ORIGINAL PAPER

Mining and taxation in Sweden

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Abstract

The Swedish taxation regime for mining has been criticised for being overly advantageous for mining companies, and for not adequately safeguarding the interests of the state and/or other rights- and stakeholders. The critique has been expressed in the media and in political discourse, whereas more thorough assessments are lacking. This paper addresses this shortcoming, and it uses financial modelling and international comparisons. The Swedish taxation regime for mining is not substantially different from that of other sectors of the economy, and it has also been unchanged for a long time. It includes no royalty nor any fiscal instrument to capture windfall profits, and it is based on statues rather than bespoke contracts. In terms of incomes to the state from mining performed by private companies, the most substantial ones are the corporate income tax (CIT) and the dividend withholding tax. In terms of ensuring local benefits, there is no specific instrument in place for mining. The overall taxation system is such that municipalities charge substantial pay roll taxes, and the taxes derived in this way are of the same order of magnitude as taxes normally derived by the central state through the CIT. This principle of ensuring local benefits may however be under threat, as mining becomes increasingly mechanised—with fewer employees—and with an increasing prevalence of so-called fly in-fly out personnel. The findings confirm that the Swedish tax regime is comparatively generous towards mining companies. Furthermore, the lack of a royalty means that the state foregoes opportunities to earn incomes in times of poor mining profitability, and the lack of a windfall tax similarly gives an uneven distribution of benefits when commodity prices are high. This, in turn, suggests that there is a need for reform. Moreover, the current system includes a so-called mineral fee, which mainly functions to compensate landowners, but a smaller part also falls to the central state. The funds collected by the state in this way are insignificant, and as this component of the mineral fee is both poorly understood and contentious, it is recommended that it be discontinued. It is recommended that in general, economic tools that specifically model the outcomes of taxation regimes for mining be supplemented with general analyses of the whole taxation regime in question, to provide a better basis for analysis, and associated policy advice.

Keywords Mining · Tax · Fiscal regime · Sweden

Abbreviations

CIT   Corporate income tax
CSR   Corporate social responsibility
ETR   Effective tax rate
IMF   International Monetary Fund
LOI   Life of Mine
RRT   Resource rent tax

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Introduction

Mining has since long been necessary for the functioning of society, and the worldwide demand for mined commodities has increased dramatically in the last century as a result of economic development (e.g. Ali et al., 2017). Mining can generate considerable revenues, which in turn is often due to the existence of significant economic rents. These rents differ from normal profits as they derive from a range of factors that may be only weakly related to the performance and efficiency of any specific mining operation—such as the quality of the exploited ore and its geographical location. Given that precious mineral resources often, or even generally, are the property of the state, the issue of how this rent should be allocated is the subject of considerable interest. And it is increasingly often

stressed that mineral resources should be exploited in a way to financially benefit not only the miners, but also the state and society as a whole (e.g. OECD 2020a, b). A variety of fiscal tools and instruments exist to ensure that the state and/or communities receive a share of the financial rewards that mining generates. This may be achieved in many ways and range from the right to mine being restricted to state owned entities, to ensuring that mine operators contribute to society through taxes, fees or other commitments and/or obligatory undertakings.

The mining sector is important to Sweden, and especially so in the northern regions where mining and smelting companies are the most important industrial employers, and account for some 20% of the GDP (SGU - The Geological Survey of Sweden 2020; Copenhagen Economics 2021). The most important commodities mined include iron, base metals and gold (SGU - The Geological Survey of Sweden 2020).

Sweden's mineral strategy states that the country's position as the leading mining nation within the EU should be strengthened (Swedish Government 2013). However, the strategy and its longer-term aims have been criticised by some researchers and there has been increased pressure from various stakeholders as well as in political discourse to increase the sector's contribution to the economy overall, and to local communities specifically (e.g. Roine & Spiro, 2013; Johansson et al., 2014; Liedholm Johnson & Ericsson, 2015). The critique has been levelled at the whole of the mining sector, although it is most relevant for the parts the sector that is in private hands (the largest mining operations are held by the state owned company LKAB).

The aims of this paper are to describe how mining in Sweden is taxed, and to consider how the existing set up compares internationally. The research methods used include financial modelling of the existing taxation regime, as well as modelling of cases where additional fiscal instruments are included. Furthermore, the outcomes of the modelling, and the assessment of the fiscal system more generally, are also assessed against the OECD Guiding Principles for Durable Extractive Contracts, which is seen as a relevant and recent example of international good practice (OECD, 2020a, b).

The paper is structured as follows. The introduction is followed by a section which introduces taxation regimes for mining as well as some international trends in this regard. Sweden's taxation regime for mining is presented thereafter, and this is followed by sections that model outcomes of the current set up, as well as selected alternatives. The current taxation regime is then assessed against the OECD Guiding Principles and, finally, the conclusions of the research are presented.

Fiscal regimes for mining

The fiscal regime for mining includes not only taxes but also other legal, regulatory and contractual instruments through which the state shares in the revenues generated. The overall objective is to maximise economic returns to the state from the use of its resources. To achieve this requires balancing of interests. In simple terms, a fiscal regime that taxes too much deters investment and/or stops mining projects, whereas a fiscal regime taxes too little may leave a country worse off after mining—that is if the revenues received did not compensate for the mineral wealth extracted.

Fiscal regimes should therefore strive to achieve a fair share of revenues to the state, while also being as progressive as possible (i.e. taxing more profitable projects relatively more). They should, like all tax systems, strive for simplicity and ease of administration. They should be as neutral as possible, avoiding distortions of investment decisions. A characteristic of mining is that mineral resources are finite, which some may argue makes it especially important to ensure that benefits from extraction are maximised.

Globalisation has led to a growing number of sectors of the economy, and associated activities being influenced by international law, or even the subject to regional legislation (e.g. EU legislation). However, mining and its associated fiscal system is essentially always governed at the national level (c.f. Bastida, 2020). This in turn means that there are numerous versions of how the mining sector is taxed (PWC, 2012 provides an overview). However, the most common model is often referred to as the "tax-royalty" model. While tax-royalty regimes may also include other fiscal charges, the important parts are as follows: (i) a royalty of some type (there are various), which assures a minimum payment to government for the mineral resources extracted; and (ii) an income tax, which gives the state a share of profits from mining.

There are also other types of fees and taxes that can be used, ranging from simple charges (e.g. signing bonuses), to sophisticated fiscal instruments as well as non-fiscal requirements that mining operators engage in, for example, Corporate Social Responsibility (CSR)-related activities (e.g. Otto, 2010; Dupuy, 2014). The windfall tax (resource rent tax or RRT) is probably the most well known of the more sophisticated fiscal instruments that exist, and the RRT has been receiving increased interest since the turn of the millennium (e.g. Crowson, 1998; Land, 2008; Garnaut, 2010). An RRT targets the positive net present value (NPV) of a mining project, and requires three main parameters to be defined: (i) a "threshold rate" or discount rate to be applied to the cash flow in order to calculate the NPV; (ii) the rate at which the RRT is to be applied; (iii)

and stipulations regarding what costs may be deducted from the revenue before the RRT is calculated.

In terms of overall trends, there is a tendency for greater uniformity in fiscal regimes for mining worldwide, a move towards using statues instead of bespoke contracts (e.g. Dietsche 2019), as well as calls for increased state involvement and demands for equity (e.g. Ganbold & Ali, 2017). There are several international good practice guidelines in this regard (e.g. ICMM, 2009; IISD, 2013) and the OECD "Guiding principles for Durable Extractive Contracts" is an important initiative in this regard, and it is used in this paper (OECD, 2020a, b).

Assessment of the fiscal regime of Sweden

Presenting the status quo

The rights to explore and exploit precious minerals (referred to as "concession minerals") in Sweden are governed by the Minerals Act (SFS, 1991). The Act is based on the concessionary system, but includes strong elements of the claim system (Liedholm Johnson & Ericsson, 2015). It is an exploitative and strong law, aiming to enable the identification of mineral deposits, and their subsequent extraction, and in this, it is similar to those of most countries which have a substantial mining sector (c.f. Cameron & Stanley 2017, p72). In the Act, it is not defined who owns concession minerals (e.g. see SOU 2012:73). However, given that the state grants the right to explore and exploit, the situation is similar to where minerals belong to the state.

Sweden has a long history of mining, and over the centuries, the conditions under which the proceeds of mining have been shared and/or taxed have varied widely (see Liedholm Johnson & Ericsson, 2015 for a review). The Mineral Law defines a "mineral fee", a unique feature for Sweden,[1] and which comprises 0.02% of the value of production of which with 2/3s is paid to the land owner (in cases when the concession is in an area which is owned by a party other than the concession holder) and 1/3 to the state, ostensibly to be used to fund mineral related research (SWE Plmnt 2004; Liedholm Johnson & Ericsson, 2015). Other than this fee, there are no special requirements, taxes or fees (nor conversely significant opportunities for tax benefits) that apply to mining, nor is there a royalty. Thus, mining is in a tax sense treated as any other business, and the significant taxes payable to the central state are as follows: (i) the company income tax (CIT), which at present is 21.4%; and (ii) the dividend withholding tax which at present is 20% up to a limit above which the rate increases. In terms of losses, these may be carried forward indefinitely. Furthermore, up to ¼ of profits may be carried forward for up to 6 years. There are some relevant subsidies, but most of these are not specific to mining but apply to all industry. And furthermore, Jervelund et al. (2016) found them to be in line with, or lower, than those in comparable mining nations.

There are legal requirements to pay compensation to other land users in case of impacts, and relevant in that regard is a requirement to compensate reindeer herders who hold usufruct grazing rights on most land in the northern half of the country. There is also a requirement to establish a closure plan, and to post an associated environmental bond.

Taxation of mining in Sweden has been considered in previous studies. Otto et al. (2006) performed financial modelling based on a model copper mine in large number of countries, and found that Sweden was in the lowest taxing quartile, with an effective total tax rate of 29%. Jervelund et al. (2016) performed similar work in a more limited study on a model iron ore mine, and arrived at an effective tax rate of 25%, and with only Finland having a lower effective total tax (24%) of the five jurisdictions considered (and with the other three having substantially higher tax rates).

Swedish mining companies do not need to nor choose to become involved in sizeable CSR-related activities, as the responsibility for providing social services and infrastructure for communities' rests with government, most importantly the municipalities (Tarras-Wahlberg et al., 2017). Sweden has overall high taxes, even in comparison with other OECD countries (OECD, 2020a, b) and it is further—along with its Nordic neighbours—among the countries with the highest proportion of local taxes as a component of all taxes (Kitchen, 2004). This, in turn, means that the most substantial contribution a Swedish mining company makes to local communities is through the municipal tax charged on the salaries of those who work for the company, as well as indirectly through the taxes paid by those that have jobs that are directly or indirectly dependant on the mining operations. The municipal tax varies between municipalities, but it is on average about 32% (Finansportalen, 2021). Furthermore, research on the multiplier effect of mining employment in Sweden arrive at numbers in the range 1.6–2.1 (Ejdemo and Söderholm 2011; Ejdemo, 2013).

Financial modelling

Financial modelling was performed using the International Monetary Fund's (IMF) FARI model (c.f. Luca & Puyo, 2016 for a detailed description). The FARI model is used to support the IMF (and others) advisory work on fiscal regime design. However, it is not a tool that should be used for formal forecasting, nor for estimates of project profitability and feasibility. Thus, in this paper, the model is

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[1] Though a similar mechanism exists in Finland.

Table 1 The fiscal regime assumptions used in the modelling

Regime	Sweden	Royalty + CIT	Royalty + CIT + RRT
Royalty rate (%)	0.005[1]	4.0	4.0
Royalty base (net/gross)	Net		
Decommissioning provision (yes/no)	Yes		
Commencement of decommissioning provision	From beginning of project (0%)		
Corporate income tax rate	21.4%		
Exploration costs (expensing)	Deferred		
Development costs—intangibles (expensing)			
Development costs—tangibles (depreciation)			
Development costs—tangibles and replacement capital depreciation (years)	5		
Resource rent tax rate			20%[2]
RRT threshold			10%[2]
CIT deductible (yes/no)			Yes
Dividend withholding tax	20%	20%	20%
State equity (free)	0%	0%	0%

[1]The government's part of the so-called *minerals fee* was modelled as if it was a royalty, although strictly it is not.

[2]The tax rate and threshold are set in accordance with examples provided in Land (2008). However, the exact numbers are of less importance for the purpose of this paper as the aim to show the possible effect of the introduction of a RRT in a general sense.

used to consider and evaluate the main characteristics of the Swedish mining taxation regime. More detailed analyses and associated sensitivity analyses are not done, as that would entail work that is over and above what is required for the purpose of this investigation.

The FARI model consists of a detailed, Excel-based discounted cash flow model that operates on a project basis, with inputs including production and cost profiles, economic assumptions such as prices, inflation and discount rates, financing arrangements and the terms of the fiscal regime to be evaluated.

The FARI model comes with an existing case, in turn based on a medium-sized gold mining operation (200,000 oz/year)—with a 2-year development period with no production, 1 year of reduced production (100,000 oz/year) and then a Life of Mine (LOI) of 10 years, followed by a year of closure. The FARI model is based on extensive research and data collection, which would have been difficult to improve for the purpose of this paper. Furthermore, gold is one of the major commodities produced by Swedish mines (as well as internationally), and one which has not been considered in relevant and previous work (i.e. Otto et al., 2006; Jervelund et al 2016). And the gold production set in the FARI model is also fairly close to the total current production of gold in Sweden (291,000 oz in 2020; SGU - The Geological Survey of Sweden 2020). Thus, the FARI model should provide a useful way of considering the current Swedish fiscal set up, and to assess the impact of adding additional fiscal instruments. Some modifications were made of the pre-set economic and financial assumptions, to make

it more relevant for Sweden (e.g. the discount rates were reduced to reflect a developed country scenario). Additionally, the gold price was set at a moderate level (USD1500/oz), albeit one that ensures that the project in question will run at a healthy profit (sensitivity analysis for the gold price can readily be achieved in the model). The modelling was done in for a "what if" analysis, with three different scenarios modelled, as follows and with more details found in Table 1:

- The status quo of the current Swedish fiscal regime.
- If Sweden introduced a 4%[2] royalty (ad valorem) on gold.
- If Sweden introduced a 4% royalty (ad valorem) on gold, as well as a 20% RRT which becomes payable at threshold of 10%.

The results of the modelling are dependent upon several economic and financial assumptions, and these were set in accordance with Table 2.

Although sophisticated and rather complex, the FARI model—like most models of this type—have limitations. The whole range of taxes that apply are not included, as this type of financial modelling do not generally include general taxes that are (or may be) included in the cost structure of a mining operation (e.g. property, excise and payroll taxes). Also, the model's default rehabilitation period is set

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[2] A 4% royalty is within the span of royalty rates used internationally for gold (e.g., see Otto et al., 2006).

Table 2 Financial and economic assumptions used in the modelling

Financing assumptions		
Percent of development costs borrowed	%	70%
Repayment period (beginning production)	years	5
Real interest rate	%	5.0%[1]
Economic assumptions		
Discount rate government	%	5.0%[1]
Discount rate contractor	%	7%[2]
Inflation rate	%	2.0%
Gold smelter price	USD/oz	1,500
Transport post-fiscal point	USD/oz	25
Smelting and refining charge post-fiscal point	USD/oz	50

[1]Real interest and government discount rates have been low in the recent times but are rising. Five percent is chosen as it is in line with historic average values.

[2]The discount rate for contactors is set at 7%, higher than the government discount rate.

at 1 year only, whereas this period is likely to be much longer (although the most resource may in fact be spent in the first year after closure).

The results of the modelling are illustrated in Table 3 and Fig. 1. Some important observations can be made. One basic observation is that in the earlier years (1–2), the mining project does not generate any incomes to the state—this is a normal characteristic for the sector. Specifically for the status quo, the effective tax rate (ETR) is 37%, which is considerably higher than what Otte et al. (2008) and Jerveland et al. (2016) derived in their models, respectively (i.e. 29 and 25% respectively for modelled copper and iron ore mines in Sweden), but still low in relation to the ETR's estimated by the same authors for other jurisdictions. In the case modelled here, the ETR is most significantly related to the gold price, with a break-even gold price being USD950–1000/oz for the scenarios modelled, and with other factors/inputs being of much less importance.

However, for the purpose of this paper, it is more relevant to consider the overall characteristics of the tax regime—and its alternatives—rather than to in detail consider and compare ETR. Thus, in Table 3, it can further be observed that the most important tax in all scenarios is the CIT. And tightly coupled to the CIT is the dividend withholding tax. Both these are progressive, which means that the current Swedish fiscal regime is clearly progressive. If a royalty of 4% is introduced, it would still be of lesser importance. However, this would not hold true if the gold price (in this case) fell, and the operation became less profitable (or worse, unprofitable). In such a scenario, a royalty would ensure that at least some income is earned by the state. As Sweden does not have

Table 3 Summary results of the fiscal modelling of the FARI model gold mine

	Sweden status quo	Royalty + CIT	Royalty + CIT + RRT
Project pre-tax cash flow	1504		
Royalty (MUSD)	0.14	108	108
Corporate income tax (MUSD)	318	295	295
Resource rent tax (MUSD)	-	-	210
Dividend withholding tax (MUSD)	233	216	174
Total government revenue (MUSD)	551	619	797
Average effective tax rate (%)	37	41	52

Fig. 1 Graph illustrating the results of the fiscal modelling of the FARI model gold mine
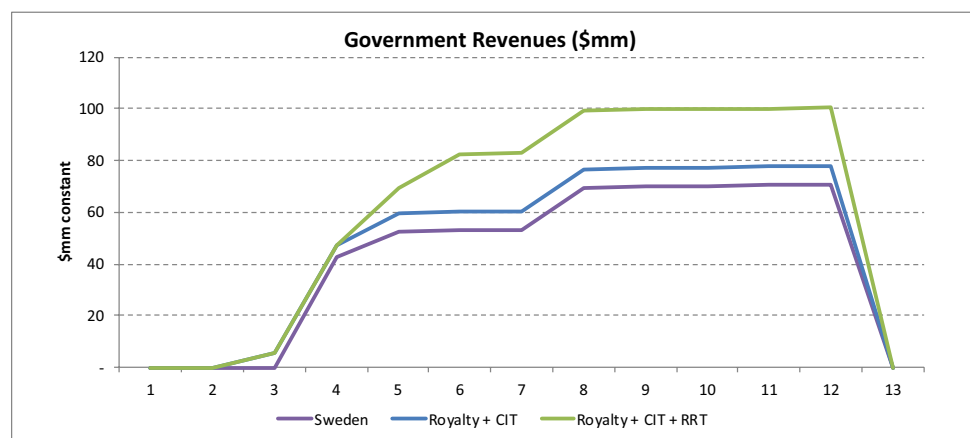
this fiscal instrument, there is a risk that mining can go ahead with no benefits deriving to the state (although taxes will still be earned at the local level, see below). It is further shown that the incomes derived from the mineral fee in the status quo case are comparatively insignificant.

The modelling also illustrates how a RRT can add substantially to the overall effective tax rate for what is in this case a highly profitable gold mine. Figure 1 also illustrates the way in which this type of tax only becomes important once the mining operation has met its development costs and is running at a considerable profit.

In Sweden as a whole, about 60% of all taxes paid are direct and indirect taxes on work. In comparison, CIT is much less significant making up only about 6% of overall taxes (Ekonomifakta, 2020). Thus, to not consider pay roll taxes in a country such as Sweden would be a significant omission. And this is further an omission that is nearly always made when analysing the fiscal set up for mining specifically (e.g. see Otto et al, 2006 or ICCM, 2009 where taxes on work are not considered).

In the modelled gold mine, operating costs (mining, milling and other) make up about 90MUSD, in turn about one-third of the modelled revenues. Inspection of data from other Swedish mining operations suggest that about 1/3 of the operating costs of a mine are costs for employing staff (SGAB & RMG, 2020), which in this case would mean about 30MUSD. This number, in turn, suggests an operation that employs some 330 staff which in turn is a reasonable number for a medium-sized gold mine in a developed country.

Of the salary-related costs, an average of 32% is paid as local municipal taxes, and a further 20% go to central government. The following "back of the envelope calculations" provide an indication of what these taxes would amount to for the modelled gold mine:

- Total costs of employing staff/year: 30MUSD
- Municipal tax on work: 10MUSD
- Other taxes on work: 6 MUSD
- Total work related taxes/year: 16MUSD
- Total work related taxes: 208MUSD
  (LOM +2 years)

The estimations above suggest that the municipal taxes are substantial and of the same order of magnitude to those derived through the other taxes and fiscal instruments considered in the FARI model. Furthermore, whereas tax-related incomes from a mine are comparatively smaller in the early years, the opposite may the case for pay roll taxes as more people are generally employed during the mine development phase, compared to during operation.

If we also add a multiplier effect, then the taxes derived from work may be significantly more than those that relate

to direct taxation of the mining operation. These findings, in turn, illustrate the difficulty of comparing the fiscal regimes for mining in different countries. In Sweden, a substantial part of the tax generated by the mining sector comes from payroll taxes which in turn is an aspect that is seldom considered in these types of analyses and comparisons.

Comparison with good practice—the OECD guiding principles

In this section, the findings made above are assessed against the OECD guiding principles for durable extractive contracts (OECD, 2020a, b). The OECD principles are not relevant in their entirety, nor is the scope of this paper sufficiently broad to include all aspects of the principles. But many of the important provisions may be assessed and shortcomings in this regard may also be identified.

The first guiding principle calls for the fiscal instruments to be aligned with the long-term vision and strategy. The Swedish fiscal set up for mining is essentially not different from that of other sectors, and it has also been unchanged since the current Mineral Law was enacted in 1992, which suggest overall stability. This, in turn, suggests that the provisions do not deviate far from what is, or has up until recently been, state policy. The set up is further based on statues rather than bespoke contracts which means that all mines operate under the same fiscal conditions. However, Swedish policies for mining have been receiving critique, and when we consider the subsequent guiding principles, we can identify and better understand some of the underlying reasons for this.

Principle II calls for fiscal provisions to be based on "agreed and understood objectives" and "shared and realistic expectations". The current Swedish set up does not live up to this principle, as there exist significant misunderstandings, for example the basis and rationale underpinning the state's part of the mineral fee. The main part of the mineral fee falls to landowners, and it may well be an important component in making relevant landowners more accommodating towards mineral related developments, but the component that falls to the state is poorly understood (it is not a royalty), and it is set at a level which makes it insignificant as a state income, in turn causing debate and contention (e.g. Haikola & Anshelm, 2016 & 2020), which in all implies that it may as well be discontinued. Furthermore, the ownership of precious minerals is not made clear in legislation, which complicates the possible introduction of a royalty instrument (Liedholm Johnson & Ericsson, 2015). And the overall reasons why the mining sector is not subject to a separate and special taxation regime appear not to be well explained in policy, nor understood by researchers and stakeholders (Roine & Spiro, 2013).

Principle III states that there should be a balance between the legitimate interests of the host government, investors and communities (including indigenous people). The analysis suggests that the current regime is in an international comparison generous to mining companies. This does not cause too much debate or conflict with regard to the dominant mining companies in Sweden (state owned LKAB, and Sweden-based Boliden) but is often brought up in cases where there are foreign interests involved (e.g. see articles in Anshelm and Haikola, 2020). And there is a risk that the level of controversy and conflict would rise significantly if a foreign-based company successfully identified and developed a major project under the current fiscal regime.

There is no mechanism by which the indigenous Sami may share in the benefits of a mining project, although there are mechanisms for compensation to be made for injury caused (Tarras-Wahlberg & Southalan, 2021). Overall, mining companies have no special responsibility to local communities' welfare, as this rests with local government, with the main funding coming through municipal taxes, combined with a nation-wide system for reallocating funds from richer municipalities to comparatively poorer ones.

A recent assessment shows that many Swedish mines are in international comparison high-cost producers, although they are also comparatively more mechanised than comparable operations elsewhere (Swedish Geological AB & RMG Consulting, 2020). This, in turn, suggests a pattern of comparatively lower grades being mined. That profitability in mining in Sweden is significant despite this fact that may at least in part be related to a comparatively generous fiscal regime for mining.

The Swedish taxation system which allows for municipalities to charge sizeable payroll taxes ensures that local benefits from mining are considerable. However, this model may be under threat, as mining is becoming increasingly mechanised—with fewer employees—and with the risk of a fly in-fly out staffing model becoming more prevalent, as has happened in other important mining nations (e.g. Perry and Rove, 2014; Tano et al., 2016), and which has been reported as an increasing concern in Sweden (e.g. SVT, 2021).

The fiscal provisions for mining are in line with the overall fiscal system (principle VIII). However, in the case of Sweden, this appears to be a shortcoming as the lack of a royalty instrument means there is no fair sharing of the financial risks during times when mining operations are poorly profitable (or unprofitable). During such times, the state will have no significant income at all. And the lack of a RRT suggests that the sharing of financial benefits when profits are especially high may be overly generous to mining companies. Being based on CIT, the present regime is progressive, but there is a risk for sustained periods of commercial production with little or no revenue flow to the central government.

Conclusions and recommendations

The Swedish taxation regime for mining is in the main no different from that of other sectors of the economy, and it has also been unchanged for a long period of time which suggest overall stability. It includes no royalty nor any fiscal instrument to capture windfall taxes, and it is based on statues rather than bespoke contracts. In terms of incomes to the state from mining performed by private companies, the most substantial benefit streams are the corporate income tax (CIT) and the dividend withholding tax. In terms of local benefits, the Swedish taxation system ensures that municipalities charge substantial taxes on workers employed by the mines, and the amounts of taxes derived in this way may be of the same order of magnitude as those derived through the CIT. The principle of ensuring local benefits through municipal taxes may however be under threat, with mining becoming increasingly mechanised—with fewer employees—and with the risk of "fly in-fly out" operations increasing.

Modelling of the outcomes of the fiscal regime in Sweden suggests that it is comparatively generous towards mining companies. Furthermore, the lack of a royalty means that the state takes on a significant risk in times when mining is poorly profitable, and the lack of a windfall tax provides a similar uneven distribution of benefits when commodity prices are high. The funds that the state derive from the so-called mineral fee are insignificant. Thus, whereas the mineral fee may have an important role in financially compensating affected landowners, its role as a source of income to the state is both poorly understood and contentious, and it may therefore just as well be discontinued.

Modelling and comparisons of the outcomes of different taxation and fiscal systems for mining are complex tasks. Much of the work done to date omits the effects of general—non-mining-specific—taxes. Such taxes may be comparatively more important in certain jurisdictions, whereby the results obtained by modelling mining-specific fiscal instruments only may be less relevant. Existing models need to be supported by wider considerations of the applicable taxation regime to allow for better analyses, and associated policy advice.

Data availability All data needed to replicate the article is included/listed in the article.

Declarations

Ethics approval One sole author with no need for ethics approval.

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