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The Impact of Tax Concessions on Extraction of Non-renewable Resources: An Application to Gold Mining in Tanzania

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Abstract

Gold mining firms in Tanzania pay royalty and corporate taxes, but also receive many tax concessions. Such tax incentives may cause to reschedule their extraction plans and thereby change the expected life of a gold mine. We model a representative mining firm's extraction decision using optimal control theory, into which various tax incentives are introduced to determine their theoretical impact. Our results suggest that in the race to take advantage of tax incentives, a firm may end up making excessive investments, which in turn increases extraction rate. Actual extraction patterns of several gold mining companies in Tanzania are also reviewed.

Key words: Natural resources, tax incentives, corporate tax policy
JEL Classification Numbers: Q38, H25

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1 Introduction

The gold mining sector in Tanzania is a major source of foreign earnings, currently accounting for about 45 percent of exports. The country is now the fourth-largest gold producer in Africa, after South Africa, Ghana, and Mali. However, gold is not a new discovery in Tanzania, with a history dating back to at least the colonial era. Large-scale mining began in the 19th century after a German gold discovery in 1894. The first gold mine opened at Sekenke in the Iramba district in 1909 in then the colony of German East Africa, followed by mines at Mwanza and Musoma in 1913. The discovery of further mining areas took place when the country (then called Tanganyika) was under British administration in the 1920s. Production of gold peaked in 1938 and 1939 at more than 100,000 oz. annually (MacDonald and Roe, 2007).

Gold production ceased after the country (now called Tanzania) gained its independence from British administration in 1961. A new mining policy was produced from statements by Tanzanian's first president and later "Father of the Nation," Mwl. Julius Kambarage Nyerere, that "We will leave our mineral wealth in the ground until we manage to develop our own geologists and mining engineers" (Chachage and Cassam, 2010). This declaration suggests that the government's mineral policy at the time was mainly to protect the sector from foreign firms.

The rebirth of mining activities in Tanzania in the 1990s was associated with attractive tax incentives or concessions offered to mining firms in the sector. Tax incentives or concessions are tax policies that favor one sector or firm over others in the economy. Zee et al. (2002) defines tax incentives as "A special tax provision, granted to qualified investment projects that represent a statutory favorable deviation from a corresponding provision applicable to investment projects in general." However, some believe these tax incentives are a root cause of the poor contribution of the mining sector to government tax revenue in Tanzania (South African Resources Watch, 2009; Cooksey, 2011; Gajigo et al., 2012). The sector yields only about 2 percent of the total tax collected by the Tanzanian government despite a 30 percent share of foreign direct investment in the country.

Unlike most previous studies focusing on the mineral sector in Africa and Tanzania in particular (MacDonald and Roe, 2007; South African Resources Watch, 2009; Gajigo et al., 2012), our work examines the impact of tax concessions on a firm's gold extraction path. We are particularly interested in understanding how tax incentives may influence a mining firm's production plans because the existing literature has only been concerned with its effects on government tax revenue. By considering natural resources as part of the wealth of the nation, we postulate that its extraction should benefit both current and future generations, which is a concept known as intergenerational equity entailing constant per capital consumption over time (Solow, 1974; Hartwick, 1977). Hartwick (1977) went further by examining how a country or society could attain a constant consumption per capital over time and found that a country should invest all net returns from exhaustible resources into reproductive capital.

In the case of Tanzania, multinational firms are principally extracting gold and repatriating profits to their home countries. Thus, taxation is the only source of a resource rent. In light of the so-called Hartwick's rule, the government should invest all the resource rent obtained into reproductive capital. However, according to the findings of several existing studies, notably Southern African Resource

Watch (2009), the Tanzanian government is not obtaining a fair share of these resource rents because of the presence of tax incentives.

Accordingly, we are interested in knowing how these tax incentives affect firm production plans. If the tax incentives in place lead to resource conservation, we may conclude that the government has foregone tax revenue for the benefit of future generations. Otherwise, we would advise the Tanzanian government to consider redesigning the tax regime to either enable the government to secure a fairer share of resource rent or to conserve the resource for the benefit of both current and future generations.

Triest (1998) has argued, "Reliable estimates of how tax incentives affect behavior are an essential input into the formation of tax policy." It is then natural to believe that the firm's extraction behavior, with or without tax incentives, will differ. For example, tax incentives may serve to maintain, increase, or decrease the rate of extraction. Therefore, this paper connects the theory of taxation and a firm's optimal extraction schedules under given tax incentives.

2 The taxation of nonrenewable resources

The design of an effective tax regime for extractive sectors is challenging because governments would generally prefer to appropriate a large share of rent while maintaining incentives for private investment. Firms in the extractive sector tend to respond to tax policies by altering their production schedules. To understand such behavior better, researchers propose the use of optimal control theory to analyze the optimal extraction paths of firms.

Hotelling (1931) pioneered this area of study in his seminal paper on the economics of exhaustible resources. He argued that the mine owner must decide whether to extract the resource or leave it underground. For the owner to be indifferent, the marginal profit should change over time according to the rate of interest, a relation known as Hotelling's rule. Hotelling (1931) also analyzed the firm's reaction to taxation. Focusing on a severance or 'royalty tax,' Hotelling (1931) argued that a high per-unit tax on material extracted from a mine tended to conserve or lengthen a mine's life. Of note is that his analysis assumed the complete exhaustion of the resource at the terminal time and a zero cost of extraction.

Burness (1976) built on the work in Hotelling (1931) by comprehensively studying firm reactions to several different tax policies: namely, a franchise tax, a royalty tax, and a profit tax for a firm operating in a competitive or monopolistic industry. Burness (1976) also assumed complete exhaustion of the resource, a price independent of time, and a cost independent of the reserves remaining. He found that a royalty tax that rises at a rate more (less) than the discounting rate tends to increase (decrease) the extraction rate, and thus influences the depletion time.

In the case of Tanzania, the royalty tax for multinational companies is fixed. We are therefore interested in examining how it alters a firm's extraction schedule. Similarly, the profit tax is constant over time, but mining firms in Tanzania enjoy a number of tax incentives that serve to delay the payment of corporate taxes in the early stages of a mining project. We model this situation to examine its impact on the mining firm's optimal production plans.

Unlike Hotelling (1931), Levhari and Liviatan (1977) replaced the assumption of complete exhaustion and a zero cost of extraction, with incomplete

exhaustion and a cost dependent on the accumulated extraction. Levhari and Liviatan (1977) did this because they argued that it is possible for the firm to cease extraction before complete exhaustion when facing constant demand and an increasing cost for the remaining reserves. They then analyzed the effect of a severance tax on the firm's optimal extraction plan, and concluded that it could either shorten or prolong the life of the mine. Heaps (1985) later revisited the taxation of nonrenewable natural resources by assuming a time-dependent price (nonconstant price). His results are similar to Burness (1976), except where the rate of change in a severance tax over time is less than the interest rate such that there is an ambiguous effect on the extraction rate.

This review of these studies essential for understanding an extractive firm's reaction to tax policies shows that regardless of the assumptions in place, the firm's response is almost similar. Therefore, in this paper, we follow the assumption of the complete exhaustion of the resource, but model the firm's response to tax concessions or incentives. A number of studies focus on the general effect of tax incentives on corporate operations.

For example, Zee et al. (2002) argued that tax incentives have an adverse effect on the government by eroding the tax base, distorting resource allocation, and creating an opportunity for rent-seeking behavior. Nevertheless, Zee et al. (2002) also pointed that tax incentives may induce a firm to purchase short-lived assets by bestowing upon it a full depreciation allowance. This argument on tax base erosion has been at the center of most research focusing on the extractive sector in Africa more generally, and Tanzania in particular.

Elsewhere, Southern Africa Resource Watch (2009) has argued that tax concessions offered to investors and the use of creative accounting by companies are the main reasons for the extractive industry's poor tax revenue contribution in most resource-rich countries in Africa. While discussing a broad range of African countries, Southern Africa Resource Watch (2009) revealed that Tanzania has a secretive agreement with its mining companies and offers additional tax concessions beyond mining tax law. They therefore argued for a more transparent tax regime.

Gajigo et al. (2012) provided a similar view that African governments are generally not obtaining sufficient tax revenue, especially through royalty taxes, because of the presence of unfair tax concession agreements. Both of these studies recognized tax concessions as the root cause of the mining sector's poor contribution to government revenue. However, none examined its impact on the firm's extraction behavior or the consequent life of the mine. Our analysis addresses this gap in the literature by combining optimal control theory with taxation and data from Tanzania.

3 Empirical behavior of gold mining firms in Tanzania

Tanzania's gold mining sector comprises seven major operating mines or projects and three mining companies, African Barrick Gold, AngloGold Ashanti, and Resolute Mining Limited. In 1997, Resolute Mining Limited was the first company to commence operations in Tanzania. In 2012, the company announced plans to close the mine by June 2013, after 16 years of operation. Total production through year 2012 was 2.12 million oz. (TMAA, 2012). If the company had a constant extraction rate, one would expect 163,076 oz. per year. However, this company's extraction rate was 122,921 oz. and 115,289 oz. for 2011 and 2012,

respectively. This implies a higher rate of extraction in the earlier than later years of a gold mining project.

We deduce a similar situation by considering one of the five mines operated by the African Barrick Gold Company. The Tulawaka project commenced in 2005, but the company announced the closure of the mine by 2013 after just nine years of operation. From its inception until 2012, the total output of this mine was 0.87 million oz. (TMAA, 2012). Figure 1 depicts the production of the Tulawaka mine over this period. As shown, a constant rate of extraction would produce 124,286 oz. per year. However, in 2011 and 2012, production was just 58,415 oz. and 31,028 oz., respectively. Estimates of the remaining proven reserve are only 16,000 oz.[1] This also suggests a higher rate of extraction in the early years of a mining project, a period typically associated with large upfront capital investments.

A more detailed look at a firm's production is possible using the more transparent production records of AngloGold Ashanti, which operates the Geita Gold Mine (GGM). AngloGold Ashanti is the largest gold producer in Tanzania, accounting for some 40 percent of all mining production. The 1999 company report for AngloGold Ashanti suggests a production capacity of 500,000 oz. per year.[2] However, from 2001 to 2005, the firm extracted more than this, with the highest production of 692,000 oz. in 2004, some 38.4 percent above its estimated capacity. This period is also associated with the company paying zero corporate tax. In fact, AngloGold Ashanti only started paying profit tax in Tanzania after about ten years of operation.

Figure 2 plots GGM gold production over a period of eleven years. As with the first two mining cases, the level of production is again initially higher. However, unlike those examples, GGM is a multiple open pit operation, and in 2011, the discovery of high-grade gold ore in one of its pits led to a major change in the pattern of production. Yet its production in the earlier years remained relatively high when compared with subsequent years. This upfront production increase could be associated with significant upfront capital investment. The company's 2011 plans to reduce the number of trucks (capital goods) from 48 to 27 within two years[3] is just one indication of this larger upfront capital investment.

There are many plausible explanations for these production patterns across time, including time discounting, the expectation of falling gold prices, and expectations of future political instability. If companies expect falling gold prices, they will tend to extract more. In reality, the prices of gold increased during the period under consideration as shown in Figure 3. Therefore, we can exclude the possibility that the extraction pattern exhibited by these firms depended largely on the expected price of gold.

In addition, the expectation of future political instability is certainly a paramount concern for mining firms, especially in Africa. However, in Tanzania there is no recent record of civil unrest or political chaos. Nevertheless, apart from referring to civil unrest as an indication of political instability, we may also

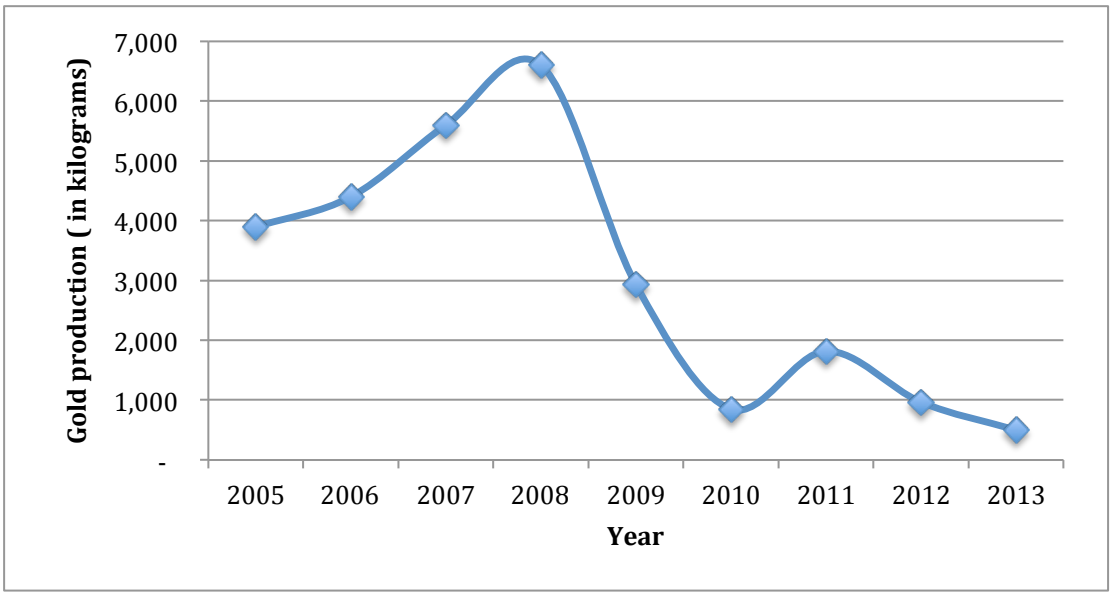
[1] www.africanbarrickgold.com/operations/operating-mines/Tulawaka.aspx. Accessed on July 24, 2013.

[2] Ashanti Goldfields Company. (1999). Annual Report. Retrieved from www.anglogoldashanti.com/NR/rdonlyres/B5CF0D38-73A1-412A-BD19-4A568F6C5C40/0/AR1999.pdf. Accessed on December 6, 2012.

[3] AngloGold Ashanti (2011). Tanzania fact sheet

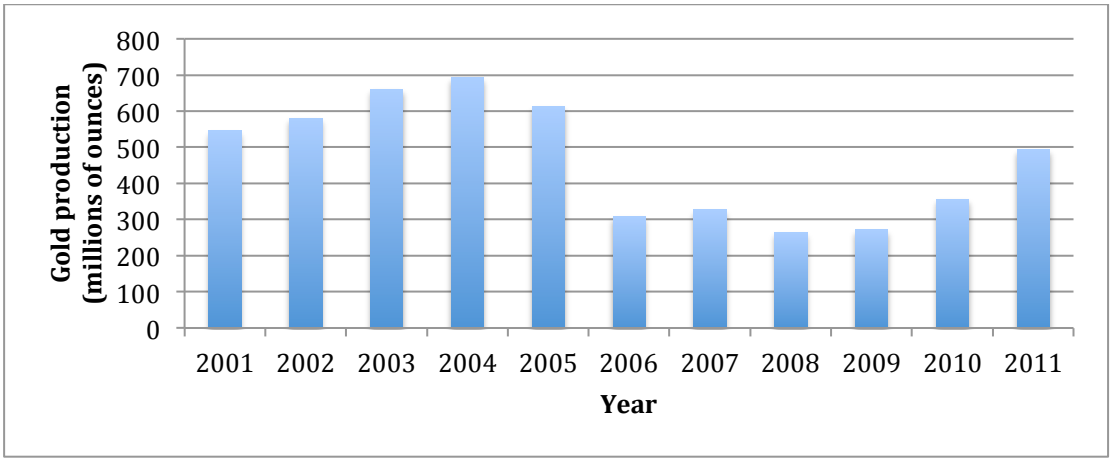
consider the instability of the tax regime as part of the political risk (Otto et al., 2006). For example, Otto et al. (2006) argue that a stable tax regime is difficult to guarantee because of difficulties in binding future governments to current promises and agreements. They then suggest that governments could enhance the stability of the tax regime by minimizing the possibility that the government and the public will be unhappy once the project is in operation by imposing modest royalty tax and progressive tax on profitable projects. However, in the case of Tanzania, the government has signed a mining development agreement with each investor. It is through these agreements that firms have secured tax concessions beyond those stipulated in the mining tax act. Therefore, in addition to several other well-studied explanations, we believe current tax incentives could also contribute to large upfront production patterns.

Figure 1. Tulawaka gold production, 2005–13



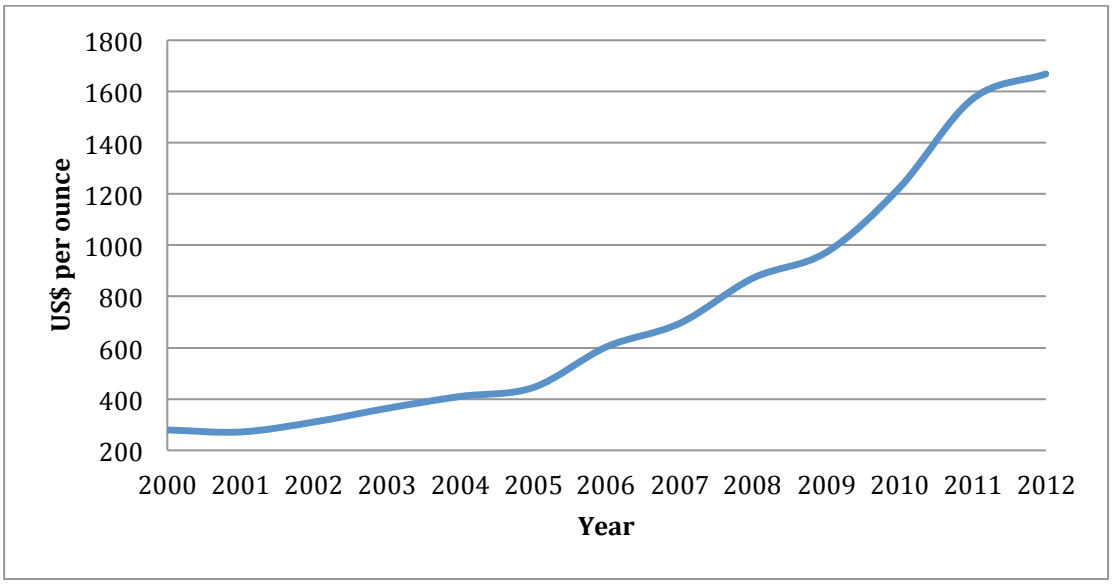
Sources: *US Mineral Yearbook 2005–09; Company financial reports.*

Figure 2. GGM gold production, 2001–11



Source: Company financial reports.

Figure 3. Average annual gold prices



Source: *London PM fix (www.kitco.com).*

4 Mining taxation in Tanzania

Given the potential importance of the mining sector taxation to the economy, it is useful to reassess Tanzania's current tax system. Current taxation theory suggests that the government should consider designing a tax system that enables it to secure a fair share of revenue from gold mining. In designing such a system, the government must understand the impact of tax incentives or concessions on the behavior of individual firms and the industry in general.

In Tanzania, mining companies have secured a range of special tax concessions, stipulated either in the mining tax act or in secret, individual agreements with the government. Currently, the mining tax act allows for full depreciation of assets during their first year of use, interest payment deductions from withholding taxes when interest payments are to affiliates, the unlimited deduction of losses from the previous period against current profit, and free profit repatriation.

As highlighted by Southern African Resource Watch (2009), mining companies that signed an agreement with the Tanzanian government prior to 2001 are entitled each year to add an additional 15 percent to the pool of capital expenditure that they have not yet been able to offset against taxable profits. Mining firms are also exempt from withholding tax on interest payments to affiliates, and this has induced them to borrow from their affiliates. According to the Bank of Tanzania (2001), the ratios of debt-to-equity for mining companies in Tanzania were as high as three in 1998 and four in 1999. Because of these concessions, companies are able to accumulate losses that they can deduct over a long period to effectively reduce and delay the payment of corporate taxes.

4.1 A basic model

We construct a basic model that allows us to analyze firm behavior under different tax incentives. Assume the initial reserve of resource is known, given by Z_0. Let

$x(t)$ be extraction at a given time *t*, such that with no new discovery, the dynamics of the remaining reserves are given by $Z_{t+1} = Z_t - x_t$ and $\dot{Z}(t) = -x(t)$ under discrete and continuous time, respectively. To avoid the problem of indivisibility, we assume time continuity. We suppose the firm's profit function depends on the quantity extracted, $x(t)$, given by $\pi(x,t)$, which satisfies the conventional assumptions, $\pi_x = \partial\pi/\partial x > 0$ and $\pi_{xx} = \partial^2\pi/\partial x^2 < 0$, and that there is a positive market interest rate, *r*. Assume the complete exhaustion of a mine within a finite time period, *T*. The firm's objective is to maximize the present value of profit over the operation horizon by selecting an optimal extraction schedule, $x(t)$ for $t \in [0,T]$, and the terminal period, *T*. Following Chiang (1992, p. 149), the firm's dynamic optimization problem then becomes:

$$maxV = \int_0^T \pi(x,t)e^{-rt}\,dt, \tag{1}$$

subject to

$\dot{Z}(t) = -x(t)$
$x(t) \geq 0$, $Z(0) = Z_0$, and $Z(T) = 0$,

where $x(t)$ is a control variable and $Z(t)$ is a state variable representing the reserves remaining at time *t*.

Therefore, the Hamiltonian equation becomes,

$$H = \pi(x,t)e^{-rt} - \lambda x,$$

where $\lambda > 0$ is the shadow price of the resource at a particular time. The first-order conditions that characterize the firm's optimal strategy are:

$$\partial H/\partial x = \pi_x(x,t)e^{-rt} - \lambda = 0 \quad \text{for all } t \tag{2}$$
$$\dot{\lambda} = -\partial H/\partial Z = 0 \tag{3}$$
$$\dot{Z} = \partial H/\partial \lambda = -x \tag{4}$$

where we assume that $x(t) > 0$ for all *t*, and $\dot{\lambda} = \partial\lambda/\partial t$ is the change in the shadow price over time. The transversality condition[4] requires that $H = 0$ at $t = T$, and thus,

$$\pi(x(T),T)e^{-rT} - \lambda(T)x(T) = 0.$$

When combined with Eq. 2 this implies,

$$\pi(x(T),T)/x(T) = \pi_x(x(T),T), \tag{5}$$

From these conditions, we obtain the following observations. Eq. 2 states that the discounted marginal profit should be the same at all times. Eq. 3 implies that the change in the shadow price ($\partial\lambda/\partial t$) should be constant over time. Eq. 4 enforces the equation of motion. Eq. 5 states that at terminal point *T*, average profit should be equal to marginal profit.

[4] See Chiang (1992, p. 177–82).

Totally differentiating Eq. 2 and solving for $\partial\lambda/\partial t$, and setting this value to be equal to zero (in accordance with Eq. 3) we have,

$$\dot{x} = (r\pi_x - \pi_{xt})/\pi_{xx}, \tag{6}$$

where $\dot{x} = \partial x /\partial t$ is the change in extraction over time, and π_{xt}=$\partial\pi/\partial x\partial t$. The value of π_{xt} represents change in the price of gold over time. Therefore, Eq. 6 informs us that unless the price of refined gold is very quickly rising, we have $\dot{x} < 0$, which means that the extraction schedule is biased towards the present because of the discounting of future profit.

4.2 A royalty tax

The above model allows us to examine how a firm's extraction plans vary in response to various tax instruments. Royalty tax is a type of tax applied only to mining firms. Most past studies, notably Hotelling (1931) and Burness (1976), concur that this type of tax directly impacts a firm's extraction behavior.

Let $\rho(t)$ be the royalty at time *t*.[5] The dynamic optimization problem then becomes:

$$V = \int_0^T [\pi(x,t) - \rho x]e^{-rt}\, dt. \tag{7}$$

Then, V is maximized when

$$[\pi_x(x,t) - \rho]e^{-rt} = \lambda. \tag{8}$$

By differentiating Eq. 8 with respect to time and $\dot{\lambda} = 0$ as before (Eq. 3), we obtain

$$\dot{x} = \frac{(r\pi_x - \pi_{xt})}{\pi_{xx}} + \frac{[\dot{\rho} - r\rho]}{\pi_{xx}}, \tag{9}$$

where $\dot{\rho} = \partial\rho/\partial t$ is the change in the royalty rate over time.

Because the royalty is a tax on unit production, the firm will tend to discount the tax payment on future production, which will alter the production schedule. More specifically, as shown in Eq. 9, a change in the royalty rate such that $\dot{\rho} < r\rho$ (i.e., the royalty tax rate grows at a slower rate than a pool of money invested to pay the royalty taxes) induces the firm to decrease its extraction rate. In contrast, a tax that increases such that $\dot{\rho} > r\rho$, induces the firm to increase its extraction rate.[6] However, if $\dot{\rho} = r\rho$, which is equivalent to $\rho = \rho_0 e^{rt}$, there should be no change in the extraction rate. This is then an optimal tax in that its imposition provides no distortion to the firm's production plan (Dasgupta and Heal, 1979).

The Tanzanian royalty applied to multinational mining firms is ad valorem, set constant over time, and levied at the rate of 3 percent on the value of the quantity extracted. Accordingly, the royalty in our model, which is formulated as

[5] We model royalty here as a 'specific tax.'

[6] Conrad and Hool (1984) provide a detailed explanation of both per unit and ad valorem taxes and introduce the concept of nominal vs. real tax rates. Their results are equivalent to what we obtain.

a specific tax, should be regarded as $\rho(t) = \alpha p(t)$, where α is the constant ad valorem tax rate and $p(t)$ is the gold price. Following this formulation, the rate of change in $\rho(t)$ equals that of the gold price. Applying the earlier argument, we can then say that if and only if we expect the price to grow faster than the interest rate, will the ad valorem royalty induce the firm to extract faster to avoid larger tax payments in the future.

Let us again consider Figure 3. If we take the period of 11 years from 2000 to 2011, the price grows at annual rate of about 17 percent on average,[7] which seems much higher than the interest rate facing mining firms. This suggests that the royalty tax has had the effect of inducing firms to extract at a faster rate than they would do otherwise. However, this effect should have been minimal and only partly lessen the impact of the fast-growing gold price because the tax rate is only 3 percent and the after-tax price of gold, $(1 - \alpha)p(t)$, continues to grow at the annual rate of about 17 percent. From this point of view, it is difficult to accept that the Tanzanian royalty rate drives the fluctuating extraction behavior observed at the Tulawaka mine in Figure 1.

4.3 Corporate or profit tax

Mining companies in Tanzania are liable for the payment of corporate (or profit) tax like any other company. However, mining firms have a number of tax concessions available that serve to reduce their taxable profit. These include the full deduction of interest expenditures regardless of source and any exploration and development expenditures, full depreciation of an asset in the year of its placement in service, and an extra 15 percent added to their pool of capital expenditure that they have not yet been able to offset against taxable profits. These arrangements effectively create a tax holiday for firms and induce them to undergo tax planning, which leads to large deductions over a long period (about ten years). Therefore, in our optimal control model, we argue that we can divide the extraction path into two periods: one period in which the firm pays no profit tax because of excessive deductions, and another period in which it pays tax after the recovery of all earlier losses. From the firm's point of view, this characterizes the situation of an increasing tax rate.

Let $\tau(t)$ represent the corporate or profit tax rate at time *t*. The dynamic optimization problem then becomes:

$$V = \int_0^T [(1 - \tau)\pi(x, t)]e^{-rt}\, dt. \tag{10}$$

V is maximized when,

$$[(1 - \tau)\pi_x(x, t)]e^{-rt} = \lambda. \tag{11}$$

Given $\dot{\lambda} = 0$ as in (Eq. 3), by differentiating Eq. 11 with respect to *t*, we have

$$\dot{x} = \frac{(r\pi_x - \pi_{xt})}{\pi_{xx}} + \frac{\pi_x \dot{\tau}}{(1-\tau)\pi_{xx}}, \tag{12}$$

[7] Because the gold price increased from US$279 to US$1,572 during this period, the annual rate of change is approximately $(\frac{1,572}{279})^{1/11} - 1 \approx 0.17$ or 17%.

where $\dot{\tau} = \partial\tau/\partial t$ is the change in a profit tax rate over time.

At a constant profit tax rate, Eq. 10 becomes similar to Eq. 6, which implies that a time-invariant profit tax rate does not affect the production plans of the firm. However, in the situation where a firm is currently paying no profit taxes, but expecting these to increase in the future, i.e., $\dot{\tau} > 0$, it does affect the production schedule. A firm will then attempt to reduce its tax payments on future production. Consequently, an increasing profit tax rate hastens depletion.

5 Conclusion and policy recommendation

Our theoretical results suggest that Tanzania's profit tax and related concessions could account for the patterns of gold extraction that we observed in the empirical data. These tax concessions for Tanzania's mining sector induce firms to extract more in the earlier years of a mining project after investing heavily upfront to accumulate losses it is then able to deduct against future profit. This analysis thus provides a new insight not addressed by the existing literature on the effect of tax concessions in developing countries, particularly in Africa. Apart from being the root cause of poor contribution to government revenue, tax concessions may also hasten the depletion of nonrenewable resources.

The Tanzanian government faces a challenge in designing a tax system that does not distort the behavior of firms, while obtaining a significant share of the resource rents to foster economic growth. It may achieve this by revisiting the current design to identify tax concessions that alter firm behavior. For example, the current full-depreciation allowances do not reflect the true life span of the assets involved in production (Atkinson and Stiglitz, 1980, p. 143–4). True economic depreciation considers the true life of durable goods and has a neutral effect on firms' decisions.

Studying how other countries mitigate the tax-planning behavior of multinational firms may provide input on designing a sound tax system without facing the risk of harming private investment. For example, in 2012, the Canadian government decided to set a limit on borrowing and any other consideration from affiliates for foreign-owned companies operating in Canada (Deloitte, 2012). The same challenge is facing Tanzania, as many mining firms also borrow from their affiliates. However, this would not be a problem if these firms were paying withholding tax on interest payments as stipulated in the tax law. Rather this informs us that there is a need for the Tanzanian government to scrutinize the implications of any forgone tax on firms' behavior. In addition, we recommend that the Tanzanian government establish a tax treaty with the home countries of foreign-owned firms. This will provide a basis for tax negotiation; otherwise, tax forgone in Tanzania may be subject to taxation in their home country, which implies a gift to the foreign country.

Alternatively, the Tanzanian government can consider further tax instruments that support the incentives available to firms. The current mining tax regime in Tanzania appears to support the imposition of a resource rent tax as first proposed by Garnaut and Clunies-Ross (1975). Their proposal focused on an extractive sector in a developing country, where extraction is through foreign firm operations. Garnaut and Clunies-Ross (1975 p. 279) set the prerequisites for a resource rent tax as follows: "(i) no deduction from taxable income for interest

payments, (ii) an immediate 100 percent depreciation or amortization of all expenditures on investment (which are thus treated in the same way as current expenditures), and (iii) an unlimited carry forward of losses, bearing interest at a specified rate."

Garnaut and Clunies-Ross' (1975) proposal therefore has some similarities with the current tax regime in Tanzania. Several subsequent studies, notably Dowell (1978), Garnaut and Clunies-Ross (1979), and Lund (2011), agree on the neutrality of this tax for firm investment decisions. However, they argue that the resource rent tax should serve as an additional tax because it allows a firm to operate over several years without paying tax. In general, the tax incentives for mining firms in Tanzania are not too bad, but if the Tanzanian government wishes to conserve resources for future generations, or secure more tax revenue, they may need to redesign the mining tax regime.

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