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A tax competition approach to resource taxation in developing countries

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A tax competition approach to resource taxation in developing countries [1]

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Abstract

In this paper, we investigate the effect of cost misreporting of extractive firms on the optimal design of tax policies. We build a two-period, two-country model where governments aim to attract a foreign-owned multinational firm to raise tax revenues by levying a profit tax and a royalty. The firm overstates its production costs and decides in which country to locate. We find that cost overstatement pushes royalties upward but remains detrimental for tax revenues as well as capital invested by the firm. The mining country that attracts the extractive firm is often the country with the highest coefficient of overstatement. However, the firm may locate in the country with the lowest overstatement and lowest royalty if both countries have the same profit tax.

Keywords: Resource countries, Rent taxes, Royalties, Cost misreporting.

JEL Classification: H25, H32, O13

1 Introduction

The strong dependence of some developing countries on extractive resources is a well-known source of vulnerability. Most of these countries have low tax rates and often proceed by trial and error in using various instruments to tax the rent on non-renewal resources. Previous research suggests the use of both royalties and profit taxes (corporate income tax, for example) among a range of other tax categories for extracting resources (IMF 2012). While it is usually easy to show the distortive character of an *ad-valorem* tax levied directly on the extraction of the resource (the royalty), the analysis becomes more interesting when considering the possibility for mining companies to reduce their taxable income by cost manipulation. Boadway and Keen (2010 and 2015) justify the use of profit taxes and royalties in presence of asymmetries of information. This aspect is particularly relevant for low-income countries where governments have a severe informational disadvantage vis-à-vis resource extraction companies (Collier 2010).

Among the open questions, an important one concerns the pressures from international tax competition for attracting mining companies on resource tax policy. In this paper, we aim to give some insight into this issue. More specifically, we contribute to the research on tax design for extractive resources in low-income countries under international tax competition. We build a partial equilibrium model of two countries where the government sets royalties and profit taxes to attract a foreign extractive firm.

A number of signals and stylized facts observed in sub-Saharan Africa tend to suggest the presence of forms of international tax competition for attracting multinational mining companies[1]. For instance, in sub-Saharan Africa, reforms of mining codes began in the 1980s and were generalized across the African continent in the 1990s. They led to the widespread adoption of liberalized mining codes, the wholesale privatization of state companies, an end to foreign ownership restrictions, and decreased rates of taxation and royalties (Laporte *et al.* 2016). The new codes are designed

[1] To the best of our knowledge, there is no econometric analysis on international tax competition for resource extraction in developing countries. Unfortunately, despite the progress generated by the Extractive Industries Transparency Initiative (EITI), the available data do not allow for the construction of a relevant taxation indicator on an extended period.

to attract foreign investment through various incentives to foreign mining companies (Campbell 2010; Besada and Martin 2013; Moussa *et al.* 2015). Thus the framework for an international tax competition is in place. In 2014, the Ivorian Parliament approved a new mining code, with the aim of attracting more international investors in gold extraction, which has long been neglected in this country, compared to its neighbors. A special tax on exceptional profits has been removed from the project.[2] In March 2016, the government of Ghana agreed to lower the corporate tax from 35% to 32.5% in addition to lowering the royalty rate for Gold Fields, a South African company that was reviewing a $100 million expansion of gold mining operations in the country.[3] In addition, in Zambia, some initiatives were taken in 2015 to redesign the mining tax regimes in order to make the country more attractive to foreign investors.

The specialized press regularly reports issues typically associated with strategies consistent with international tax competition to attract mining companies. For example, the Fraser Institute conducts an annual survey asking managers of mining companies to grade countries and states according to their investment potential (Fraser Institute 2015). An index of perceived attractiveness is constructed on the basis of 15 policy factors that influence company decisions to invest in various jurisdictions. Taxation features (including personal, corporate, payroll, capital and other taxes, and the complexity of tax compliance) appear prominently. In regards to African countries, in the 2015 report, the changes in fiscal regimes is the most commonly mentioned topic in the comments made by top executives to justify their gradings, followed by corruption issues. According to a United Nations survey of mining companies in 2005, 60% of the top 10 decision criteria a prospective mining investor considers before undertaking a mining project are tax related (EY, 2015).

In this paper, we set a model of tax competition between two countries that aim to attract a foreign-owned multinational firm. The firm chooses its location by taking into account the

[2] These new fiscal measures are greatly appreciated by the mining company, Randgold (based in Caïman), and can also be found in other African countries (citation here)

[3] This large mining company, with operations from Australia to Peru, had not yet decided whether to inject more cash into the project or keep the gold in the ground.

tax burden, royalties and rent tax to be paid in each country. Tax authorities in each country must rely on self-reporting by the firm to establish tax liabilities, which - though the government has an opportunity to audit those reports - puts firms in a position of informational advantage. This asymmetry is always present, but is particularly marked in the resource sector in developing countries. More specifically, following Boadway and Keen (2005), we assume that the resource firm purposefully overstates its costs, with the aim of paying lower taxes. The tax authority in the developing country is unable to identify the overstatement. The two governments need to decide the optimal tax policy to attract the firm to their the country while still collecting the highest possible tax revenue. A conflict is inherent because higher taxes increase tax revenues but may push the firm towards the other country. In such a setting, we analyze the role of royalties in tax competition. In the absence of information about how firms decide the rate of cost overstatement, we analyze two scenarios. In the first, the rate of overstatement of productions costs is a constant coefficient. In the second scenario, costs are overstated with a coefficient that depends positively on the profit tax in the country.

Our main results can be summarized as follows. Under a constant rate of overstatement, asymmetries of information are detrimental for all agents – for the governments as well as for the firms' profits. Furthermore, inefficiencies are amplified because in order to be attractive, a country will decrease the profit tax rate and increase the royalty. Under a variable rate of cost overstatement, asymmetries of information bring advantages to the firm while remaining detrimental for tax revenues. Moreover, variability in the overstatement rate neutralizes the role of the profit tax as a tool for attractiveness. In this scenario, the foreign firm locates where she can overstate the most, regardless of the level of the profit tax.

Our study contributes to two strands of the existing literature, namely the optimal tax policy design in extractive industries and the international public economics literature.

Since the pioneering work of Hotelling (1931) and Brown (1948), an abundant literature on resource taxation has focused on tax instruments capable of capturing a portion of the specific rents in the mining industry. Indeed, the distinctive features of extractive industries as the relatively fixed supply, collective ownership of resources and information asymmetry can legitimate an inefficient taxation as royalties (Boadway and Keen 2010). Royalties involve inefficient resource exploitation (depletion) and tend to take complex forms in order to be more responsive to profitability (Garnaut and Clunies-Roos 1975, 1983; Otto *et al.* 2006). Taxation engineering has been developed to model the effects of various taxes on extractive resources (cf. the survey by Smith 2013). In our paper, following Boadway and Keen (2010 and 2015), we are *not* interested in exploring the different types of royalties and rent taxes, but rather focus on a combination of a simple royalty and a profit tax introduced into a tax competition setting.

The tax competition literature has generally neglected the extractive industries. These industries, such as mining for instance, are unique and not easily compared to other generic sectors. Countries hosting mines must compete for highly mobile international exploration and development investment capital. Furthermore, many mines are hosted by developing countries that suffer from a lack of expertise in mining that negatively affects their ability to verify the tax declarations of foreign firms. Hence, classical tax competition models are unadapted to analyzing the effect of tax competition on tax design in the extractive sectors of developing countries. The objective of this paper is to offer a suitable setting to highlight the specificities of these industries and corresponding countries in the context of open economies. The classical tax competition literature concentrates on the size of the countries, finding that the firm always invests in the larger country when the home market effect is stronger than the tax incentives offered by the small country (Haufler and Wooton 1999). Market size plays a minor role when countries broaden their fiscal instruments by competing not only through taxes, but also through the level of infrastructure that boosts the profits of firms (van Ypersele and Thisse; Benassy-Quéré *et al.* 2007; Zissimos and Wooders 2008; Zissimos and Wooders 2008; Hindriks *et al.* 2008; Pieretti and Zanaj 2011). Barros and Cabral (2000) consider a subsidy game between asymmetric countries aiming to attract foreign direct investments to alleviate unemployment. In equilibrium, the winner is the country that gains the most in terms of employment for given transportation costs. Here, we outline a similar game where two countries where the government sets royalties and profit taxes to attract a foreign extractive firm in the context of cost overstatement by the firm.

The structure of the paper is as follows. Section 2 sets out the model. Sections 3 and 4 develop two scenarios of cost overstatement: constant and variable cost overstatement, respectively. In Section 5, we present the tax choices in the absence of cost overstatement to underscore the effect of these asymmetries of information. Conclusions are provided in Section 6.

2 The model

Consider a two-period-two-country model with the countries denoted by a and b. Each country hosts a mine that can be exploited by a foreign firm.[4] Each government imposes an *ad valorem royalty* at rate θ_i, $i = a, b$ on the revenues of the extracting firm and *a profit tax* on reported rents/profits at rate τ_i, $i = a, b$. The tax authority in each country relies on self-reporting by the firm in order to establish its tax liabilities, putting the firm at a significant informational advantage compared to the tax authority.

A resource firm decides which mine to exploit while operating in a competitive commodity market. Previous work has shown that, for instance, in the global market for gold,[5] the price of the extracted good p is fixed on the global market. The price p is than charged irrespective of the country in which the good is sold. For simplicity and without loss of generality, we set $p = 1$.

The resource firm is a foreign-owned multinational that decides to locate its branch either in country a or b. The monopoly condition of the mine is dictated by the nature of the market. As a matter of fact, the right to exploit a mine is usually given to only one firm. The firm is risk-neutral and capital markets are competitive and efficient.

The technology is simplified so that the producer incurs capital costs for exploration and development in the *first period*, and only costs of extraction in the *second period*, when the resource is being exploited. Hence, the resource firm incurs an initial investment K in the first period

[4] We focus on the effects of *international* tax competition on tax design and therefore make the simplifying assumption that only foreign multinational firms that are mobile can exploit the mine.

[5] The price-taking behavior of the extractive firm in the market for the resource is documented in O'Connor *et al.* 2016.

in order to generate a quantity of the resource $q(K)$ with certainty in the second period. The corresponding extractive costs in the second period are given by $C\left[q(K)\right], \ \partial C\left[q(K)\right]/\partial K > 0; \partial^2 C\left[q(K)\right]/\partial^2 K > 0$. Finally, under competitive and efficient global credit markets, the resource firm can borrow and lend at a competitive risk-free interest rate r which then constitutes its discount rate factor for future period profits.

The key assumption of the model is that the resource firm may overstate production costs by multiplying these costs by a factor β that exceeds one. The tax authority is unable to know the nature of the cost of the firm, hence it is unable to determine whether the factor β is cost overstatement or it is part of the production costs of the firm.

Two scenarios are analyzed. In the first, overstatement is an exogenous, country specific, *tax independent*, fixed coefficient β_i

$$\beta_i \geq 1, i = a, b,$$

whereas in the second scenario, the overstatement is assumed to be a linear function of the *profit tax* τ_i

$$\beta_i \tau_i \geq 1, \ i = a, b.$$

In second scenario, as in Boadway and Keen (2010) the higher the rent tax in the country, the higher the firm's incentive to overstate its costs.

In both scenarios, we assume that overstatement is country specific, suggesting that a firm may behave differently depending on the country in which it decides to locate. This may be due to the level of corruption in a country or the country's lack of expertise. The higher the level of corruption or the more accentuated the absence of expertise in mining technologies, the larger the door to cost overstatement.

The two governments are assumed to be risk-neutral, to be imperfectly informed, and to be able to commit to the tax policy they announce before location takes place. This time consistency of the tax policy may be guaranteed by international contracts law.

The objective function of the government intervention is to raise revenues as well as to attract the firm to the country. The two governments anticipate that the firm will select its location based on profits after tax and thus the governmental decision is affected by the classical horizontal tax externality.

In the next section, we investigate the scenario of constant overstatement. First, we define the optimal tax policy and the corresponding capital investment, then we analyze the tax competition aspects. In Section 4, we turn our attention to the scenario of tax-dependent overstatement, where we again look at the optimal capital investment as well as the location decision of the firm in a tax competition setting.

3 Optimal tax design under constant overstatement

3.1 Absence of tax competition

The firm maximizes her *real* profit to fix the amount of capital to invest. The optimal level of capital invested depends on the cost overstatement rate applicable in the country through the tax policy mix. To obtain closed form solutions, in line with the existing literature (Boadway and Keen 2010 and 2015), we assume that the final transformation is a linear function $q(K) = \alpha K$ whereas extractive costs are, for simplicity, quadratic $C(q(K)) = \frac{1}{2}\left[\frac{1}{\alpha}q(K)\right]^2$. We assume $\alpha > 1 + r$: the productivity of the transformation technology pays more than the intertemporal investment of a unit of capital.

The firm maximizes the following profit function, which is composed of two parts. The first part is the initial capital invested in the first period K, and the second is the net present value of the total revenues from selling the final output quantity $(1-\theta_i)\alpha K$ minus the extraction costs $\frac{1}{2}K^2$:

$$\Pi_i(\theta_i, \tau_i) = (1-\tau_i)\left(-K + \frac{(1-\theta_i)\alpha K - \frac{1}{2}K^2}{1+r}\right),\ i = a, b \tag{1}$$

Being concavity conditions, optimal capital investment as a function of taxes is given by:

$$K_i(\theta_i) = \alpha\,(1-\theta_i) - r - 1 > 0 \tag{2}$$

The government in each country i, $i = a, b$, decides the tax policy mix (τ_i, θ_i) anticipating the choice of the firm. We assume that the government maximizes the amount of tax revenues $R(\tau_i, \theta_i)$ taking into account the real initial investments $K(\theta_i)$ and the profits under conditions of asymmetric information:

$$R_i(\tau_i, \theta_i) = \frac{1}{1+r}\left\{\theta_i\left[\alpha K(\theta_i)\right] + \tau_i\left[(1-\theta_i)\,\alpha K(\theta_i) - \beta_i \frac{1}{2}\left[K(\theta_i)\right]^2\right]\right\},\ i = a, b.$$

We check that concavity conditions are satisfied with respect to the royalty while the decision of the profit tax is a corner solution. Define $\tau_i^{\max}$,$i = a, b$, as the maximum rate that the government in country i can fix as profit tax. The optimal policy mix is as follows:

Proposition 1 *Assuming a constant coefficient of cost overstatement, a government maximizing its tax revenue selects*

$$\theta_i^* = \frac{\left(1 + r - 2\alpha + \beta_i\left(\alpha - 1 - r\right)\right)\tau_i^{\max} + \left(\alpha - 1 - r\right)}{\alpha\left(2\left(1 - \tau_i^{\max}\right) + \beta_i \tau_i^{\max}\right)} \tag{3}$$

$$\tau_i^* = \tau_i^{\max} \tag{4}$$

Positivity of the optimal royalty is guaranteed under the condition

$$\alpha > (r+1)\,\frac{1 + \tau_i^{\max}\left(\beta_i - 1\right)}{1 + \tau_i^{\max}\left(\beta_i - 2\right)}. \tag{5}$$

Comparative statics on optimal royalty yields

$$\frac{\partial \theta_i^*}{\partial \beta_i} = \tau_i^{\max}\frac{\alpha - \left(1 - \tau_i^{\max}\right)(1+r)}{\alpha\left(-2\tau_i^{\max} + \beta_i \tau_i^{\max} + 2\right)^2} > 0,$$

whereas the relationship between the royalty and the profit tax is more complex and depends on the size of the coefficient of overstatement. If $\beta_i > 2\alpha/\left(\alpha - r - 1\right),\ i = a, b$, then $\frac{\partial \theta_i^*}{\partial \tau_i^{\max}} > 0$, otherwise, $\frac{\partial \theta_i^*}{\partial \tau_i^{\max}} < 0$. A reasonable assumption about the range of values for the coefficient of overstatement is that β_i, $i = a, b$, does not exceed two. Hence, for $\beta_i < 2$, $i = a, b$, the inequality $\beta_i < 2\alpha/\left(\alpha - r - 1\right)$ is satisfied, leading to a negative relationship between the profit tax and the royalty.[6]

[6] Notice that if $\beta_i > 2$, $i = a, b$, then overstatement is so high that the government optimally selects tax instruments that are complements (the higher the profit tax, the higher the royalty) trying to offset the large loss in tax revenue.

Summarizing,

Lemma 1. *The optimal royalty increases with the coefficient of overstatement but decreases with the optimal profit tax.*

Using Proposition 1 and Lemma 1, we find that in the presence of asymmetric information, a revenue-maximizing government selects the highest possible profit tax and the lowest royalty. This property is reminiscent of well-known results in the existing literature on optimal taxation. Royalties bring distortive effects on tax revenues because they increase the burden of taxation on firm revenues while neglecting the firm's costs. The optimal tax policy that alleviates this distortion will privilege high-profit taxes while reducing royalties as much as possible. We confirm the same result in presence of asymmetries of information between the government and the firm(s).

The optimal level of royalties depends positively on the coefficient of overstatement of costs. Our result suggests that in a developing country hosting a mine and whose government maximizes tax revenues, two forces exist that have opposing effects on royalties. The first force is the effect of the profit tax, whereas the second force is the influence of the misreporting coefficient. This implies that royalties may or may not be higher in countries where overstatement is more difficult.

The optimal capital investment obtains as

$$K_i^* = \frac{\alpha - \left(1 - \tau_i^{\max}\right)(1 + r)}{2\left(1 - \tau_i^{\max}\right) + \beta_i \tau_i^{\max}}, i = a, b$$

Comparative statics on capital invested yield $\frac{\partial K_i^*}{\partial \beta_i} < 0$; and furthermore $\frac{\partial K_i^*}{\partial \tau_i^{\max}} > 0$ for $\beta_i < 2$. Hence,

Lemma 2. *The optimal level of capital invested depends negatively on the coefficient of overstatement and positively on the profit tax.*

The positive relationship between the capital invested and the profit tax is surprising. This association is based on the effect of the profit tax on the royalty rate. Recall that for $\beta_i < 2$, $i = a, b$ the royalty decreases with the profit tax rate. Hence, a higher profit tax implies lower royalties, which leads to an increase in the capital invested.

Finally, we can evaluate the real profit of the firm and the tax revenue for the government at the optimal taxes:

$$\Pi_i^* = \frac{(1-\tau_i^{\max})}{2(1+r)} \frac{\left(\alpha - r - 1 + \tau_i^{\max}(1+r)\right)^2}{\left(2 - \tau_i^{\max}(2-\beta_i)\right)^2} > 0, \ \ i = a, b$$

and

$$R_i^* = \frac{1}{2} \frac{\left(\alpha - r - 1 + \tau_i^{\max}(1+r)\right)^2}{2 - (2-\beta_i)\,\tau_i^{\max}} > 0, i = a, b$$

As expected, the overstatement of production costs has a negative impact on tax revenues $\frac{\partial R_i^*}{\partial \beta_i} < 0$. Interestingly, cost overstatement also has detrimental effects on a firm's profits. Indeed $\frac{\partial \Pi_i^{R^*}}{\partial \beta_i} < 0$. The overstatement of costs induces the government to raise royalties in order to offset the negative impact of amplified costs, ultimately leading to negative effects on a firm's profits.

3.2 Tax competition

In this section, we assume that the foreign firm can place its investment in one of two countries. What is the optimal level of policy mix that allows the government to not only maximize tax revenues but also attract the firm to its territory? The firm locates in country a if and only if $\Pi_a^* > \Pi_b^*$.[7] Note that even if our setting remains quite simple, there are several forces in place that attract or repel a firm from a country. The magnitude of the coefficient of overstatement positively affects the royalty rate but has a negative effect on the capital invested. The profit tax directly affects the profit after tax, but also the royalty rate, which in turn affects the capital invested. Therefore, a high level of overstatement is not in itself attractive because overstatement affects positively the royalty rate. But higher overstatement combined with a higher profit tax may lead to more capital being invested and therefore higher profits, making the country attractive. Then, one can naturally ask what is the balance of these forces and under what conditions is that balanced reached?

We proceed in steps to analyze the balance of the aforementioned forces.

[7] It is important to notice that the location decision is made considering the real profit and not the declared one.

We first offset the effect of the difference in overstatements by assuming countries are characterized by the same overstatement i.e. $\beta_i = \beta_j = \beta$. Then, the profit differential $\Delta\Pi \equiv \Pi_a^* - \Pi_b^*$ is

$$\Delta\Pi = \frac{1}{2(r+1)}\left(\frac{\left(1-\tau_i^{\max}\right)\left(\alpha-r-1+\tau_i^{\max}+r\tau_i^{\max}\right)^2}{\left(-2\tau_i^{\max}+\beta\tau_i^{\max}+2\right)^2} - \frac{\left(1-\tau_j^{\max}\right)\left(\alpha-r-1+\tau_j^{\max}+r\tau_j^{\max}\right)^2}{\left(-2\tau_j^{\max}+\beta\tau_j^{\max}+2\right)^2}\right)$$

To analyze the sign of the above difference notice that $\Delta\Pi$ is the difference of the same function evaluated at two different levels of the profit tax $\tau_i^{\max}$. Hence, to sign the difference $\Delta\Pi$ it is useful to check the sign of the derivative $\frac{\partial\Pi_i^*}{\partial\tau_i^{\max}}$. We prove that this derivative can take a positive or a negative value depending on the level of profit taxes $\tau_i^{\max}$ (see Appendix A). In Appendix A, we define a threshold value $\tilde{\tau}$ for $\tau_i^{\max}$. The derivative $\frac{\partial\Pi_i^*}{\partial\tau_i^{\max}}$ is positive for $\tau < \tilde{\tau}$, and negative for $\tau > \tilde{\tau}$.

It follows that if $\tau_i^{\max}$ and $\tau_j^{\max}$ lie in the interval $\tau < \tilde{\tau}$, where the derivative is positive, then locating in the country with a higher $\tau_i^{\max}$ gives greater profit. However, if $\tau_i^{\max}$ and $\tau_j^{\max}$ lie in the interval $\tau > \tilde{\tau}$, where the derivative is negative, then locating in the country with a lower profit tax offers a higher profit, as more classically expected.

The result is summarized in the following proposition:

Proposition 2 *Assume countries have the same cost overstatement. Tax competition privileges the country offering the highest profit tax if profit taxes in both countries do not exceed a threshold value $\tilde{\tau}$. By contrast, if profit taxes are set higher than $\tilde{\tau}$ in both countries, then the firm locates in the country with the lowest profit tax.*

Notice that optimal royalties of each country θ_i^* and θ_j^* differ even though the level of overstatement is for the time being the same, because profit taxes are different (see expressions 3). Interestingly,

Remark *When $\tau < \tilde{\tau}$, in the attractive country $\tau_i^{\max} > \tau_j^{\max}$ but $\theta_i^* < \theta_j^*$, $i, j = a, b$, $i \neq j$. By contrast, when $\tau > \tilde{\tau}$, $\tau_i^{\max} < \tau_j^{\max}$ but $\theta_i^* > \theta_j^*, i, j = a, b, i \neq j$!*

The above Proposition and Remark show the interplay between the profit tax and royalties as means of attractiveness. As long as the profit taxes do not exceed a threshold value in both countries, then the highest profit tax determines the lowest royalty and the highest invested capital, making the country with the highest profit tax attractive. Then, the instrument of attractiveness is the low royalty.

When profit taxes in both countries are fixed at levels that exceed a certain threshold, then the firm tries to avoid the countries with the highest profit tax. In this range of values, the profit tax becomes the instrument of attractiveness, regardless of the corresponding level of the royalty.

We now turn to the role of the rate of overstatement in the tax competition game. To do so, for the time being, we switch off the role played by the profit tax differential assuming $\tau_i^{\max} = \tau_j^{\max} = \tau$.

Then, the firm decides where to locate by the sign of the profit differential:

$$\Delta\Pi = \Pi_j - \Pi_i = \left(\beta_i - \beta_j\right) \tfrac{(1-\tau)(\alpha-1-r+\tau(1+r))^2}{2(1+r)} \tau \tfrac{4(1-\tau)+\tau\left(\beta_i+\beta_j\right)}{\left(2+\tau\left(\beta_j-2\right)\right)^2 (2+\tau(\beta_i-2))^2} \tag{6}$$

The study of the profit differential leads to the following result:

Proposition 3 *Assume the same profit tax in each country. The firm locates in the country with the lowest cost overstatement.*

Proof. The sign of the difference (6) is given by the sign of $4 - 4\tau + \tau\left(\beta_i + \beta_j\right)$. Since $0 < \tau < 1$, then $4 - 4\tau + \tau\left(\beta_i + \beta_j\right) > 0$, implying $\Pi_j - \Pi_i > 0$ iff $\left(\beta_i - \beta_j\right) > 0 \Leftrightarrow \beta_j < \beta_i$, $i, j = a, b$, $i \neq j$. ■

The intuition behind the above proposition lays in the relationship between the cost overstatement, the royalty and the optimal invested. Recall that the lower the cost overstatement, the lower the royalty and the higher the capital invested. Therefore, *when profit taxes of both countries are the same, the most attractive location corresponds to the country with the lowest cost overstatement, where the royalty paid is the lowest and capital invested is the highest.*

The final scenario to consider embodies the interplay between the role played by the overstatement, which determines the royalty, and the magnitude of the profit tax. From Proposition

1 and 2, we already know that the country with the lowest profit tax and lowest overstatement may win the tax competition, if profit taxes in both countries are set quite high. It remains to be checked whether it possible for the country with the highest overstatement and highest profit tax to attract the firm? Is it possible for the country with the highest overstatement but the lowest profit tax to win the tax competition? To answer these questions, a direct comparison of the profits is needed. For any value of the overstatement coefficient and the profit tax, this comparison is cumbersome. Nonetheless, we can easily prove that both configurations, namely highest overstatement and highest profit tax, as well as highest overstatement and lowest profit tax, may appear as optimal choices of a country that successfully attracts the foreign firm.

We graph in Fig 1 the profit function of the firm corresponding to location in country a and in country b. The bold curve corresponds to the country with the highest profit tax. We use admissible values for all our parameters and express the profits as functions of β. We see that there exists a threshold value, call it $\tilde{\beta}$, where the two profit curves cross.

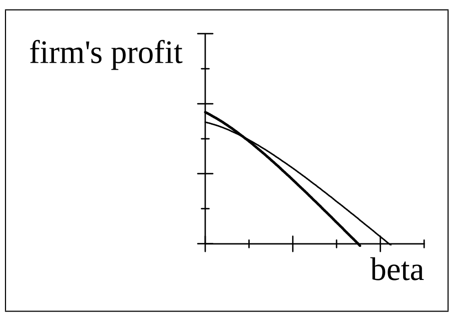

Fig 1: Firm's profits in country a and in country b as functions of cost overstatement.

Hence, a firm locates in the country with the highest profit tax if $\beta < \tilde{\beta}$. Conversely, the firm locates in the country with the lowest profit tax if the rate of overstatement exceeds $\tilde{\beta}$. The reason for attractiveness for $\beta < \tilde{\beta}$ is the lower royalty.

Hence,

Proposition 4 *If the rate of overstatement in a country remains relatively low, then a country is attractive for foreign firms through low royalty. If the rate of overstatement is relatively high, then a country is attractive for foreign firms through low profit tax.*

Our analysis shows countries suffering from a high overstatement, the inefficiencies related to royalties are amplified. Indeed, to be attractive, these countries fix low profit taxes, which in turn increases royalties. This result is in line with our stylized facts, in the introduction, on the evolution of the taxation of gold extraction in Africa.

To conclude, we observe that international attractiveness is not built using policy taxation exclusively, but rather, attractiveness also depends on the level of cost overstatement. A very low overstatement of costs (lower β) combined with a certain level of profit tax (even greater than the level of profit tax in the rival country) leads to small royalties, which makes the country attractive. We can conclude that to be attractive, the government either needs to reduce informational asymmetry by bolstering its expertise in extractive activities, or fight against corruption.

4 Optimal tax design under variable overstatement

4.1 Absence of tax competition

In this section, we assume that the coefficient of overstatement is a function of the *profit tax* τ_i, namely $\beta_i\tau_i$, $i = a, b$ as suggested by Boadway and Keen (2010). Hence, the higher the profit tax in the country, the higher the incentive for the firm to overstate its costs. As above, a firm maximizes the profit function given by expression (1) to determine the optimal capital investment as a function of taxes, given (as above) by

$$K(\theta_i) = \alpha (1 - \theta_i) - r - 1 > 0, \; i = a, b. \tag{7}$$

The government maximizes tax revenues $R(\tau_i, \theta_i)$ taking into account the real initial investments $K(\theta_i)$ and the declared profits of the firm, which now include $\beta_i\tau_i$:

$$R_i(\theta_i,\tau_i) = \frac{1}{1+r}\left[\theta_i(\alpha(\alpha-r-\alpha\theta_i-1)) + \tau_i\left((1-\theta_i)\alpha(\alpha-r-\alpha\theta_i-1) - \beta_i\tau_i\frac{1}{2}(\alpha-r-\alpha\theta_i-1)^2\right)\right]$$

In contrast to the scenario of constant overstatement, concavity conditions are satisfied for both the profit tax and the royalty, yielding interior solutions for both tax instruments.

Proposition 5 *Under a variable cost overstatement, the government decides on the following optimal tax mix* $(\check{\theta}_i, \check{\tau}_i)$*:*

$$\check{\theta}_i = \frac{\alpha(\beta_i-1) - \beta_i(1+r)}{\alpha(2\beta_i-1)}, \check{\tau}_i = \frac{1+r+\alpha}{(1-\beta_i)(1+r)+\beta_i\alpha}, i = a, b. \tag{8}$$

Positivity of the optimal royalty is guaranteed by the condition (5). The corresponding optimal capital invested is now:

$$\check{K}_i = \frac{1+r+\beta_i(\alpha-r-1)}{2\beta_i-1}, i = a, b.$$

Comparative statics with respect to the coefficient of overstatement lead to the following results

Lemma 3. *The coefficient of overstatement* β_i *positively affects the profit tax but lowers both the royalty and the optimal capital invested.*

Proof. Taking the partial derivative, we obtain $\frac{\partial\check{\tau}_i}{\partial\beta_i} = \frac{r+\alpha+1}{\alpha(2\beta_i-1)^2} > 0$; $\frac{\partial\check{\theta}_i}{\partial\beta_i} = (r+\alpha+1)\frac{r+1-\alpha}{(-r+\beta_i+r\beta_i-\alpha\beta_i-1)^2} < 0$; $\frac{\partial\check{K}_i}{\partial\beta_i} = -\frac{r+\alpha+1}{(2\beta_i-1)^2} < 0$. ■

Note that under constant overstatement of costs, the coefficient of overstatement β_i increases the royalty rate but does not have a direct effect on the profit tax rate. In contrast, variable overstatement increases the profit tax but lowers the royalty.

Finally, the firms' profits $\check{\Pi}_i$ and the tax revenue for the government $\check{R}_i$ evaluated at the optimal policy mix obtain as

$$\check{\Pi}_i = \frac{1}{2}\beta_i(\alpha-r-1)\frac{\alpha(\beta_i-1)-\beta_i(1+r)}{(2\beta_i-1)^2(1+r)}, \ i = a, b$$ [8]

and

$$\check{R}_i = \frac{1}{2}\frac{(r-\alpha+1)^2\beta_i + 2\alpha(r+1)}{2\beta_i-1}, \ i = a, b$$

The overstatement of production costs still has a negative impact on tax revenues $\frac{\partial R_i^*}{\partial \beta_i} < 0$. In contrast to the preceding scenario however, cost overstatement now has beneficial effects on the firm's profits. Indeed, $\frac{\partial \Pi_i^{R^*}}{\partial \beta_i} > 0$. Variable overstatement of costs induces the government to lower royalties, leading to a positive final effect on a firms' profits.

4.2 Tax competition

Taxes being interior solutions, in this scenario, the profit depends solely on the coefficient of overstatement, $\beta_i, i = a, b$. We know that $\frac{\partial \check{\Pi}_i}{\partial \beta_i} > 0$. This implies that

Proposition 6 *Assuming a variable cost overstatement, the mining country that attracts the extractive firm is the country with the highest coefficient of overstatement and the lowest royalty.*

To summarize, under variable overstatement, the distortion of asymmetric information becomes even more accentuated. A firm decides to locate where overstatement is the highest, even if the profit tax is also the highest. This choice of location distorts the capital invested, which depends negatively on β_i. Hence, variable overstatement not only distorts the tax choices of the government, but also the level of capital invested.

5 Optimal tax design in the absence of overstatement

We are now in a position to underscore the distorting effects of cost overstatement on tax policies and the capital invested by the firm. To do so, we check the optimal tax policy in absence of cost overstatement. The capital invested as a function of the royalty is again given by the expression (2). Thus, tax revenues write as

$$R(\theta_i, \tau_i) = \theta_i (\alpha K(\theta_i) + \tau_i \left((1-\theta_i) \alpha K(\theta_i) - \frac{1}{2} K(\theta_i)^2 \right), \ i = a, b$$

The maximization of tax revenues gives the following optimal choice for the government:

$$\bar{\theta}_i = \frac{\alpha - 1 - r - \alpha\bar{\tau}_i^{\max}}{\alpha\left(2-\tau_i\right)}, i = a, b$$
$$\bar{\tau}_i = \tau_i^{\max}, i = a, b$$

Choosing the maximum possible profit tax yields the lowest possible royalty, since $\partial\bar{\theta}_i/\partial\tau_i^{\max} < 0$. The corresponding optimal capital invested is

$$\bar{K}_i = \frac{\alpha - r - 1 + \tau_i^{\max}\left(1+r\right)}{2-\tau_i^{\max}},\ \ i = a, b$$

Evaluating the profit for the firm and the tax revenues at the optimal tax rates, we obtain

$$\bar{\Pi}_i^{\text{real}}(\theta_i, \tau_i) = \frac{1}{2}\left(1-\tau_i^{\max}\right)\frac{\left(\alpha - r - 1 + \tau_i^{\max}\left(1+r\right)\right)^2}{\left(\tau_i^{\max}-2\right)^2\left(1+r\right)}, i = a, b$$

and

$$\bar{R}_i = \frac{1}{2}\frac{\left(\alpha - r - 1 + \tau_i^{\max}\left(1+r\right)\right)^2}{2-\tau_i^{\max}}, i = a, b.$$

To evaluate the impact of cost overstatement on taxes and capital invested by the firm, as well as profits and tax revenues, we compare these choices under overstatement and in the absence of overstatement. We start with the scenario of constant overstatement. By direct comparison we obtain

Proposition 7 *Constant overstatement of production costs puts upward pressure on the royalty and downward pressure on the capital invested, lowering both the firms' profits and the governments' tax revenues, as compared to the scenario with absent overstatement.*

Proof. The difference in optimal royalties is given by

$\tau_i^{\max}\left(\beta_i - 1\right)\frac{\alpha-1-r+\tau_i^{\max}+r\tau_i^{\max}}{\alpha\left(2-\tau_i^{\max}\right)\left(2-2\tau_i+\beta_i\tau_i^{\max}\right)} > 0$; the optimal capital invested difference is

$-\tau_i^{\max}\left(\beta_i - 1\right)\frac{+\alpha-r+\tau_i^{\max}+r\tau_i^{\max}-1}{\left(2-\tau_i^{\max}\right)\left(2-2\tau_i^{\max}+\beta_i\tau_i^{\max}\right)} < 0$; profit difference is $\frac{1}{2}$
$-\frac{\tau_i^{\max}\left(1-\tau_i^{\max}\right)\left(\beta_i-1\right)\left(4-3\tau_i^{\max}+\beta_i\tau_i^{\max}\right)\left(\alpha-r+\tau_i^{\max}+r\tau_i^{\max}-1\right)^2}{\left(\tau_i^{\max}-2\right)^2\left(+\beta_i\tau_i^{\max}+2-2\tau_i^{\max}\right)^2\left(r+1\right)} < 0$;

and the difference in tax revenue is

$-\frac{1}{2}\tau_i^{\max}\left(\alpha - r + \tau + r\tau - 1\right)^2 \frac{\beta_i - 1}{\left(2-\tau_i^{\max}\right)\left(2-2\tau_i^{\max}+\tau_i^{\max}\beta_i\right)} < 0.$ ■

Returning to variable overstatement, we can compare taxes and capital invested by the firm, as well as profits and tax revenues, in the presence and absence of overstatement. Nonetheless, comparing these two scenarios is tricky because under variable overstatement the profit tax is an interior solution depending on β_i, whereas in absence of overstatement, the profit tax is a corner solution on the size of which we remain agnostic. To make this comparison possible, we will make the simplifying assumption that $\tau_i^{\max} = \check{\tau}_i$. Such an assumption is restrictive but nevertheless acceptable because with variable overstatement the profit tax is not relevant for attractiveness (see Proposition 6).

By direct comparison, we obtain

Proposition 8 *Variable overstatement of production costs puts upward pressure on the royalty and downward pressure on the capital invested. It always lowers the tax revenues but it may turn positive for the firms' profits.*

Proof. The royalty comparison is $\left(\beta_i\tau_i^{\max} - 1\right)\frac{r+\alpha+1}{\alpha\left(2-\tau_i^{\max}\right)(2\beta_i-1)} > 0$; the optimal capital invested difference is $-\left(r+\alpha+1\right)\frac{\beta_i\tau_i^{\max}-1}{\left(2-\tau_i^{\max}\right)(2\beta_i-1)} < 0$; the difference in the firms' profits is

$\frac{1}{2}\left(\left(r+3\alpha+1\right)\left(r-\alpha+1\right)^2\beta_i + 4\alpha^2\left(r+1\right)\right)\frac{\alpha+\beta_i+r\beta_i-\alpha\beta_i}{(2\beta_i-1)^2(r-\alpha+1)^2(r+\alpha\beta_i+1-\beta_i-r\beta_i)}$

which can be positive or negative; and the tax revenue comparison writes as $\frac{1}{2}\left(r+1\right)\left(r+\alpha+1\right)\frac{(r-\alpha+1)^2\beta_i+2\alpha(r+1)}{(2\beta_i-1)(\alpha-r-1)(-r+\beta_i+r\beta_i-\alpha\beta_i-1)} < 0$ for $\alpha > 1+r$.

$\frac{\alpha(\beta_i-1)-\beta_i(1+r)}{\alpha(2\beta_i-1)}$ ■

Variable overstatement may be profitable for the firm, whereas constant overstatement is always detrimental for both firms and governments. This result is worrisome. It implies that if firms practice cost overstatement in developing extractive countries, then we should expect that they choose a strategy of variable overstatement. The distortion of asymmetric information then becomes even more accentuated. Firms will always decide to locate where overstatement is the highest, even if the profit tax is also high. This choice of location distorts the capital invested, which depends negatively on the coefficient β.

6 Conclusion

It is widely acknowledged that mining industries hosted in developing countries suffer from serious asymmetries of information between the firms that exploit the mines and the government that levies several taxes – often distortive – to raise tax revenues. Asymmetries of information often concern the overstatement of production costs as a means of reducing tax liabilities. This issue draws even more attention in the presence of a foreign multinational firm for at least two reasons. First, the multinational firm may have a technical advantage over the developing country's experts. This technical advantage may be used to overstate costs. Second, by definition, the mobility of this type of firm is very high *and justifies a tax competition framework.* A multinational firm can exert pressure by threatening to exploit a mine in a different country in order to gain tax advantages. Hence, in such a setting, one may naturally ask what are the effects of asymmetries of information on tax policies in the presence of international tax competition that adds pressure on governments. Shedding light on this issue is the purpose of the present paper, which has yielded some interesting results.

Under a constant rate of overstatement of costs, if the country is affected by a strong asymmetry of information, the distortions caused by royalties are amplified and are detrimental to both the government and the firm's revenues. Indeed, to be attractive, a country will decrease the profit tax rate and increase the royalty. If cost overstatement is a function of the profit tax however, asymmetries of information bring advantages to the firm while remaining detrimental for tax revenues. In this case, variability in the overstatement rate neutralizes the role of the profit tax in the attractiveness of the country and the foreign firm locates where she can overstate the most.

Whether constant or variable, cost overstatement puts downward pressure on government tax revenues. From a tax policy point of view, it appears that the reduction of information asymmetries, with the aim of decreasing cost overstatement, is a key strategy to increase tax revenues.

Future empirical works can be envisaged that would test the main results of our model. The success of this empirical analysis relies on the careful approximation of the coefficient of cost overstatement. With a good proxy for β, it could be interesting to investigate how the intensity of asymmetries of information affect the tax policy and government tax revenues in mining countries.

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Appendix A

The sign of the derivarive $\frac{\partial \Pi_i}{\partial \tau_i^{\max}}$ is given by the sign of the expression

$$(2r - r\beta + 2 - \beta)\,\tau^2 + (\alpha\beta - 2\alpha - \beta - r\beta - 4r - 4)\,\tau + (2r + 2\alpha + 2\beta + 2r\beta - 2\alpha\beta + 2)$$

which is a convex parabola with two positive roots given by

$$\tilde{\tau} = -\tfrac{1}{(\beta-2)(r+1)}\left(\begin{array}{c} 2r + \alpha + \frac{1}{2}\beta + \frac{1}{2}r\beta - \frac{1}{2}\alpha\beta - \\ \frac{1}{2}\sqrt{(2\alpha + \beta + r\beta - \alpha\beta)\,(2\alpha + 9\beta + 9r\beta - \alpha\beta)} + 2 \end{array}\right),$$
$$\check{\tau} = -\tfrac{1}{(\beta-2)(r+1)}\left(\begin{array}{c} 2r + \alpha + \frac{1}{2}\beta + \frac{1}{2}r\beta - \frac{1}{2}\alpha\beta + \\ \frac{1}{2}\sqrt{(2\alpha + \beta + r\beta - \alpha\beta)\,(2\alpha + 9\beta + 9r\beta - \alpha\beta)} + 2 \end{array}\right)$$

We prove that $\tilde{\tau}$ is positive and smaller than one and thus acceptable for our setting, whereas $\check{\tau} > 1$.

$$\begin{gathered} \tilde{\tau} \overset{?}{<} 1 \\ \left(\begin{array}{c} 2\,(r+1) + \alpha - \frac{1}{2}\beta\,(\alpha - r - 1) \\ -\frac{1}{2}\sqrt{(2\alpha + \beta + r\beta - \alpha\beta)\,(2\alpha + 9\beta + 9r\beta - \alpha\beta)} \end{array}\right) \overset{?}{<} (2-\beta)\,(r+1) \\ 2\beta\,(r+1) + \alpha - \frac{1}{2}\beta\,((\alpha - r - 1) \overset{?}{<} \sqrt{(2\alpha + \beta + r\beta - \alpha\beta)\,(2\alpha + 9\beta + 9r\beta - \alpha\beta)} \end{gathered} \tag{9}$$

Both the LHS and RHS of the above inequality are monotone increasing functions of α, under the assumptions of the model that $\beta < 2$ and $\alpha > 1 + r$. Evaluated at the smallest value of

$\alpha, i.e. \alpha = 1 + r$ and $\beta = 2$ (it actually holds for any $\beta \in [1, 2]$) we have

$$5(1 + r) < \sqrt{36\,(r + 1)^2}$$

which is true. Evaluating the inequality for very large but finite values of α, we have that

$$(1 - 0.5\beta)\,\alpha < (2 - \beta)\alpha$$

which is again true. Hence, for the lowest value of α the RHS is bigger than the LHS. As α increases, the RHS is alwas higher than the LHS. Hence, due to monotonicity of the RHS and LHS, the inequality (9) is always true for all admissible values of α. It follows that $\tilde{\tau} < 1$. Clearly $\tilde{\tau} > 0$. Using the same method, we show easily that the other root $\check{\tau}$ exceeds 1. It follows that in the interval (0,1) where $\tau_i^{\max}$ lays, the parabola is first positive and then negative. Hence, for $\tau < \tilde{\tau}$, the derivative $\frac{\partial}{\partial \tau_i^{\max}} \Pi_i > 0$, and for $\tau > \tilde{\tau}$, $\frac{\partial}{\partial \tau_i^{\max}} \Pi_i < 0$. QDE