TAX INSTRUMENTS FOR THE MINING SECTOR: PROFIT-BASED TAXES VERSUS PRODUCTION-BASED TAXES

INSTRUMENTS FISCAUX POUR LE SECTEUR MINIER: IMPÔTS BASÉS SUR LES BÉNÉFICES CONTRE IMPÔTS BASÉS SUR LA PRODUCTION

INSTRUMENTOS TRIBUTÁRIOS PARA O SECTOR DE MINERAÇÃO: IMPOSTOS BASEADOS NO LUCRO VERSUS IMPOSTOS BASEADOS NA PRODUÇÃO

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ABSTRACT

The sharing of mining rents is a particular challenge for African countries. To explain the determinants of profit-based and production-based taxes, we use a panel of 22 gold-producing countries in Africa between 2000 and 2020 using the ordinary least squares (OLS) method controlled for time and country fixed effects. Our empirical results show that the road distance between the capital of the country and its relevant port is an important indicator in the choice of rent taxation instruments. The road distance between the capital of a country and its relevant port tends to reduce the average effective tax rate (AETR) through the share of profit-based taxes in AETR. Thus, countries that do not have direct access to the sea should favour production-based taxes over profit-based taxes in the taxation of mining rents.

Keywords: African gold-producing countries, mining sector, natural resources taxation, rent-sharing

JEL codes: Q38, K34, H30, C80

RÉSUMÉ

Le partage des rentes minières constitue un défi particulier pour les pays africains. Pour expliquer les déterminants des impôts basés sur les bénéfices et sur la production, nous utilisons un panel de 22 pays producteurs d'or en Afrique entre 2000 et 2020 en utilisant la méthode des moindres carrés ordinaires (MCO) contrôlée pour les effets fixes temporels et nationaux. Nos résultats empiriques montrent que la distance routière entre la capitale du et son port concerné est un indicateur important dans le choix des instruments de taxation des loyers. La distance routière entre la capitale d'un pays et son port concerné a tendance à réduire le taux d'imposition effectif moyen (TEMI) à travers la part des impôts sur les bénéfices dans le TEMI. Ainsi, les pays qui n'ont pas d'accès direct à la mer devraient privilégier les impôts basés sur la production plutôt que les impôts basés sur les bénéfices dans la taxation des rentes minières.

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Mots clés: fiscalité des ressources naturelles, partage des rentes, pays africains producteurs d'or, secteur minier

RESUMO

A partilha das receitas mineiras é um desafio particular para os países africanos. Para explicar os determinantes dos impostos baseados no lucro e na produção, utilizamos um painel de 22 países produtores de ouro em África entre 2000 e 2020, utilizando o método dos mínimos quadrados ordinários (OLS) controlado por efeitos fixos de tempo e de país. Os nossos resultados empíricos mostram que a distância rodoviária entre a capital do país e o seu porto relevante é um indicador importante na escolha dos instrumentos de tributação das rendas. A distância rodoviária entre a capital de um país e o seu porto relevante tende a reduzir a taxa média efectiva de imposto (AETR) através da participação dos impostos baseados no lucro na AETR. Assim, os países que não têm acesso directo ao mar deveriam favorecer os impostos baseados na produção em detrimento dos impostos baseados no lucro na tributação das rendas mineiras.

Palavras-chave: países africanos produtores de ouro, partilha de rendas, sector mineiro, tributação dos recursos naturais

I INTRODUCTION

Since the Addis Ababa Conference on Development in July 2015, the issue of the mobilisation of internal resources has become increasingly important, and even more so with the COVID-19 health crisis. The application of barrier measures ranging from physical distancing to the closure of land and/or air borders to prevent the spread of the disease led to a decline in economic activities worldwide (Ozili, 2020). This led to the closure of some businesses, resulting in increased unemployment and a global economic recession. Some donor countries who usually provided official development assistance (ODA) themselves needed help to face the economic crisis that COVID-19 had caused. Moreover, the Russo-Ukrainian war that began in February 2022 continues to create economic disruption that continues to be felt around the world (Währungsfonds, 2023). Developing countries, some of which still depend on official development assistance, have suffered, and continue to suffer, the adverse effects of this war and the economic after-effects of COVID-19. This is another reason why all countries should focus their development on mobilising their internal resources.

Tax revenue mobilisation, which is a key instrument for building a strong state, has historically been weak in developing countries. The percentage of tax revenues as a share of GDP differs between developed countries and developing countries, with Okunogbe and Santoro (2023) demonstrating that it is 20% in developed countries and only 11% in developing countries. The collection of tax revenues from

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developing countries is so poor that there is reason to fear for their development, particularly since sustainable development goals require a minimum performance of 15% of GDP to build a strong state. In essence, developing countries still require a 4% increase in tax revenue margins to meet the requirements for establishing healthy states in alignment with the sustainable development goals.

The African continent has a wealth of natural resources on which it could rely to increase its fiscal performance in order to improve its sustainable development. Worldwide, African mineral reserves, including gold, bauxite, diamonds, cobalt, copper and iron account for 30% of the global total. These minerals are coveted, with global interest in a secure mineral supply increasing. For example, the British government created a critical minerals centre (CMIC) in 2022. The centre's core mission is collecting and analysing information on 'critical' minerals and raw materials for the benefit of the country's economic activity and national security. The CMIC is hosted by the British Geological Survey (BGS), a work programme with great potential for the UK and elsewhere. Recently the BGS conducted a study in Africa for flake graphite using a reconnaissance exploration methodology (Idoine et al, 2023). Gold is the only mineral mined in most African countries, as evidenced by the latest BGS publication (Idoine et al, 2023) which identified 40 out of 54 countries on the continent producing gold.[1] According to the report, South Africa was the country with the highest gold production in 2021, producing 105,019 kilograms or 105.019 metric tons of gold. Moreover, according to the 2019 EITI reports[2] for Burkina Faso, Côte d'Ivoire and Mali, these three countries recorded an overall annual production of 148 tons of gold (50.3 tons for Burkina, 32.5 tons for Côte d'Ivoire and 65.2 tons for Mali).

The mining sector is unique in generating a surplus income known as 'rent'. The rent is shared between investors and the state. Thus, the objective of internal resource maximisation also involves maximising the state's share of the rent. This means taxing rent at 100%. Indeed, taxing 100% rent is economically neutral in terms of optimal rent taxation theory, since investment decisions and production trajectories need not be altered (Boadway & Michael, 2010). The government cannot accurately assess the upstream rent because of uncertainties related to operating conditions that may be of a geological, economic or even political nature. In reality, there is heterogeneity in the way countries define the tax system. Depending on a country's priorities

[1] See the Appendix for more details.

[2] Extractive Industries Transparency Initiative, EITI https://eiti.org/fr

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or objectives[3] (Baunsgaard, 2001) in the short or long term, a tax system is developed by each country while allowing it to capture an important part of the rent. As a result, mining tax regimes are complex, with several tax instruments deviating from the standard regime, and sometimes including special levies likely to cause economic distortions.

The state's share of mining rent depends not only on the nature of the levy, but also on its basis, rate and calculation method. These instruments can also be used to determine the adaptability of the state's rent to changing operating costs and/or gold prices. Two types of tax levies have been distinguished by Otto (2006; 1998): (i) in rem taxes and (ii) in personam taxes. The first, also called 'production-based taxes', are made up of customs duties, fixed duties, annual ground fees, taxes on petroleum products, turnover minimums and mining royalties. They guarantee state revenues from the moment mining production begins, irrespective of the project's economic viability. The second represents profit-based taxes, and benefits companies. It is based solely on their profits since it comprises rent tax, corporate income tax, and dividend and interest withholding tax. Very often, these taxes are sources of tax optimisation for companies. Through the abuse of transfer pricing, the tax base is narrowed, thus reducing the state's share of rent. Despite these tax levies, the state's ownership stake in the company's capital is a form of parafiscal levy to which the mining sector is subject (Laporte, de Quatrebarbes & Bouterige, 2022). Governments are, therefore, looking for the best possible combination of taxes on profits and taxes on production to ensure a fair share of mining rent. While some governments have chosen to focus on profit-based taxes, others have prioritised production-based taxes or seek to strike a balance between the two tax instruments. In this paper, we construct two different indicators of tax design as dependent variables for analysis: profit-based taxes share in the average effective tax rate (AETR) and production-based taxes share in AETR. Maximisation of government revenues by capturing an important part of the rent is usually achieved through production-based taxes, since rent will be taxed at the first extracted unit. However, it is possible to increase the government's share of rent if the tax design is progressive.

In Africa, most mining operations are conducted by foreign companies. While many African countries have access to the sea, 16 of the 54 countries on the continent have no access to ports.[4] Countries like Burkina Faso, Mali, Niger and Chad, to name but a few, are forced

[3] Priorities may include improving adaptation to countries' administrative capacities, making tax regimes more generous, influencing mining operators' behaviour or minimising information asymmetries (Kumar & Radetzki, 1987; Baunsgaard, 2001).

[4] Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Eswatini, Ethiopia, Lesotho, Malawi, Mali, Niger, Rwanda, South Sudan, Uganda, Zambia and Zimbabwe.

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to use the ports of neighbouring countries for their maritime exports and imports. Consider the case of two neighbouring countries: Burkina Faso, which does not have access to the sea, and Cote d'Ivoire, which does have access to the sea. For example, maritime imports of mining products will pass through the port of Abidjan in Côte d'Ivoire before arriving in Ouagadougou in Burkina Faso. All else being equal, these maritime imports of mining products will be relatively more expensive for a foreign investor based in Burkina than another investor based in Côte d'Ivoire for the same imported mining product. In addition to the transportation costs associated with maritime transport, road and/or shipping costs and insurance costs (Limao & Venables, 2001) for overland transport between Abidjan and Ouagadougou will be added to the existing maritime transport costs. These are production costs for the extractive company and will be accounted for in its balance sheet. Thus, the longer the land distance between the port and the capital of the importing country, the higher the transport costs are likely to be, resulting in a decrease in rent for a given world price, and in the profits generated by the company (Faye et al, 2004; Limao & Venables, 2001; Lee, 2021). This leads us to wonder about the choice of tax policies that these landlocked countries must make in taxing the mining sector.

This paper extends the existing literature on mining rent taxation and access to the sea in mining countries. It argues that the country's distance to the sea should be considered in rent taxation instruments. To this end, we study the impact of the distance of the mining country from the sea on profit-based taxes and production-based taxes, which are the two main components of the AETR through ordinary least squares (OLS) method controlled for time and country fixed effects. The sample used is a set of gold-producing countries in Africa over the period 2000 to 2020. Our main objective is to introduce the idea of considering access to the sea in the choice of taxation instruments. Thus, countries that have favoured profit-based taxes and do not have direct access to the sea take more risks regarding the level of revenues earned. On the other hand, by relying on production-based taxes, state revenues can be assured since they are not dependent on profitability.

The rest of the paper is organised as follows: the second section presents the indicator of rent-sharing. The third section examines the data and the econometric methodology. The fourth section presents and discusses the estimation results. The fifth section considers robustness checks. The last section concludes with policy implications.

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II AN INDICATOR OF RENT-SHARING: THE AVERAGE EFFECTIVE TAX RATE (AETR)

The sharing of mining rent is dependent on both the tax system and the economic structure[5] of mine and world prices. To assess the rental sharing between governments and investors and to mitigate the last-mentioned two points, an average effective tax rate (AETR) was determined for a given gold price across three representative African gold mining projects. The Foundation for International Development Studies and Research (FERDI) provided economic data and national legislation to support this analysis (Laporte et al, 2015). The AETR calculation uses a cash flow model similar to the Fiscal analysis of resource industries (FARI) model developed by the International Monetary Fund (Luca & Puyo, 2016). The AETR represents the ratio between the discounted government revenue from a mining project and the net pre-tax cash flow from the same project. In other words, the AETR reflects the state's share of mining rent from a mining project, assuming the discount rate appropriately reflects the capital opportunity cost (Laporte et al, 2015).

Among the tax instruments[6] used to calculate the AETR, some were not considered due to the lack of information needed to calculate their value. These included the tax charges for fuels and petroleum products, customs duties for capital goods imports, and value added tax (VAT) credits not reimbursed by tax authorities to operating companies. According to the model, the mine operator benefited from a stability clause[7] that ensured the maintenance of the tax regime for the duration of the project (on average, over 13 years). Thus, in a given country and year, the distribution of rents determined by the legislation in force was reflected in the AETR.

III DATA AND THE ECONOMETRIC METHODOLOGY

This paper aims to empirically explain tax design in 22 gold-producing countries in Africa (see Table 6 in the appendix) as defined by the FERDI database.[8] We use annual data from 2000 to 2020. Building on the existing literature on natural resources and tax revenue mobilisation, we identify several explanatory variables, such as distance to the sea, prices, government effectiveness, and voice and accountability (Laporte et al, 2022; Feyrer, 2009; Amedanou & Laporte, 2024; Adebayo et al, 2021).

[5] A mine's economic structure is determined by its lifespan, its potential production, its operating costs, its capital costs and its ore grade (Laporte et al, 2015).

[6] Annual ground fees, fixed fees, mining royalties, withholding taxes on interest and turnover minimum tax, withholding taxes on dividends, corporate income tax, and the payment of dividends to the state. For further details, see Laporte et al (2015) and Laporte et al (2022).

[7] The guarantee period covered by the stability clause is usually the duration of the validity of the mining title (South Africa, Tanzania, Burkina Faso, Côte d'Ivoire and Mali), but it may also be longer (Mauritania and Senegal) or be specified in years (Ghana).

[8] Fiscalité des industries minières (ferdi.fr).

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We use the robust least square regression (OLS) method, controlled for time and country fixed effects. The estimates are based on the following equations:

$$Prod_{Tax_{it}} = \beta_0 + \beta_1 SDistance_{it} + \beta_2 Prices_{it} + \beta_3 VA_{it} + \beta_4 GE_{it} + \beta_5 Polity2_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (1)$$

$$Prof_{Tax_{it}} = \beta_0 + \beta_1 SDistance_{it} + \beta_2 Prices_{it} + \beta_3 VA_{it} + \beta_4 GE_{it} + \beta_5 Polity2_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

Where β_0 and ϵ_{it} represent the constant term and the error term respectively, in both equations.

i=1, 2, 3…, N and t=1, 2..., T stands for countries and years. β_1, β_2, β_3 and β_4 are unknow parameters to be estimated. μ_i *and* γ_t are country fixed effects and time fixed effects, respectively.

$SDistance_{it}$, $Prices_{it}$, VA_{it}, GE_{it} and $Polity2_{it}$ represent sea distance, average gold prices, voice and accountability, government effectiveness, and political regime respectively (see Table 2 for more details).

$Prod_{Tax_{it}}$ and $Profit_{Tax_{it}}$, our dependent variables, represent the share of production-based taxes and profit-based taxes in AETR. They were constructed as follows:

$$Prod_{Tax_{it}} = \Sigma(\text{ground fees}_{it} + \text{fixed fees}_{it} + \text{royalties}_{it} + \text{interest tax}_{it}) \quad (3)$$

$$Prof_{Tax_{it}} = \Sigma(\text{taxes on dividends}_{it} + \text{corporate tax}_{it} + \text{state's dividends}_{it}) \quad (4)$$

All these variables constituting the share of production-based taxes and profit-based taxes in AETR are provided by the FERDI database set up by Laporte, et al (2015). The data is extracted according to the average annual gold price variation. Data on gold prices, voice and accountability, and government effectiveness have been collected from commodity prices databases and worldwide governance indicators (WDI) published by the World Bank, respectively. Sources and descriptions of the variables are shown in Table 2. Table 1 reflects the summary statistics.

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Table 1: *Summary statistics*

Variables	Obs	Mean	Std. dev.	Min	Max
Gold price	506	1,046.22	516.48	270.99	1,800.60
AETR low-grade	351	0.60	0.16	0.27	1.11
AETR medium-grade	351	0.44	0.08	0.24	0.76
AETR high-grade	351	0.40	0.08	0.23	0.87
Government effectiveness	462	-0.83	0.45	-1.84	0.65
Voice and accountability	462	-0.56	0.61	-1.73	0.79
Polity 2 score	418	2.48	4.51	-6.00	9.00
Sea distance	483	519.60	454.15	0.00	1,528.72
Profit-based taxes (low-grade)	350	0.60	0.13	0.19	0.89
Profit-based taxes (medium-grade)	350	0.75	0.09	0.43	0.92
Profit-based taxes (high-grade)	350	0.82	0.09	0.54	0.94
Production-based taxes (low-grade)	351	0.40	0.13	0.11	0.81
Production-based taxes (medium-grade)	351	0.25	0.10	0.06	0.57
Production-based taxes (high-grade)	350	0.18	0.09	0.04	0.45

Source: *Author*

Table 2: *Definition and source of variables*

Variable	Definition	Source
Production-based taxes in AETR	The sum of the share of each production-based component in the AETR.	Author's calculation from FERDI database
Profit-based taxes in AETR	The sum of the share of each profit-based component in the AETR.	
Sea distance	The distance between the country's capital and its home port, measured in kilometres.	CERDI sea distance database

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Variable	Definition	Source
Government effectiveness	Determined by the quality of public services, political independence, policy formulation and implementation, and the government's commitment to these policies. Values are arranged from -2.5 to 2.5.	WDI
Voice and accountability	The extent to which citizens are involved in selecting their government, as well as freedom of expression, association and media freedom. Values are arranged from -2.5 to 2.5.	
Gold price	The average price of gold in US$.	World Bank
Polity 2 score	Measures the political regime. The variable ranges from -10 to +10. (+10) indicates a democracy, and (-10) indicates an authoritarian regime.	Polity IV

Source: *Author*

IV RESULTS AND DISCUSSIONS

Table 3 below reflects the results of our estimates. The first three columns (columns 1, 2 and 3) indicate the results of our estimates with the dependent variables taxes based on mine production at low, medium and high grades, respectively. The last three columns (columns 4, 5 and 6) contain the results of the share of taxes based on profit, with the same information in relation to mine grade. It appears that the road distance between the country's capital and its relevant port positively affects the production-based taxes regardless of the mine grade. This effect becomes negative and significant at 1% on profit-based taxes, whatever the mine grade. Indeed, the longer the road distance between the relevant port and the country's capital, the higher the transport costs for the delivery of mining products destined for ore production.

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Table 3: *Results of OLS estimation*

	Share of production-based taxes in AETR			Share of profit-based taxes in AETR		
	Low-grade	Medium-grade	High-grade	Low-grade	Medium-grade	High-grade
	(1)	(2)	(3)	(4)	(5)	(6)
Sea distance	0.002***	0.001***	0.001***	-0.002***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Gold prices	0.000	0.000***	0.000***	-0.000	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Voice and accountability	-0.124***	-0.130***	-0.131***	0.121***	0.131***	0.137***
	(0.025)	(0.020)	(0.021)	(0.025)	(0.020)	(0.021)
Government effectiveness	0.100***	0.089***	0.078***	-0.099***	-0.088***	-0.079***
	(0.026)	(0.019)	(0.019)	(0.026)	(0.020)	(0.019)
Polity 2 score	-0.001	0.002	0.004**	0.001	-0.001	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	-1.554***	-1.341***	-0.983***	2.511***	2.331***	2.006***
	(0.216)	(0.221)	(0.221)	(0.210)	(0.201)	(0.199)
Observations	293	293	292	292	292	292
R-squared	0.828	0.788	0.770	0.828	0.772	0.723

Source: *Author. Robust standard errors are in parentheses.* *** *p<0.01,* ** *p<0.05,* * *p<0.1*

Profit-based taxes exclusively encompass the different taxes levied on the profit of the extractive companies (Otto, 2006), which are calculated as the difference between their revenues and ore production costs. All things being equal, an increase in production costs will decrease the company's profits. The value of the taxes applied to the company's profit depends on the actual rate applied and the taxable base. By keeping the rate intact, a decrease in the taxable base due to increased transportation costs will necessarily lead to a decrease in taxes on the profit of extractive companies. This may pose a risk for the mineral-producing country as it alters the share of the rent that goes to the state.

The relationship between prices and the share of profit-based taxes is negative and only significant for medium- and high-grade mines.

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In other words, higher prices tend to reduce the share of profit-based taxes. In fact, profit-based taxes are very often a source of tax optimisation for companies through transfer pricing, for example (Laporte et al, 2022). The reverse is true when it comes to production-based taxes. The last-mentioned results align with those of Laporte et al (2022) who found a positive effect of price on production-based taxes.

Although our policy regime variable (polity 2 score) does not influence profit-based taxes, our results show that our governance variables do affect profit-based taxes. The different effects depend on the nature of these variables. Government effectiveness tends to decrease the share of taxes on profit in the AETR, while voice and accountability tend to increase this same profit. These results are consistent with the literature that found a positive association between government effectiveness and the share of the state rent (Adebayo et al, 2021). The positive and negative effects of government effectiveness and voice and accountability on profit-based taxes are reversed, becoming negative (government effectiveness) and positive (voice and accountability) on production-based taxes.

The only positive effect of the policy regime variable (polity 2 score) on production-based taxes suggests that countries with strong democratic institutions tend to levy more taxes on company production. Indeed, stable democratic institutions translate into low country risk (Amedanou & Laporte, 2024). A large proportion of mining companies on the African continent are foreign. It is worth remembering that, prior to any investment, foreign companies assess the country's risk, which is a key determinant in the decision to invest. All things being equal, where there are stable democratic institutions, we can expect to see an influx of mining companies. This will lead to an increase in production taxes since these are generally paid well in advance of the actual mine exploitation (Laporte et al, 2022).

V ROBUSTNESS CHECK

In this section, we conduct a series of robustness tests. First, we use an alternative measure of our variable of interest regarding access to the sea, which is a dummy variable (1 if the country has access to the sea and 0 otherwise). This choice is substantiated by the existing literature on landlocked African countries (Limao & Venables, 2001; Faye et al, 2004; Lee, 2021). Increasingly, access to the sea is becoming a key indicator of a country's developmental trajectory and its potential to become a maritime power.[9] According to Noorali et al (2022), as with the current world geopolitical order, future dominance will not be determined by

[9] A port power is a country that leads in eight areas of port construction, management and control, making it a major maritime player, notably in terms of shipping and maritime capacity, and with access to the Eurasian landmass (Noorali, Flint & Ahmadi, 2022).

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military might alone, but by the naval capabilities of countries. In this context, China's ascendancy is noteworthy.

The results are presented in Table 4. As can be seen, countries with access to the sea are able to capture a significant share of the mining rent based on profit taxes. The converse is true for countries without access to the sea.

Table 4: *Estimation results with sea access as the variable of interest*

	Share of production-based taxes in AETR			**Share of profit-based taxes in AETR**		
	Low-grade	**Medium-grade**	**High-grade**	**Low-grade**	**Medium-grade**	**High-grade**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Access to the sea	-0.171***	-0.133***	-0.094***	0.166***	0.129***	0.092***
	(0.020)	(0.020)	(0.020)	(0.019)	(0.018)	(0.018)
Gold prices	0.000	0.000***	0.000***	-0.000	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Voice and accountability	-0.126***	-0.128***	-0.127***	0.124***	0.130***	0.134***
	(0.025)	(0.020)	(0.020)	(0.025)	(0.020)	(0.021)
Government effectiveness	0.085***	0.078***	0.068***	-0.085***	-0.077***	-0.070***
	(0.025)	(0.019)	(0.018)	(0.025)	(0.019)	(0.018)
Polity 2 score	0.001	0.003*	0.004***	-0.001	-0.003*	-0.003**
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
Constant	0.509***	0.216***	0.100***	0.496***	0.799***	0.918***
	(0.058)	(0.041)	(0.036)	(0.058)	(0.041)	(0.038)
Observations	310	310	309	309	309	309
R-squared	0.828	0.791	0.775	0.828	0.776	0.730

Source: *Author. Robust standard errors are in parentheses.* *** *p<0.01,* ** *p<0.05,* * *p<0.1*

Secondly, to test the impact of distance to the sea on the overall AETR, we use the AETR as an independent variable. The first three columns of Table 5 provide an overview of the results obtained as a function of mine grade. The AETR is negatively correlated with the distance from the host country (i.e. the country in which the ore is mined) to the sea, regardless of mine grade. This means that the effect of distance on the share of profit-based taxes in the AETR outweighs the effect of distance

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on the share of production-based taxes in the AETR. Indeed, countries aiming to maximise the share of rent accruing to the state often opt for production-based taxes to secure a portion of the rent from the outset of the project (Laporte et al, 2022). However, in most cases profit-based taxation instruments are more commonly used (see Table 1). As the distance between the host country and the sea increases, the state's share of the rent decreases.

Table 5: *Estimation results with AETR as independent variable*

	AETR			AETR		
	Low-grade	Medium-grade	High-grade	Low-grade	Medium-grade	High-grade
	(1)	(2)	(3)	(4)	(5)	(6)
Sea distance	-0.001***	-0.001***	-0.001***			
	(0.000)	(0.000)	(0.000)			
Access to the sea				0.154***	0.138***	0.133***
				(0.020)	(0.014)	(0.014)
Gold prices	-0.000***	0.000	0.000	-0.000***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Voice and accountability	0.027	0.026	0.028	0.017	0.020	0.023
	(0.031)	(0.023)	(0.023)	(0.030)	(0.021)	(0.022)
Government effectiveness	-0.045*	-0.012	-0.007	-0.041*	-0.011	-0.007
	(0.026)	(0.018)	(0.018)	(0.024)	(0.017)	(0.017)
Polity 2 score	-0.007**	-0.004*	-0.003*	-0.005**	-0.002	-0.002
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Constant	2.251***	1.783***	1.703***	0.652***	0.328***	0.292***
	(0.226)	(0.156)	(0.165)	(0.045)	(0.038)	(0.041)
Observations	293	293	293	310	310	310
R-squared	0.876	0.790	0.769	0.877	0.788	0.767

Source: *Author. Robust standard errors are in parentheses.* *** *p<0.01,* ** *p<0.05,* * *p<0.1*

Thirdly, we once again use our sea access variable as a proxy to assess the effect of distance. Columns 4, 5 and 6 of Table 5 show the results for different types of mines. Access to the sea has a positive impact on

AETRs. Countries with access to the sea are likely to have a minimum distance between the capital and the relevant port. All these different results are robust compared to our baseline estimates.

VI CONCLUSION AND IMPLICATIONS

A major challenge for the governments of Africa's gold-producing countries is the perpetual quest to maximise mining revenues. To this end, some try to employ a combination of other tax instruments, according to their own preferences. For example, some countries choose production-based taxes because they secure state revenues independently of the company's profitability. Others will focus on profit-based taxes, even though these taxes are often the object of tax evasion by companies. Our paper employs the OLS method, controlled for time and country fixed effects, to evaluate the impact of the distance between the sea and the mineral-producing country in 22 African gold-producing countries over the period 2000 to 2020.

Our findings reveal the following: (i) There is a negative association between the proportion of profit-based taxes in the AETR and the distance from the sea. The greater the distance between the sea and the mineral-producing country, the greater the increase in production costs, reducing the proportion of profit-based taxes. (ii) There is a positive correlation between the proportion of production-based taxes associated with the distance to the sea. However, the effect of this positive correlation is absorbed by the negative correlation between profit-based taxes and the country's distance from the sea when evaluating the effect of distance on the AETR.

In terms of policy implications, African gold-producing countries must take into account access to the sea in employing rent taxation instruments. Countries with no ports should opt for production-based taxation instruments rather than profits-based taxes.

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APPENDIX

Table 6: *African countries where gold is mined annually (units indicated in kg)*

Country	2017	2018	2019	2020	2021
Algeria	137	286	70	59	71
Angola (*)	–	–	23	59	35
Benin (*)	5	5	5	5	5
Botswana	913	1105	942	851	650
Burkina Faso (*)	46436	52898	51500	62470	66000
Burundi	1742	1898	1599	863	847
Cameroon (*)	713	478	1599	450	450
Central African Republic	118	142	341	401	858
Congo (*)	150	150	150	150	150
RDC (*)	37100	43800	43000	40000	42000
Egypt	16941	14694	14946	14069	12919
Equatorial Guinea	200	200	200	200	200
Eritrea	2700	3700	3700	3800	4600
Eswatini (Swaziland)	–	12	6	1	–
Ethiopia	4704	2570	3180	3320	9560
Gabon (*)	600	83	107	110	100
Ghana (*)	133303	149216	146780	125874	87677
Guinea (*)	46847	25823	27708	91800	99371
Côte d'Ivoire (*)	25395	24488	32568	38523	41800
Kenya (*)	503	472	395	150	292
Liberia	6071	7289	5068	4396	7860
Madagascar (*)	2833	3000	2100	1500	–
Mali (*)	51500	61000	63000	65000	69400
Mauritania (*)	9096	9235	13554	14125	6302
Morocco	220	386	221	143	147
Mozambique	166	507	430	488	764
Namibia	7469	6632	6526	6254	7103
Niger (*)	914	6207	5224	2361	4010
Nigeria (*)	19000	18000	9000	5000	3000
Rwanda	8800	18100	11400	11532	6500
Senegal (*)	11700	14900	16100	14600	18800
Sierra Leone (*)	142	464	75	14	92

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Country	2017	2018	2019	2020	2021
South Africa (*)	136833	117150	105185	95789	105019
South Sudan	200	200	200	200	200
Sudan	107300	93600	55400	35700	49700
Tanzania (*)	43489	39304	48408	55508	59638
Togo	20000	10000	10000	10000	10000
Uganda	4	12	10	7	7
Zambia (*)	4373	4044	4522	3994	3987
Zimbabwe (*)	23929	35054	29429	20873	31477

Source: *Critical Minerals Centre. (*) Gold-producing countries (except Chad) according to the FERDI database (including Chad). https://nora.nerc.ac.uk/id/eprint/534316/*

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