific taxation and the demand elasticity of the sector, we assume that this special taxation is due by the mobile phone companies themselves. The sum of special ad valorem taxes and fees raised turnover vary from 0.55 percent in South Africa to 8.5 percent in Burkina Faso. We express specific taxes in Euro.

Spectrum fees are the main component of regulatory fees. Table 3 displays an estimation of these fees in terms of turnover, which is based on the average relevant payment reported in

[18] The AETR computation does not take into account VAT, sales tax, and excise duties on telecommunication services.
[19] These are collected on network equipment and mobile device imports for TELCO.

the GSMA database. However, spectrum fees vary significantly in their form across countries and from one year to another. For example, DRC raises a specific tax of 53,500 USD/MHz for GSMs, 6,000 USD/MHz for microwaves, and 3,000 USD/MHz for internet. The Guinean spectrum fees have the following structure: 5,525 Euro/MHz for WiMAX networks, 110 Euro for ARMC's, 7,735 Euro for GSM 900's and DCS 1800's, 5,525 Euro for VSAT's and from 1,547 to 9,282 Euro paid annually for digital terrestrial networks depending on the size of beams.

Table 1: Direct taxes in 2018

	Corporate Income Tax (CIT)	CIT minimum perception	Other direct taxes				
			Apprenticeship tax	Professional tax	Property tax	Commercial publicity tax	Other taxes
Taxable base	Profits	Turnover	Wages	Turnover, lump sum, rental value of property or turnover	Fixed assets value inclusive of all taxes	Number or area of advertising mediums days or operations	Turnover
Algeria	0.26	-	-	0.02	-	-	-
Angola	0.3	-	0.08	-	-	-	-
Benin	0.3	0.0075	0.04	-	-	-	-
Burkina Faso	0.275	0.005	0.03	Fixed duty: 610 Euro Proportional duty: 0.08	-	-	-
Cameroon	0.33	0.022	-	0.00156 [1]	-	-	-
Chad	0.35	0.015	0.20 [2]	-	-	-	-
Cote d'Ivoire	0.30	0.005	Nationals: 0.035 Foreigners: 0.155 [3]	0.007 [1]	-	-	0.003 [4]
DRC	0.35	0.01	0.02	-	-	-	-
Egypt	0.225	-	-	-	-	-	-
Ethiopia	0.3	-	0.11	-	-	-	-
Gabon	0.30	0.01	0.005 [2]	-	-	-	0.01 [5]
Ghana	0.25	-	-	-	-	-	0.05 [6]
Guinea	0.35	0.015	0.075 [3]	Fixed duty: 279 Euros Proportional duty: 0.15 [1]	-	-	-
Kenya	0.3	0.03	0.05 [7]				
Madagascar	0.2	0.005	0.13	-	-	-	-
Mali	0.30	0.01	0.085 [8]	Fixed duty: 1,524 Euro Proportional duty: 0.10	-	-	-
Morocco	0.31	0.005	-	0.10	-	-	-
Niger	0.30	0.015	Nationals: 0.03 Foreigners: 0.05	Fixed duty: 4,573 to 45,734 Euro Proportional duty: 0.10	0.01	0.3 to 7,6 Euro/day, M2, or operation	-
Nigeria	0.3	0.0025	0.01 [9]	-	-	-	0.03 [10]
Senegal	0.30	0.005	0.03	0.003 of the before tax turnover [11]	-	-	-
Sierra Leone	0.3	-	0.1	-	-	-	-
South Africa	0.28	-	0.01 [12]	-	-	-	-
Tanzania	0.3	0.005	0.06 [12]	-	-	-	0.003 [13]
Tunisia	0.35	0.002	0.1857 [14]	-	-	-	0.002 on turnover + 0.01 on CIT base [16]
Zambia	0.4	-	0.055 [17]	-	-	-	-

Source: Countries' General tax codes and finances acts.

[1] Business licence tax.

[2] It includes the lump-sum tax on salaries at a rate of 7.5 percent, the tax on salaries at a rate of 11.5 percent, and the apprenticeship tax at a rate of 1.2 percent.

[3] Including the national levy for economic, cultural and social development of the nation at the rate of 1.5 percent, the apprenticeship tax at the rate of 0.5 percent; and additional taxes for continuing professional training at the rate of 1.5 percent. For foreigners, the employer levy at the rate of 11.5 percent is included.

[4] Including artisitic creation tax at the rate of 0.2 percent and equipment special tax at the rate of 0.1 percent.

[5] Special solidarity levy.

[6] National fiscal stabilisation levy which applies on the CIT base. It is expected to apply from 2018 to 2025.

[7] Employer contribution.

[8] Including the employer lump sum contribution at the rate of 3.5 percent, professional training tax at the rate of 2 percent, young people employment tax at the rate of 2 percent, and housing tax at the rate of 1

[9] Industrial training cost.

[10] Including the tertiary education tax of 0.02 and the international technology tax of 0.01.

[11] It is about local economy levy which replace the busing licensing tax in 2018.

[12] Skill development levy.

[13] Local service tax.

[14] Including the professional training tax at a rate of 0.02 and the social security levy at a rate of 0.1657.

[15] Tax on establishments of an industrial, commercial or professional nature for the benefit of local authorities.

[16] Social solidarity levy.

[17] Including the skill development levy at a rate of 0.5 percent and the national pension scheme at a rate of 5 percent.

Table 2: Indirect taxes, customs duties and fees in 2018

Indirect taxes	Custom duties	Non deductible VAT	Community Solidarity levy	Statistical import charge	Community levies [1]	OHADA levy [2]	Pre-shipment inspection tax
Taxable base	CIF imports value	Before tax Goods and services value	CIF imports value				
Algeria	0.3	0.19	0.01	-	-	-	-
Angola	0.1	0.14	-	-	-	-	-
Benin	0.05; 0.1; 0.2; 0.35	0.18	0.008	0.01	0.005	-	0.01
Burkina Faso	0.05; 0.1; 0.2; 0.35	0.18	0.008	0.01	0.005		0.01
Cameroon	0.05; 0.1; 0.2; 0.30	0.1925	0.01	0.01	0.004	0.0005	0.002
Chad	0.05; 0.1; 0.2; 0.30	0.16	0.01	0.01	0.004	0.0005	0.002
Cote d'Ivoire	0.05; 0.1; 0.2; 0.35	0.18	0.008	0.01	0.005		0.01
DRC	0.05; 0.1; 0.2; 0.30	0.16	0.01	0.01	0.004	0.0005	0.002
Egypt	0.05-0.4	0.1	-	-	-		-
Ethiopia	0-0.35	0.15	-	-	-	-	-
Ghana	0 - 0.2	0.15	0.035 [3]	0.01	0.005	-	-
Gabon	0.05; 0.1; 0.2; 0.30	0.18	0.01	0.01	0.004	0.0005	0.002
Guinea	0.05; 0.1; 0.2; 0.35	0.18	0.008	0.01	0.005	-	0.01
Kenya	0 - 0.25	0.16	0.015 [3]	0.02			
Madagascar	0.05 - 0.2	0.2	-	-	-	-	-
Mali	0.05; 0.1; 0.2; 0.35	0.18	0.008	0.01	0.005	-	0.01
Morocco	0-0.25	0.20					
Niger	0.05; 0.1; 0.2; 0.35	0.19	0.008	0.01	0.005	-	0.01
Nigeria	0 - 0.24	0.05	0.005	0.01			
Senegal	0.05; 0.1; 0.2; 0.35	0.18	0.008	0.01	0.005	-	0.01
Sierra Leone	0.05; 0.1; 0.2; 0.35	0.15	-	0.01	0.005	-	-
South Africa	0 - 0.4	0.14	-	-			
Tanzania	0 - 0.25	0.18	0.015 [4]	0.02			
Tunisia	0.3	0.19	-	-	-	-	-
Zambia	0 - 0.25	0.16	-	-	-		-

Source: Countries' General tax codes and finances acts.

[1] Community integration levy: Communauté des Etats d'Afrique Centrale (CEMAC), Eastern Africa Community (EAC), Economic Community of West African States (ECOWAS), South Africa Custom Union (SACU), Western African Economic and Monetary Union (WAEMU).

[2] Organisation pour l'Harmonisation en Afrique du Droit des Affaires.

[3] Including the special import levy at a rate of 0.01 in place from 2018 to 2025 and the national insurance levy at a rate of 0.025.

[4] Railway development levy.

Table 3: Special taxation in 2018

Special taxes	Tax on national traffic	Tax on international inbound traffic	Numbering fees	Telecommunication network access tax	Universal service fund	Research and development fund	Regulatory agency financing levy	Annual fees on turnover [5]	Spectrum fees
Taxable base	Number of interconnected national minutes (Euro/minute)	Number of international inbound minutes (Euro/minute)	Number of assigned/booked phone numbers (Euro/number)			Gross turnover			Turnover (Computed)
Algeria	-	-	-	0.01	0.03	0.003	0.005	0.01	0.74%
Angola	-	-	0.20598	-	0.01	-	-	-	0.74%
Benin	-	*0.1 [1]	0.2286	0.02	0.01	0.005	0.01	-	0.74%
Burkina Faso	-	-	0.61	0.05 [2]	0.02	0.005	0.01	-	1.50%
Cameroon	-	-	0.23	0.03 [3]	-	-	0.015	-	1.60%
Chad	-	0.0762	0.2515	-	0.025	0.01	0.035 [4]	-	0.74%
Cote d'Ivoire	-	-	0.15	0.05	0.02 [5]	0.005	0.005	-	1.70%
DRC	0.00367 [6]	0.0678 [7]	0.38	-	-	-	-	0.03 [8]	2.50%
Egypt	-	-	-	0.03	0.005	-	-	-	2.00%
Ethiopia	-	-	-	-	-	-	-	-	0.74%
Gabon	-	0.0716 [9]	0.686	-	0.01	0.02	-	-	1.60%
Ghana	0.06 [10]	0.0508 [11]	0.42379	-	0.01	-	-	0.01	0.61%
Guinea	0.00279 [12]	0.1	0.07	0.03	0.015	0.01	-	-	3.00%
Kenya	-	-	-	-	0.005	-	-	0.004	1.85%
Madagascar	-	-	-	0.02	0.02 [13]	-	-	-	3.00%
Mali	-	-	0.3	0.05	0.01	-	-	-	1.10%
Morocco	0.0066 for termination call 0.011 for interconnection [14]	-	-	0.01	0.02	-	-	-	1.60%
Niger	-	0.1311 [15]	0.15	-	0.02	0.01	0.02	-	1.30%
Nigeria	-	-	0.02348	-	0.025	-	-	-	0.17%
Senegal	-		0.3	0.05 [16]	-	-	-	-	2.00%
Sierra Leone	-	-	0.1926	0.005	-	-	-	0.01	3.50%
South Africa	-	-	-	-	0.002	-	-	0.0035	0.74%
Tanzania	-	0.0419 [17]	0.1695	-	0.003	-	-	0.01	0.47%
Tunisia	-	-	0.1614	0.05	-	-	-	-	0.74%
Zambia	-	-	0.0244	-	-	-	-	0.03	0.74%

Source: National legislations.

[1] Turnover relating to international incoming calls.
[2] Specific tax on telecommunication companies.
[3] Telecommunication special fund levy.
[4] ARCEP administration fee.
[5] In addition to the 3 percent annual fees on turnover DRC raises also some managment fees on interconnection activities at the rate of 15 percent of the cost of interconnected minutes.
[6] Local interconnection tax.
[7] Telecommunication regulation tax.
[8] Telecommunication special fund levy.
[9] The tax on international incoming trafic rate is 0.2086 Euro/Minute, of which 65.7 percent is refunded to MNOs.
[10] CST on interconnection.
[11] Applicable to telecommunication operators and internet providers.
[12] National interconnection fees.
[13] Contribution to the development of telecommunication fund.
[14] It is about the interconnection fees for termination rate of interconnections traffic.
[15] This tax was repealed in FY 2018 and restaured by the 2019 Finance Law.
[16] Special levy of telecommunications' (CST).
[17] It represents the share returned to the government.

3 Results

Table 4 displays the AETR results. The tax burden on TELCO exceeds 50 percent in several countries and even 100 percent in some of them, meaning that TELCO's investors would lose money.[20] The AETR varies from 33 percent of generated cash flows in Ethiopia to 118 percent in Niger with an average value of 64 percent across the sample (column 1 of Table 3). We notice that the telecommunication sector in Ethiopia was still State-owned in 2018, the market liberalization process beginning in this country only in June 2019.

We compute the AETR considering only CIT (column 3 in Table 3). This range from 8.5 percent in Tunisia to 37.6 percent in Zambia with an average of 27.9 percent. This average is close to the estimation of the AETR for the information media and telecommunication sector equal to 24.33% computed by Steinmüller et al. (2019). These authors calculate average firm-industry-level ETR for 142 countries over the period 2004 to 2014.

Columns 4 and 6 provide a breakdown of the AETR in term of general (AEGTR)[21] and special taxation (AESTR).[22] The former expresses the burden of general taxation in each country, as the national Tax and Customs Codes (or Acts) define it, while the AESTR summarizes special taxation applied to the telecommunication sector. The high level of AETRs results mainly from mobile-special taxation. AESTR represents from 2 percent of the pre-tax cash flows in Ethiopia to 106 percent in Niger with an average value of 38 percent. The AESTR is significantly higher than the AEGTR in 14 countries. The online Appendix O.IV displays a sensitivity analysis of our results with respect to the discount rate and the interest rate. Our results remain robust to these variations.

Some special taxes are deductible from CIT. Table 4 displays a striking result in several countries (Benin, Chad, DRC, Gabon, Niger, Senegal, Tanzania, Tunisia), where the AEGTR is below the CIT AETR. It may appear surprising since the computation of the AEGTR encompasses the CIT and other direct taxes. The taxable base of the AEGTR is actually smaller since special taxation are deductible for CIT purpose and are not taken into account in the computation of the CIT AETR. For instance, DRC displays a gap of 21 percent: its CIT AETR is equal to 37.2 percent, while its AEGTR amounts to 16.4 percent. DRC raises numerous and

[20] In such a case MNOs may obtain additional and particular tax advantages, which may not been publicly disclosed.
[21] Average Effective General Tax Rate.
[22] Average Effective Special Tax Rate

significant special taxes on MNOs, its AESTR reaching 81.1 percent.

Table 4: AETR (percentage)[23]

	AETR	Statutory rate (CIT)	AETR (CIT)	AEGTR [2]	*% AETR*	AESTR [1]	*% AETR*
Algeria	48.77	26.0	26.8	28.84	*59.1%*	19.92	*40.8%*
Angola	43.25	30.0	30.4	32.76	*75.7%*	10.49	*24.3%*
Benin	78.84	30.0	29.5	28.19	*35.8%*	50.66	*64.3%*
Burkina Faso	87.29	27.5	31.7	23.53	*27.0%*	63.75	*73.0%*
Cameroon	66.38	33.0	25.4	25.41	*38.3%*	40.97	*61.7%*
Chad	70.54	35.0	32.3	23.61	*33.5%*	46.93	*66.5%*
Cote d'Ivoire	81.27	25 ; 30 [3]	22.0 ; 26.4	23.24	*28.6%*	58.04	*71.4%*
Congo, DR	97.49	35.0	37.2	16.36	*16.8%*	81.13	*83.2%*
Egypt	41.17	22.5	23.9	21.4	*52.0%*	19.77	*48.0%*
Ethiopia	33.08	30.0	28.8	31.2	*94.3%*	1.88	*5.7%*
Gabon	64.84	30.0	34.8	31.08	*47.9%*	33.76	*52.1%*
Ghana	54.23	25.0	25.7	29.23	*53.9%*	25.0	*46.1%*
Guinea	93.69	35.0	34.3	17.93	*19.1%*	75.76	*80.9%*
Kenya	43.16	30.0	31.7	34.37	*79.6%*	8.79	*20.4%*
Madagascar	46.71	20.0	21.9	22.39	*47.9%*	24.33	*52.1%*
Mali	93.83	30.0	20.7	20.8	*22.2%*	73.02	*77.8%*
Morocco	35.06	31.0	16.8	18.58	*53.0%*	16.48	*47.0%*
Niger	118.16	30.0	19.8	12.37	*10.5%*	105.79	*89.5%*
Nigeria	40.51	30.0	27.7	32.63	*80.5%*	7.88	*19.5%*
Senegal	92.53	30.0	34.8	32.23	*34.8%*	60.3	*65.2%*
Sierra Leone	70.05	30.0	28.5	28.14	*40.2%*	41.91	*59.8%*
South Africa	37.2	28.0	32.7	31.58	*84.9%*	5.62	*15.1%*
Tanzania	63.2	30.0	28.9	27.03	*42.8%*	36.16	*57.2%*
Tunisia	47.32	25 ; 35 [3]	6.2 ; 8.5	25.13	*53.1%*	22.19	*46.9%*
Zambia	50.55	25 ; 40 [3]	32.9 ; 37.6	37.8	*74.8%*	12.75	*25.2%*

Source: Authors computations.

[1]: Average Effective General Tax Rate.

[2]: Average Effective Special Tax Rate.

[3]: Côte d'Ivoire, Tunisia and Zambia apply a higher CIT rate for MNOs, respectively 30, 35 and 40 percent instead of 25 percent.

Figure 2 depicts the AETR by type of tax. We distinguish special telecommunication taxes from standard general taxes. We notice that license fees represent more than 50 percent of the AESTR (57 percent of the AESTR in Benin, 67 percent in Mali, 63 percent in Senegal, and 60 percent in Sierra Leone). In the other countries, the other special mobile phone companies' taxes explain more than 50 percent of the AESTR. Their share in TELCO's pre-tax cash flows varies from 2 percent in Ethiopia to 76 percent in Niger. We complete our analysis by breaking down the AETR within all beneficiary institutions namely States and local

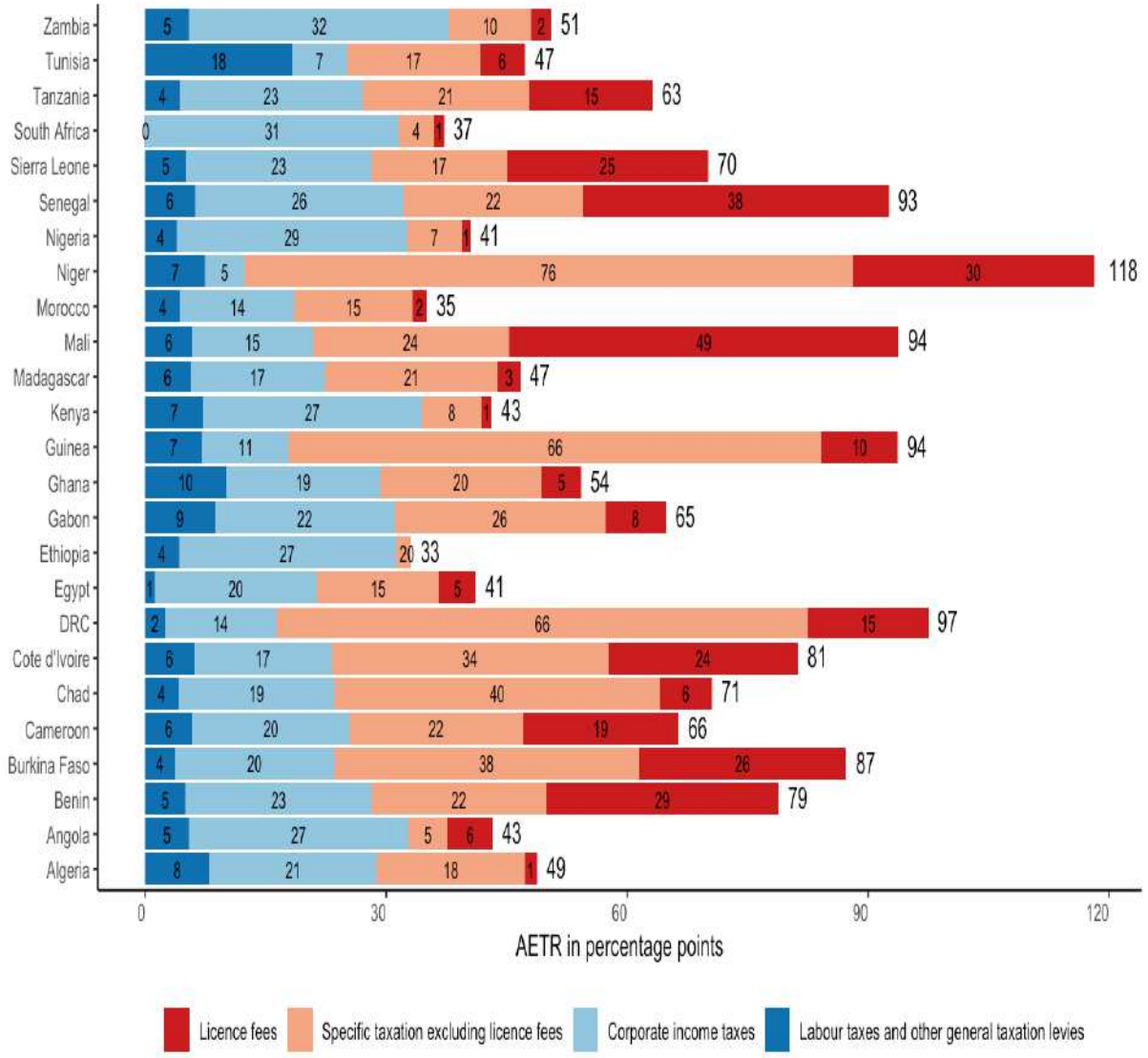
[23] Online Appendix O.II provides an illustration of our approach for the case of Cameroon.

governments, Regulatory Agencies (RA), and other stakeholders such as Customs Unions[24] or other institutions as the pre-shipment inspection firms (see Figure 3). State and local governments are the main beneficiaries of tax revenues with an AETR ranging from 20 percent of TELCO's pre-tax cash flows in Morocco to 98 percent in Niger. They receive direct taxes, non-deductible VAT on petroleum products, custom duties, and a share of special telecommunication taxes. RAs are the second most important beneficiary as they receive the remaining part of special telecommunication taxes including universal services fund, regulatory taxes and fees, and research and development contributions.

The autonomy or independence of the Telecommunication RA may trigger a race to the top with the Ministry of Finance, which means an excessive tax burden. Keen and Kotsogiannis (2002) formalize the vertical tax competition between two levels of government in a federal State. Both governments tax the same base and this competition, or equivalently the lack of cooperation among them, induces higher tax rates. Such interactions contrast with the standard view of horizontal tax competition (see Wilson, 1986, Zodrow and Mieszkowski, 1986, and Rota-Graziosi, 2018) and its race to the bottom. Beyond vertical tax competition, Berkowitz and Li (2000) develop the notion of tax rights that is the property rights that a government or an agency has on a particular tax base. The over-exploitation of the same tax base by multiple tax agencies involves an excessively high aggregated tax rate, low investments, inefficient public expenditures, and a poor economic performance. The competition or cooperation between the Telecommunication RA and the Ministry of Finance can explain the high level of the AETR of TELCO and its heterogeneity across countries.

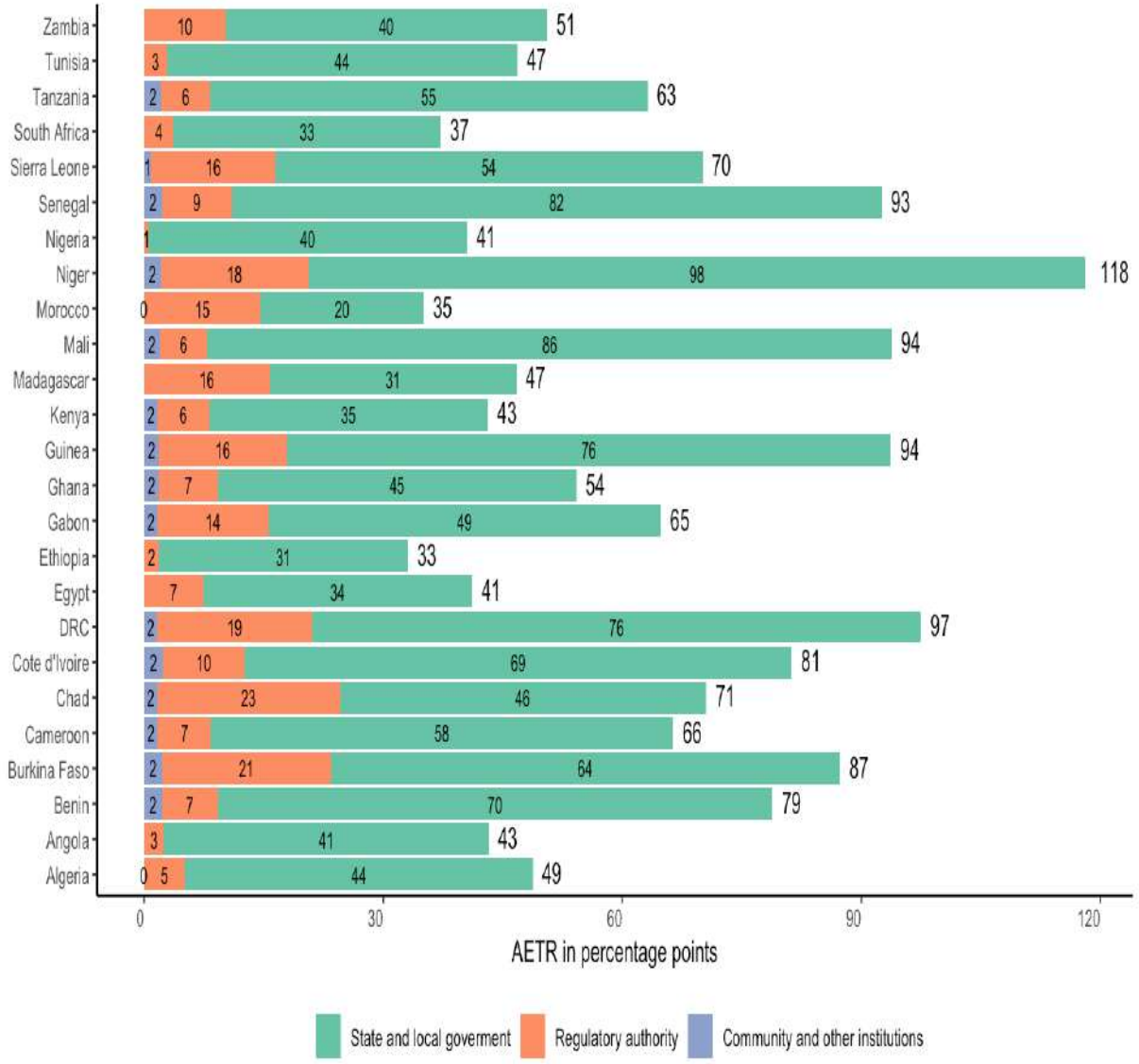
[24] WAEMU, CEMAC and ECOWAS for example.

Figure 2: AETR breakdown by taxation type.



Source: Authors.

Figure 3: AETR breakdown by beneficiary institution.



Source: Authors.

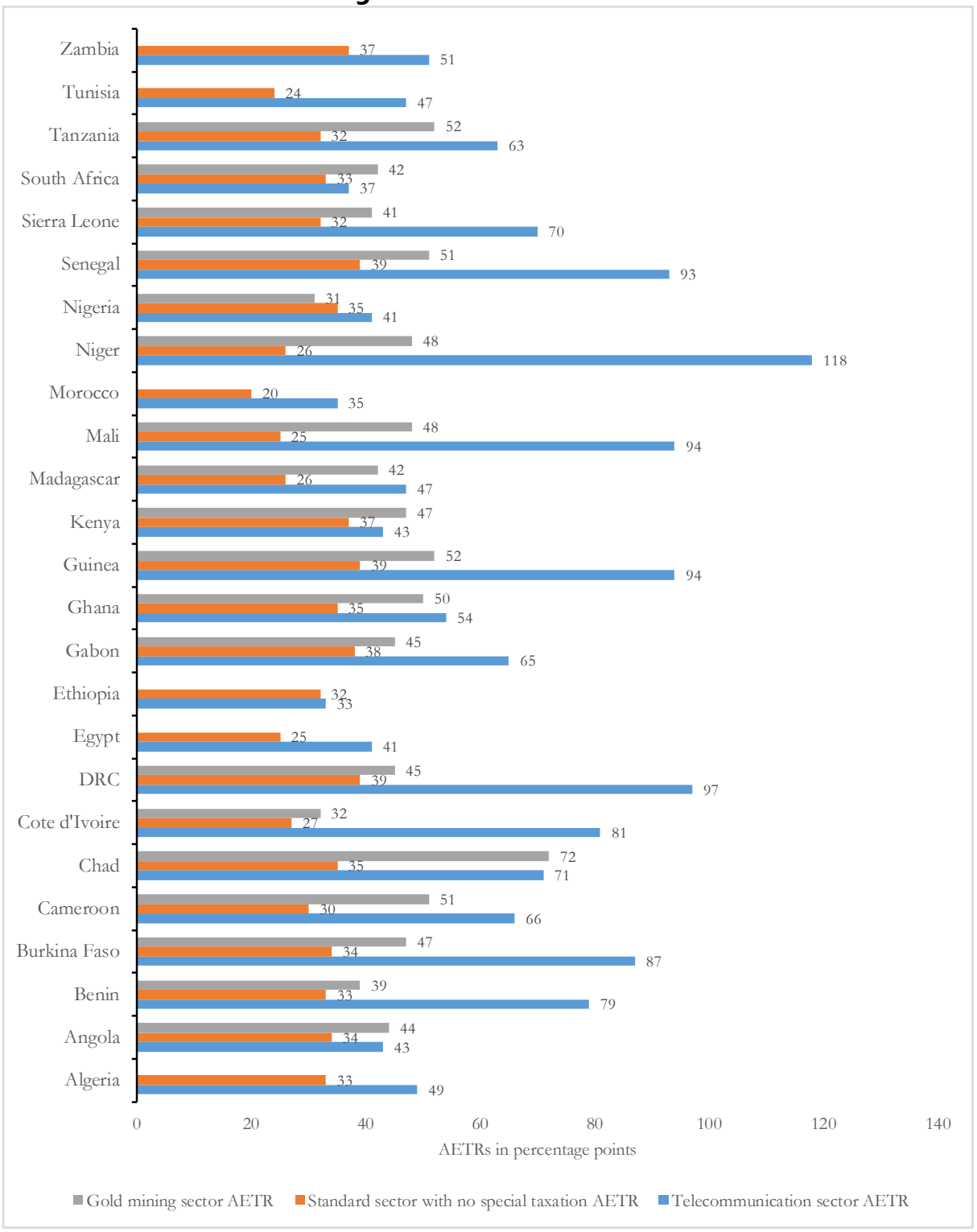
We now compare the AETRs of three sectors in each country: telecommunications, gold mining,[25] and a standard economic one.[26] An immediate result (see Figure 4) is that mobile phone companies face a higher tax burden than the gold mining sector in fifteen (15) countries. The AETR in the gold mining sector varies from 31 percent in Nigeria to 72 percent in Chad. Its average value is around 46 percent against 68 percent for the mobile sector. In

[25] The AETR computation for the gold mining's comes from https://fiscalite-miniere.ferdi.fr/en consulted on June, 21th 2019. We retained simulations with a medium grade open- pit mine (3g/t) and a price of 1,300 USD/oz. Details on the FERDI's representative mining firm are given in the online Appendix O.III (for more details, see Laporte et al., 2019). The gold price is considered to be 1,300 USD in regard with its observed value on June 17th 2019 at 10h30 (1,333.2 USD/oz on https://www.banque-france.fr/en/statistics/rates/gold-prices-0 consulted on June, 17th 2019). Algeria, Egypt, Ethiopia, Morocco, Tunisia, and Zambia are not covered in the FERDI analysis of gold mining sector.

[26] We also compute the AETR of a firm operating in a standard economic sector under the general tax regime and with similar financial features (turnover, OPEX, CAPEX...) than TELCO.

several countries, the special taxation on telecommunications alone is higher than the total tax burden applied to the mining sector. The mining sector remains however more taxed than the standard economic one except in Nigeria.

Figure 4: AETRs across sectors.



Source: Authors.

The difference of taxation between the mining and telecom sector results from the number and the rates of special taxes. It may appears surprising even inconsistent given the tax base: a non-renewable resource on one side, a limited resource with important positive externalities on the other. This difference can reflect a better coordination, or equivalently a lower tax competition between the MoF and the Minister in charge of the Mining and Petroleum sector than between the former and the Telecommunication RA. Another potential explanation is a more efficient lobbying activity of the extractive industry, which translates into a lower tax burden. For instance, the mining sector enjoys tax stability clauses, which protect investors against any modification of general and special tax rates. The main justification of these clauses is the risky nature of the mining investment given the profile of generated cash flows. Extractive industries have to invest a significant level of capital at the beginning of the exploitation to build the mining plant. This investment is irreversible and linked to the deposit. These characteristics expose the sector to partial expropriation through an increase of the tax burden, or even a complete one with nationalization. Initial investment of the telecommunication sector is however also important, irreversible, and linked to a given territory. Moreover, it may represent a significant share of total capital expenditures (more than 50 percent for our representative firm). Finally, a last explanation of a higher tax burden for telecommunications is the history of each sector, which shapes their respective tax regime: The extractive industry is in place for some time in almost all the studied countries, while the telecommunication sector is relatively new.

4 Conclusion

We estimate the AETR for a standard representative firm, TELCO, in twenty-five (25) African countries using a cash flow model over the length of a telecommunication license. The tax burden varies significantly from one country to another depending on the weight and the characteristics of special taxes applied to telecommunications companies. The AETR varies from 33 percent in Ethiopia to 118 percent in Niger. We distinguish general taxation from sector-special taxation highlighting the risk of a tax competition between the MoF and the Telecommunication RA. Mobile special taxation component explains more than 50 percent of the AETR in many countries. States and RAs are the main beneficiaries of tax revenues. We computing the AETR for CIT only. We observe that this measure is lower for TELCO than for a standard firm since several special telecommunication taxes and fees are deductible from the

CIT base.

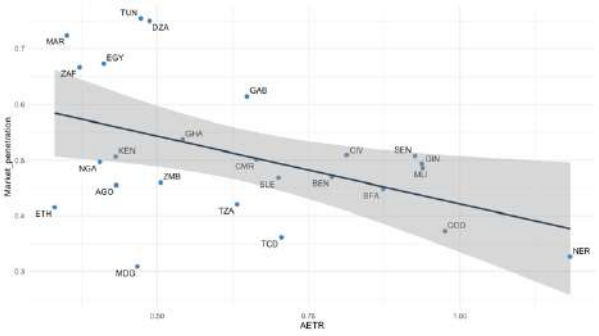
Telecommunication is generally more taxed than the mining sector. We compare the AETR of TELCO with a representative gold mining firm and a standard firm, which both display the same gross return of investment, around 60 percent. The tax burden of TELCO is higher in 15 countries out of the 19 countries for which we have information over their mining tax regime. We mention some potential explanations such as a more efficient lobbying activity of the mining sector or a vertical tax competition between the MoF and Telecommunication RAs, which deserve more investigations.

Figure 5 displays a correlation analysis between computed AETRs and market penetration and Gross National Income (GNI) per capita.[27] We find a negative correlation between the AETR and these two variables. Countries with lower market penetration rates and GNI per capita experience higher AETRs. These results are driven by special taxes and fees since the correlation is also negative between AESTRs and market penetration or GNI per capita. The correlation is by contrast positive between the standard taxes captured by the AEGTRs and the two variables. Beyond the level of taxation measured through AETR the form of taxation seems to matter in terms of revenue and telecommunication development. Telecommunication RAs can raise very distortionary taxes or fees as Hausman (1998) emphasized it in the case of the US Telecommunication Act of 1996.[28] The deductibility of some special taxes from the CIT base may increase the economic inefficiencies of special taxation. Alternatively, theses correlations may also illustrate that more advanced countries in terms of mobile phone market penetration rely less on special taxation. This relationship could result from a more powerful lobbying of MNOs in these countries. Further research would address these issues.

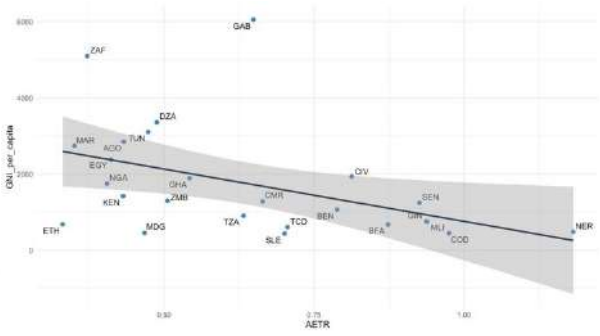
[27] The small number of countries limits our capacity to conduct a rigorous empirical analysis.
[28] The author highlights the inefficiency of fees raised by the Federal Communications Commission to fund a program providing free internet access to schools and libraries. Despite all the technological innovations in the telecommunication sector over the past decades, several issues addressed in this paper remain highly relevant.

Figure 5: Correlation analysis.

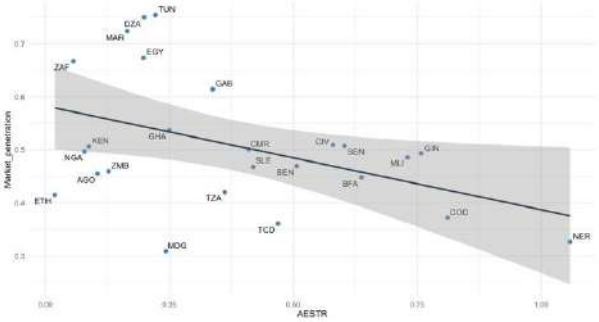
Panel A: AETR and market penetration



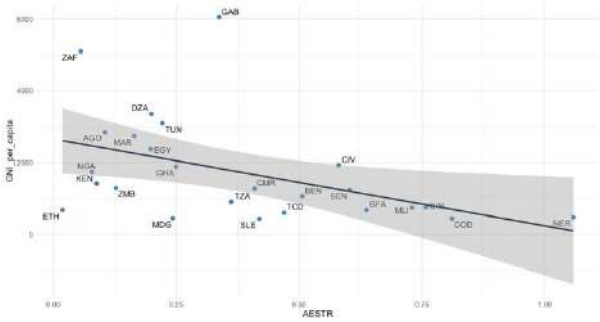
Panel B: AETR and GNI per capita



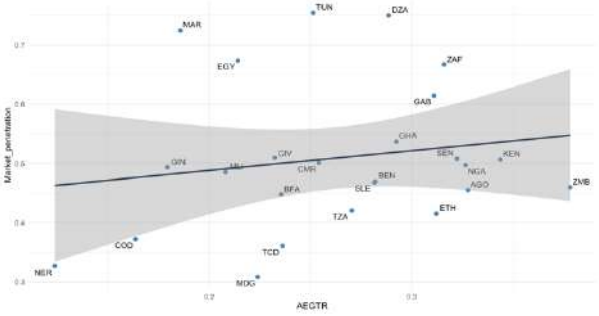
Panel C: AESTR and market penetration



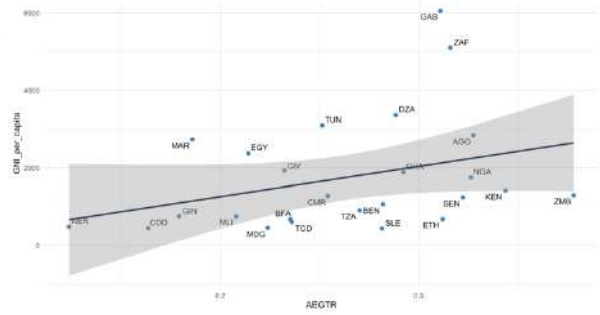
Panel D: AESTR and GNI per capita



Panel E: AEGTR and market penetration



Panel F: AEGTR and GNI per capita



Source: Authors.

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References

Aker, J. and I. Mbiti, (2010). "Mobile phones and economic development in Africa." *Journal of Economic Perspectives*, 24 (3), 207-232.

Auerbach, A. and D. Jorgenson, (1980). "Inflation-Proof Depreciation of Assets." *Harvard Business Review*, 58(5), 113-118.

Baltagi, B. (2008). *Econometric analysis of panel data*. John Wiley and Sons, Chichester.

Buys, P., S. Dasgupta, T. Thomas, and D. Wheeler. **(**2009). "Determinants of a Digital Divide in Sub-Saharan Africa: A Spatial Econometric Analysis of Cell Phone Coverage." *World Development*, 37(9): 1494–1505

Berkowitz, D. and L. Wei. (2000). "Tax rights in transition economies: a tragedy of the commons?". *Journal of Public Economics*, 76(3), 369-397.

Blake, A. and M. Roberts, (2006). "Comparing petroleum fiscal regimes under oil price uncertainty. *Resources Policy*," 31(2), 95-105.

Boadway, R. and N. Bruce, (1984). "A general proposition on the design of a neutral business tax." *Journal of Public Economics*, 24(2), 231-239.

Bonds, S. and M. Devereux, (1995). "On the design of a neutral business tax under uncertainty." *Journal of Public Economics*, 58(1), 57-71.

Chennells, L. and R. Griffith, (1997). *Taxing profits in a changing world*, The Institute for Fiscal Studies, London.

Daniel, P., Keen, M., and C. McPherson, (2010). *The taxation of petroleum and minerals: Principles, problems and practice*. Routledge.

Devereux, M. and R. Griffith, (1998). "Taxes and the location of production: Evidence from a panel of US multinationals." *Journal of Public Economics*, 68(3), 335-367.

Djankov, S., T. Ganser, C. McLiesh, R. Ramalho, and A. Shleifer. (2010). "The Effect of Corporate Taxes on Investment and Entrepreneurship." *American Economic Journal: Macroeconomics*, 2 (3): 31-64.

Driscoll, J. C. and A. C. Kraay, (1998). "Consistent covariance matrix estimation with spatially dependent panel data." *Review of economics and statistics*, 80(4), 549-560.

Diouf, A., and B. Laporte, (2017). "Oil contracts and government: Issues for Senegal and developing countries," *The Journal of Energy and Development*, 43(1/2), 213-234.

Djankov, S., Ganser, T., McLiesh, C., Ramalho, R., and A. Shleifer, (2010). "The Effect of Corporate Taxes on Investment and Entrepreneurship." *American Economic Journal: Macroeconomics*, *2*(3), 31-64.

Faccio, M., and L. Zingales, (2017). "Political determinants of competition in the mobile telecommunication industry." Working Paper, National Bureau of Economic Research.

Fane, G. (1987). "Neutral taxation under uncertainty." *Journal of Public Economics*, *33*(1), 95-105.

Dequiedt, V., Geourjon, A.-.M., and G. Rota-Graziosi, (2012) "Mutual supervision in preshipment inspection programs,' *Journal of Development Economics*, 99, 282-291.

GSMA, 2017, *Accelerating affordable smartphone ownership in emerging markets*, 116 p.

Hausman, J., (1998). "Taxation by telecommunication regulation." In Poterba, J. (ed.) *Tax Policy and the Economy*, Vol. 12, p. 29-48, MIT Press.

Henisz, W., Zelner B., and M. Guillén, (2005). "The Worldwide Diffusion of Market-Oriented Infrastructure Reform, 1977-1999." *American Sociological Review*, 70(6), 871-897.

Howard, P. and N. Mazaheri, (2009). "Telecommunications reform, internet use and mobile phone adoption in the developing world." *World Development*, 37(7), 1159-1169.

ITU. (2013). *Taxing telecommunication/ICT services: An overview*. https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/Taxation%20Study-final-en.pdf

Keen, M. and C. Kotsogiannis. (2002) "Does federalism lead to excessively high taxes?". *American Economic Review*, 92(1):363-370.

Laporte, B., de Quatrebarbes, C., and Y. Bouterige, (2019). *Partage de la rente et progressivité des régimes fiscaux dans le secteur minier: Une analyse sur 21 pays africains producteurs d'or*. FERDI Working Paper.

Li, W., and L. C. Xu, (2004). "The Impact of Privatization and Competition in the Telecommunications Sector around the World." *The Journal of Law & Economics*, 47(2), 395–430.

Luca, O., and D. Mesa Puyo, (2016). Fiscal Analysis of Resource Industries: (FARI Methodology). *Technical Notes and Manuals*.

Matheson, T. and P. Petit, (2020). "Taxing telecommunications in developing countries," *International Tax and Public Finance*, forthcoming.

Mistry, J. J. (2005). "A conceptual framework for the role of government in bridging the digital divide." *Journal of Global Information Technology Management*, *8*(3), 28–47.

Noll, R. G. (2000). "Telecommunications reform in developing countries." in A. O. Krueger (Ed.), *Economic policy reform: The second wave*. Chicago, IL: University of Chicago Press.

Pedros, X. and M. Sivakumaran, (2019). *Rethinking mobile taxation to improve connectivity*, GSMA Intelligence.

Rota-Graziosi, G. (2018). "The supermodularity of the tax competition game." *Journal of Mathematical Economics*, 82: 25-35.

Steinmüler, E., Thunecke, G. and G. Wasmer, 2019, "Corporate Income Taxes around the World: a survey on forward-looking tax measures and two applications," *International Tax and Public Finance*, 26(2), 418-459.

Summers, L. H., Bosworth, B. P., Tobin, J., and P. M. White, (1981). "Taxation and corporate investment: A q-theory approach." *Brookings Papers on Economic Activity*, (1), 67-140.

Wilson, J. D. (1986). "A theory of interregional tax competition." *Journal of Urban Economics* 19(3), 296-315.

Zodrow, G. R. and P. Mieszkowski. (1986). "Pigou, Tiebout, property taxation, and the underprovision of local public goods." *Journal of Urban Economics 19*(3), 356-370.

Appendix A: Some characteristics of the studied countries in 2018

	Population	GDP/capita EUR (2018)	Unique subscribers Market penetration	Number of MNOs	Date of liberalization	ARPU by subscriber in EUR	3G network coverage by population	SIM cards per subscriber
Algeria	42,228,429	3,487.6	74.97%	3	2002	5.19	90.00%	1.57
Angola	30,809,762	2,913.9	45.50%	2	2001	14.12	61.00%	1.04
Benin	11,485,048	1,099.1	46.94%	4	2000	6.07	63.36%	1.66
Burkina Faso	19,751,535	726.5	44.78%	3	2000	4.85	65.00%	2.15
Cameroon	25,216,237	1,359.2	50.08%	4	1998	5.54	74.99%	1.51
Chad	15,477,751	643.2	36.09%	3	1998	5.5	36.89%	1.71
Congo, Dem. Rep.	84,068,091	493.4	37.22%	4	2001	2.42	53.10%	1.23
Cote d'Ivoire	25,069,229	2,039.6	50.94%	4	1997	9.52	94.44%	2.48
Egypt	98,423,595	2,160.6	67.33%	4	2003	2.2	99.00%	1.51
Ethiopia	109,224,559	653.9	41.50%	1	-	0.85	85.00%	1.38
Gabon	2,119,275	7,047.7	61.43%	3	2000	19.15	63.64%	2.23
Ghana	29,767,108	1,950.7	53.69%	6	1990	7.13	85.00%	2.29
Guinea	12,414,318	871.0	49.34%	4	2005	5.58	65.00%	1.75
Kenya	51,393,010	1,512.9	50.64%	3	2000	6.41	88.00%	1.6
Madagascar	26,262,368	467.2	30.86%	4	1998	4.18	81.46%	1.21
Mali	19,077,690	797.3	48.54%	3	2003	7.59	31.63%	2.36
Morocco	36,029,138	2,854.1	72.40%	3	2000	8.11	98.00%	1.7
Niger	22,442,948	506.2	32.66%	4	2002	5.37	62.76%	1.45
Nigeria	195,874,740	1,800.5	49.69%	4	1999	5.75	70.00%	1.57
Senegal	15,854,360	1,298.2	50.78%	3	1997	6.86	85.00%	2.00
Sierra Leone	7,650,154	473.0	46.79%	3	2003	6.33	40.02%	1.64
South Africa	57,779,622	5,645.9	66.69%	4	1994	16.16	99.20%	2.36
Tanzania	56,318,348	939.8	42.03%	6	2005	3.38	48.96%	1.61
Tunisia	11,565,204	3,046.0	75.41%	3	2002	3.93	97.00%	1.95
Zambia	17,351,822	1,378.5	45.96%	3	1995	4.42	40.00%	1.77
Africa	1,303,404,680	2,319.0	49.15%	2.76	-	5.7	69.99%	1.65
World	7,591,932,907	9,646.9	69.58%	3.08	-	17.55	89.85%	1.544

Sources: WDI, GSMA Intelligence, ITU Measuring the Information Society Report 2018 – Volume 2, and google search.

Note: 3G network coverage by population correponds to "3G mobile coverage, expressed as a percentage of the total market population, at the end of the period."

Appendix B: Tax advantages (exemption and reduced rates) in 2018

	CIT			Custom duties on equipment		Other advantages	
	Advantage	Number of years	Losses carry forward (Nb. Years)	Advantage	Number of years	Allowance for special taxes on turnover (% of turnover)	Other taxes
Algeria	Exempt.	3	4	Exempt.		0.15	Professional tax (exempt.), 3 years
Angola	Reduced rate: 20%	2	3			0.15	
Benin	Exempt.	5	3	Exempt.		0.15	
Burkina Faso	Exempt. CIT min. tax	1	4	Exempt.		0.15	Apprenticeship tax (exempt.), 7 years.
Cameroon	Reduced rate: 75%	5 Year 6 to 10	4	Reduced rate: 5%		-	Bussiness licensing fees (exempt.), 2 years.
Chad	Exempt.	5	3	Exempt.		0.15	
Egypt			5	Reduced		0.15	
Ethiopia			5	Exempt.	6	0.15	
Gabon	Exempt.	2	5	Reduced		-	
Cote d'Ivoire	Tax credit		5			0.05	Tax credit (25%) on Bussiness License fees and payroll charges for national employees.
DRC	Exempt.	1	Infinite			0.15	
Ghana			3			0.15	
Guinea	Exemption Reduced rate by 50% by 25%	Year 1 and 2 Year 3 and 4 Year 5 and 6	3			0.15	Lump-sum levy on salaries, Apprenticeship tax: Reduction by 100% for the first 2 years, 50% for year 3 and 4, 25% for year 5 to 8.
Kenya	Reduce rate at 27%	3	9			0.15	
Mali	Reduce rate at 25%	15	3	Exempt.	3	0.1	
Morocco	Exemption Reduce rate at 17.5%	5 Infinite	4			0.15	Local taxes (exempt.), 5 years
Niger	Exempt.	7	3	Exempt.	7	0.22	
Nigeria	Exempt.	5	Infinite			0.15	Apprenticeship tax reduced by 50%.
Senegal			3	Exempt.	3	0.2	Lump-sum levy (exempt.), 3 years.
Sierra Leone	Exempt.	5	10			0.15	
South Africa			Infinite			0.15	
Tanzania	Exempt.	5	Infinite	Exempt.		-	
Tunisia	Exemption Reduce rate by 50%	Year 1 to 10 Year 11 to 20	5			0.15	
Zambia	Exempt.	5	5	Exempt.	5	0.15	

Source: Discussions with financial services of some telecommunication companies, investment and general tax codes, and authors assumptions.

Appendix (online)

Appendix O.I: TELCO's accounting and financial assumptions

Table O.I.1: Descriptive statistics for TELCO's accounting data computation.

Variable	Obs	Mean	Std. Dev.	Min	Max	Percentage of missing values
Turnover/Final consumption (ToFC)	1,584	.0001264	.0001419	8.15e-09	.0015828	.3764
Opex/Turnover	88	.4938151	.1167453	.319425	.788625	.8425
Capex/Turnover	313	.2210995	.1346501	.00505	.911525	.8768
Tang.Capex/Capex	69	.8691934	.1884045	.2329916	1.013813	.9783
Cost of equipment/Opex	83	.0463415	.0229626	.000539	.0995864	.9752
Cost of personnel/Opex	125	.10545	.0482724	.0002055	.263306	.9661
Domestic inbound minutes of use/Subscriber	58	78.74932	62.06309	7.809492	250.0107	.9606
Domestic outbound minutes of use/Subscriber	30	273.6386	108.9875	121.3219	478.9531	.9622
International inbound minutes of use/Subscriber	63	62.58331	73.94194	.8589212	264.4342	.9579
International outbound minutes of use/Subscriber	77	27.87493	15.79096	2.62794	65.2664	.9618
Total SMS/Subscriber	128	158.5911	185.1106	.1344846	749.5158	.9197
Operator's subscribers	2,536	1433894	3027245	0	2.80e+07	.0000
National total subscribers	2,540	6961383	1.35e+07	1187	9.38e+07	.0000
Number of operators	2,540	3.797638	1.871406	1	10	.0000
Final consumption	2,216	2.43e+10	5.35e+10	4.14e+8	3.82e+11	.1110
Population	2,540	2.43e+07	3.51e+07	4035	1.93e+08	.0000
Total market penetration	2,540	.1446449	.1821082	0	1.205	.0000

Source : Authors.

Table O.I.2: Summary of assumptions.

Parameters	Percentage
Rental value of business property occupation in Other* Opex	5
Wages and salaries in cost of personnel	70
Sales commission on phone top-ups in Other* Opex	10
Petroleum products share in other Opex	5
Discount rate	10
Imported capex in total capex	80
Share of tangible capex in total capex	95
Debt to capital ratio	60
Equity to capital ratio	40
Interest rate	10
Repayment period	5
Share of salaries paid to foreign workers	5

Source : Authors assumptions.

* Other OPEX = Total OPEX minus costs of personnel and equipment.

Table O.I.3: TELCO financial and market data.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unit of measure
Turnover	88	110	121	130	150	166	195	212	233	219	205	215	218	243	247	10^{-4} * FC
Capex	69	60	51	38	36	40	39	42	47	43	39	42	40	42	42	10^{-4} * FC
Tangible	65	57	48	36	34	38	37	40	45	40	37	40	38	40	40	10^{-4} * FC
Intangible	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	10^{-4} * FC
OPEX	55	69	75	77	69	73	83	91	94	92	89	90	87	102	101	10^{-4} * FC
Cost of equipements	3	5	3	5	4	3	2	4	4	5	4	4	3	5	5	10^{-4} * FC
Cost of personnel	5	8	10	9	3	4	5	7	10	10	7	8	7	10	10	10^{-4} * FC
Of which wages and salaries	*3*	*6*	*7*	*6*	*2*	*3*	*4*	*5*	*7*	*7*	*5*	*5*	*5*	*7*	*7*	10^{-4} * FC
Rental charges	2	3	3	3	3	3	4	4	4	4	4	4	4	4	4	10^{-4} * FC
Other	45	53	58	59	58	63	72	76	76	73	74	74	73	82	82	10^{-4} * FC
Of which sales commission on phone top-ups	*4*	*5*	*6*	*6*	*6*	*6*	*7*	*8*	*8*	*7*	*7*	*7*	*7*	*8*	*8*	10^{-4} * FC
Of which petroleum products	*2*	*3*	*3*	*3*	*3*	*3*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	*4*	10^{-4} * FC
Financial charges	0	4	7	9	9	9	8	8	8	8	8	8	8	8	7	10^{-4} * FC
Depreciation charges	8	15	21	25	29	30	31	33	37	40	37	35	34	33	34	10^{-4} * FC
Minutes of use																
National	324	315	342	310	344	314	402	449	193	307	406	446	478	247	168	x subscribers
Outbound	234	238	229	268	275	245	335	379	139	228	321	408	427	186	133	x Subscribers
Inbound	90	77	113	42	69	69	66	70	54	78	84	38	52	61	34	x Subscribers
International	73	52	67	55	72	78	94	44	50	61	93	75	93	72	51	x Subscribers
Outbound	31	18	19	12	14	28	23	19	25	30	34	34	40	33	28	x Subscribers
Inbound	42	34	48	42	59	50	71	25	25	31	59	41	54	39	23	x Subscribers
Traffic SMS	32	147	68	230	272	129	126	265	157	188	365	278	306	334	532	x Subscribers
Market share	20	33	33	25	20	33	40	33	33	43	37	37	37	33	33	Percentage

Source : Authors calculations based on GSMA Intelligence database.
FC : Final consumption.

Table O.I.4: Tangible CAPEX breakdown and details on depreciation charges determination.

	First year % in tangible capex	Other year % in tangible capex	Duration	Straight line depreciation allowance rate
Civil engineering Photovoltaic machines Pylon	50%	30%	10 years	10%
Network hardware Base transceiver station Transmitting devices Waveguide devices	35%	55%	10 years	10%
VSAT equipment Cold equipment Computer equipment Software licences Rolling equipment Others	15%	15%	5 years	20%

Source : Authors.

Table O.I.5: TELCO's assets composition.

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Unit of measure
Civil engineering Photovoltaic machines Pylon	33	17	15	11	10	11	11	12	13	12	11	12	11	12	12	10^{-4} * FC
Network hardware Base transceiver station Transmitting devices Waveguide devices	23	31	27	20	19	21	20	22	25	22	20	22	21	22	22	10^{-4} * FC
VSAT equipment Cold equipment Computer equipment Software licences Rolling equipment Others	10	9	7	5	5	6	6	6	7	6	6	6	6	6	6	10^{-4} * FC

Source : Authors calculations based on GSMA Intelligence database.
FC : Final consumption.

Appendix O.II: Illustration of our methodology: The case of Cameroon.

Table O.II.1: The AETR in Cameroon (in Million Euro).

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Note
Final consumption	1 060	1 110	1 150	1 230	1 300	1 430	. . .	
Subscribers (in thousand)	973	1 332	1 841	2 456	3 2889	3 928	. . .	
Cash Flows computation								Note
Turnover	93	122	139	159	195	237	. . .	
Turnover (1) = Base of the minimum tax (CIT)	93	122	139	159	195	237	. . .	
Turnover (2) = Base for special telecom taxes	93	122	139	159	195	237	. . .	
Total CAPEX	73	66	59	47	47	57	. . .	
Total OPEX including custom duties	58	77	86	94	89	104	. . .	
Custom duties	**4**	**4**	**4**	**3**	**3**	**4**	. . .	
Total OPEX excluding custom duties	54	73	82	91	86	100	. . .	
Pre-tax Cash Flows	-33	-17	-2	21	62	79	. . .	

Source : Authors.

Table O.II.1: The AETR in Cameroon (in Million Euro) (continuation)

CIT base computation	Rates	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Note
Turnover		93	122	139	159	195	237	. . .	
Deductible operational charges		54	73	82	91	86	101	. . .	
Depreciation charges		8	16	23	29	36	43	. . .	
Financing costs		0	5	8	11	12	12	. . .	
Sum of CIT base deductible taxes		10	12	13	14	16	19	. . .	
CIT base		**21**	**17**	**13**	**15**	**45**	**62**	. . .	
CIT	0.33	7.0	5.6	4.4	4.8	14.8	20.4	. . .	75 percent exemption the first 5
Minimum tax (CIT)	0.022	2	2.7	3	3.5	4.3	5.2	. . .	years and 50 percent from the
Amount of CIT		**1.7**	**1.4**	**1.1**	**1.2**	**3.7**	**10.2**	. . .	6th to the 10th year
Turnover		93	122	139	159	195	237	⋯	2 years exemption at the
Business license fees	0.00159	**0.00**	**0.00**	**0.22**	**0.25**	**0.31**	**0.38**	⋯	exploitation beginning

Source: Authors.

Table O.II.1: The AETR in Cameroon (in Million Euro) (continuation)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Note
Imported capital goods		2.669	6.066	3,689	6.763	4.930	3.842		
Tangible CAPEX		68.9	63.1	55.6	44.7	44.4	54.6		
Imported tangible CAPEX	0.8	55.18	50.53	44.49	35.80	35.57	43.69		Assumption: 80 percent of tangible CAPEX is imported
CIF values approximation									
Imports (approx. CIF value)		53	52	44	39	36	43	. . .	
Imported capital goods (approx.CIF value)		2	5	3	6	4	3	...	According to the rate of 10 percent
Imported tangible CAPEX (approx. CIF value)		51	47	41	33	33	40	...	According to the reduced rate of 5 percent
Community solidarity levy	0.004	0.21	0.21	0.18	0.16	0.15	0.18	. . .	
ECOWAS community levy	0.01	0.54	0.52	0.45	0.39	0.37	0.44	. . .	
Pre-shipment inspection fee	0.002	0.107	0.105	0.089	0.078	0.075	0.088	. . .	
Statistical import fee	0.01	0.54	0.52	0.45	0.39	0.37	0.44	. . .	
Custom duties	0.05 0.1	2.80	2.88	2.39	2.26	2.09	2.37	. . .	
OHADA fee	0.0005	0.02	0.02	0.02	0.02	0.02	0.02	. . .	
Total custom duties		**4**	**4**	**4**	**3**	**3**	**4**	. . .	

Source : Authors.

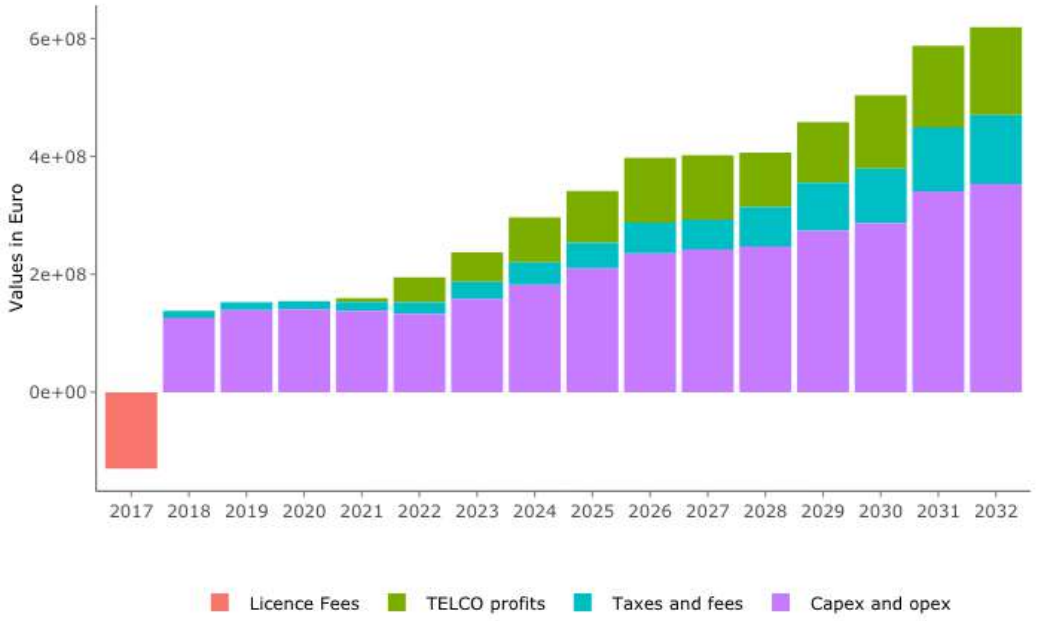
Table O.II.1: The AETR in Cameroon (in Million Euro) (continuation)

		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Note
Number of subscribers (in Thousand)		973	1 332	1 841	2 456	3 289	3 928	. . .	
Turnover (2) = Base of special telecom taxes		93	122	139	159	195	237	. . .	
Telecom special taxes									
Telecom network access tax	0.03	2.79	3.64	4.16	4.77	5.84	7.11	. . .	
Financing levy of the Regulatory Agency	0.015	1.4	1.82	2.08	2.38	2.92	3.55	. . .	
Spectrum fees	0.016	1.49	1.94	2.21	2.54	3.11	3.79	. . .	
Numbering fees	0.152	0.15	0.20	0.28	0.37	0.50	0.59	. . .	
Total special taxes		**5.83**	**7.62**	**8.74**	**10.09**	**12.38**	**15.06**	. . .	

	Net present Value	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	. . .	Note
Pre-tax cash-flows	**669**	-33	-17	-2	21	62	79	. . .	
Taxes	**442**	12	13	14	15	19	29	. . .	
Post-tax cash-flows	**356**	-45	-31	-16	6	42	50	. . .	
AETR	**0.66**								

Source : Authors.

Figure O.II.1: Cash flows sharing for TELCO in Cameroon.



Source: Authors.

Appendix O.III: A gold mining sector representative firm.

We consider a medium grade open pit mine, which has a similar gross return than TELCO. Its production potential is 1.6 million ounces with a grade of 3 g/t. Its exploitation period is 13 years established as following: 2 years of initial investments, 10 years of exploitation, and 1 year of rehabilitation. Capital investments are financed by debt at a proportion of 90 percent but limited in some countries by thin capitalization rules. The borrowing period is 5 years with an interest rate of 6 percent. However, we considered a baseline interest rate of 10 percent in our analysis. The considered representative firm pre-tax Internal Rate of Return (IRR) at a gold price of 1,300 USD/oz retained in our study is 62.03 percent. TELCO pre-tax IRR is on average 60 percent during its license duration across studied countries.

Appendix O.IV: Sensitivity analysis of the AETR computation.

We develop a sensitivity analysis of our AETR results by changing the discount rate and the interest rate (see Table F.1). Column 1 presents the baseline results.

Table F.1: Sensitivity analysis of TELCO

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Algeria	**0.49**	0.44	0.46	0.5	0.5	0.45	0.47	0.52
Angola	**0.43**	0.38	0.4	0.45	0.45	0.39	0.41	0.46
Benin	**0.79**	0.56	0.65	0.86	0.8	0.57	0.66	0.87
Burkina Faso	**0.87**	0.64	0.73	0.94	0.89	0.65	0.75	0.96
Cameroon	**0.66**	0.5	0.57	0.71	0.67	0.52	0.58	0.72
Chad	**0.71**	0.63	0.66	0.73	0.72	0.64	0.67	0.74
Cote d'Ivoire	**0.81**	0.58	0.67	0.89	0.83	0.59	0.68	0.9
DRC	**0.97**	0.81	0.87	1.03	0.99	0.82	0.89	1.04
Egypt	**0.41**	0.35	0.38	0.43	0.42	0.36	0.39	0.44
Ethiopia	**0.33**	0.33	0.33	0.33	0.34	0.34	0.34	0.34
Gabon	**0.65**	0.53	0.58	0.68	0.66	0.55	0.59	0.7
Ghana	**0.54**	0.47	0.5	0.56	0.55	0.48	0.51	0.58
Guinea	**0.94**	0.81	0.87	0.97	0.95	0.83	0.88	0.99
Kenya	**0.43**	0.39	0.41	0.44	0.45	0.4	0.42	0.46
Madagascar	**0.47**	0.39	0.42	0.49	0.48	0.4	0.43	0.5
Mali	**0.94**	0.59	0.73	1.05	0.95	0.59	0.74	1.06
Morocco	**0.35**	0.3	0.32	0.36	0.36	0.31	0.33	0.37
Niger	**1.18**	0.93	1.03	1.26	1.19	0.94	1.04	1.26
Nigeria	**0.41**	0.39	0.39	0.41	0.42	0.4	0.41	0.42
Senegal	**0.93**	0.63	0.75	1.02	0.94	0.64	0.76	1.03
Sierra Leone	**0.7**	0.51	0.59	0.76	0.71	0.52	0.6	0.77
South Africa	**0.37**	0.32	0.34	0.39	0.39	0.34	0.36	0.4
Tanzania	**0.63**	0.5	0.55	0.67	0.64	0.51	0.56	0.68
Tunisia	**0.47**	0.39	0.42	0.5	0.48	0.39	0.43	0.5
Zambia	**0.51**	0.47	0.49	0.52	0.52	0.49	0.5	0.53

Source: Authors computations using the cash flow sharing model.

[1] Baseline results (Interest rate of 10 per cent and discount rate of 10 per cent).

[2] Interest rate of 10 per cent and discount rate of 0 percent.

[3] Interest rate of 10 per cent and discount rate of 5 per cent

[4] Interest rate of 10 per cent and discount rate of 12 per cent.

[5] Interest rate of 6 per cent and discount rate of 10 per cent.

[6] Interest rate of 6 per cent and discount rate of 0 per cent.

[7] Interest rate of 6 per cent and discount rate of 5 per cent.

[8] Interest rate of 6 per cent and discount rate of 12 per cent.

We first impose a discount rate of 0 percent. The AETR decreases and varies between 30 percent in Morocco to 93 percent in Niger with an average value of 51 percent (column 2). A discount rate of 5 percent also decreases the AETR values from 1 percentage points in Ethiopia and DRC to 21 in Mali with an average value of 56 percent while a higher discount rate of 12 percent increases the AETR from 1 percentage points in Algeria, Ethiopia, Kenya, Nigeria, Morocco, and Zambia to 11 in Mali with an average value of 68 percent (column 3 and 4 respectively).

With an interest rate of 6 percent, the AETR increases in all countries by at most 2 percentage points. Across the sample, its average value is 65 percent (column 5). When we combine the

interest rate of 6 percent with a discount rate of 0 percent, the tax burden decreases across countries. It goes from 31 percent in Morocco to 94 percent in Niger with an average value of 52 percent (column 6). With an interest rate of 6 percent and a discount rate of 5 percent, the AETR also decreases and its average value is 58 percent (column 7).

At the opposite, a discount rate of 12 percent with an interest rate of 6 percent increases TELCO's tax burden which goes from 34 percent in Ethiopia to 126 percent in Niger, with an average value of 69 percent (column 8).

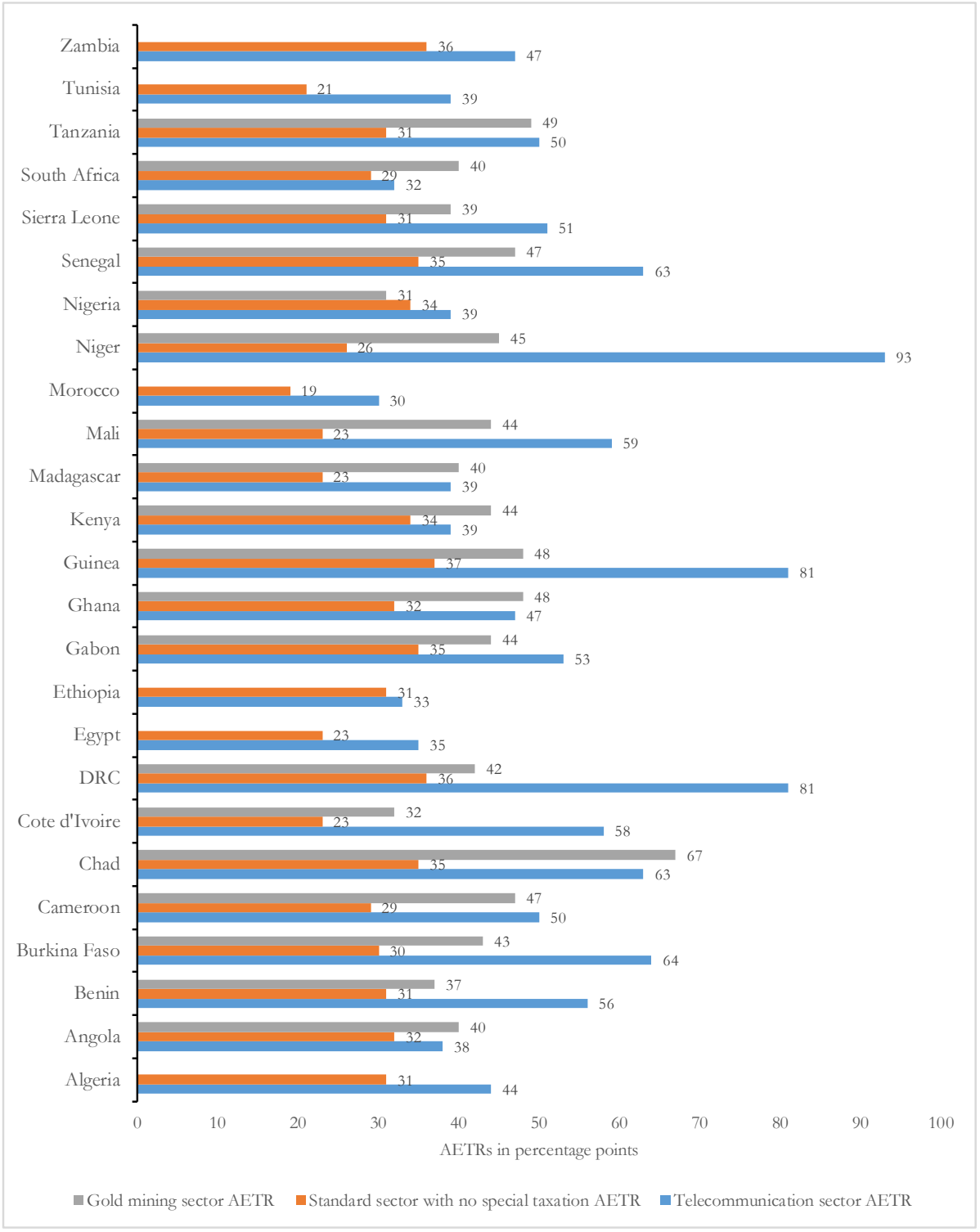
We also conduct the same sensitivity analysis on the cross-sectoral comparisons. In all cases except in Angola, Chad, Ghana, Kenya, Madagascar, and South Africa, the AETR for the telecommunication sector remains higher compared to the other two sectors. Figure F.1 presents the results for an interest rate of 10 percent and a discount rate of 0 percent.

Table F.2 presents the results of the sensitivity analysis for the gold mining sector. The lower observed AETR is 31 percent in Nigeria and remains constant for all parameters we retain. Its higher value is observed for Chad where it varies between 67 percent and 75 percent.

The sensitivity analysis results for the standard sector are presented in table F.3. In Morocco where the lower value is observed, the AETR varies between 19 percent and 22 percent. The higher standard sector AETR is 42 percent and is observed in Senegal where it varies between 35 percent and 42 percent.

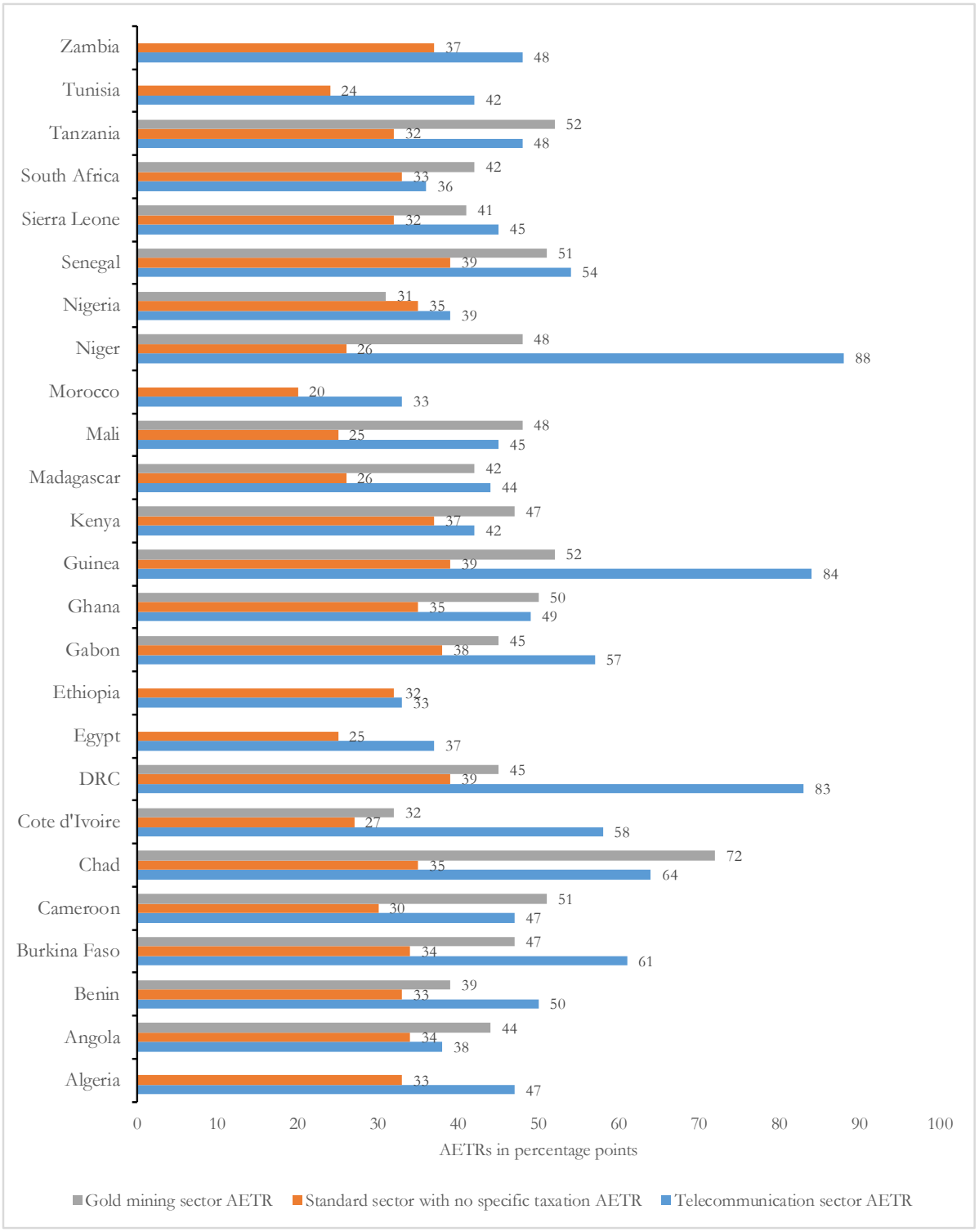
Given the importance of license fees in some countries and the fact that there is no license fees in the gold mining sector or the standard economic sector, we re-compute the AETR excluding license fees. We then observe that TELCO's AETR falls under 100 percent and goes from 33 percent in Ethiopia and Morocco to 88 percent in Niger. However, except in Angola, Cameroon, Chad, Ghana, Kenya, Mali, South Africa and Tanzania, the telecommunication sector remains more taxed than the other two sectors (figure F.2).

Figure O.IV.1: Cross-sectoral comparison with a discount rate of 0 percent



Source: Authors.

Figure O.IV.2: Cross-sectoral comparison excluding license fees



Source: Authors.

Table O.IV.2: Sensitivity analysis for the gold mining plant.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Algeria	**-**	-	-	-	-	-	-	-
Angola	**0.44**	0.4	0.42	0.45	0.44	0.41	0.42	0.45
Benin	**0.39**	0.37	0.38	0.4	0.4	0.37	0.38	0.41
Burkina Faso	**0.47**	0.43	0.45	0.48	0.48	0.44	0.45	0.49
Cameroon	**0.51**	0.47	0.49	0.52	0.52	0.48	0.5	0.53
Chad	**0.72**	0.67	0.69	0.74	0.73	0.67	0.7	0.75
Cote d'Ivoire	**0.32**	0.32	0.32	0.32	0.32	0.32	0.32	0.32
DRC	**0.45**	0.42	0.43	0.46	0.46	0.43	0.44	0.47
Egypt	**-**	-	-	-	-	-	-	-
Ethiopia	**-**	-	-	-	-	-	-	-
Gabon	**0.45**	0.44	0.45	0.46	0.45	0.44	0.45	0.46
Ghana	**0.5**	0.48	0.49	0.51	0.51	0.49	0.5	0.52
Guinea	**0.52**	0.48	0.5	0.53	0.52	0.48	0.5	0.53
Kenya	**0.47**	0.44	0.45	0.47	0.47	0.45	0.46	0.48
Madagascar	**0.42**	0.4	0.4	0.42	0.42	0.4	0.41	0.43
Mali	**0.48**	0.44	0.46	0.49	0.49	0.45	0.47	0.5
Morocco	**-**	-	-	-	-	-	-	-
Niger	**0.48**	0.45	0.46	0.49	0.48	0.46	0.47	0.49
Nigeria	**0.31**	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Senegal	**0.51**	0.47	0.49	0.52	0.52	0.48	0.49	0.53
Sierra Leone	**0.41**	0.39	0.4	0.42	0.41	0.39	0.4	0.42
South Africa	**0.42**	0.4	0.41	0.43	0.43	0.4	0.41	0.43
Tanzania	**0.52**	0.49	0.5	0.53	0.53	0.5	0.51	0.53
Tunisia	**-**	-	-	-	-	-	-	-
Zambia	**-**	-	-	-	-	-	-	-

Source: FERDI (taxation of mining industries, 2018).

[1] Baseline results (Interest rate of 10 per cent and discount rate of 10 per cent).

[2] Interest rate of 10 per cent and discount rate of 0 percent.

[3] Interest rate of 10 per cent and discount rate of 5 per cent

[4] Interest rate of 10 per cent and discount rate of 12 per cent.

[5] Interest rate of 6 per cent and discount rate of 10 per cent.

[6] Interest rate of 6 per cent and discount rate of 0 per cent.

[7] Interest rate of 6 per cent and discount rate of 5 per cent.

[8] Interest rate of 6 per cent and discount rate of 12 per cent.

Table O.IV.3: Sensitivity analysis for the standard sector.

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Algeria	**0.33**	0.31	0.32	0.34	0.34	0.32	0.33	0.35
Angola	**0.34**	0.32	0.33	0.35	0.36	0.34	0.34	0.36
Benin	**0.33**	0.31	0.32	0.34	0.34	0.32	0.33	0.35
Burkina Faso	**0.34**	0.3	0.32	0.35	0.35	0.32	0.33	0.37
Cameroon	**0.3**	0.29	0.29	0.3	0.31	0.3	0.3	0.31
Chad	**0.35**	0.35	0.35	0.35	0.37	0.36	0.36	0.37
Cote d'Ivoire	**0.27**	0.23	0.25	0.28	0.28	0.24	0.26	0.29
DRC	**0.39**	0.36	0.37	0.4	0.41	0.37	0.39	0.41
Egypt	**0.25**	0.23	0.24	0.25	0.26	0.24	0.25	0.27
Ethiopia	**0.32**	0.31	0.32	0.32	0.33	0.32	0.33	0.33
Gabon	**0.38**	0.35	0.36	0.39	0.4	0.36	0.38	0.41
Ghana	**0.35**	0.32	0.33	0.36	0.36	0.33	0.34	0.37
Guinea	**0.39**	0.37	0.38	0.39	0.4	0.38	0.39	0.41
Kenya	**0.37**	0.34	0.35	0.37	0.38	0.35	0.36	0.39
Madagascar	**0.26**	0.23	0.25	0.27	0.27	0.24	0.26	0.28
Mali	**0.25**	0.23	0.24	0.26	0.26	0.24	0.25	0.27
Morocco	**0.2**	0.19	0.2	0.21	0.21	0.2	0.2	0.22
Niger	**0.26**	0.26	0.26	0.26	0.27	0.27	0.27	0.27
Nigeria	**0.35**	0.34	0.34	0.35	0.36	0.35	0.35	0.36
Senegal	**0.39**	0.35	0.36	0.4	0.41	0.36	0.38	0.42
Sierra Leone	**0.32**	0.31	0.31	0.33	0.33	0.32	0.33	0.34
South Africa	**0.33**	0.29	0.31	0.34	0.35	0.31	0.32	0.36
Tanzania	**0.32**	0.31	0.31	0.32	0.33	0.32	0.32	0.34
Tunisia	**0.24**	0.21	0.22	0.26	0.25	0.21	0.23	0.26
Zambia	**0.37**	0.36	0.36	0.37	0.38	0.37	0.38	0.38

Source: Authors computations using the cash flow sharing model.

[1] Baseline results (Interest rate of 10 per cent and discount rate of 10 per cent).

[2] Interest rate of 10 per cent and discount rate of 0 percent.

[3] Interest rate of 10 per cent and discount rate of 5 per cent

[4] Interest rate of 10 per cent and discount rate of 12 per cent.

[5] Interest rate of 6 per cent and discount rate of 10 per cent.

[6] Interest rate of 6 per cent and discount rate of 0 per cent.

[7] Interest rate of 6 per cent and discount rate of 5 per cent.

[8] Interest rate of 6 per cent and discount rate of 12 per cent.

"Sur quoi la fondera-t-il l'économie du monde qu'il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l'ignore."

Pascal

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