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Taxation of the Mining Industry in Latin America and the Caribbean: Analysis and Policy

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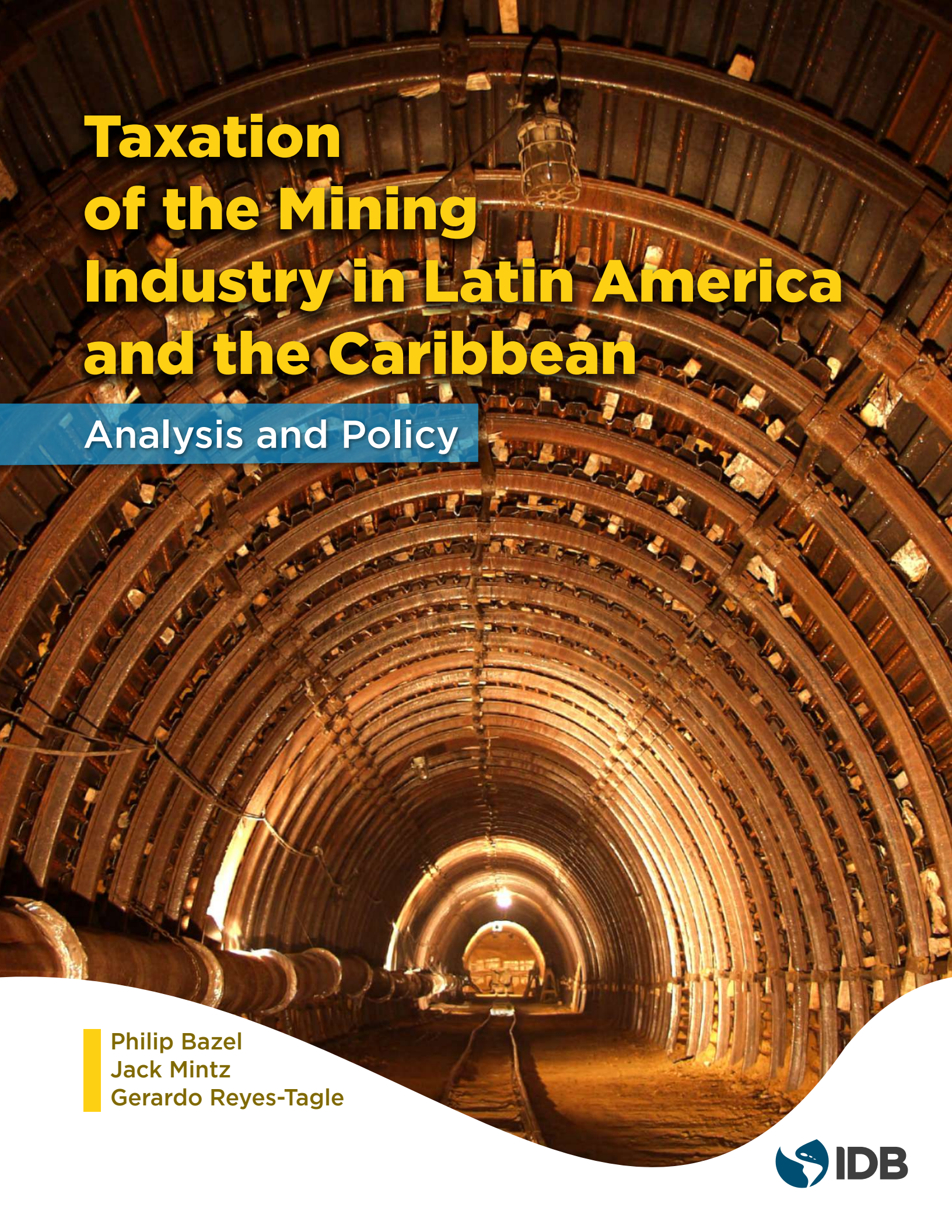

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CONTENTS

ABSTRACT*

Little is known about mining taxation in Latin America and the Caribbean (LAC), although it is both particularly complex and has large effects on incentives for investments in mining activities. This paper reviews the types and consequences of mining taxes that are applied in the region and their implications for investment. Most countries assess royalties based on the value of production, which are consistent with royalties applied globally. However, miners confront additional taxes such that tax regimes, in the aggregate, inefficiently discourage investment, including income taxes, non-refundable sales taxes on capital purchases, capital taxes, gross receipt taxes, and real estate transfer taxes. Several reforms emerge from the analysis. The most important is for LAC countries to consider profit-based regimes—similar to Chile, Mexico, and Peru--supplemented by a minimum royalty based on the value of production. Company tax reforms should also be considered with the aim to tax mining similarly to other sectors of the economy to improve the allocation of capital.

JEL Codes: H23, L72, Q38, Q54

Keywords: mining industry, mining taxation, royalties, government take, marginal effective tax and royalty rate, government mining policy, Latin America and Caribbean

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1

INTRODUCTION

Mining has been an important industry in many Latin American and Caribbean (LAC) countries as a source of export earnings, tax revenues, and employment. With digitization and the energy transformation taking place and increasing worldwide demand for these new technologies in the coming decades, the metal mining industry (including lithium, cobalt, copper, and rare earth metals) will play an even more significant role. To attract investment and employment and ensure they have an appropriate share of rents that come from owning nonrenewable assets that cannot be replaced once developed, LAC countries need to assess and reform their taxes on mining.

Mining tax policy is a complex subject. It not only applies to the design of royalties—the payment made by companies to the resource owner—but also other taxes affecting investment decisions such as company income taxes, sales taxes on capital purchases, and real estate taxes. Thus, when governments are deciding their royalty policies, they need to consider their other tax policies that impact investment decisions and revenues.

In many ways, the government, as owner of the resource, is the principal who hires an agent—the mining company—to explore, develop, and extract resources.[1] As owner of the resource, the principal (government) should therefore be receiving rents from its extraction (rents being revenues net of the full economic costs incurred to explore, develop, and extract resources). The government therefore designs a "contract" that maximizes payoffs (e.g., economic growth and revenues) subject to a constraint that the agent will be willing to accept the contract rather than go to another country (competitiveness). To attract the most able producers, the optimal contract requires the rents to be shared between the government and private producers.

The fiscal system is therefore the primary means by which a government collects rents from resource ownership. Levies, intended to collect resource rents, include bonus bids on lease sales and royalties. The latter are assessed as a percentage of revenues from selling mining ore, a charge on each unit of output sold to the market, or a share of profits (or rents).[2] Mining companies, however, also pay

[1] The discussion here borrows from the principal-agent economics literature. See Laffont and Martimort (2002).

other taxes including company income taxes, sales taxes on capital and intermediate goods, capital taxes, and property taxes. Therefore, governments look at their overall revenue take compared to other countries.

This paper focuses on tax incentives and revenue generation capacity of mining levies in LAC countries. We evaluate the impact of mining taxes and royalties on investment, economic distortions in the allocation of capital, and the revenue take of governments. We account for all royalties and taxes in our assessment of the impact of investment and government revenues on the country's fiscal system. As LAC countries impose relatively high company and other taxes on investment, it puts some constraint on mining levies if competitiveness is to be maintained. However, some mining levies, particularly profit-based ones, can improve revenue collection without compromising attractiveness for investment. This will be a major recommendation for all LAC countries to consider regardless of the mining product.

More specifically, we come to two general conclusions with respect to reforms. First, mining royalty rates on the value of production in most LAC countries are consistent with international rates but discourage investments in marginal mines the most. Profit-based royalties are less distortionary and more sensitive to economic cycles. To protect the royalty base and provide upfront revenues, governments could levy a minimum tax on the value of production that is creditable against the profit tax (or vice versa). Second, it is other taxes like the company income tax that makes many LAC countries less attractive for mining investment. LAC company income taxes are assessed at rates higher than other countries in general. Many LAC countries have relatively high company income tax rates but then provide special tax concessions to attract investment, resulting in distortions in the allocation of capital. Company tax reforms should also be considered with the aim of taxing mining similarly to other sectors of the economy to improve the allocation of capital.

The remainder of this report is divided into four sections: (i) a description of mining in LAC countries and globally, (ii) assessment of LAC levies paid by the mining industry on investment incentives and revenues, (iii) tax competitiveness with major producers for investment, and (iv) policy recommendations. The Technical Appendix explains modeling and the Data Appendix provides economic and tax parameters used in the modeling.

[2] Note that the terms "mining taxes" and "royalties" are used interchangeably. It is typical to refer to royalties as payment based on a percentage of revenues. However, in this paper "royalty" refers to a payment intended to collect rents given government ownership of rents. The term "profit taxes" is used in the context of company income taxes.

2

METAL MINING IN LATIN AMERICA AND THE CARIBBEAN

The metal mining industry is a significant sector in several LAC countries, including the Lithium Triangle (Argentina, Bolivia, and Chile), iron ore in Brazil, copper in Chile, silver in Mexico, and gold and zinc in Peru. Even in small countries like the Dominican Republic, Guatemala, Guyana, and Suriname, mining is a prominent sector accounting for a significant share of business activity in the country.

Mining is a complex process which is simplified here according to three stages of production: exploration, development, and extraction (and processing). Companies hire prospectors, undertake seismographic testing, and explore leased land to stake out potential mining reserves. Once a company is satisfied that reserves are commercially and technically available for extraction, development expenditures are incurred to prepare underground shafts or above-ground mining facilities as well as other infrastructure including roads and pits. The extraction process requires the mining and transportation of ore from pits to a primary crusher or stockpiles, stripping overburden, and removal of waste. Near the pit, milling and some processing may occur to prepare the ore for transportation to the market. Once the mining company exhausts its reserves, it is then responsible for reclamation of the land (the latter depending on government regulations).

As shown in Table 1, three LAC countries are among the top eight metal mining producers as measured by the 2018 value of production of iron and ferro-alloys, non-ferrous metals, and precious metals: Chile (US$43.3 billion), Brazil (US$38.3 billion), and Peru (US$30.7 billion). In 2018, China was the largest producer with US$150.8 billion in revenues followed by South Africa (US$125.8 billion, of which 80 percent was iron and ferro-alloys) and Australia (US$89.3 billion).

Several LAC countries are highly dependent on the metal mining industry as measured by revenues as a share of GDP.[3] These include the most prominent mining jurisdictions—Chile (14.4 percent) and Peru (13.8 percent)—and some smaller countries such as Bolivia (10.2 percent), Guyana (16 percent), and Suriname (27.5 percent). In mining-intensive South Africa

[3] Since GDP is the sum of value-added of all industry sectors, it would be better to measure mining value-added rather than revenues to determine their importance. However, it is difficult to find such data for the metal sector broken down by country.

TABLE 1 VALUE OF METAL MINING PRODUCTION BY COUNTRY (IN BILLIONS OF US$, 2018)

	Value of Production	Percentage of the Country's 2018 GDP
China	$150.8	1.1%
South Africa	$124.3	33.6%
Australia	$89.3	6.2%
Chile	$43.3	14.4%
Russia	$39.3	2.4%
India	$38.9	1.5%
Brazil	$38.3	2.0%
Peru	$30.7	13.8%
United States	$27.0	0.1%
Canada	$25.4	1.5%
Indonesia	$19.5	1.9%
Mexico	$18.0	1.5%
Philippines	$6.4	0.5%
Argentina	$4.4	0.8%
Bolivia	$4.1	10.2%
Colombia	$2.2	0.7%
Dominican Rep.	$1.8	2.1%
Guinea	$1.1	9.2%
Suriname	$1.1	27.5%
Guyana	$0.8	16.0%
Guatemala	$0.6	0.8%

Source: World Bank (n.d.); Republic of Austria (2020).

(revenues are 33.6 percent of GDP), iron and ferro-alloys (e.g., manganese and nickel, among others) account for 80 percent of the value of South African production from metal mining.

Of the 21 countries in this study, Brazil, being the largest LAC country by GDP (GDP of US$1.6 trillion in 2021), is the fourth-largest global producer of bauxite, second-largest producer of iron ore, third-largest producer of manganese, and a significant producer of nickel.[4] The second-largest country by GDP in this study, Mexico (GDP of US$1.3 trillion in 2021), is the largest silver producer in the world and has substantial production in lead (sixth largest globally), molybdenum (fifth largest), and zinc (ninth largest). Argentina (with GDP of US$490 billion in 2021) is well known for its opportunities in lithium (third-largest reserves globally) as well as its major bauxite and silver production (ninth largest globally).

Of middle-size countries—Colombia (GDP of US$315 billion in 2021), Chile (GDP of US$317 billion in 2021), and Peru (GDP of US$225 billion in 2021)—the mineral and metal mining sectors are a considerable source of wealth and

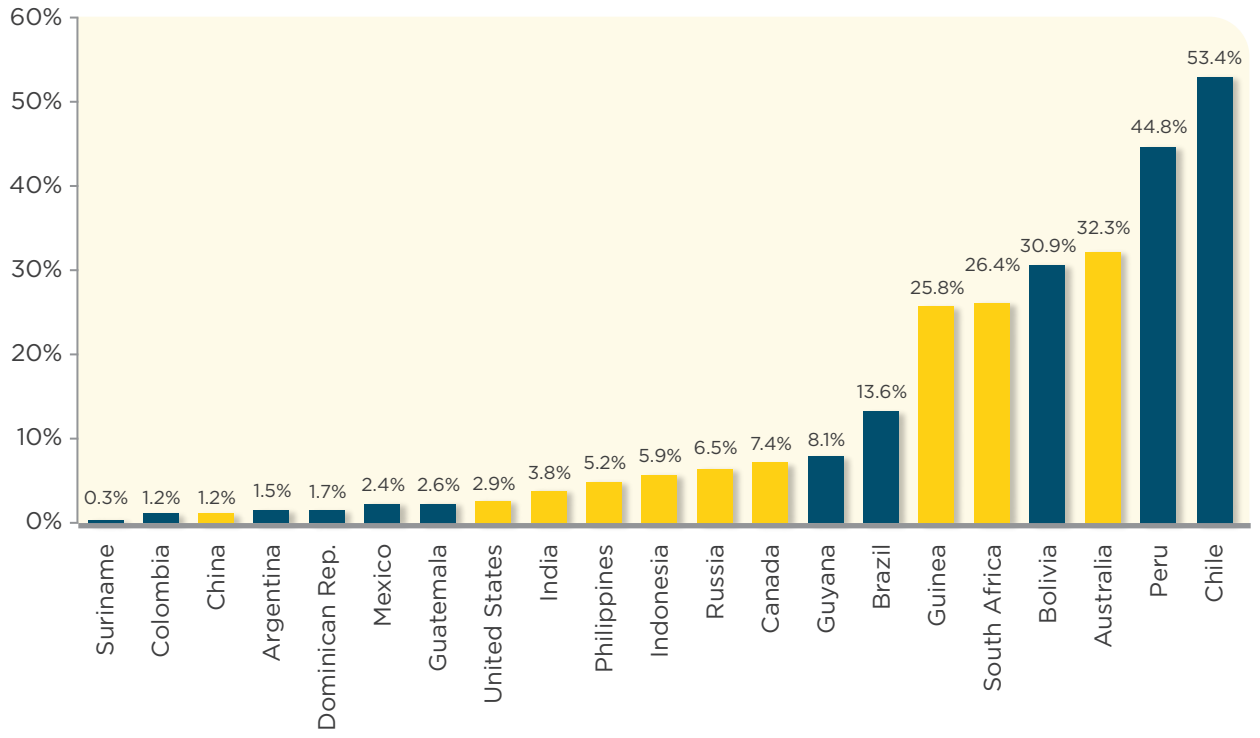
[4] Discussion in this paragraph and the two following uses statistics from USGS (2021).

employment. Colombia is better known for its sizable oil/gas reserves but still has significant production in iron, nickel, and, to a lesser extent, gold. Chile is the largest producer of copper in the world and has the largest lithium reserves globally. It is also the second-largest global producer of molybdenum and the seventh-largest silver producer. Peru is a heavyweight as the second-largest producer of copper, silver, tin and zinc. Peru also has leading production in gold (sixth largest), lead (third largest) and molybdenum (fourth largest).

Of the smaller LAC countries in this study, the Dominican Republic (GDP of US$95 billion in 2021) is one of the larger global producers of nickel with sizable silver production. Although not a leading global producer, Guatemala (GDP of US$85 billion in 2021) has significant nickel and silver deposits (ninth-largest global producer of nickel). Bolivia (GDP of US$40 billion in 2021) is best known for tin (fourth largest), silver (sixth largest), and zinc (eighth largest) production. Although not a significant producer yet, Bolivia has the largest lithium reserves in the world. Guyana (GDP of US$8 billion in 2021) has made considerable news with its oil developments but has traditionally been a mining producer of bauxite and gold. Similar to Guyana, metal production is one of the largest sectors in Suriname (GDP of $3 billion in 2021), with gold as its primary mining commodity.

For some countries, mining exports account for a substantial share of exports (Figure 1). Ores and metal exports account for 53.4 percent of Chile's exports, 44.8 percent of Peru's, and 30.9 percent of Bolivia's. Mining also accounts for more than a tenth of Brazil's exports and relatively small portions for other LAC countries

FIGURE 1 ORES AND METAL EXPORTS AS A SHARE OF MERCHANDISE EXPORTS (AVERAGED 2016–20)



Source: World Bank (n.d.). Note that LAC countries indicated by blue bars.
Note: Blue bars indicate LAC countries.

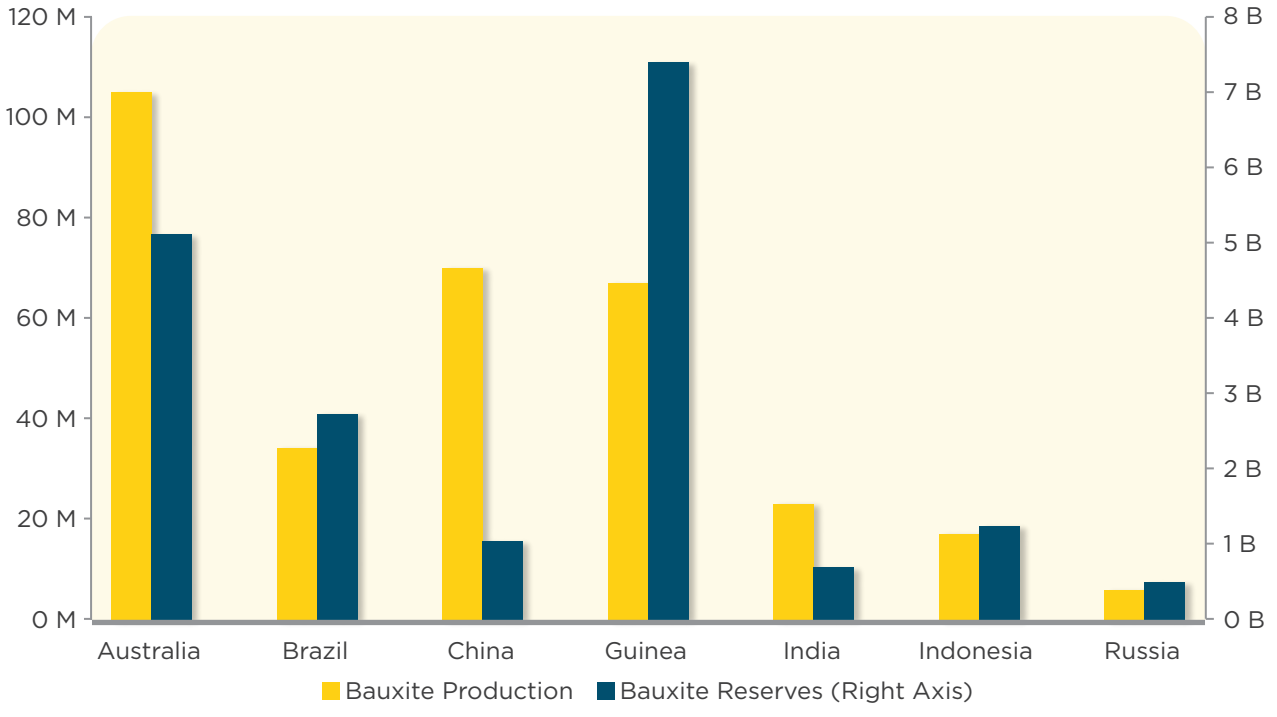
considered in this study. Other countries in which metals and ores have more than a 10 percent share of exports include Australia, Guinea, and South Africa.

Multinational mining companies, which are engaged in most LAC countries, compare investment climates across countries when allocating capital expenditures. Among the top 40 mining companies in the world, the most revenues received from metal mining come from copper, iron ore, and gold (PWC, 2021). However, other mining products are critical to economic development, including those needed for renewable energy. Metal products expected to be high in demand for battery technologies include lithium, copper, manganese, and zinc, which are included in our analysis. Solar panels use bauxite, iron ore, lead, molybdenum, and silver; they are also included in our analysis. LAC is especially appealing for investors because of the rich deposits available for many of these products.

Based on 2019 data available from United States Geological Survey (USGS) 2021 Mineral Commodity Summaries (USGS, 2021), we provide a comparison of significant LAC country production and proven reserves for 12 mining products in Figures 2 to 13 considered in this study. Production data (in thousands or millions of tons) gives an indication of the current ranking of countries in terms of their impact on the economy. Reserves (in billions of tons) provides a critical indication of the availability of resources for future extraction. Given the energy transition will likely take decades, reserves are a source of considerable wealth for a country in future years.

Brazil is one of the world's largest producers with substantial reserves of bauxite (Figure 2), an important input for aluminum

FIGURE 2 BAUXITE PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



Source: USGS (2021).
Notes: Left axis M = million, right axis B = billion; unit is metric dry tons.

production. The world's largest producers are Australia, China, and Guinea; Guinea has the largest reserves and will be a significant competitor in future years.

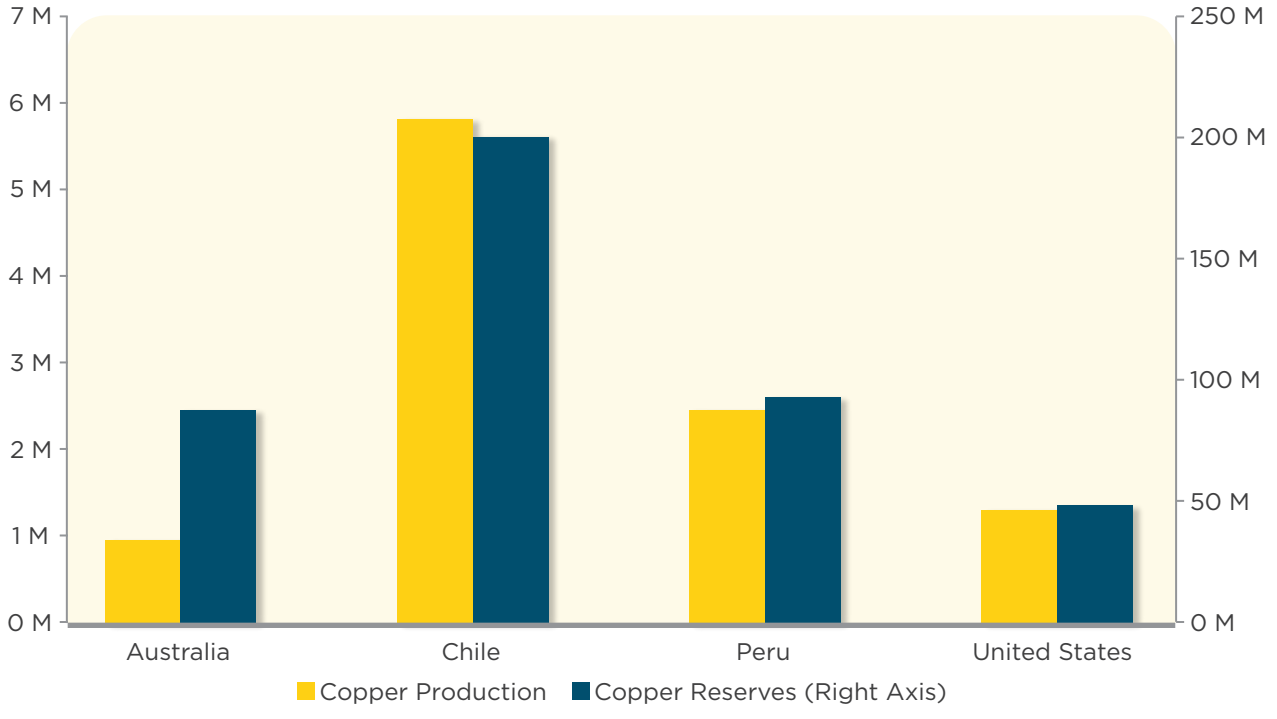
Copper is an important product for the energy transition to be used in electrification. Chile and Peru are the largest producers with the most reserves (Figure 3). Other major producers include Australia and United States, both with substantial reserves.

Gold is a precious metal used in consumption and as a commodity investment. It is also used as part of reserves as a store of value held by central banks. Peru is a significant producer with the fourth most reserves in the world although much larger gold reserves are in Australia and Russia (Figure 4). Similarly, silver has been an important precious metal, with the largest production in Mexico followed by Peru (Figure 5); Australia and Peru have the largest reserves.

Iron ore, lead, manganese, and molybdenum have important industrial applications. Iron ore is the most valuable mining product since it is widely used in steel, which is critical for transportation and the production of machinery and structures. Brazil is a significant producer of iron ore, but its current proven reserves are not large (Figure 6). In comparison, Australia is both the largest producer and owner of reserves of iron ore in the world. Brazil is also the third-largest producer of manganese (Figure 8). Mexico is the fifth-largest producer both in lead (Figure 7) and molybdenum (Figure 9). Peru is the fourth-largest producer in lead and molybdenum with substantial reserves for future production.

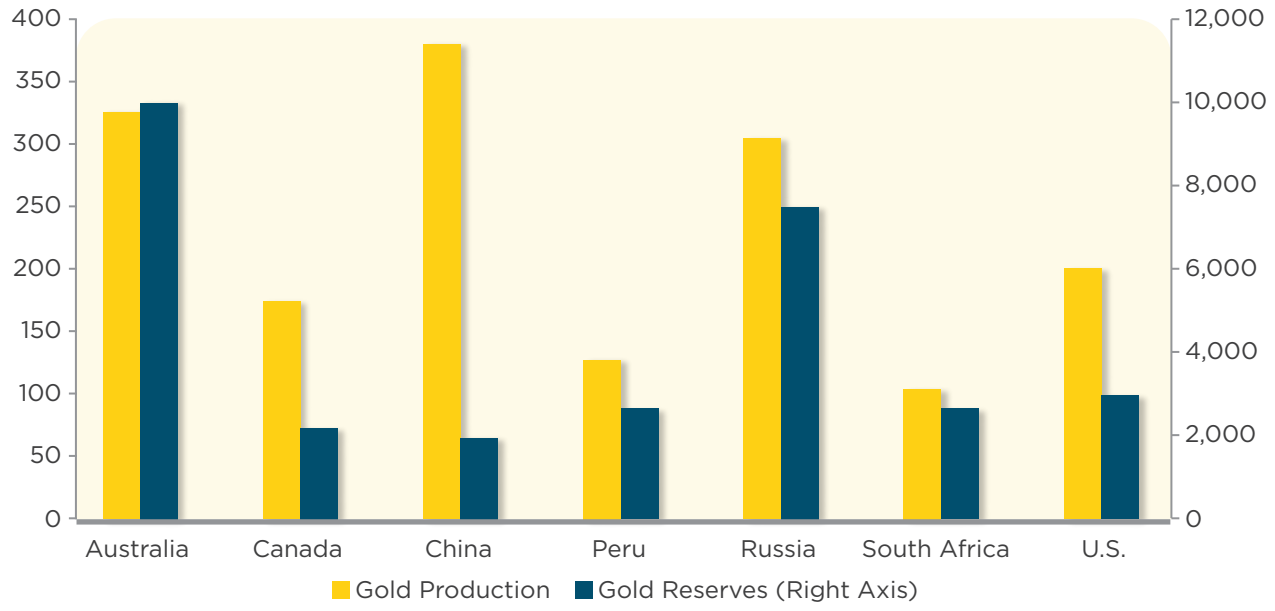
As mentioned above, lithium (Figure 10) is the mining product that receives the most attention with respect to the coming energy transition. Chile and Argentina are significant producers of lithium with large proven

FIGURE 3 COPPER PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



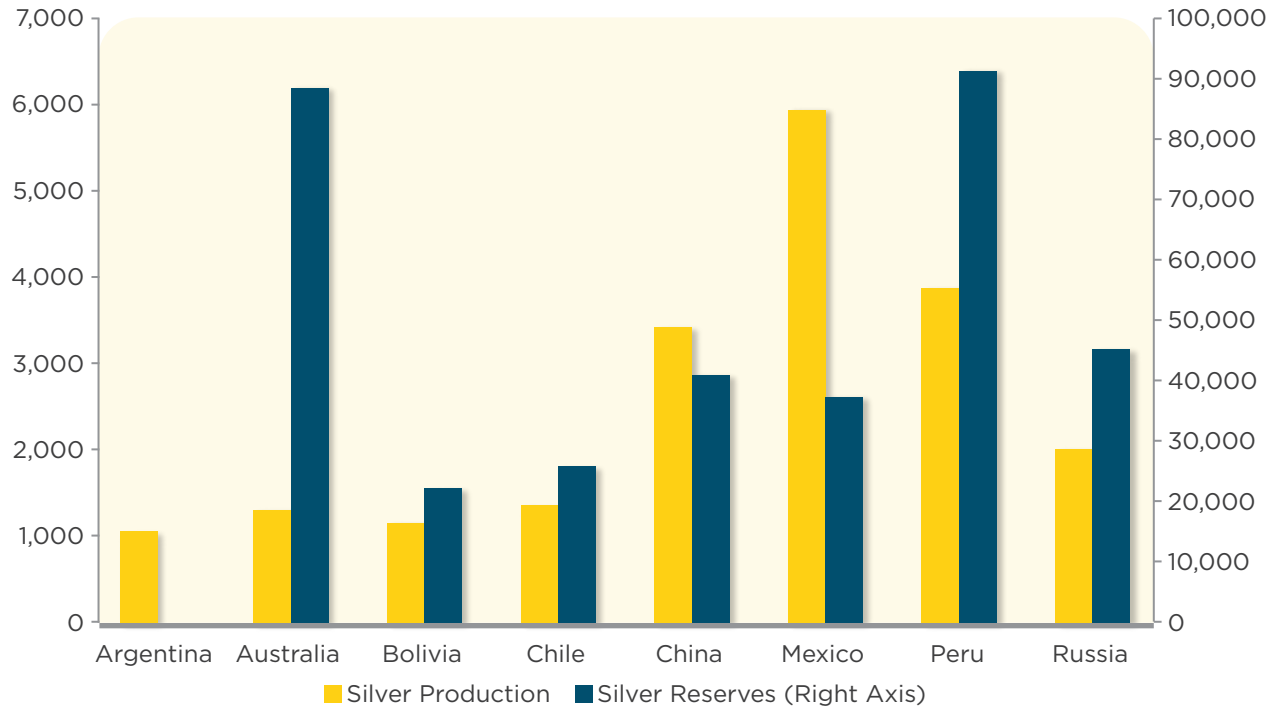
Source: USGS (2021).
Notes: M = million; unit is metric tons.

FIGURE 4 GOLD PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



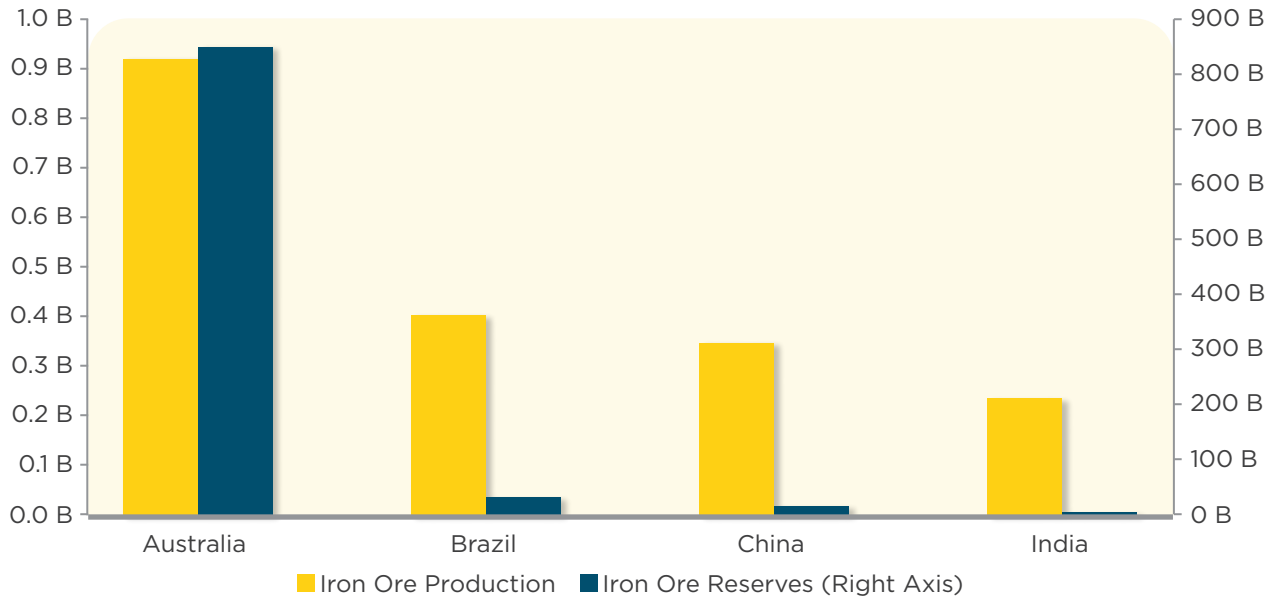
Source: USGS (2021).
Note: Unit is metric tons.

FIGURE 5 SILVER PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



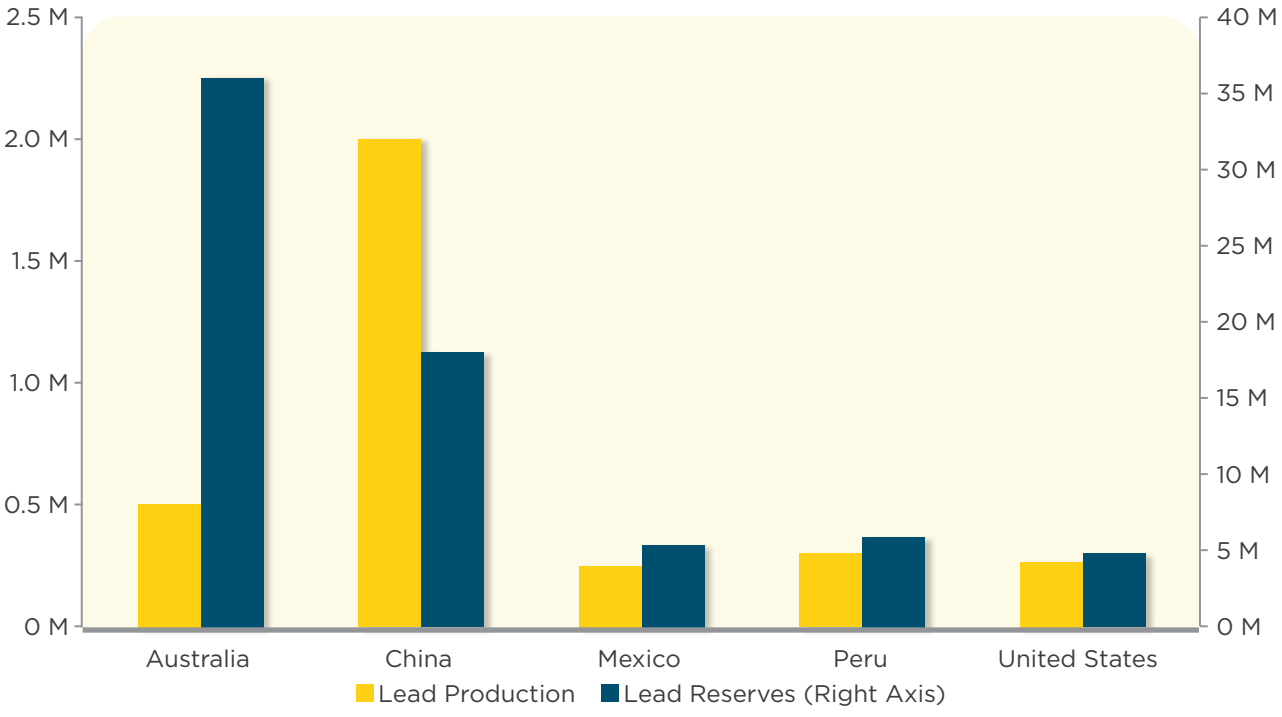
Source: USGS (2021).
Note: Unit is metric tons.

FIGURE 6 IRON ORE PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



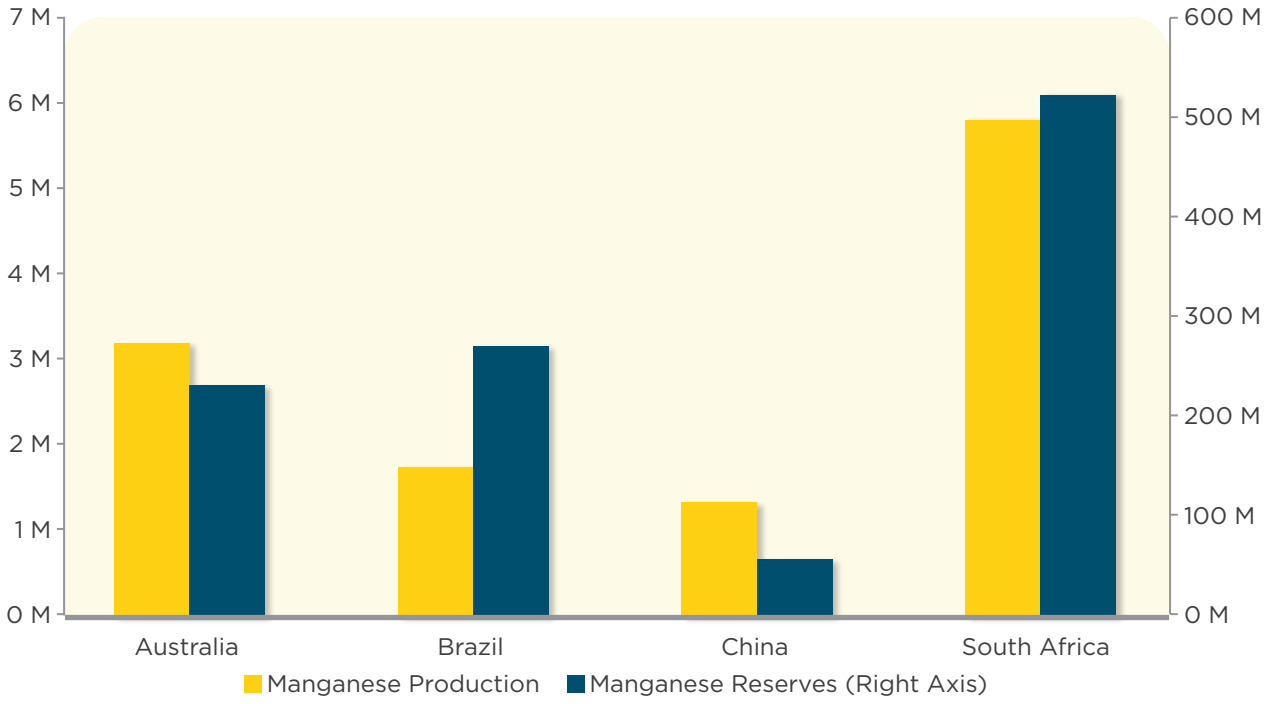
Source: USGS (2021).
Note: B = billion; unit is metric tons.

FIGURE 7 LEAD PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



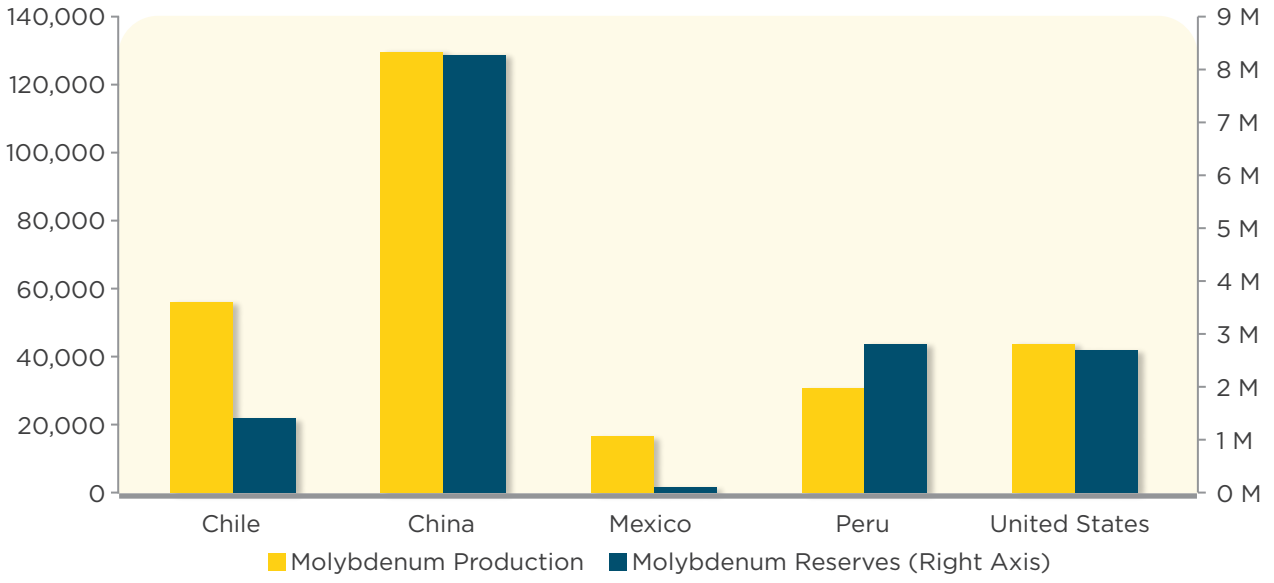
Source: USGS (2021).
Notes: M = million; unit is metric tons.

FIGURE 8 MANGANESE PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



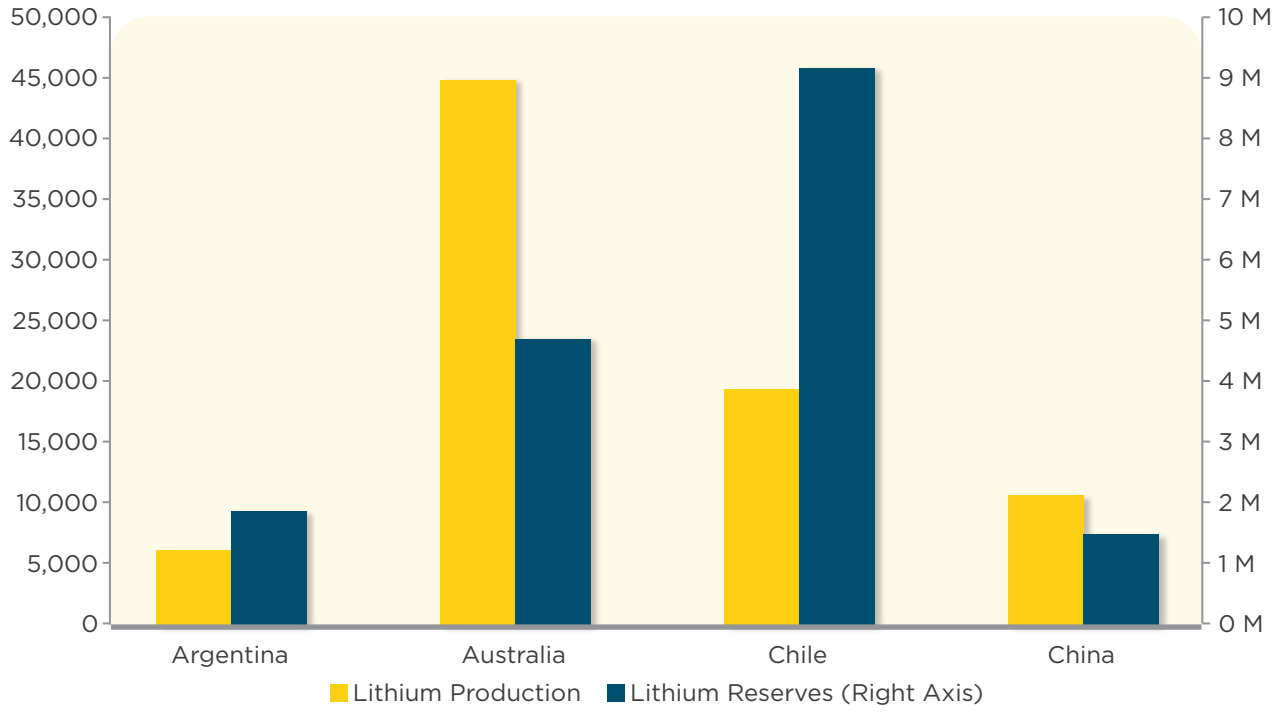
Source: USGS (2021).
Notes: M = million; unit is metric tons.

FIGURE 9 MOLYBDENUM PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



Source: USGS (2021).
Notes: Right axis M = million; unit is metric tons.

FIGURE 10 LITHIUM PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



Source: USGS (2021).
Notes: Right axis M = million; unit is metric tons.

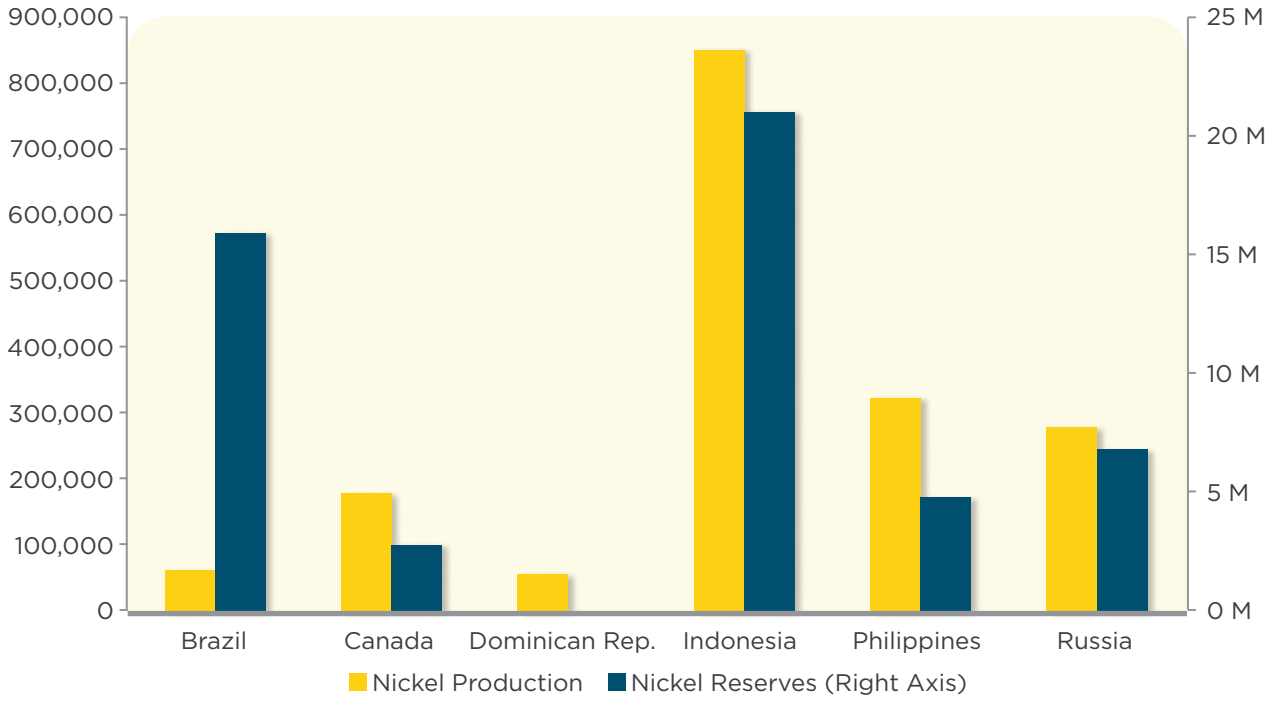
reserves. Not shown is Bolivia, which has large contingent (unproven) reserves but so far has had little production. Bolivia, Chile, and Argentina have been referred to as the "Lithium Triangle" as their contingent lithium reserves make up roughly two-thirds of world reserves. Australia is the largest producer and most important competitor.

Three other critical minerals important for the energy transition include nickel, tin, and zinc. Brazil is a major nickel producer (Figure 11) with the second most reserves in the world. Dominican Republic is the fifth-largest producer but does not have significant reserves. Overall, Indonesia and Philippines are the two largest producers and most important competitors. With respect to tin, Bolivia and Peru are both large producers with substantial reserves (Figure 12). Nonetheless, Indonesia is the dominant producer of tin. Zinc, which is also expected to be important in electrification, is produced by Peru (second-largest producer), Mexico (sixth largest), and Bolivia (seventh largest), with China and Australia dominating world production or reserves (Figure 13).

In summary (Table 2), the taxation and royalty tax impacts on investment in selected LAC countries—Argentina, Brazil, Chile, Colombia, Dominican Republic, Guatemala, Guyana, Mexico, Peru, and Suriname—are compared to other major producing countries by product. Mining products were chosen based on their importance in terms of the value of production in each country. For each product, the largest non-LAC producing countries were identified.

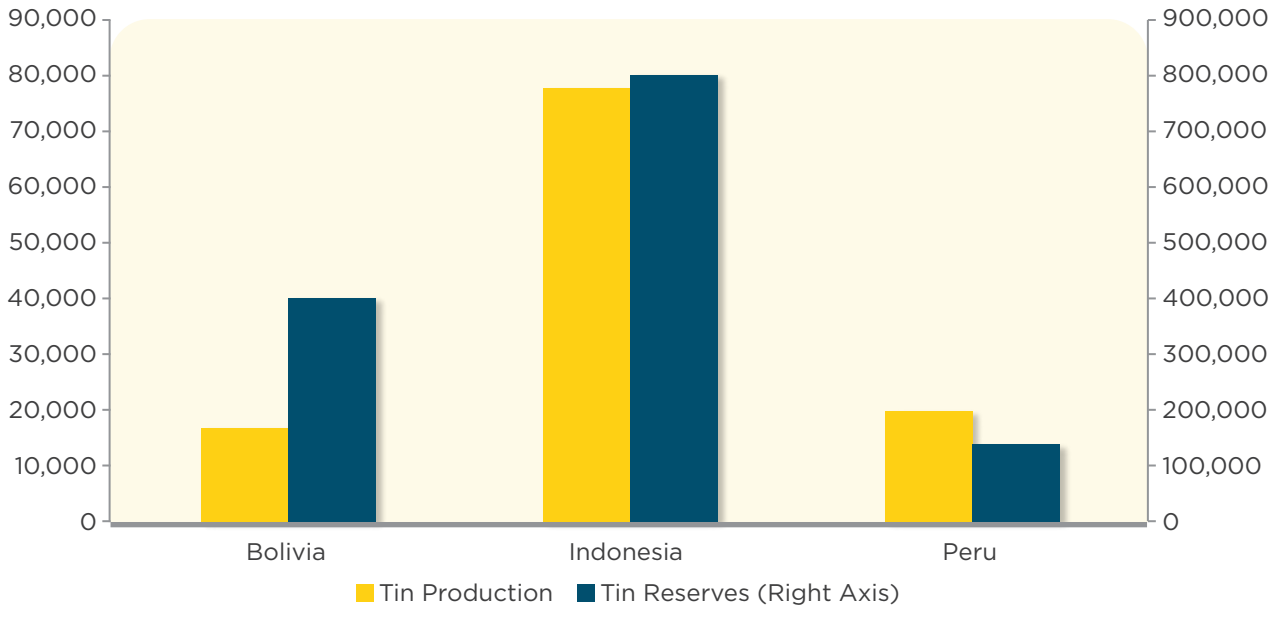
LAC countries need to compete with others globally to attract investment. Other major producing countries of particular interest include

FIGURE 11 NICKEL PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



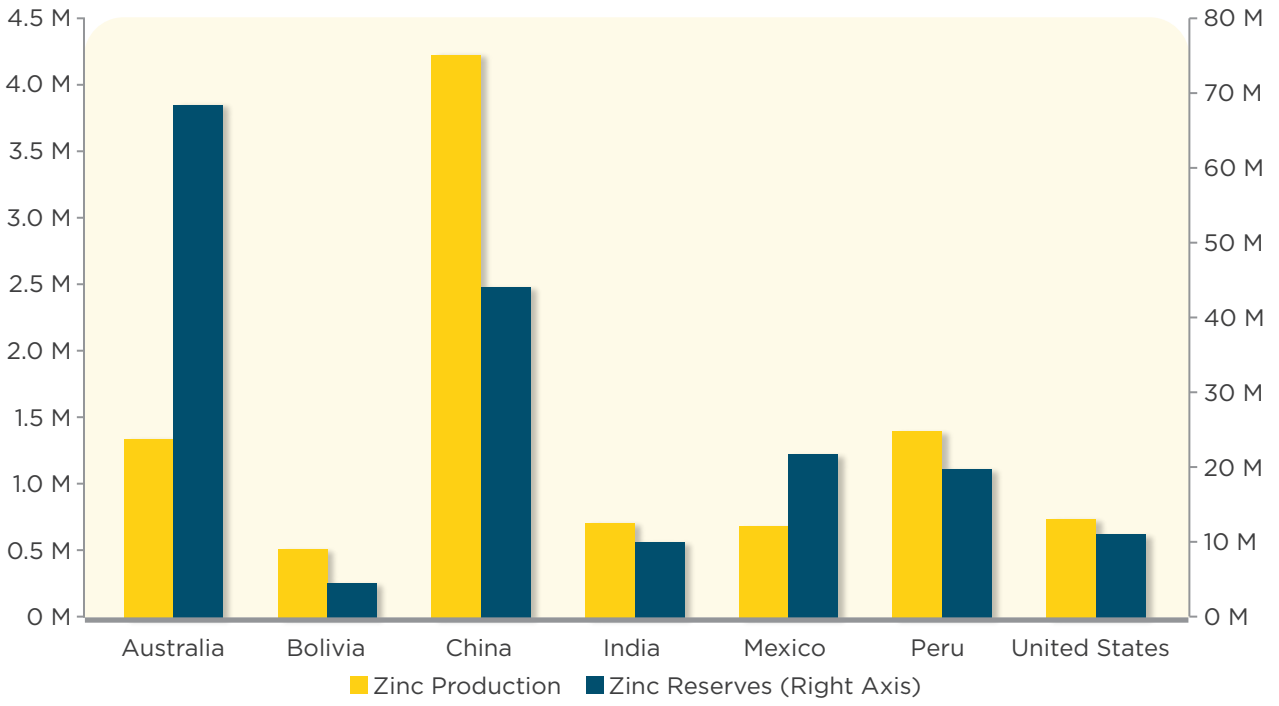
Source: USGS (2021).
Notes: Right axis M = million; unit is metric tons.

FIGURE 12 TIN PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



Source: USGS (2021).
Note: Unit is metric tons.

FIGURE 13 ZINC PRODUCTION AND RESERVES OF MAJOR PRODUCERS (2019)



Source: USGS (2021).
Notes: M = million; unit is metric tons.

Australia, Canada, China, Indonesia, and the United States. Australia is the largest producer of bauxite, iron ore, and lithium. It is also one of the largest producers of bauxite, gold, lead, manganese, silver, and zinc. Canada is one of the largest producers of gold and nickel as well as an important producer of copper, iron ore, and zinc. China is one of the largest metal producers, especially of bauxite, gold, lead, manganese, molybdenum, silver, and zinc. Indonesia is especially dominant in nickel and tin while the United States is a major producer of copper, gold lead, molybdenum, and zinc. Other countries of interest include Guinea (the largest producer of bauxite), India (bauxite and zinc), Philippines (nickel), Russia (bauxite, gold, nickel, and zinc), and South Africa (gold and manganese but also a significant producer of iron, nickel, and titanium).

TABLE 2 COUNTRIES AND PRODUCTS INCLUDED IN THE STUDY

	Bauxite	Copper	Gold	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Silver	Tin	Zinc
Argentina	✓					✓				✓		
Australia	✓	✓	✓	✓	✓	✓	✓			✓		✓
Bolivia						✓				✓	✓	✓
Brazil	✓			✓			✓		✓			
Canada*			✓						✓			
Chile		✓				✓		✓		✓		
China*	✓		✓	✓	✓	✓	✓	✓		✓		
Colombia									✓			
Dominican Rep.			✓						✓	✓		
Guatemala									✓	✓		
Guinea	✓											
Guyana	✓		✓									
India	✓			✓								✓
Indonesia									✓		✓	
Mexico					✓			✓		✓		✓
Peru		✓	✓		✓			✓		✓	✓	✓
Philippines									✓			
Russia	✓		✓						✓	✓		
South Africa			✓				✓					
Suriname			✓									
United States*		✓	✓		✓			✓				✓

* Denotes countries with subnational jurisdictions with their own tax and royalty policies. These are analyzed separately. For example, for Australia, New South Wales, Northern Territory, Queensland, South Australia, and Western Australia are considered, each specializing in certain mining products.

3

MINING TAXATION IN LATIN AMERICA AND THE CARIBBEAN

Mining taxation is complex, especially considering the different taxes levied by governments on mining investments. LAC countries collect land lease payments and royalties as a share of rents from the extraction of mining ore. They also collect taxes on investments that are applied to other industries including company income taxes, non-refundable sales taxes on capital purchases, real estate and financial transaction taxes, and capital taxes (on assets or equity). Table 3 provides a brief summary of the mining levies affecting investment that were considered in this study (see further discussion below on methodology and details in the Technical and Data Appendixes).

The profit-based royalties in Chile, Mexico, and Peru differ from each other in terms of rates and bases. In Chile the mining levy is being reformed, but the country currently applies rates varying from 5 to 14 percent on operating income (for production of more than 50,000 metric tons, the effective rate is 14 percent).[5] Mexico applies 7.5 percent tax on profits with expensing for operating and capital expenditures (no deduction is provided for depreciation, depletion, or net interest expense). Peru assesses three profit-based mining levies on operating income (exploration and capital costs are deductible over the life of the mine and interest is not deductible): (i) a mining royalty varying from 1 to 12 percent (minimum rate of 1 percent on sales), (ii) a special mining tax varying from 2 to 8.4 percent (with no minimum tax), and (iii) a special mining contribution of 4 to 13.2 percent only paid voluntarily under stability agreements.

As discussed earlier, accounting for deductibility of royalties and profit taxes from corporate income taxes, the effective statutory tax rate is calculated as the combined federal-subnational corporate, mining profit, and revenue-based royalty rates. The latter is expressed as a share of the price-cost margin (costs exclude depreciation, amortization, depletion, and financing expenses).[6] This puts the royalty on the value of production on an equivalent gross income measure like other profit taxes.

[5] Large mining companies pay a flat tax rate between 4 and 5 percent under tax stability agreements. A proposed royalty would also be levied on sales varying according to size and copper prices.

[6] For additional information on price cost margin source and calculation, see the Data Appendix.

TABLE 3 GENERAL TAX PROVISIONS AFFECTING METAL MINING INVESTMENTS

	Mining royalty on revenues or profits[a]	Corporate income tax rate	Sales tax on capital purchases[b]	Real estate transfer tax	Capital asset tax[c]	Gross receipts tax	Financial transaction tax
Argentina	3%	35%[d]			0.75%	1.0%	1.0%
Bolivia	3–6%	40.9%					0.3%
Brazil	2–3%	34.0%	8.0%	4.0%		2.48%	1.5%
Chile	14%*	27.0%[d]					
Colombia	5–12%	30.0%[e]		7.93%		0.75%	0.4%
Dominican Rep.	5%	40.0%		3.0%			
Guatemala	1%	25.0%		3.0%	0.9%		
Guyana	5%	25.0%					
Mexico	7.5%*	30.0%[d]					
Peru	20.4%*	29.5%		3.0%			
Suriname	6.5%	36.0%					

Source: Data compiled from government sources by authors (see Data Appendix).
Notes: [a] All royalties are revenue-based except for profit-based ones indicated by *. Top rates are used for profit-based royalties and company income taxes.
[b] Non-refundable VAT and other sales/excise taxes.
[c] Excludes a capital tax that operates as a minimum tax under the company income tax.
[d] Inflation adjusted. Note that the Dominican Republic only has partial indexation applied to capital gains and depreciable assets.
[e] In 2022 Colombia raised its company income tax rate to 35 percent instead of reducing the rate from 31 percent in 2021 to 30 percent as planned. The simulations below use the 30 percent rate.

The importance of mining taxes and royalties as a share of GDP is provided in Table 4. Mineral mining includes metal and coal mining (coal could not be excluded) and no data were available for Guyana and Suriname. Government take is calculated as a share of the value of production, which does not recognize costs of production. This approach is quite different from the estimates provided of effective rates relative to profitability, which is important to use to understand incentive impacts.

LAC royalty rates on the value of production are comparable to Australia but much lower than China (see the Data Appendix). By international standards, the company income tax rates in LAC countries are on the high side (the GDP-weighted average OECD company income tax rate is 26.3 percent, 30.3 percent for the included LAC countries). Most countries have well-functioning VAT systems, although businesses might pay non-refundable sales taxes on capital purchases due to lack of input tax credits (such as in Brazil). Real estate transfer taxes are found in many LAC and developed countries—these taxes distort location decisions as they apply when a company decides to sell its structures and land.

The official statutory or headline tax rate does indicate the amount of tax paid; the total amount paid will also depend on the tax base, which may deviate from economic values. This is especially important in determining the effective company income tax paid by a business because capital costs are affected by accelerated or insufficient write-offs for capital expenses, allowances, and investment tax credits.

TABLE 4 TAXES, ROYALTIES, AND PRODUCTION VALUE OF MINERAL MINING AS A SHARE OF GDP (AVERAGED 2014–18)

	Production value (as % of GDP)	Taxes on income, profits, capital gains, and "other"	Royalties and "other holdings"	Taxes and royalties as share of production value
Argentina	0.66%	0.04%	0.01%	7.5%
Bolivia	7.59%	0.23%	0.49%	9.5%
Brazil	1.87%	0.04%	0.04%	4.3%
Chile	14.11%	0.68%	0.37%	7.4%
Colombia	3.00%	0.12%	0.21%	11.0%
Dominican Rep.	1.96%	0.30%	0.06%	18.3%
Guatemala	1.46%	0.05%	0.03%	5.5%
Mexico	1.91%	0.17%	0.02%	9.9%
Peru	12.30%	0.41%	0.16%	4.6%

Source: CEPALSTAT database and S&P global SNL metals mining database via International Council on Mining and Metals.
Notes: Non-income taxes are excluded. Mineral mining includes both metal and coal mining.

The remainder of this section provides a brief explanation of the methodology used to measure effective tax rates on investment and then compares effective statutory rates, effective tax rates on marginal investment, and average tax rates.

Methodology

As part of this assessment, three measures of effective tax rates are important to understanding incentive effects and revenues. The first is the effective statutory tax rate, which is combined central-subnational company income tax rates, profit-based royalty rates, and revenue-based royalty rates (expressed as a percentage of price-cost margins). For example, Argentina has a 3 percent royalty on bauxite sales (with a price-cost margin of 62 percent). The effective royalty rate is therefore 4.8 percent on bauxite sales (3 divided by 62). The royalty is deductible from the 35 percent company income tax, resulting in a total effective statutory tax rate of 38.1 percent on bauxite sales. Statutory tax rates provide a headline indication of how much profit is taxed. Statutory tax rates are also relevant to company decisions, such as the determination of transfer prices and income flows to investors (e.g., profit distributions versus fees) or, such as the case of company tax on shareholder profits, the choice between debt and equity financing.

The second is the marginal effective tax and royalty rate (METRR), which measures the impact of taxes on investment in marginal projects. When measuring the impact of taxes on investment, the focus is on those levies that affect the return to capital. Companies invest in capital until the rate of return is equal to the cost of financing capital (or the financing rate) and any taxes paid on capital. Thus, taxes or royalties create a wedge between the pre-tax and post-tax rate of return on capital. For example, if the pre-tax rate of return is 9 percent and the after-tax return is 5 percent, then the tax wedge is 44.4 percent.

If the METRR is increased, it will create a bigger wedge between pre-tax/royalty and post-tax/royalty rates of return on capital. Because large mining companies fund investment from

international capital markets, the post-tax cost of capital or interest rate is exogenous to LAC countries, which are relatively small open economies in international capital markets. Thus, the incidence of capital taxes results in an increase in the pre-tax cost of capital since the post-tax return is fixed. That would require companies to reduce investments that were previously acceptable when the tax rate was lower.

Thus, taxes impinge on capital decisions as taxes make marginal investments unprofitable. These are investments that generate little or no economic rents since profits are only sufficient to cover the cost of capital, which is equal to interest and equity financing costs and taxes. Taxes also reduce the rents earned by mining companies, but these come from profits earned by the company on their non-marginal investments. If the tax is applied to only rents with all economic costs deducted from revenues, the mining company will earn a lower "average" not "marginal" rate of return on capital. This point is relevant to later discussion on policy.

The third measure is an average tax rate (ATR), which is the portion of annualized profits paid out as taxes and royalties, including inframarginal investments. To provide an analysis of how much tax revenue is paid by a mining company, the aggregate tax and royalty payments as a percentage of profits earned on mining investments should be calculated from financial statements. Such information is not available to us. However, by measuring the average pre-tax and royalty real rate of return on capital for a mining company, it is possible to measure an "effective" ATR that is related to statutory tax rates and METRR estimates discussed above (this concept, which was derived for this paper, is presented in the Technical Appendix).

Note that the average effective tax rates can be above or below the marginal tax rates. When the average return on capital is higher than the marginal return, more taxes are collected as a share of the pre-tax rate of return (the higher the statutory tax rates, the bigger the impact). Some taxes, such as royalties based on the value of production, have a larger impact on marginal investments compared to inframarginal ones. Incentives for capital investment such as accelerated write-offs and investment tax credits can drive the marginal effective tax rate below the ATR.

BOX 1. MARGINAL EFFECTIVE TAX AND ROYALTY RATES

The impact of taxes on capital investment is based on an analytical measure of the marginal effective tax and royalty rate (METRR). The METRR is the annualized value of mining royalties and company taxes paid as a percentage of the pre-tax profitability of marginal investments. Marginal investments are those that earn just enough profit to attract financing from investors, covering risk, royalties, and taxes.

Taxes that impinge on capital investment include mining royalties, the rate of company income taxes, cost deductions (e.g., depreciation, exploration, development, inventory and interest expense, allowances and tax credits), sales taxes on capital purchases (such as non-refundable sales taxes), asset-based taxes (capital taxes and property taxes), and transfer taxes on real estate and financial transactions. Our analysis includes most taxes except municipal property taxes and tariffs because both are unobservable by industry.

It is important to note that defining the tax paid as a share of the return to capital, not equity, results in debt sheltering investment from company income taxation. Companies relying more on leverage to

(continued on next page)

BOX 1. MARGINAL EFFECTIVE TAX AND ROYALTY RATES *(continued)*

finance capital will have a lower METRR. We assume that 40 percent of capital is financed by debt for all countries in order to focus on tax differences among countries rather than differences in leverage ratios.

Another key metric that plays an important role in our assessment of the METRR is the gross profit margin (net price of unit operating costs divided by price). Since royalties fall on the value of production, its impact on profitability will depend on the price-cost margin—the smaller the difference between prices and unit costs, the greater the effective tax on the return to mining investments. Based on USGS data, price-cost margins are estimated by each product (see the Data Appendix for values by product, along with sources and methodology).

This analysis uses similar capital structures to isolate tax differences among countries (country-specific capital weights, if available, would give a different ranking). The division between property, plant and equipment, and inventories is obtained from PWC top 40 mining company data. However, there was no breakdown between exploration, development, and depreciable capital expenditures. To obtain this breakdown, Natural Resources Canada and Statistics Canada data were used, supplemented by Finance Canada data on tax depreciation categories. Economic depreciation rates for assets are also based on Statistics Canada estimates. Bond interest rates reflect differences in inflation rates across countries (following the purchasing power parity assumption). Equity costs are based on a marginal owner who is indifferent between after-tax rates of return on stocks and bonds (the marginal investor is assumed to be a G7 investor holding an international portfolio of bonds and equity). The analysis includes manufacturing and service industries (services include construction, utilities, transportation, communications, trade, and other business and household services). The Technical Appendix provides the model used to derive METRR. The Data Appendix provides information on parameters used for the modelling.

The model is based on a "time to build" operation whereby exploration, design, and development expenditures are initially incurred to prepare reserves for extraction (see the Technical Appendix). Once reserves are prepared, extraction and processing at the mining site takes place (smelting is treated as manufacturing and therefore excluded). The Technical Appendix provides modeling details. As shown in the Data Appendix, and as explained further below with respect to their derivation, exploration accounts for 17 percent, development for 46 percent, production capital 25 percent, and inventories 12 percent of capital investment.

Projects, however, often earn returns higher than those of the marginal project. For this reason, the revenues collected by governments is more than what companies might pay for marginal projects. Although detailed financial and tax statements of mining projects in each of the LAC countries is not available, information on the top 40 mining companies in the world provides at least an indication of the average pre-tax and royalty rates of returns on the book value of capital.[7] For this purpose, the ATR to evaluate the government take is estimated as a percentage of profitability (not revenues that are typically assumed). Given many countries are federal in nature, the analysis includes both central and subnational government tax and royalty levies on the industry.

[7] The average real rate of return on capital, gross of royalty and company income tax payments, is estimated at 15 percent based on data for various years taken from PWC (2021), a report on the top 40 mining companies.

Note that risk can be treated as part of the cost of capital (which is conventionally done) or be viewed, like labor and intermediate good expenses, as reducing the return on capital (the risk-adjusted rate of return). When losses are deductible from taxable income and refundable, the government shares both the profits and losses earned on investment through the tax. This implies that the government also share risk costs with the private sector, which is an implicit deduction of risk costs from the tax base (Mintz, 1995). The working assumption below is that most tax losses on marginal investments are fully deductible from other income rather than carried forward. Otherwise, if losses have to be carried forward (without being indexed at a rate of interest), the effect of METRR will depend on timing of losses. For example, for start-up projects, deductions carried forward in loss pools would result in a higher METRR than we calculate. On the other hand, loss carry-forwards shelter taxes paid on new investments in later years. There is no data to work through the importance of each case.

Our assessment does not include taxes on other inputs in production such as labor, energy, and intermediate goods and services purchased by the company. Taxes on these inputs increase production costs, which is the sum of capital, labor, energy, and intermediate good expenses. In measuring the effective tax rate on capital, only those taxes that directly apply to capital are

BOX 2: AN EXAMPLE ILLUSTRATING EFFECTIVE TAX AND ROYALTY RATES

Here the different effective tax rates—statutory, marginal, and average—relevant to the profits earned by a mining company are illustrated. Average and marginal effective tax and royalty rates are expressed as a percentage of profits gross of interest expense (the return to capital).

Financial statements are provided in the table below for a hypothetical mining company that invests in a marginal project that adds to the total profits earned by the company. The company has $33,500 in tangible assets and marginal investment is equal to $5,000. Average profitability (profits gross of interest, taxes, and royalties) is 10 percent of capital. Marginal profitability, measured in the same way, is 4.9 percent.

	Profits from Marginal Investment	Inframarginal and Marginal Profits[b]
Revenue	$500	$5000
Operating Cost	-$200	-$1000
Royalty on Revenues (5%)	-$25	-$250
Depreciation, Depletion, and Exploration Costs[a]	-$55	-$650
Interest	-$20	-$100
Pre-Tax Profit	$200	$3000
Company Income Tax (30%)	-$60	-$900
Exploration Tax Credit	+$50	+$50
Net Profit	$190	$2150

[a] Exploration costs are expensed for tax purposes in determining taxable profits.
[b] Profits for the whole company includes profits from the marginal investment.

(continued on next page)

BOX 2: AN EXAMPLE ILLUSTRATING EFFECTIVE TAX AND ROYALTY RATES *(continued)*

The company income tax is levied at 30 percent of profits. The royalty is applied at 5 percent of revenues. Operating costs are current costs, therefore excluding depreciation, depletion, exploration, and interest expenses. The marginal project is assumed to have a lower gross price-cost margin (60 percent) compared to the company as a whole (80 percent). Only exploration is being carried out by the marginal project. Effective tax rates are calculated for two cases: one in which the exploration tax credit at 33 percent is provided and another in which no credit is provided.

Consistent with the model, the average effective tax royalty rate is calculated as taxes and royalties paid divided by profits gross of taxes, royalties, and interest. If the exploration tax credit is provided, the average and marginal effective tax and royalty rates are calculated as follows:

ATRR = (company income tax payments + royalties)/(pre-tax profits + royalties + interest)
= ($900–$50+$250)/($3000+$250+$100) = $1100/$3350 = 32.8%

METRR = ($60–$50+$25)/($200+$25+$20) = $35/$245 = 14.2%

Even though the profitability of marginal investments is less than the profitability of the company's whole investment, the METRR is lower than the ATR because the exploration tax credit is of greater significance to marginal profitability compared to average profitability.

If the company did not have an exploration tax credit available to it, the ATR and METRR would be calculated as follows:

ATRR = ($900+$250)/($3000+$250+$100) = $1150/$3350 =34.3%

METRR = ($60+$25)/($200+$25+$20) = $85/$245 = 34.7%

Without the exploration tax credit, the ATR is slightly lower than the METRR because average profitability is more than marginal profitability.

Effective Statutory Tax Rate: Taking into account the deductibility of royalties from taxable company profits, the combined company income tax and royalty rate is calculated as 30% + 5%(1–.3) = 33.5%. However, we calculate the effective statutory tax rate considering royalty payments as a share of net revenues (revenues net of operating costs) for the marginal project. For the marginal project, the royalty payments are $25 of $300 in net revenues or 8.3%. The effective statutory tax rate is 30% +8.3(1–.3) = 35.8%, more than the METRR. We expect that effective statutory tax rates are higher than the METRR or ATRR because capital costs do not reduce the effective statutory tax rate, but they do lower profitability for gross profits measured for the METRR and ATRR.

considered (payroll taxes, for example, would be part of the effective tax on labor).[8]

Results

To start, an illustrative comparison of effective statutory tax rates, METRRs, and ATRs by country is provided. Since these vary by product, the presentation is simplified by using a simple average of the individual product estimates in each country (Figure 14).[9] Detailed estimates by products are provided below.

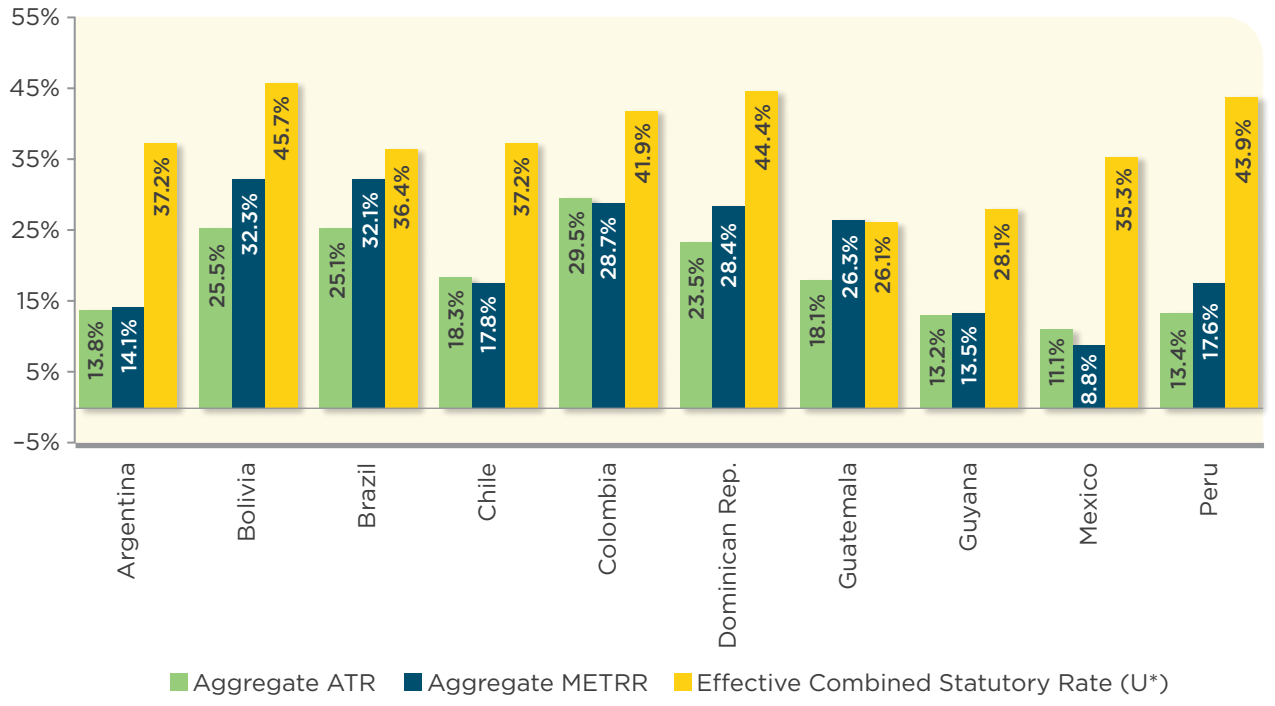
Effective Statutory Tax Rates

For the LAC countries in this study, combined central and subnational royalty, company income, and mining profit tax rates (taking into account the deductibility of mining levies

[8] To analyze the impact of taxation on the cost of doing business, analysis would be needed to aggregate effective tax rates on inputs (McKenzie, Mintz, and Scharf, 1997).

[9] Weighted average based on capital weights would have been preferred but such data are not available.

FIGURE 14 EFFECTIVE STATUTORY, MARGINAL, AND AVERAGE TAX RATES ACROSS LATIN AMERICAN AND CARIBBEAN COUNTRIES (2021)



Source: Authors' calculations.

from company taxable income) vary from as low as 26.1 percent in Guatemala and 28.1 percent in Guyana to as high as 44.4 percent in the Dominican Republic and 45.7 percent in Bolivia. The company income tax rates that are roughly 30 percent or higher (27 percent in Chile, 25 percent in Guatemala and Guyana) account for most of the effective statutory tax rates. However, mining profit taxes in Chile, Mexico, and Peru add significantly to the effective tax rate.

For example, Chile has a relatively low company income tax rate of 27 percent but an effective statutory tax rate of 37.2 percent due to its mining tax rate of 14 percent (the mining tax is deductible from the company income tax base, so the total rate is 27 plus 14(1-.27) which equal 37.2 percent). In the case of Peru, the company income tax rate is 29.5 percent and mining profit tax rate is 20.4 percent, resulting in an overall combined statutory tax rate of 43.9 percent, the third highest of the eleven countries (mining taxes are also deductible from the company income tax base).

While the headline rates are only indicative of the amount of taxes paid on investment, they are not sufficient to understand the full impact of taxation on investment, since the tax treatment of production and investment costs is important to incorporate. One needs to delve into the details of the tax base for each of the taxes. However, statutory tax rates are quite important to evaluating the effect of tax policy on business decisions and government revenues for other reasons. First, it can be noted that the higher effective statutory tax rates contribute to higher taxes on rents (and higher ATRs). Second, they affect transfer pricing as (higher) rates encourage companies to price more highly imported goods from related

affiliates and to price less highly export goods and services sold to affiliates abroad (the transfer pricing rules limit flexibility). Third, higher statutory tax rates also encourage subsidiary companies to pay fees and other deductible charges rather than dividends to their parent multinational. High company income tax rates, which are present in most of the LAC countries, encourage mining companies to use debt to finance capital.

Marginal Effective Tax and Royalty Rates and Investment

Taking into account the deductibility of costs from profits, tax incentives, and other taxes paid on capital investment, the METRR is less than the effective statutory tax rate for each country. With respect to attractiveness for investment, the greatest METRR on marginal investments are in Bolivia at 32.3 percent and Brazil at 32.1 percent. The lowest METRR is in Mexico at 8.8 percent.

The following factors most influence the METRR comparisons across LAC countries (see the Data Appendix for details on rates and deductions under the company income tax and mining levies as well as other taxes):

- Royalties based on the value of production in all countries except for Chile, Mexico, and Peru are typically levied at rates of 5 percent or below except for silver in Bolivia (6 percent) and gold in Suriname (6.5 percent). However, as a share of price-cost margins (PCMs), royalties can be high for some products and low for others. For example, in Bolivia, silver's PCM is about 40 percent, so a royalty rate of 6 percent is roughly equivalent to 15 percent of the PCM; for lithium the royalty rate is 3 percent, which is only 3.4 percent of the PCM.
- Company income tax rates vary widely although, as mentioned, most are 30 percent or above. Various deductions and tax credits reduce the METRR below the ATR. The most important one is the tax treatment of exploration, which is expensed in Chile, Mexico, Peru, and Suriname and double expensed in Argentina, Bolivia, and Colombia. Development expenditures tend to be amortized in most countries but in several cases it is accelerated at relatively high rates (in Argentina and Peru). Investments during the extraction phase are at times accelerated at rates higher than economic depreciation rates but not in LAC countries. On the other hand, inflation erodes the value of capital write-offs over time so countries with higher inflation rates will have higher METRRs even if depreciation is somewhat accelerated.
- METRRs are higher for those countries that use first-in-first-out (FIFO) accounting for inventories, which results in the use of historical prices to value inventories. Those countries with last-in-first-out (LIFO) accounting enable companies to write off inventory costs based on replacement value (so long as there is a constant turnover of inventory within a year). Those countries that index asset prices for inflation enable the company to deduct inventory costs at replacement cost, resulting in a lower METRR.
- Other taxes—including real estate transfer levies and non-refundable sales tax on capital purchases and capital taxes—add to the METRR, especially in the cases of Brazil, Colombia, and Guatemala.
- Inflation contributes to higher effective company profit tax rates and METRRs especially in Brazil, Colombia, and Suriname. In Argentina, Chile, and Mexico, profits are indexed for inflation so effective tax rates are unaffected. In the Dominican Republic, partial indexation is provided for capital gains and depreciation although no

inflation adjustment is provided for inventory costs and net financial expense.

- Despite mining profit taxes levied at 14 percent in Chile and 20.4 percent in Peru, the METRRs are well below the effective statutory tax rates at 17.8 and 17.6 percent respectively. This no doubt reflects the advantage in providing incentives for marginal mining projects because costs are deductible from the mining profit royalty base (Table 5). Mexico is particularly surprising because it has one of the highest company income tax rates in the OECD (at 30 percent) and an additional profit-based mining royalty of 7.5 percent, resulting in an effective statutory rate of 35.3 percent on mining profits. However, under the corporate income tax, exploration costs are expensed and depreciation deductions for production capital tend to be on the higher side compared to other LAC countries except for Guatemala.

Investment Distortions

The effects of mining taxes and royalties is to discourage investment in marginal projects that earn little or no rent. The various taxes also distort the choice of technology used in the exploration, development, extractive, and processing stages. If some types of capital expenditures are more heavily taxed, that could encourage substituting other types of inputs to save on capital costs. This can undermine the allocation of capital put toward its best economic use, impairing productivity and profitability of projects.

The various taxes also distort the choice of technology used in the exploration, development, extractive, and processing stages. If some types of capital expenditures are more heavily taxed, that could encourage substituting other types of inputs to save on capital costs. Table 6, which provides METRR by asset type, illustrates the differential tax rates on capital expenditures in the case of gold.

TABLE 5 COMPANY INCOME DEDUCTIONS FOR CAPITAL EXPENSES BY LAC COUNTRY

	Exploration	Development	Depreciable Production Capital	Inventory Costs
Argentina*	200%	60%	4–40%	LIFO
Bolivia	200%	13%	2–33%	FIFO
Brazil	8%	10%	8–40%	Optional
Chile*	100%	10%	4–66%	LIFO
Colombia	40%	40%	10–50%	LIFO
Dominican Rep.*	6%	6%	10–47%	LIFO
Guatemala	20%	5.1%	10–47.3%	Optional
Guyana	20%	20%	8–20%	Optional
Mexico*	100%	4.9%	7.5–40.3%	LIFO
Peru	100%	66%	10–40%	Optional
Suriname	100%	6%	5–47%	FIFO

Note: Depreciable assets written off during the production state vary depending on the type of capital equipment, which are broken down into 30 categories of equipment and structures based on available data. All rates expressed as declining balance depreciation for comparability. * indicates those countries that provide inflationary adjustments for assets prices.

TABLE 6 MARGINAL EFFECTIVE TAX AND ROYALTY RATE (METRR) BY ASSET AND COUNTRY FOR GOLD

METRR	Dominican Rep.	Guyana	Peru	Suriname
Production Capital	37.2%	23.1%	42.5%	43.5%
Land	20.0%	13.4%	18.7%	-200.9%
Inventory	17.6%	16.8%	40.9%	43.9%
Exploration	18.0%	12.5%	-3.0%	-1.5%
Development	19.5%	13.3%	2.4%	34.4%
Aggregate	**23.9%**	**16.1%**	**16.1%**	**31.4%**

Source: Authors' calculations.

An example is the choice between development and extraction (production) capital expenditures whereby the development costs are written off faster than depreciable assets. Companies have some leeway to shift capital expenditures from the production to the development stage. While this results in earlier financing costs and potentially higher operating costs, the tax savings from having expenditures classified as development can override any additional economic costs.

Exploration in Peru and Suriname is effectively tax subsidized given expensing for exploration costs under the company income tax. The expensing of exploration leads to a mismatching of income and cost deductions because the income from extraction is earned at a later time (exploration costs incurred before the project earns income can be written off against other income earned by the company).

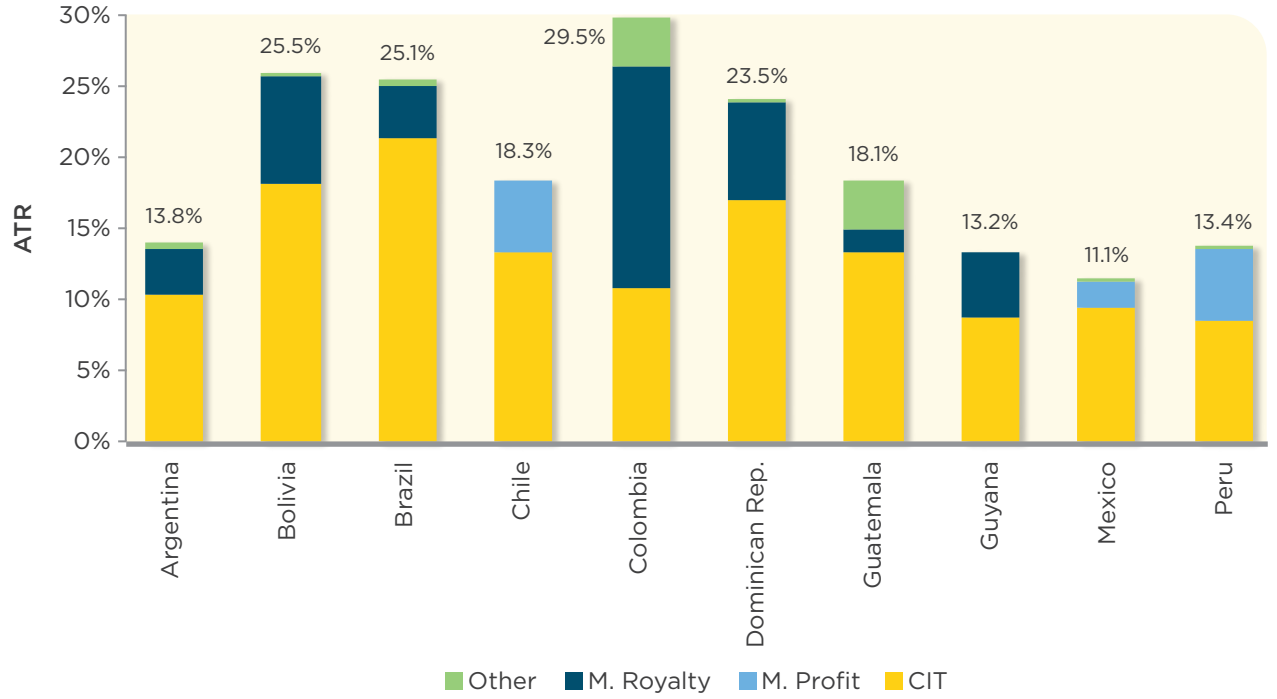
Development expenditures, even if amortized among the countries, may also be tax favored compared to production expenditures if the expenses are written off prior to income being earned from the mine. Some countries only allow exploration and development expenditures to be written off once income is earned from the project (such as the Dominican Republic). In other cases, exploration and/or development expenditures may be written off when incurred (as in Peru under the company income tax).

Inflation can distort capital decisions as well. If inventory and depreciation costs are based on historical prices, the company's tax deduction for tax purposes is much lower than the cost of replacing assets. This is partly offset by deductions for nominal interest expenses—the company gains from a transfer of wealth from bond lenders who realize a purchase power loss on the debt's principal. Thus, the tax on non-depreciable assets like land falls with inflation. As a result, Suriname, with an inflation rate of 25 percent, has a highly negative effective tax rate on land and rather high effective tax on inventories and depreciable assets because historical prices are used to value costs.

Average Tax Rates

As seen in Figure 14, the ATRs are below the corresponding METRRs for all cases except Chile, Colombia, and Mexico (Chile and Mexico have profit-based royalties that result in lower METRR compared to average effective tax rates). The highest ATR is in Colombia (26.0 percent) followed by Bolivia (25.5 percent). The lowest is in Mexico at 11.1 percent, reflecting its profit-based

FIGURE 15 DECOMPOSITION OF AVERAGE TAX RATES (ATR)



Source: Authors' elaboration.
Notes: M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax. Results here are "cross resource": the result is averaged across the various commodities included in this study for a particular jurisdiction.

royalty structure and company income tax incentives for exploration and development.

As discussed above, ATRs are above the METRR estimates when average pre-tax rate of return to capital is well above the marginal return. The additional tax paid reflects the effective statutory tax rates multiplied by the additional return on the project. Thus, for example, Mexico has a lower marginal tax rate than ATR because its profit-based royalty provides for the deductibility of most costs. On the other hand, the tax paid as a proportion of the marginal return could be greater than the share of the average profit simply because the tax paid is the same no matter the return on capital. For example, in Brazil, with relatively high non-refundable taxes on capital purchases, the METRR is above the ATR.

Figure 15 decomposes the ATRs for mining royalties, mining profit taxes, company income taxes, and other. For most countries, company income taxes play an important role in determining the overall government take, even more important than the special mining levies. For example, the company income tax accounts for two-thirds of the ATR in Bolivia, while in Colombia it accounts for about two-fifths of the ATR. Given the deductibility of mining taxes from the company income tax, their impact on the ATR is mitigated.

4

INTERNATIONAL COMPARISONS

So far, two conclusions have been reached about mining taxation in LAC. First, mining tax structures vary considerably, reflecting different rates and tax bases, especially under the company income taxes which make up a large share of government take. Second, mining taxes distort investment decisions by favoring exploration and development compared to other assets while levying combined statutory tax rates at relatively high rates. This section compares the competitiveness of LAC mining tax systems with those of other major producers regarding their attractiveness for investment.

Details regarding mining royalties and taxes in Australia, Canada, China, Guinea, India, Indonesia, Philippines, Russia, South Africa, and the United States are provided in the Data Appendix. Here, we make the following observations:

- Mining royalty rates on the value of production in most LAC countries are comparable with international royalty rates. They are below those of China and India.
- Profit-based mining royalties in Chile, Mexico, and Peru are also used in Canadian provinces and several U.S. states. However, Chile's and Peru's mining profit tax rates are higher than those found in North America in general.
- LAC company income taxes are assessed at rates higher than other countries in general. In most cases, exploration and development deductions are similar to other countries, with exploration often expensed.
- Similar to LAC, some competing countries apply significant sales taxes on capital purchases, capital taxes, gross receipt taxes, and real estate transfer taxes as part of their government take. These include stamp duties in Australia; a capital tax in Russia; non-refundable sales taxes on capital purchases in India, British Columbia, and the United States; and real estate transfer taxes in Australia, China, and India.

As above, in the comparisons below across countries, the same product-specific PCMs, capital, and financing structures are assumed across countries to isolate tax factors. Given that company and mining profit tax provisions are often adjusted in the wake of inflation, we allow inflation rates to differ by country. This also implies that nominal interest rates are higher in those

countries with higher inflation rates so that investors earn the same after-tax real rate of interest across countries. The focus is on the effective tax on marginal investments since we are interested in tax competitiveness for mining investment in LAC countries.

Results are compared on a product basis with other major producers including Australia (New South Wales, Northern Territory, Queensland, South Australia, and Western Australia), Canada (British Columbia and Ontario), China, Guinea, India, Indonesia, Philippines, Russia, South Africa, and the United States (Alaska, Arizona, and Nevada). International comparisons are relevant to the extent that mining tax and royalty policies are established with the intent of ensuring that companies, as the agent working for the principal (the owner) willing to participate in resource development. For companies to engage in mining activities they require a minimum rate of return on capital equal to the returns available by investment in mining opportunities elsewhere, adjusting for other factors such as the quality of the resource, costs, infrastructure and political stability.

Canada tends to have low METRRs on mining investments given company income tax incentives for exploration, development and processing expenditures with profit-based royalties levied at relatively low rates. The United States also provides company income tax incentives for exploration and development and in recent years has been shifting from revenue-based to profit-based royalties such as in Nevada. China tends to have high royalties, high real estate transfer taxes and few incentives for exploration and development. Further details are provided in the Data Appendix.

In Table 7, a summary of results for each of the countries is provided (with key producing

TABLE 7 MARGINAL EFFECTIVE TAX AND ROYALTY RATES BY COUNTRY AND PRODUCT (2021)

	Bauxite	Copper	Gold	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Silver	Tin	Zinc
Argentina	13.7					12.8				15.6		
Australia	24.9[a]	20.4[b]	16.2[b]	19.0[b]	35.8[a]	17.1[b]	21.2[b]			21.5[a]		24.2[a]
Bolivia						23.9				35.2	31.9	38.2
Brazil	34.0			31.3			32.8		30.0			
Canada			2.2[c]						8.4[d]			
Chile		17.2				17.9		17.9		18.3		
China	27.2		23.6	19.9	70.6	12.9		24.5		16.0	28.4	41.5
Colombia									26.0			
Dominican Rep.			23.9						29.9	31.5		
Guatemala									25.9	26.6		
Guinea	26.5											
Guyana	10.9		16.1									
India	42.4			36.2								46.4
Indonesia									27.9		29.2	
Mexico					8.8					8.8		8.8
Peru		17.6	16.1		16.1			16.1		16.1	16.1	16.1

(continued on next page)

TABLE 7 MARGINAL EFFECTIVE TAX AND ROYALTY RATES BY COUNTRY AND PRODUCT (2021) *(continued)*

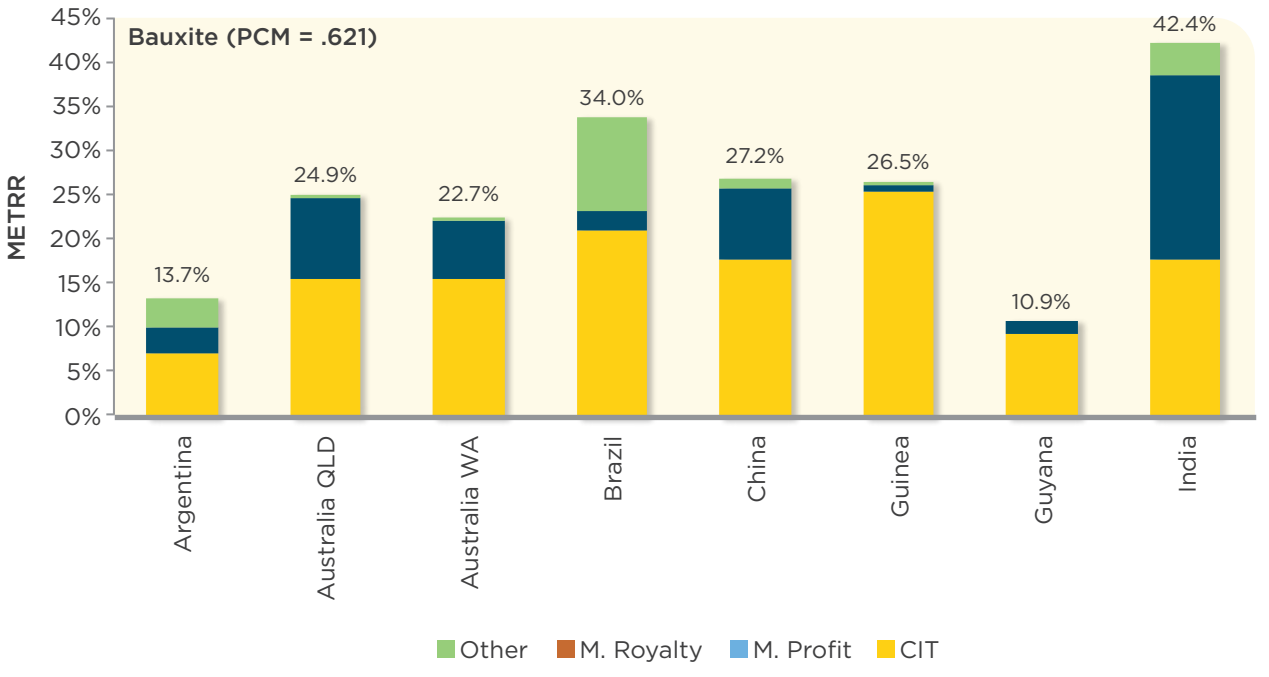
	Bauxite	Copper	Gold	Iron	Lead	Lithium	Manganese	Molybdenum	Nickel	Silver	Tin	Zinc
Philippines									32.4			
Russia			22.7						26.0	25.7		
South Africa			18.1				18.4					
Suriname			31.4									
United States		10.2[e]	10.3[e]		25.6[f]			9.9				16.5[f]

Source: Authors' calculations.
Notes: In some countries, subnational governments own the mining resources. The most significant ones are selected for this table.
[a] Queensland
[b] Western Australia
[c] British Columbia
[d] Ontario
[e] Nevada
[f] Alaska

subnational states/provinces used for Australia, Canada, and the United States).

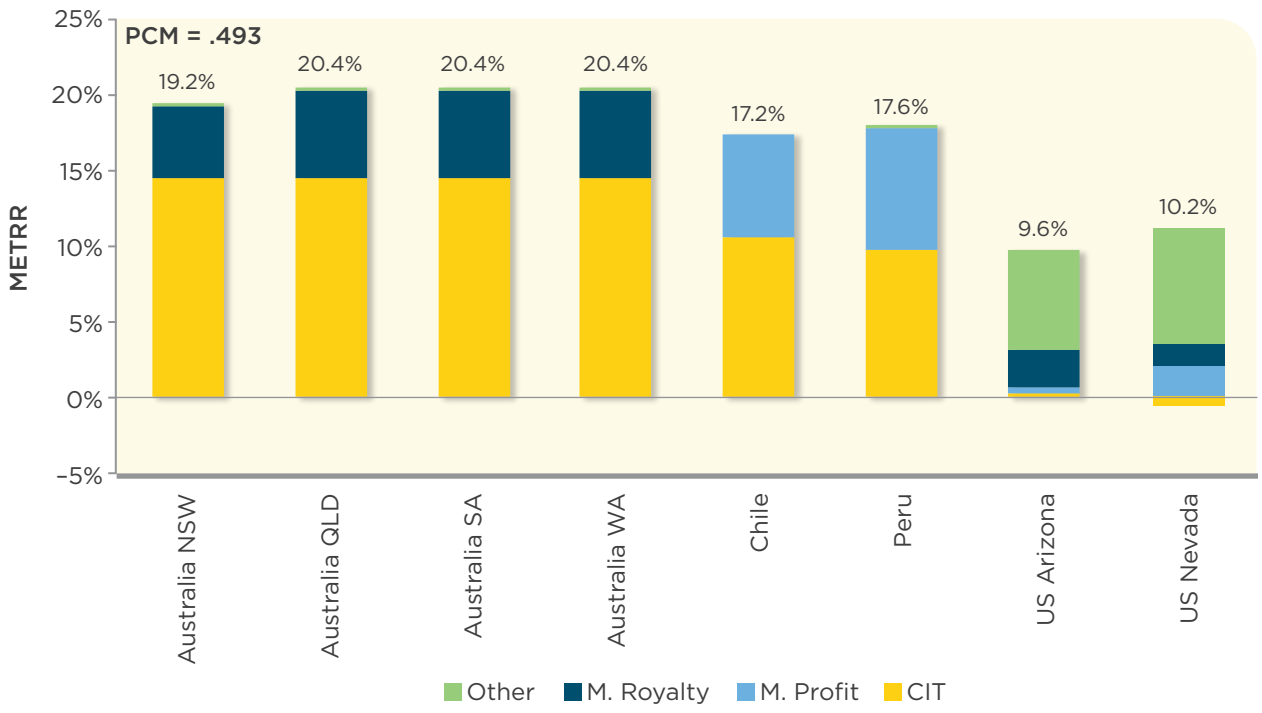
In Figures 16–27, the METRRs for 11 products are presented for LAC and other major producers. The choice of non-LAC countries for each product depends on their share of global production. The LAC countries are chosen based on the share of international production or share of mining production in an individual country even though it may not be a significant international producer.

FIGURE 16 METRR ON INVESTMENT IN BAUXITE BY COUNTRY (2021)



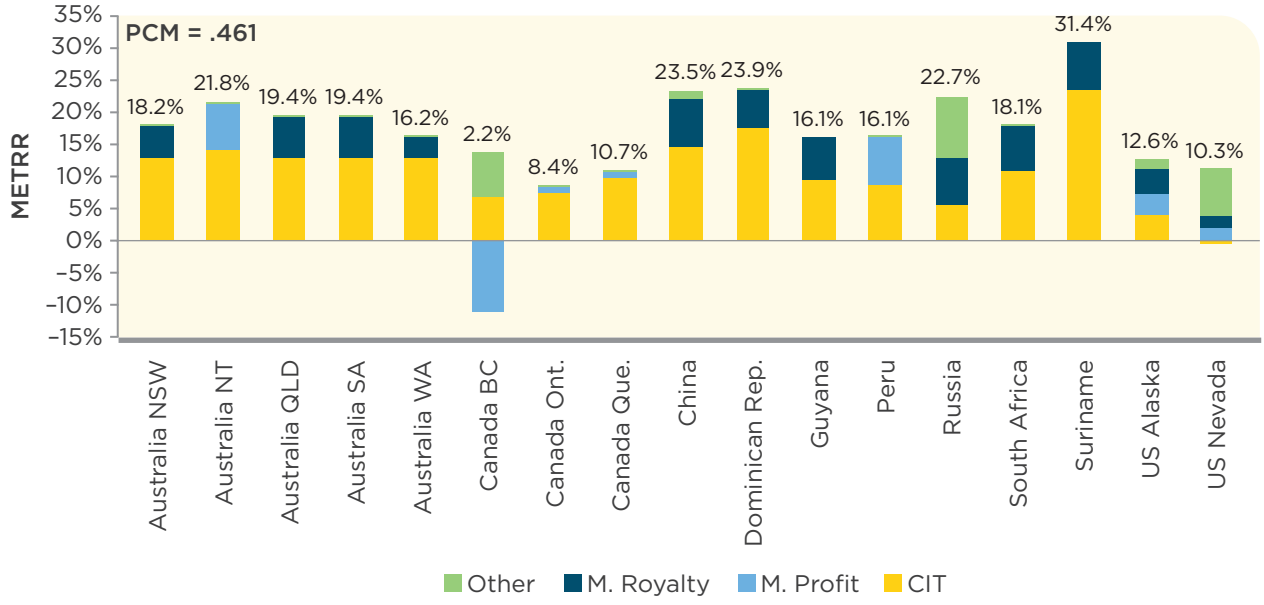
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 17 METRR ON INVESTMENT IN COPPER BY COUNTRY (2021)



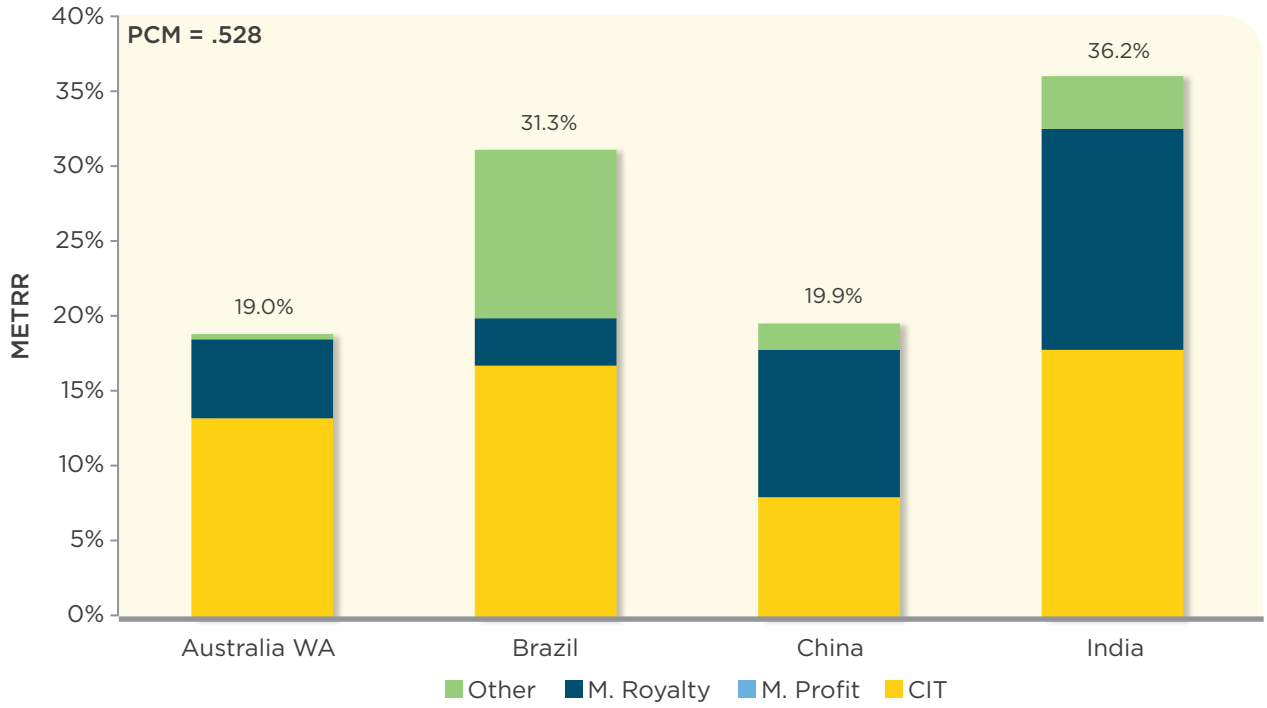
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 18 METRR ON INVESTMENT IN GOLD BY COUNTRY (2021)



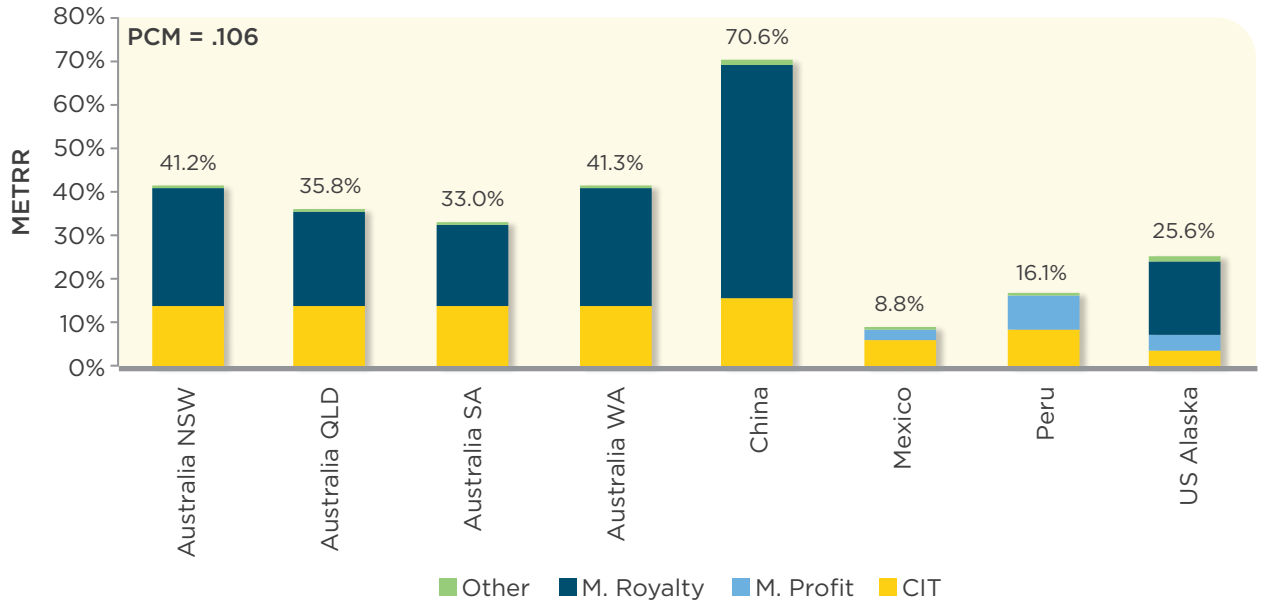
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 19 METRR ON INVESTMENT IN IRON ORE BY COUNTRY (2021)



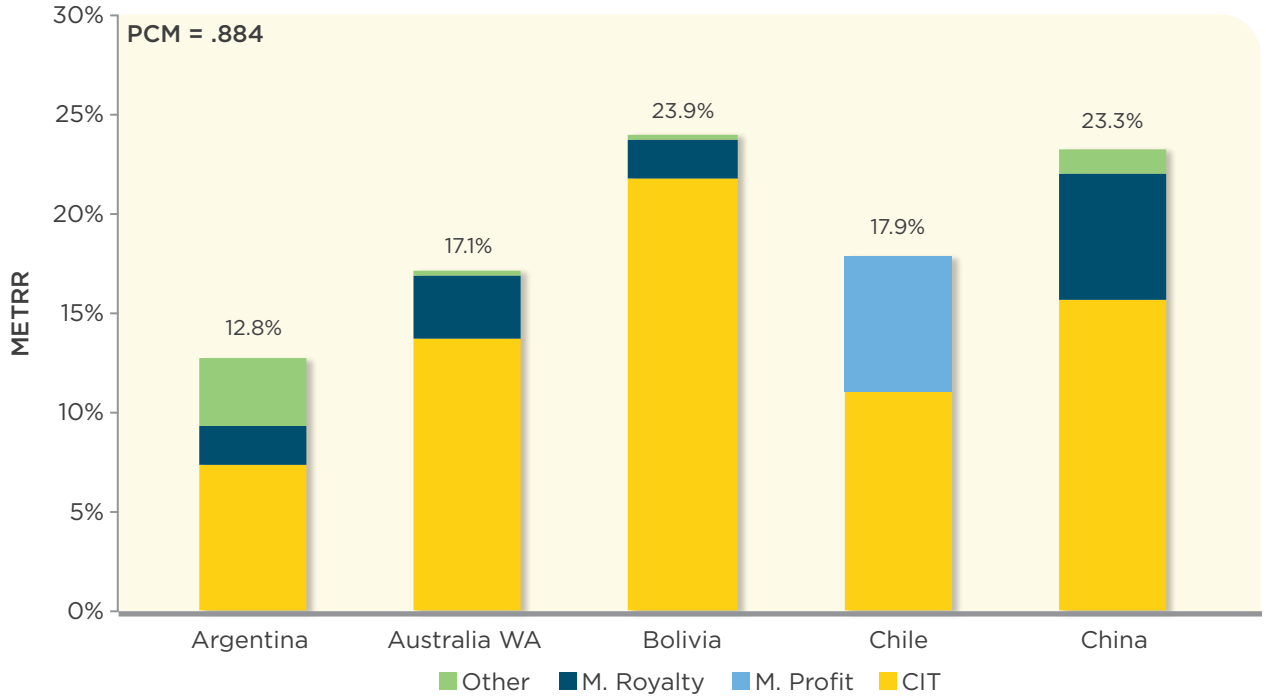
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 20 METRR ON INVESTMENT IN LEAD BY COUNTRY (2021)



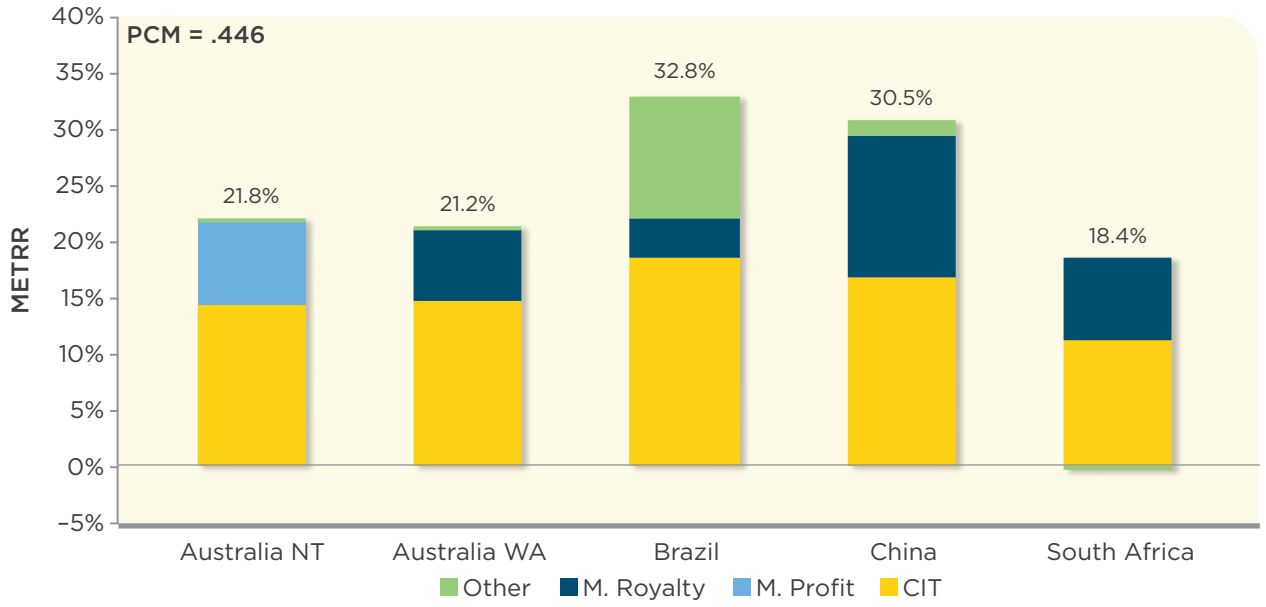
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 21 METRR ON INVESTMENT IN LITHIUM BY COUNTRY (2021)



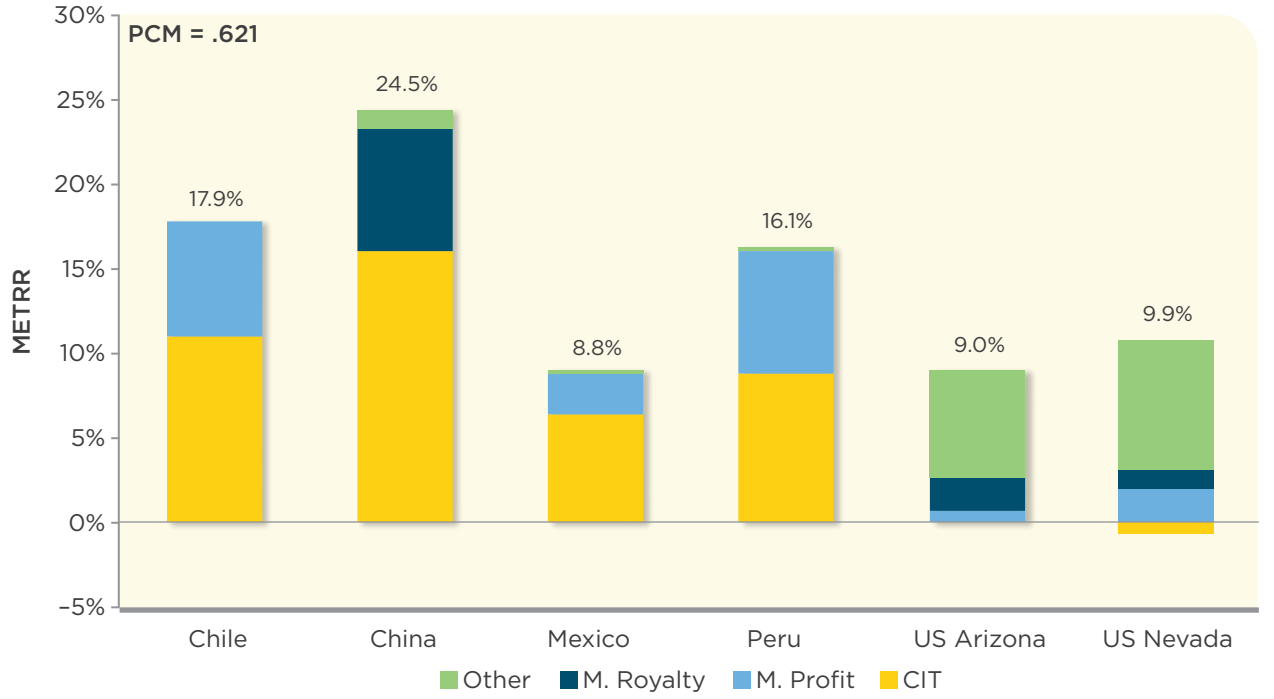
Source: Authors' own calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 22 METRR ON INVESTMENT IN MANGANESE BY COUNTRY (2021)



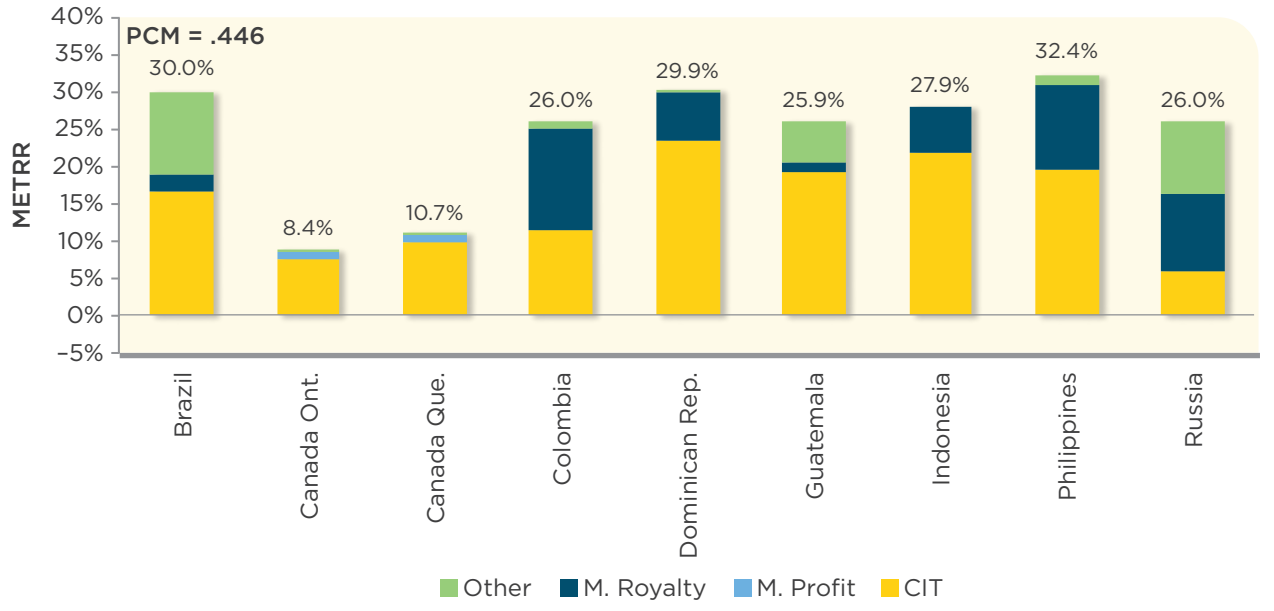
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 23 METRR ON INVESTMENT IN MOLYBDENUM BY COUNTRY (2021)



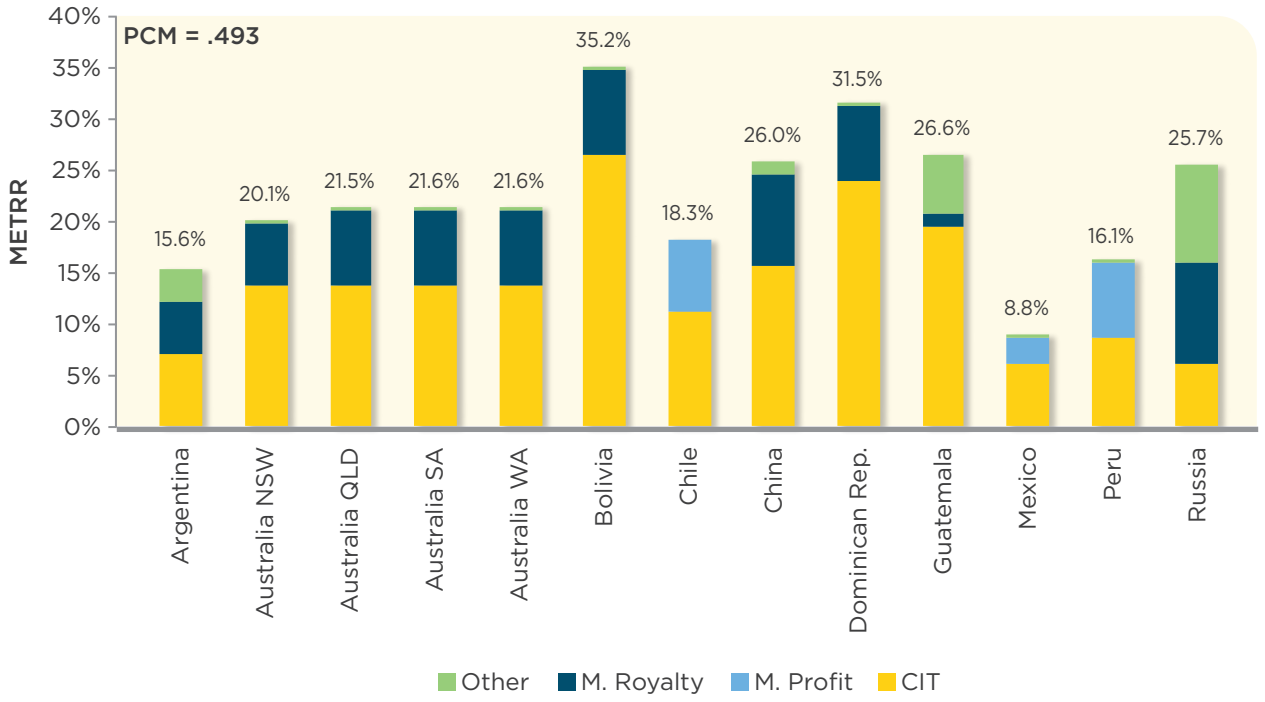
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 24 METRR ON INVESTMENT IN NICKEL BY COUNTRY (2021)



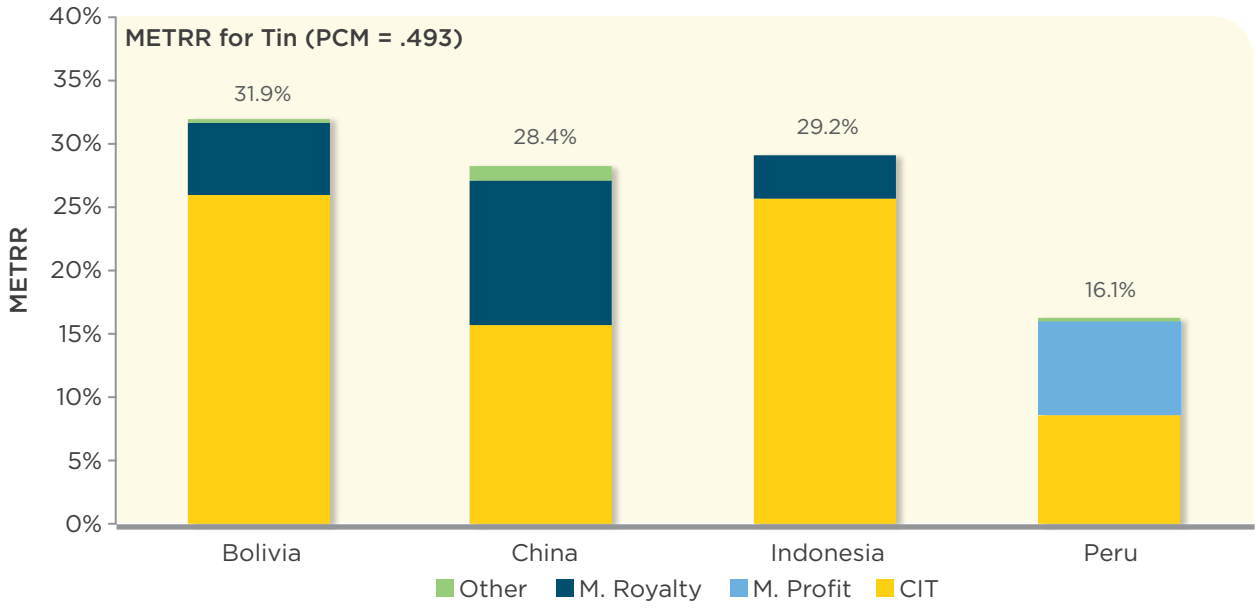
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 25 METRR ON INVESTMENT IN SILVER BY COUNTRY (2021)



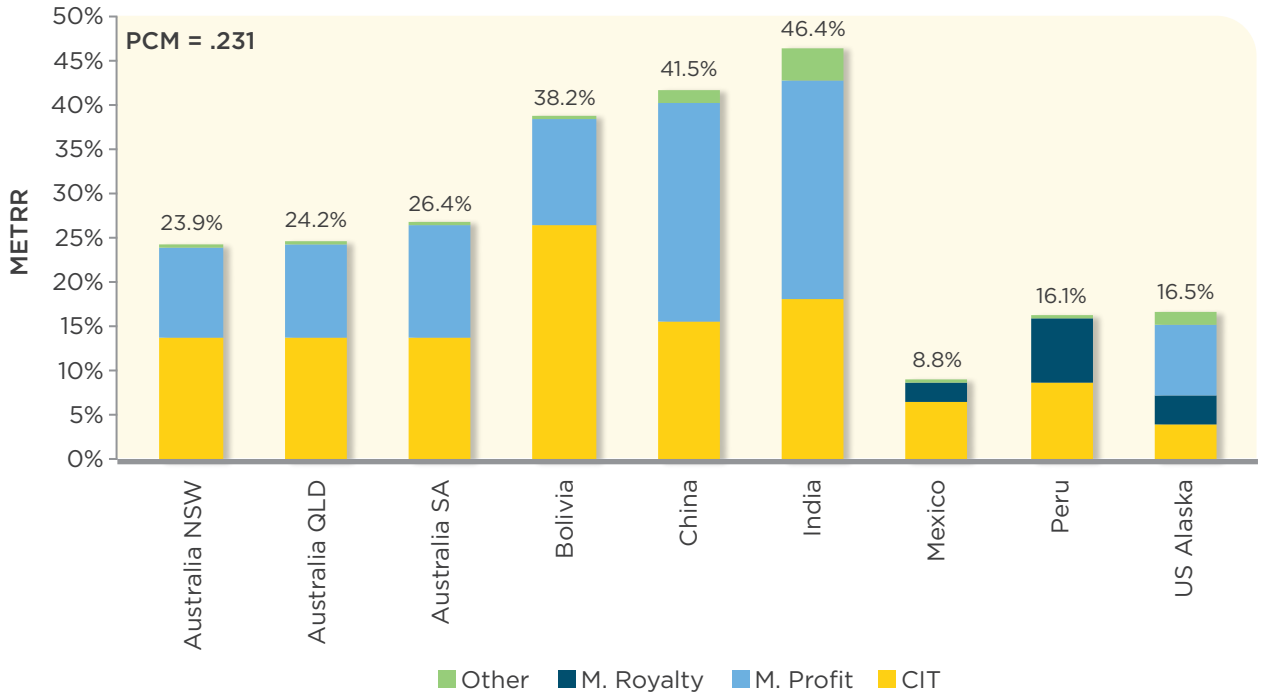
Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 26 METRR ON INVESTMENT IN TIN BY COUNTRY (2021)



Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

FIGURE 27 METRR ON INVESTMENT IN ZINC BY COUNTRY (2021)



Source: Authors' calculations.
Notes: PCM is price-cost margin, M. Royalty is mining royalty, M. Profit is mining profit tax, and CIT is corporate income tax.

Each of the comparisons below provides a breakdown that indicates the importance of specific mining levies, company income taxes, and other taxes in determining the METRR for each product. Several conclusions can be reached from these comparisons.

Australia

As discussed earlier, Australia is a significant home to investment in just about every mining product except for nickel and tin. Its royalty rates at the state level tend to be somewhat higher than those in LAC but its company income tax, with few tax preferences except exploration, is levied at a lower rate than in LAC except for Chile, Guyana, and Peru. Its METRR on its major mining product, iron ore, is 19 percent—far less than the 31.3 percent in Brazil. Brazil levies a lower mining royalty, but its company income and other taxes result in a heavier tax on iron ore investments. Gold is also a significant mining product in Australia that is taxed at rates ranging from 16.2 percent in Western Australia to 21.8 percent in Northern Territory. LAC gold mining investments are taxed at similar or lower rates in Guyana and Peru but at much higher rates in the Dominican Republic and Suriname. Investments in lithium are particularly heavily taxed in Bolivia (23.9 percent) compared to Western Australia (17.1 percent). Many of these differences are explained by company income tax rates, which are highest in the Dominican Republic and Suriname and lower than Australia in Guyana and Peru. As for other mining products, Chile, Guyana, and Peru are relatively competitive compared to Australia, either due to lower company income tax rates or reliance on a profit-based mining royalty.

Canada

While Canada produces many mining products included in this study (such as iron ore in Quebec and copper in British Columbia), it is especially prominent in the production of gold (British Columbia) and nickel (Ontario). Each province levies mining profit taxes. In the case of British Columbia, the mining tax is on cash flow (revenues net of capital and operating expenses but not interest expense), so marginal investment is not taxed (except for its interactions with the company income tax). In Quebec, Ontario, and other provinces (except Alberta), mining profit taxes are levied on profit gross of interest expense (capital is depreciated although exploration and development expenditures are expensed, and special allowances are provided for processing expenditures). Under the company income tax, federal and provincial governments provide incentives for exploration and development as well as expansion of new mine assets and processing. For these reasons, Canadian METRRs for each product are well below those of LAC countries. The METRR in British Columbia is only 2.2 percent, reflecting substantial tax incentives.

China

China has become a major mining producer with a substantial market share in production for a wide range of products except for copper and nickel. Mining royalties are higher than most countries in this study including those in LAC. China's company income tax is consistent with international rates and few incentives are provided for capital investments. As a result, China tends to tax mining investments more heavily compared to LAC except for Brazil (iron ore) and Bolivia.

Guinea

Guinea's most important mining product, bauxite, is taxed at 26.5 percent, above Argentina (13.7 percent), well above Guyana (10.9 percent), and below Brazil (34 percent). Guinea's company income tax rate is equal to Australia but its cost deductions for capital are smaller in general despite a relatively high inflation rate (over 9 percent).

India

Unlike LAC countries, India assesses high royalties on its three prominent mining products, bauxite (22.5 percent), iron ore (10 percent), and zinc (10 percent). Even though India's company income tax is more competitive, its high royalty rates result in mining investments being more heavily taxed than in LAC. For example, Brazil's METRR on iron ore is 31.3 percent while in India the METRR is 36.2 percent.

Indonesia

As a prominent producer of nickel and tin, Indonesia's METRR on mining investments is lower than Bolivia and the Dominican Republic but higher than Peru. Indonesia's advantage is its company income tax (at a 27.5 percent rate) and somewhat lower royalty rates. However, Peru's profit-based mining royalty provides an advantage compared to Indonesia as costs reduce the mining profit levy.

Philippines

Philippines is a significant producer of nickel, which bears a relatively high royalty rate of 9 percent, much more than in LAC countries. Despite the country's more competitive company income tax, the METRR on nickel (32.4 percent) is higher compared to LAC, where it ranges from 30.0 percent in Brazil to 25.9 percent in Guatemala.

Russia

Russia is a primary producer of many mining products, including bauxite, copper, gold, lead

manganese, nickel, and silver. Its royalty rates on the value of production, varying from 4.8 percent (manganese) to 8 percent (bauxite, copper, lead, and nickel), are typically higher than those found in LAC. However, Russia's company income tax—assessed at 20 percent, with incentives for exploration and capital expenditures—results in a more competitive METRR (e.g., 26 percent on nickel, below Brazil and the Dominican Republic and roughly equal to Colombia and Guatemala). However, in the case of gold, Russian mining investments are more heavily taxed than those in LAC countries using a profit-based royalty.

South Africa

South Africa is a major mining producer with a significant share of global production in gold and manganese. Its royalties on the value of production (5 percent on manganese and gold) are similar to those of LAC. However, its company income tax is much more competitive at 27 percent with expensing of both exploration and development expenditures. It is therefore more tax attractive than Brazil in manganese investment and the Dominican Republic and Suriname in gold (with an METRR somewhat above Peru and Guyana).

United States

Similar to Canada, the United States' mining taxes on investment are quite competitive, especially since company tax reform led to a large drop in the federal company tax rate from 35 to 21 percent as of January 1, 2018 (no upward revision is expected to be passed by Congress). The United States is unique in having both mining profit taxes as well as royalties on the value of production in many states (e.g., Alaska, Arizona, Minnesota, and Nevada). Revenue-based royalty rates are quite low, ranging from 1.1 percent in Nevada to 3 percent in Alaska. The mining profit royalties vary from 1.3 percent in Arizona to 7 percent in Alaska. The company tax enables exploration and development costs to be written off either as a portion of company profit or amortized over the life of the mine. Thus, it is not surprising that the METRRs for gold (10.3 percent in Nevada), lead (25.6 percent in Alaska), molybdenum (9 percent in Arizona), and zinc (16.5 percent in Alaska) are generally below those in LAC except for Mexico and Peru with their profit-based royalties.

Observations

To conclude, a few general observations can be made regarding the competitiveness of mining tax systems in LAC. Countries with high company income tax rates and few incentives for investment like Bolivia, Dominican Republic, and Suriname are not particularly tax competitive for mining investments. Those with profit-based royalties (Chile, Mexico, and Peru) benefit from a more tax competitive system. As a final observation, LAC inflation rates (averaged for the past five years) are higher than 4 percent in some countries like Argentina, Brazil, Colombia, Mexico, and Suriname. While inflation adjustments are used for company income taxes in Argentina, Chile, and Mexico, inflation contributes to higher effective tax rates on mining investments in other countries.

5

POLICY REFORMS

From the analysis above several observations can be made about LAC mining tax and royalty regimes.

- The simplicity of revenue-based royalties has several drawbacks. They impinge heavily on marginal investments, discouraging them the most. Depending on royalty payments relative to profit margins, they also have uneven impacts across products.
- Since revenue-based royalties are less volatile than mining profits, governments raise rates when revenues do not rise as fast as profits when booms occur and lower rates during downturns to attract mining investments.
- Although company taxes are assessed across industries, special provisions with respect to exploration, development, and processing are unique to mining. Many LAC countries have relatively high company income tax rates but then provide special tax concessions to attract investment, resulting in distortions in the allocation of capital.
- Capital-intensive industries like mining that are subject to general levies like real estate transfer taxes and non-refundable sales taxes on capital purchases bear a heavier tax burden compared to labor-intensive industries.
- If taxes on investment are high in a jurisdiction, it may discourage multinational investors from investing there because the after-tax returns on capital are better elsewhere. A lack of investment erodes productivity by discouraging the adoption of new technologies embedded in new capital.
- Both royalty and company tax provisions may distort the allocation of capital across assets, thereby reducing the pre-tax and royalty profitability of mining investments.

This section discusses reform possibilities, focusing first on royalty reforms and then on company income tax reforms.

Optimal Royalty Design

Royalty design is a complex subject because governments around the world use a variety of approaches to extract a share of the rents. As owner of the resource, the government needs to have royalty policies that balance the

government's desire for revenues with a royalty regime that is sufficiently attractive for investment, economically sound in application, and administrable.

A typical royalty is a payment either based on a charge on gross output or a percentage share of revenues of a non-renewable resource project. Unlike in the private sector, there is no competitive setting of royalty prices because the government is the sole owner of the land and extractive resources. Indeed, there is no need for governments to use royalties based on output or revenues to collect a "payment." Governments can, and do, use other mechanisms.

In recent years, several governments have resorted to the use of profit-based mining royalties, by which costs are deductible in some form when determining the royalty base (in Canada a profit-based approach has been used for more than a century). Some governments have adopted a resource royalty or mining tax based on rents, which provides for the full deductibility of economic costs from revenues earned from extracting resources. Unlike profit-based royalties that are an ex post approach to collecting revenues, governments also use bonus bids for land tracts to raise revenue on an ex ante basis.

Economic rent arises from non-reproducible (or fixed) factors of production such as entrepreneurship, land, and natural resources. It can also arise from the presence of natural or artificial barriers to entry that generate market power and special advantages that firms may possess (i.e., location, patents, etc.). More generally, rent is the surplus value of a resource after all opportunity costs of using factors of production are subtracted from the value of production. Rent is thus measured as the difference between the revenues a resource can generate and its discovery, extraction, and production costs, including a rate of return on equity finance that can be obtained by investing in projects with similar risk and scale.

As discussed above, any tax or levy applied to pure economic rent will not distort the use of capital or other production factors. At the margin, firms employ capital, labor, and other factors until the marginal return on the last unit employed is equal to its economic costs. A pure rent-based tax will neither discourage nor encourage investment because the levy is *neutral* (in that it does not affect allocation decisions).

The relationship between the government as owner of the resource and the private producer is similar to a public-private partnership. The government is the principal owner and the private company is the agent brought in to maximize the amount of rent that can be generated by the non-renewable resource project. Several objectives in royalty design should be considered:

1. *Government ownership*: As the owner of the natural resource, the government is entitled to the rents earned from extraction. Some of the rents may be associated with entrepreneurship or land and therefore accrue to the private producer and landowners with the government receiving the remainder.
2. *Competitive return for private investors*: As the agent, the government must provide the private producer and its investors with a risk-adjusted rate of return on capital that is at least equal to their opportunity cost to attract investment capital. That is, the after-tax risk-adjusted rate of return on the mining project should be at least as good as alternative investments in other countries. To attract the best producers, the government gives up some of its share of rents.[10]
3. *Efficiency*: The royalty structure should be devised to maximize rents available to both the public owner and the private producer.

[10] In principal-agent models, the principal does not know the most cost-efficient producers. It therefore designs a contract to attract the best agent to produce the resource. This requires the government to share some of the rents with the producer.

A rent-based royalty achieves a maximum amount of rents being earned by the public and private partners because production, investment, exploration, and development is sufficiently profitable with and without the royalty.

4. *Stability*: Royalty regimes can exacerbate uncertainty if they are not properly designed. When resource prices are high, governments may not feel they receive their share of rents, resulting in royalty hikes. When prices fall, governments might look at providing new incentives yet find them too rich once the economy recovers. To minimize political risk for private investors, it is appropriate for the government to choose a royalty structure that provides it with both sufficient incentive for investment and sufficient revenues without changing public policy on a continuous basis.

These four principles are simple to consider for royalty design and lead to our key recommendation: the optimal royalty is rent based. Rent taxation can be assessed using two approaches: excess profit or cash flow. Under the excess profit approach, a mining tax would be levied on revenues net of labor and current capital costs (depreciation and depletion of reserves) and financing costs including an allowance for the cost of equity financing (e.g., an allowance equal to a company or government bond rate). Under the cash flow approach, the mining tax would be applied to revenues with the expensing of current and capital expenditures including exploration costs with no deduction for borrowing and equity financing costs (asset disposals would be fully taxed). With both rent-based approaches, unused deductions would be carried forward at a rate of interest (the financing allowance) to preserve the time value of deductions. These two approaches are compared in Box 3, which demonstrates their equivalency of rent bases in terms of the time value of rents earned on projects.

Several important design issues are critical in applying a rent-based royalty: (i) whether to apply a minimum royalty, (ii) determining the

BOX 3. EQUIVALENCY OF CASH FLOW AND EXCESS PROFIT ROYALTY BASES (NEGATIVE VALUES IN PARENTHESES)

	Year 1	Year 2	Year 3	Year 4	Present Value[f]
Cash flow tax base					
Net revenues[a]		$2000	$1800	$1600	
Capital expenditure	($5000)				
Asset disposal[b]				$3500	
Cash flow[c]	($5000)	$2000	$1800	$5100	$2943
Excess profit base[d]					
Net revenues		$2000	$1800	$1600	
Depreciation and depletion		($500)	($500)	($500)	
Financing costs[e]		($250)	($225)	($200)	
Rent		$1250	$1075	$900	$2943

[a] Net revenues are revenues net of labor and other current costs. Amounts decline by 10 percent per year matching the decline in undepreciated capital stock.
[b] Asset disposal is at the end of the year.
[c] Cash flow is equal to net revenue minus capital expenditure (asset disposal is added to the tax base).
[d] Excess profit base to determine rents is net revenue minus depreciation and financing costs.
[e] Equity financing cost is at the interest rate of 5 percent of the undepreciated capital stock and equal to the bond rate.
[f] Calculated by discounting each year's tax base back to Year 1 by the discount rate of 5 percent.

(continued on next page)

BOX 3. EQUIVALENCY OF CASH FLOW AND EXCESS PROFIT ROYALTY BASES (NEGATIVE VALUES IN PARENTHESES) *(continued)*

With a cash flow approach, $5000 capital expenditure is written off in the first year. Net revenues earned in subsequent years and remaining depreciable assets are sold off in the fourth year when the project closes. Discounting values back to Year 1 by a 5 percent rate yields a present value of rents equal to $2943. If a cash flow royalty is imposed, say at 50 percent, the government would collect royalty payments equal to $1000 in Year 2, $900 in Year 3, and $2550 in Year 4. The government would provide a refund of $2500 to the firm in Year 1 to cover the investment cost (alternatively, the $5000 could be carried forward as a deduction at the 5 percent interest rate and reduce the future royalty base). In present value terms, the royalty payment would be $1471.50 on rents equal to $2943. This is identical to the value under the excess profits approach.

With the excess profit approach, the profit-based royalty each year is net revenues less depreciation and depletion costs and imputed financing costs. With $5000 in capital expenditure and straight-line amortization at 10 percent, the depreciation and depletion cost in Years 2–4 are $500 each year. The financing cost is 5 percent of undepreciated capital at the beginning of the year: $250 in Year 2 (5% of $5000), $225 in Year 3 (5% of $4500), and $200 in Year 4 (5% of $4000). The excess profit base after deducting amortization and financing costs is $1250 in Year 2, $1075 in Year 3, and $900 in Year 4. Discounting these values at 5 percent back to Year 1 yields $2943 in rent. At a 50 percent tax rate each year, the present value of the royalty payments would be $1471.50.

appropriate interest rate for financing costs, (iii) applying graduated rates based on the level of profits or ore prices, and (iv) other design features.

Minimum Royalty

A minimum royalty may be desirable for two reasons: (i) providing upfront revenue and (ii) protecting the profit base. Several countries use minimum revenue-based royalties, such as Canadian oil sands (rates range between 1 and 9 percent depending on the level of West Texas Intermediate oil prices), Newfoundland & Labrador oil (1 percent), Saskatchewan potash tax (an add-on minimum tax of 3 percent of sales), and Peru mining (1 percent minimum tax on sales).

Mining companies bear capital expenditures on exploration and development before they earn revenues from extracting ore. Under the cash flow approach, the company will initially have negative cash flow as seen in Box 3. The government could provide a refund when losses are incurred (the refund equal to the royalty rate times the loss) but that would lead to upfront revenue losses. It would be simpler to allow unused deductions to be carried forward. However, to preserve the value of deduction the loss should be carried forward at a rate of interest (such as 5 percent in the example of Box 3). However, this would result in the government receiving little or no revenue for several years until deductions are claimed. If the government wishes to have upfront revenue when payouts begin, a revenue-based royalty (or output-based payment) could be levied as a minimum royalty. The profit-based royalty payments could be credited against the minimum royalty payments (or vice versa). Any excess minimum royalty payments can be carried forward at the rate of interest.

Governments are also concerned about profit-based mining levies because of potential auditing costs associated with related party transactions. The revenue-based royalty is assessed on the value of production at the pit. This price is determined by subtracting from observed world markets prices an allowance for the cost of transporting the mining product to international markets. With the profit-based royalty, the payment is not only related to sales revenues at the mine's pit but also costs incurred to produce mining ore. Many of these costs may be related party transactions within the multinational group. Even with arm's-length pricing, there is a certain amount of judgment required in assessing transfer prices—it is well possible that within the scope of rules related party transactions could result in fewer profits earned in a host jurisdiction (affecting both profit-based royalty and company income tax payments). The minimum royalty as described above can be used to ensure some payment.

Interest Rate

A controversial aspect of the rent-based royalty is determining the appropriate financing rate or carry-forward rate. If the government shares investment costs and any operating losses, the rent-based royalty enables governments to share the project risk associated with projects, which is equivalent to a deduction for risk costs.[11] Thus, no explicit deduction need be given for risk if losses are fully deducted from profits or refunded by the end of the project. Both the UK's Mirrlees report (Adam et al., 2011) and the Australian Treasury's Henry Report (Treasury of Australia, 2010) discussed these issues at length, recommending that the financing allowance should reflect a riskless interest rate (such as the long-term government bond rate) if losses are fully shared by the government.

Both approaches to taxation of economic rents require "full refundability," whereby the government shares the cost of losses with the owners by refunding the tax value of losses (losses multiplied by the corporate tax rate) in cash or by carrying back losses against previous years' rents or forward at an interest rate against future years' rents. Without the full sharing of losses, a risk premium should be added to the government bond rate. One possibility is a company bond rate, which includes a premium for bankruptcy. If a mine closes without deductions fully claimed, a premium on the company bond rate might approximate the risk involved with losing deductions. The British Columbia profit-based royalty uses the government bond rate while the Australia natural gas royalties use an arbitrary premium added to the government rate.

Graduated Profit-Based Levies

Profit-based royalty rates could be assessed at a flat rate or graduated rates that rise according to the level of profits (or just global prices). The flat rate will result in royalty payments that vary according to profitability. The argument in favor of the graduated royalty schedule is that it allows smaller projects to pay less tax. Yet, compared to a flat rate, a graduated schedule leads to higher ATRs over time, discouraging risky investments.

Graduated profit rates also contribute to procyclical investment patterns. At the top of the price cycle, cost deductions create the greatest royalty savings (since the royalty rates are highest then) with an expectation that future profits generated by the investment will be subject to lower royalty rates when profits revert to the average. This leads to a lower effective

[11] This proposition is well known in the literature and implies that the risk premium from capital asset pricing models is reduced by the factor one minus the tax rate under loss refundability. See Gordon and Wilson (1989) and Mintz (1995).

royalty rate on investment, providing an extra kick to investment in a boom. The converse holds at the bottom of the price cycle in that the graduated rates will discourage investment. For example, suppose the royalty rate is 5 percent on profits below $1 million and 15 percent on profits above $1 million. Suppose Company A earns $750,000 in each of two years; it will pay a total $75,000 in royalties over two years. Company B earns no profits in the first year and $1.5 million in the second year, which in total is the same as Company A. However, Company B pays $125,000 in total royalties (5 percent of $1 million plus 15 percent of $500,000 in the second year). Despite the same average profitability, Company B, with more variable profits, pays more tax with a graduated schedule.

Other Design Issues

Despite the benefits associated with rent-based royalties, various other issues should be considered in designing the optimal royalty system.

- Once mining ore is extracted, it cannot be replaced. A government might wish to hold back extraction if the social discount rate in determining the benefits accruing to future generations is less than the private sector's discount rate for determining profitability. In this case, a rent-based royalty will not be socially efficient since too much production and investment take place by discounting too heavily the future value of non-renewable resources. Therefore, some other sort of mechanism might be used to discourage investment including a revenue-based royalty that discourages exploration and development. However, if the aim is to provide income to future generations, a government could instead create an endowment fund from non-renewable resource receipts that could provide revenues for public services on a perpetual basis. That would be a preferable strategy compared to distorting mining production.
- Non-renewable resource production may impact the use of clean air, water, and land. Royalties could be adjusted to reward good environmental behavior. On the other hand, other economic instruments are likely better suited to control the environment since they are specifically directed at the problem. Examples would be production-related environmental taxes or cap-and-trade pricing to cost emissions, grants, and reclamation funds when the mine is terminated.
- As stressed earlier, it is critical to recognize that governments not only collect royalties or other mining-specific charges but also collect company income taxes, capital taxes, and other capital-related levies. These taxes add to investment costs and reduce the return to capital earned by the investor. Any royalty policy should account for its interaction with the corporate income tax. As shown in the Technical Appendix for interested readers, a rent-based royalty system is not neutral with respect to investment because the government does not share the corporate tax burden with investors—investments are discouraged given interactions of the rent-based royalty with the company income tax.[12]
- Governments will need well-trained personnel and modern auditing technologies to audit direct financial data provided by companies. Nonetheless, even with high-quality

[12] To make the royalty truly neutral, two adjustments would be needed when mining rent taxes are deductible from the company income tax (Mintz, 2016). The first is that capital cost and depletion allowances under the company tax should be based on the cost of investment net of the government's royalty share of the cost. The second is the provision of an investment tax credit to offset the grinding down of cost deductions from the rent-based royalty (the credit rate would be equal to the royalty rate multiplied by the company income tax rate). Combining these two adjustments, the rent-based royalty would not affect the METRR.

tax administration, some limitations are needed with respect to indirect cost deductions. For example, many rent-based systems do not allow multinational overhead costs to be deducted because a government cannot observe how much these costs can be attributed to the project being developed. Instead, a rough adjustment through an uplift factor on costs might be used. They may also require "ring fencing" to limit costs to those directly related to projects.

- One of the important issues affecting mining developments is their impact on local communities. New mining developments result in the importation of labor, putting a strain on infrastructure and community hospitals, schools, and other amenities. Indigenous populations are concerned about the impact that mining development might have on their way of life and the preservation of treaty rights. Mining companies often cover the cost of infrastructure needed for their projects. They may also have benefit agreements with local communities to provide support for their needs. The government can provide support from the royalty payments they receive. Sometimes, local communities and indigenous bands might receive a percentage share of royalties, though that could create unfairness among local communities if some receive payments and not others. It is better to link revenues to expenditure needs instead.
- When a rent-based royalty is introduced for the first time, transition issues need to be dealt with. Under the cash flow approach, past capital expenditures would be valued at the time of implementation and deducted from the base (the amount claimed could be written off over time as long as unamortized amounts are carried forward at the financing rate). With the excess profit approach, asset book values would also be revalued to current replacement cost to compute annual depreciation and financing costs.

To conclude, the rent-based royalty system is an appropriate way to collect rents while minimizing economic distortions. Governments, however, might be concerned about the lack of revenues when payouts begin and carry-forward costs are still being written off. They may also want to make sure that they collect sufficient revenue given the challenges in administration especially with respect to determining costs. With rent-based royalties, government could receive revenues by requiring minimum payments based on revenues, an arrangement that is found in some profit-sensitive royalty systems. The minimum royalty would be credited against the profit-based royalty with unused credits carried forward at a rate of interest to be claimed in the future. The minimum royalty does impose some risk on private producers because government shares the upside in profits but not the downside if credits are not fully refunded at the end of the mine's life. However, it can be an acceptable trade-off when governments do not have full access to information.

Any reform requires not just an examination of incentive impacts but also the impact on government revenues. For example, if some incentives are scaled back or enhanced, the statutory tax rate might be adjusted if the government desires not to gain or lose revenue. As a general guide, the following royalty reforms are recommended.

- Countries could keep existing royalties as a minimum tax and add on the rent-based royalty as a secondary payment. Either the cash flow approach or the excess profit approach described earlier could be used. This would result in these countries raising more mining-related revenues. However, it would discourage to some degree

mining investments due to higher effective tax rates (given interactions of rent-based royalties with the company income tax as discussed above). This might require some reduction in the revenue-based royalty rates.

- Those countries with profit-based royalties could consider converting their levy into a true rent-based royalty by providing for a deduction of both equity and bond financing costs. This would entail a loss in revenue but could be offset by adjustments to the minimum revenue-based royalty. If a country is proposing to add on a revenue-based royalty to the existing profit-based royalty, it should operate as minimum tax rather than an add-on tax. It might further consider moving to a flat-rate mining profit tax rather than the existing graduated rate to encourage investment in a cyclical industry.

Optimal Corporate Income Tax Design

The purpose of the company income tax is threefold. It serves as a withholding tax on profits to shore up personal taxes that cannot be applied uniformly on all sources of income, especially capital gains. It also serves as a withholding tax on income paid to non-resident owners. Third, the company tax is surrogate payment for the use of public services by businesses that are not subject to cost-recovery user charges.

Company tax policy is further complicated by the potential adoption of the global minimum tax of 15 percent. Parent companies investing in LAC countries will pay a top-up tax on adjusted profits of an affiliate in each country if the effective tax rate (company income taxes and withholding taxes as a share of accounting profits) is below 15 percent. It will be in the interest of LAC countries to impose the top-up tax on foreign affiliates operating in their country because the tax will be credited against foreign taxes. Given the relatively high company income tax rates in LAC countries, it is not clear whether the tax will have much impact on LAC company income tax design. It is also not yet known whether the global minimum tax will proceed as it must still be adopted in legislation (such as being approved by the U.S. Congress).

In the absence of other considerations (particularly addressing market failures as discussed below), the company tax should be neutral whereby the tax burden on investment would be the same across business activities. This is best achieved by applying the company tax at equal effective tax rates on economic income accruing to shareowners given the difficulties of taxing all forms of equity income at the personal level. Neutrality—similar tax treatment of business activities—is an appropriate benchmark against which to assess the company income tax.[13]

If market failures are present, policies may stray from neutrality. For example, companies investing in the acquisition of knowledge may also benefit other businesses through knowledge spillovers. When a company internalizes its own benefits and costs, ignoring gains from knowledge spillovers, it underinvests in knowledge acquisition. This provides a basis for exploration and development tax incentives similar to tax support for research and development. The discovery (or not) of a mining deposit in a particular region conveys information to other companies that adjacent lands may also contain mining resources. It should, however, be kept in mind that tax policy may not be the best approach to correct all market failures. Public spending on grants or regulations (patents or leasing rights) may be better approaches.

[13] A caveat to the principle of neutrality is the potential market failures that could arise with respect to the economy-wide impacts of certain forms of business activities. While an argument might be made to adjust company tax policies to account for these market distortions, other forms of intervention are often superior when it comes to effectiveness.

Ideally, any "subsidy" to account for informational spillovers due to either research or exploration should be based upon the size of those spillovers. In reality, the size of spillovers is rarely measurable as such, but many countries typically expense both research and exploration costs to encourage knowledge acquisition. Many (like Canada) also use research and exploration tax credits in addition to expensing, although grants could be used instead.[14]

Under the company tax, special rules must apply to non-renewable resource sectors like mining especially with respect to exploration and development expenses that are incurred to prepare reserves for later extraction. The company tax treatment of expenditures before the completion of capital projects that will earn income is common not only to mining projects but also construction projects before buildings are completed. Under the company income tax, an attempt should be made to match income to expenditures. An approach similar to the treatment of construction costs would be to delay writing off exploration and development costs until income is earned, which is already done in Argentina and the Dominican Republic.

The company income tax generally should be reviewed with the aim of establishing neutrality across sectors at low company income tax rates. By taxing all business activities at similar rates, the allocation of capital will be based solely on economic considerations (pre-tax rates of return on capital). Sectoral-specific statutory company income tax rates are difficult to administer because they provide opportunities to shift profits from high to low sectors via financing structures and prices of related transactions. For mining income, it would be better to review the tax bases to better match income and expenses earned by the mine with an exception for knowledge acquisition expenditures that might be expensed rather than amortized. Periodic reviews of the company income tax, however, can create political uncertainty. One could use stability agreements to provide political certainty with the company paying some additional tax (as is done in Chile and Peru).

Given higher inflation rates in certain countries recently, some LAC governments should consider adjusting profits for inflation. This would reduce the company tax burden by adjusting assets and liabilities for inflation. It would improve profit-based royalties where historical prices are used to calculate capital depreciation and other current costs.

As mentioned above, the rent-based royalty does not fully share the corporate tax burden with investors. It is therefore not neutral, as often claimed, in the presence of a company income tax. Thus, increasing the rent-based tax rate leads to higher effective tax rates on marginal investments in the industry due to these interactions (Chen and Mintz, 2012; Mintz, 2016). Adjustments could be made to rates to maintain investment incentives.

Following are specific recommendations for company income tax reform specifically related to mining. They do not include comment on general company income tax reform because that raises other issues that would need to be addressed.

Exploration Costs

Countries can consider scaling back exploration write-off, especially in excess of 100 percent. To maintain incentives for exploration, a country might prefer a 100 percent deduction for exploration expenditures when incurred to capture the full market benefits from discovery. Some

[14] If countries move ahead to implement an international agreement to levy a 15 percent global minimum company tax on income earned by foreign affiliates, research and exploration tax credits available to foreign companies operating in LAC countries might be ineffective if the effective tax rate in the host country falls below 15 percent. Thus, using a grant instead of a tax credit would ensure that the incentive will not be clawed back by foreign company taxes.

thought could be given to delay write-offs until a project earns income to better match income with expenditures.

Development Costs

Given development expenditures are incurred after mining deposits have been found, these costs should be amortized rather than expensed (unlike exploration, which is incurred to find deposits). Development capital expenditures should be amortized similarly to depreciable capital in the production state to reduce the incentive to distort the allocation of capital between development and extraction stages.

Depreciable Capital

Amortization rates reflect the expected lifetime of assets, keeping in mind new technologies and obsolescence of old assets. To reflect a shorter mine life span, tax depreciation should be adjusted upward. If assets are already written off faster than economic life would suggest, tax depreciation rates should be reduced.

Inventory Costs

Countries may wish to consider replacing FIFO (first-in-first-out) accounting for inventory costs with LIFO (last-in-first-out), which enables mining companies to deduct inventory costs at current rather than historical prices (Bazel and Mintz, 2021).

Inflation

If a country experiences relatively high inflation, it might wish to introduce inflation adjustments to corporate profits. This would require adjusting asset prices each year for inflation to calculate depreciation and inventory deductions. It would also require interest expense on borrowed money to be adjusted downward reflecting the real loss in the debt's principal.

Other Taxes

Given the wide applicability of VAT, transfer taxes, sales tax on capital purchases, and asset-based taxes, a general tax reform is best considered that would impact all industries, not just mining. However, consideration could be given to provide for partial relief from non-profit taxes that have a large impact on capital-intensive industries like mining. If refunding is not possible such as under the VAT, an investment tax credit for depreciable assets administered under the company income tax could be given as a partial offset for non-refundable VAT payments incurred by mining companies. Exemptions might be provided from real estate transfer taxes to encourage the acquisition of mining property.

6

CONCLUSIONS

Mining taxation is complex when considering the different taxes levied by governments that impact mining investments. LAC countries collect royalties as a share of rents from the extraction of mining ore as well as revenues from leasing land. They also collect taxes on investments that are applied to other industries including company income taxes, non-refundable sales taxes on capital purchases, real estate and transaction taxes, and capital taxes (on assets or equity).

This analysis led to several conclusions. First, mining royalty rates on the value of production in most LAC countries are consistent with international rates. Profit-based mining royalties in Chile, Mexico, and Peru can be assessed at higher rates but have a smaller impact on investment because exploration, development, and extraction costs are deductible from mining profits. Second, it is other taxes like the company income tax that make many LAC countries less attractive for mining investment. LAC company income taxes are assessed at rates higher than other countries in general. Company tax incentives are similar to other countries, especially for exploration and development. Some countries also apply significant non-refundable sales taxes on capital purchases, capital taxes, gross receipt taxes, and real estate transfer taxes as part of their government take.

Mining royalty and tax systems in LAC should be reviewed to reduce distortions and adjust revenue take. The simplicity of revenue-based royalties has several drawbacks. They impinge heavily on marginal investments, discouraging them the most. Depending on royalty payment relative to profit margins, they also have uneven impacts across products. Further, revenue-based royalties are less volatile than mining profits. Governments feel they do not receive enough revenues when booms occur and worry that they cannot attract mining investments when downturns occur.

Although company taxes are assessed across industries, special provisions with respect to exploration, development, and processing are unique to mining. Many LAC countries have relatively high company income tax rates but then provide special tax concessions to attract investment, resulting in distortions in the allocation of capital. Relatively high taxes on marginal mining capital investment in some countries undermines economic growth. These taxes erode productivity by discouraging the adoption of new technologies embedded in new capital.

Several reforms are suggested. The most important is for LAC countries to consider profit-based regimes—similar to Chile, Mexico, and Peru—supplemented by a minimum royalty based on the value of production. Company tax reforms should also be considered with the aim of taxing mining similarly to other sectors of the economy to improve the allocation of capital.

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TECHNICAL APPENDIX

The theoretical model follows that found in Boadway et al. (1987), with an adjustment to recognize that it takes time to build up reserves with exploration and development before extraction takes place (MacKie-Mason and Mintz, 1991; Chen and Mintz, 2012). The "time to build" analysis results in a higher cost of capital for a company because income is earned after spending on exploration and development has taken place with a financing cost. Tax payments are affected because tax deductions for exploration and development expenditures are taken prior to income being earned when the resource is exploited, thereby leading to a mismatch of income and costs for tax purposes. The delay in creating income increases the cost of capital but the mismatch of income and expenses under the tax system reduces the cost of capital.

A resource firm maximizes the present value of cash flows from its project subject to the constraint that the extracted resources equal the amounts discovered over time. Let T be the period in which reserves are discovered and prepared for extraction that begins at that time.

$$\text{Max } V = \sum_0^{\infty} (1+R)^{-t} CF_t \, dt \qquad (1)$$

subject to

$$\sum_T^{\infty} Q_t[L_t,k_t] = X = \sum_0^{T} f[e_t] \qquad (2)$$

(accumulated reserves equal total extraction)

with

$$CF_t = P_t \, Q_t[L_t,k_t] - w_t L_t - (\delta K_t + k_t)(1+\pi)^t - TAX_{c[t]} - TAX_{R[t]} \text{ for } t \geq T$$

$$CF_t = -e_t (1+\pi)^t - T_{c[t]} \text{ for } t \leq T$$

V is the present value of the firm's nominal cash flows CF, discounted by the nominal financing rate R over the lifetime of the firm's project. The nominal cost of finance is the weighted average of debt and equity finance ($R = Bi(1-u)+(1-B)\rho$) used by the firm for all of its projects, adjusted for the deductibility of interest expense (B is the portion of assets financed by debt, i is the nominal cost of debt, and ρ is nominal cost of equity, net of risk with all values expressed in certainty-equivalent terms[15]). These costs are determined by international markets and can depend on tax planning opportunities.

Note that P_t= nominal price of output normalized to one and rises at the same inflation rate as other prices ($P_t = P(1+\pi)^t$) and $w_t L_t$ are current costs (which are later denoted as C and $w_t = w(1+\pi)^t$). Note that these costs are equivalent to market prices, abstracting from any transfer pricing issues. The marginal productivity of outputs declines with the use of factors of production. Current costs, $C_t[Q_t,k_t]$, Q_K, and Q_L, can therefore be alternatively treated as a strictly joint convex in output Q (denoted as $C_Q>0$ and $C_{QQ}>0$) and capital that reduces costs (denoted as $C_K<0$ and $C_{KK}<0$) with K_t = depreciable capital stock, k_t = new investment = $K_{t+1} - K_t$ and δ= economic depreciation. (Note that $C_Q = w/ Q_L$ with profit maximization.) Capital is treated as the numeraire with a real price equal to one.

[15] It is assumed below that companies are fully taxpaying in that they can use their deductions against other sources of income. This implies governments implicitly provide a deduction for risk costs through full refundability of losses.

Note that $f[e_t]$ are reserves found through spending on exploration in period t with the function being strictly concave in expenditure on exploration and development ($f'>0$ and $f''<0$).

$TAX_{c[t]}$ = company tax payments (paid in each period and can be negative)

$TAX_{R[t]}$ = royalty payments in each period t (only paid after extraction begins)

The company tax is imposed on the revenues earned from the sale of resources net of the costs of production, which include current extraction costs, capital cost allowances, and exploration and development costs (exploration is expensed but development is capitalized and written off at the declining balance rate σ). This implies the following:

$$TAX_{c[t]} = u\{P_tQ_t - wL_t(1+\pi)^t - \alpha D_t - \sigma E_t(1+\pi)^t - T_{R[t]}\} \quad (3)$$

$$D_t = (\delta K_s + k_s)(1+\pi)^t - \alpha D_{t-1} \quad (4)$$

$$E_t = e_t(1+\pi)^t - \sigma E_{t-1} \quad (5)$$

with α = capital cost allowance rate, (6)
D_s = the undepreciated capital cost base and
E_s = the undepreciated "stock" of exploration and development spending at time s.

Manipulating the terms associated with capital cost allowances and investment, $(\delta K_t + k_t)(1+\pi)^t$, in Equation (1) with the insertion of terms in (3), (4), and (5), one can show that the investment costs are reduced by the present value of capital allowances so that:

$$CF_t = \{PQ_t - wL_t\}(1-u)(1+\pi)^t - (\delta K_t + k_t)(1-uZ)(1+\pi)^t - TAX_{R[t]}(1-u)$$

for

$$t \geq T$$

$$CF_t = -e_t(1-uZ')(1+\pi)^t - TAX_{R[t]}(1-u) \text{ for } t < T$$

with

$Z = \alpha(1+R)/(\alpha+R)$ and $Z'=\sigma(1+R)/(\sigma+R)$[16].

Note that royalty payments in the exploration and development phase are "negative" if such costs are deductible from the royalty base, which will be the case for the rent tax.

Revenue-Based Royalty

Revenue-based royalties are a percentage of the value of extracted output and the corporate income tax system allows companies to deduct exploration and development expenses against other income earned. Let τ be the ad valorem payment on sales, PQ, so that $T_R = \tau PQ$ (suppressing time scripts here on in unless needed). Maximizing Equation (1), subject to (2) and (2'), choosing L, K, k, and E, with appropriate substitutions, yield the following.

Output Decision

The choice of Q yields the following result (λ is the Lagrange multiplier for the constraint in Equation (2)):

$$(1+r)^{-t}(P(1-\tau) - C_Q)(1-u) = \lambda \quad (7)$$

with

$$r = R - \pi = Bi(1-u)+(1-B)\rho - \pi.$$

The implied Hotelling Rule by using two first-order conditions is the following:

$$\{(p_{t+1} - p_t)(1-\tau) - (C_{Q,t+1} - C_{Q,t})\} / \{p_t(1-\tau) - C_{Q,t}\}. = r.$$

The firm extracts output until the net of royalty

[16] See Mintz (1990) for a derivation.

gain from holding a unit of reserve is equal to financing costs that could be saved by selling one more unit of output.

The shadow price of extracted output λ is equal to marginal value of extracting a marginal unit of output. The royalty rate on ad valorem sales generally reduces quasi-rents and the incentive to extract since the royalty reduces revenues relative to costs of extraction. On the other hand, the deductibility of interest expense from taxable income lowers the cost of finance and, therefore, shifts extraction to early periods.

Depreciable Capital

The choice of capital stock and new investment, post-exploration and development, as well as the undepreciated capital cost base and changes to it, yields the following cost of capital for depreciable capital:

$$-C_K = (\delta+R-\pi)(1-uZ)/(1-u) \qquad (8)$$

This is the familiar cost of capital expression, noting that R is the weighted average of the cost of debt and equity finance and Z is the present value of depreciation.

Exploration and Development

The choice of exploration and development, e, yields the following for the cost of capital:

$$(P_T-C_T')f_t' = (1-uZ')(1+r)^{(T-t)}/[(1-u) \{1-\tau P/(P-C')\}] \qquad (9)$$

The quasi-rent earned by investing in exploration $(P_T-C_T')f_t'$ is equal to the interest-adjusted cost of exploration (the price of exploration and development is set equal to unity) divided by the one minus the royalty imposed on the cost of capital. The term in the denominator $\tau P/(P-C')$ is the ad valorem tax paid as a share of the quasi-rents on incremental sales (this is expected to be less than one so long as the ad valorem tax rate is less than the margin $(P-C')/P$). The cost of exploration is reduced by interest deductions taken early at time t relative to the earning of income at time T. Given the deductibility of interest expense from income, the effect of corporate taxation is to reduce the real cost of finance (r) and the discount factor $(1+r)^{(T-t)}$ resulting in a lower cost of capital (and lower effective tax rate on capital).

Rent-Based Royalty on Cash Flows

Cash flow is equal to the revenues net of both current and capital costs incurred in undertaking the project. Interest expense is not deductible and unused deductions, fully written off in later years, are carried forward at the riskless bond rate (the uplift factor).

The royalty payment after payout is the following:

$$T_R = \tau[P_tQ_t - C(Q_t,K_t)(1+\pi)^t - (\delta K_t+k_t)(1+\pi)^t - e_t(1+\pi)^t],$$

which is substituted into Equation (3).

The determination of output, Q, accords with the following Euler equation:

$$(1+r)^{-t}(1-\tau)(P-C')(1-u) = \lambda \qquad (10)$$

implying that only interest deductibility of debt financing costs (incorporated in r) affects the extraction decision $\{(p_{t+1}-p_t) - (C_{Q,t+1}-C_{Q,t})\} / \{p_t-C_{Q,t}\}. = r.$

Depreciable Capital

The user cost for depreciable capital for the oil sands case is similar to Equation (9), but royalties directly affect the cost of capital because current

costs are deductible from the royalty base. That is, changes in the stock of capital reduce current costs, which are netted from royalty payments.

$$-C_K = (\delta+R-\pi)\{1-\tau(1-u)-uZ)\}/[(1-u)(1-\tau)] \quad (11)$$

Exploration and Development

The user cost for exploration and development for the cash flow tax is the following:

$$(P-C')f_t' = (1-uZ'-\tau(1-u))(1+r)^{(T-t)}/[(1-u)(1-\tau)]. \quad (12)$$

If the company tax terms are zero (u=0 and Z=1), the royalty terms appearing in Equations (12) to (14) disappear. Otherwise, the rent-based royalty is not neutral as it increases the company tax burden on capital. Government might fully share returns, risk, and the cost of investment but not the company tax on marginal investments.

Average Tax Rate

The average tax rate (ATR) is based on the model derived above (the full derivation is available upon request). Here is a simple derivation of the ATR.

To estimate the ATR, note that the firm's value can be denoted as Equation (1) above. The key point is that the average revenue of the firm is F[K]/K denoted as R*, which is greater than the pre-tax rate of return to capital: Rg. Using this formulation, the average tax rate is derived as the difference between the present value of cash flows with and without taxes: V = (R*–Rg)(1–u) and Vo = (R*–Rn) whereby Rn is the after-tax marginal return to capital. Vo is taken at the point with capital kept constant at R*.

After using first-order conditions for optimal capital decisions and first-order Taylor's approximation for F[K] the average tax rate is estimated as:

$$T = \{u(R^*-Rn) + (Rg-Rn)(1-u)\}/R^*$$

The average tax rate is a weighted average of the average and marginal return on capital divided by the pre-tax average return on capital. The first term is the tax on rents (at the statutory company income tax rate) and the second term is the marginal tax on capital (the difference between pre- and post-tax rates of return on marginal investments). Note if R*=Rg (average and marginal returns are equal), then T= (Rg–Rn)/Rg (the marginal effective tax rate).

For each type of capital, the average tax rate is calculated and then aggregated by the distribution of capital.

DATA APPENDIX

	Argentina	Australia NSW	Australia NT	Australia QLD	Australia SA	Australia WA	Bolivia	Brazil
Company Income Tax Rate	35.0%	30.0%	30.0%	30.0%	30.0%	30.0%	40.9%	34.0%
Revenue-Based Royalty[1]								
Bauxite (Aluminum)	3.0%			10.0%		7.5%		3.0%
Copper		4.0%		5.0%	5.0%	5.0%		
Gold		4.0%		5.0%	5.0%	2.5%		
Iron Ore						7.5%		3.5%
Lead		5.0%		4.0%	3.5%	5.0%		
Lithium	3.0%					5.0%	3.0%	
Manganese						5.0%		3.0%
Molybdenum								
Nickel								2.0%
Silver	3.0%	4.0%		5.0%	5.0%	5.0%	6.0%	
Tin							5.0%	
Zinc		4.0%		4.2%	5.0%		5.0%	
Profit-Based Royalty			**20.0%**					
Additional Taxes								
Effective Sales Tax on Capital Purchases								8.00%
Real Estate Transfer Tax		7.00%	5.95%	5.75%	7.00%	7.00%		4.00%
Capital Asset Tax[2]	0.75%							
Gross Receipts Tax	1.0%							2.48%
Financial Transaction Tax(es)	1.0%						0.30%	1.50%
Additional Features								
Inflation Adjustment	Yes							
								INE/JCP
								Non-VAT Manu. tax[a]
Company Income Tax Depreciation[3]								*
Depreciable Capital - Min	4%	8%	8%	8%	8%	8%	2%	4%
Depreciable Capital - Max	40%	47%	40%	47%	47%	47%	33%	20%
Exploration[4]	200%	100%	100%	100%	100%	100%	200%	4%
Development[5]	60%	6%	25%	6%	6%	6%	13%	5%
Mining Tax								
Exploration			50%					
Development			50%					
Depreciable Capital			100%					
Depreciable Capital - Processing								
Minimum Tax			Yes					
Inventory	LIFO	Optional	Optional	Optional	Optional	Optional	FIFO	Optional
Non-Tax Parameters								
Inflation	38.8%	1.5%	1.5%	1.5%	1.5%	1.5%	2.9%	7.2%
Real Interest Rate	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Nominal Interest Rate	42.6%	5.3%	5.3%	5.3%	5.3%	5.3%	6.7%	11.0%
Debt-to-Asset Ratio	40%	40%	40%	40%	40%	40%	40%	40%
Cost of Equity	3.5%	4.9%	4.9%	4.9%	4.9%	4.9%	6.2%	10.2%
Nominal Financing Cost	42.2%	4.4%	4.4%	4.4%	4.4%	4.4%	5.3%	8.5%
Real Financing Cost	3.3%	2.9%	2.9%	2.9%	2.9%	2.9%	2.4%	1.4%
Time to Payout - Exploration	8	8	8	8	8	8	8	8
Time to Payout - Development	4	4	4	4	4	4	4	4
Capital Weights[6]								
Depreciable Assets	25%	25%	25%	25%	25%	25%	25%	25%
Inventory	12%	12%	12%	12%	12%	12%	12%	12%
Land	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%
Exploration	17%	17%	17%	17%	17%	17%	17%	17%
Development	46%	46%	46%	46%	46%	46%	46%	46%
Aggregate-Including E&D		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	Canada BC	Canada Ont.	Canada Que.	Canada Sask.	Chile	China	Colombia	Dominican Rep.	Guatemala
Company Income Tax Rate	27.0%	25.0%	26.5%	27.0%	27.0%	25.0%	30.0%	40.0%	25.0%
Revenue-Based Royalty[1]									
Bauxite (Aluminum)						9.0%			
Copper									
Gold						6.0%		5.0%	
Iron Ore						9.0%			
Lead						10.0%			
Lithium						10.0%			
Manganese						10.0%			
Molybdenum						8.0%			
Nickel							12.0%	5.0%	1.0%
Silver						6.0%		5.0%	1.0%
Tin						10.0%			
Zinc						10.0%			
Profit-Based Royalty	**13.0%**	**10.0%**	**16.0%**	**10.0%**	**14.0%**				
Additional Taxes									
Effective Sales Tax on Capital Purchases	7.00%			6.0%		1.02%			
Real Estate Transfer Tax	3.00%	2.00%	1.50%	0.30%		4.0%	7.93%	3.0%	3.0%
Capital Asset Tax[2]									0.9%
Gross Receipts Tax							0.75%		
Financial Transaction Tax(es)							0.40%		
Additional Features									
Inflation Adjustment					Yes			for depreciation	
	33%								
	super-deduction								
Company Income Tax Depreciation[3]					*	*	*		
Depreciable Capital - Min	5%	5%	5%	5%	2%	5%	5%	10%	10.0%
Depreciable Capital - Max	100%	100%	25%	25%	33%	33%	25%	47%	47.3%
Exploration[4]	100%	100%	100%	100%	100%	6%	20%	6%	20.0%
Development[5]	30%	30%	30%	30%	5%	6%	20%	6%	5.1%
Mining Tax									
Exploration	100%	100%	100%	150%					
Development	100%	100%	150%	150%					
Depreciable Capital	133%	100%	30%	100%					
Depreciable Capital - Processing	133%	15%	30%	100%					
Minimum Tax									
Inventory	FIFO	FIFO	FIFO	FIFO	LIFO	Optional	LIFO	LIFO	Optional
Non-Tax Parameters									
Inflation	2.0%	2.0%	2.0%	2.0%	3.1%	2.0%	4.7%	2.2%	3.7%
Real Interest Rate	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Nominal Interest Rate	5.8%	5.8%	5.8%	5.8%	6.9%	5.8%	8.5%	6.0%	4.8%
Debt-to-Asset Ratio	40%	40%	40%	40%	40%	40%	40%	40%	40%
Cost of Equity	5.4%	5.4%	5.4%	5.4%	3.5%	5.4%	7.9%	5.6%	7.0%
Nominal Financing Cost	4.9%	5.0%	4.9%	4.9%	6.3%	5.0%	7.1%	4.8%	6.5%
Real Financing Cost	2.9%	3.0%	2.9%	2.9%	3.2%	3.0%	2.4%	2.6%	2.7%
Time to Payout - Exploration	8	8	8	8	8	8	8	8	8
Time to Payout - Development	4	4	4	4	4	4	4	4	4
Capital Weights[6]									
Depreciable Assets	25%	25%	25%	25%	25%	25%	25%	25%	25%
Inventory	12%	12%	12%	12%	12%	12%	12%	12%	12%
Land	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%
Exploration	17%	17%	17%	17%	17%	17%	17%	17%	17%
Development	46%	46%	46%	46%	46%	46%	46%	46%	46%
Aggregate-Including E&D	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	Guinea	Guyana	India	Indonesia	Kazakhstan	Mexico	Peru	Philippines
Company Income Tax Rate	30.0%	25.0%	25.1%	27.5%	20.0%	30.0%	29.5%	30.0%
Revenue-Based Royalty[1]								
Bauxite (Aluminum)	0.8%	1.5%	22.5%		2.8%			
Copper					5.7%			
Gold		5.0%			5.0%			
Iron Ore			15.0%		2.8%			
Lead					8.0%			
Lithium								
Manganese					2.5%			
Molybdenum								
Nickel				5.0%				9.0%
Silver					5.0%			
Tin				3.0%				
Zinc			10.0%		7.0%			
Profit-Based Royalty						**7.5%**	**20.4%**	
Additional Taxes								
Effective Sales Tax on Capital Purchases			4.0%		0.00%			
Real Estate Transfer Tax	8.5%		7.0%		0.00%		3.0%	
Capital Asset Tax[2]								
Gross Receipts Tax								1.50%
Financial Transaction Tax(es)			0.20%					0.50%
Additional Features								
Inflation Adjustment						Yes		
Company Income Tax Depreciation[3]								
Depreciable Capital - Min	8%	8%	8%	10%	15%	7.5%	5%	10.0%
Depreciable Capital - Max	40%	20%	40%	13%	25%	40.3%	20%	47.3%
Exploration[4]	3%	20%	10%	6%	25%	100%	100%	100%
Development[5]	3%	20%	10%	6%	25%	4.9%	33%	5.1%
Mining Tax								
Exploration								
Development								
Depreciable Capital								
Depreciable Capital - Processing								
Minimum Tax								
Inventory	Optional	Optional	Optional	Optional	Optional	LIFO	Optional	Optional
Non-Tax Parameters								
Inflation	9.4%	1.0%	5.3%	4.0%	8.0%	4.0%	2.7%	2.8%
Real Interest Rate	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Nominal Interest Rate	13.2%	4.8%	9.1%	7.8%	11.8%	7.8%	6.5%	6.6%
Debt-to-Asset Ratio	40%	40%	40%	40%	40%	40%	40%	40%
Cost of Equity	12.3%	4.5%	8.5%	7.2%	11.0%	3.5%	6.0%	6.1%
Nominal Financing Cost	11.1%	4.1%	8.3%	6.6%	10.4%	7.2%	5.4%	5.5%
Real Financing Cost	1.6%	3.1%	2.9%	2.6%	2.4%	3.2%	2.8%	2.7%
Time to Payout - Exploration	8	8	8	8	8	8	8	8
Time to Payout - Development	4	4	4	4	4	4	4	4
Capital Weights[6]								
Depreciable Assets	25%	25%	25%	25%	25%	25%	25%	25%
Inventory	12%	12%	12%	12%	12%	12%	12%	12%
Land	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%
Exploration	17%	17%	17%	17%	17%	17%	17%	17%
Development	46%	46%	46%	46%	46%	46%	46%	46%
Aggregate-Including E&D	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

	Russia	South Africa	Suriname	US Alaska	US Arizona	US Nevada
Company Income Tax Rate	20.0%	25% / 27%[b]	36.0%	28.4%	24.9%	21.0%
Revenue-Based Royalty[1]						
Bauxite (Aluminum)						
Copper					2.0%	1.1%
Gold	6.0%	5.0%	6.5%	3.0%		1.1%
Iron Ore						
Lead				3.0%		
Lithium						
Manganese		5.0%				
Molybdenum					2.0%	1.1%
Nickel	8.0%					
Silver	6.5%					
Tin						
Zinc				3.0%		
Profit-Based Royalty				**7.0%**	**1.3%**	**5.0%**
Additional Taxes						
Effective Sales Tax on Capital Purchases		0.15%		1.7%	7.7%	7.8%
Real Estate Transfer Tax						0.26%
Capital Asset Tax[2]	1.32%					
Gross Receipts Tax						0.9%
Financial Transaction Tax(es)						
Additional Features						
Inflation Adjustment						
		Special CIT for Gold[c]				
Company Income Tax Depreciation[3]	*	*				
Depreciable Capital - Min	20%	10%	5%	4%	4%	4%
Depreciable Capital - Max	67%	20%	47%	45%	45%	45%
Exploration[4]	100%	100%	100%	70%	70%	70%
Development[4]	6%	100%	6%	70%	70%	70%
Mining Tax[d]						
Exploration						
Development						
Depreciable Capital						
Depreciable Capital - Processing						
Minimum Tax						
Inventory	Optional	Optional	FIFO	Optional	Optional	Optional
Non-Tax Parameters						
Inflation	6.8%	4.9%	25.3%	2.0%	2.0%	2.0%
Real Interest Rate	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Nominal Interest Rate	10.6%	8.7%	29.1%	5.8%	5.8%	5.8%
Debt-to-Asset Ratio	40%	40%	40%	40%	40%	40%
Cost of Equity	9.9%	8.1%	27.0%	5.4%	5.4%	5.4%
Nominal Financing Cost	9.3%	7.5%	23.6%	4.9%	5.0%	5.1%
Real Financing Cost	2.5%	2.5%	-1.6%	2.9%	3.0%	3.1%
Time to Payout - Exploration	8	8	8	8	8	8
Time to Payout - Development	4	4	4	4	4	4
Capital Weights[5]						
Depreciable Assets	25%	25%	25%	25%	25%	25%
Inventory	12%	12%	12%	12%	12%	12%
Land	0.16%	0.16%	0.16%	0.16%	0.16%	0.16%
Exploration	17%	17%	17%	17%	17%	17%
Development	46%	46%	46%	46%	46%	46%
Aggregate-Including E&D	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: E&Y, PWC, KPMG. Various relevant government sources and legislation.
Notes:
[a] INE/JCP: Imposto sobre a Renda e Proventos de Qualquer Natureza/Juros sobre o Capital Próprio, which is a tax on income and profits of any nature/interest on equity in Brazi. Non-VAT Manu tax = Non-VAT manufacturing tax.
[b] Similar in structure to the corporate franchise tax
[c] Assumes 19 percent profit to revenue ratio for gold producers. For more info see https://www.sars.gov.za/wp-content/uploads/Ops/Guides/LAPD-Gen-G02-Guide-for-Tax-Rates-Duties-Levies.pdf.
[d] Data is not available / tax is non-applicable for those countries.

[1] Where sales in various forms or stages of processing face different rates, the rate for "Concentrate" is used.
[2] Capital asset tax is not a minimum tax.
[3] Declining balance unless denoted by an asterisk.
[4] Where additional mining tax depreciation rates are not explicitly given, rates shown are also applied for depreciation under the mining profit tax for jurisdictions with a profit tax.
[5] Capital weights derived from top 40 mining company balance sheets and Canadian sources for 2017–2019.

Tax Parameters Common Features

Real Interest Rate	3.8%
Debt-to-Asset Ratio	40%
Time to Payout - Exploration	8
Time to Payout - Depreciation	4
Capital Weights[a]	
Depreciable Assets	25.1%
Inventory	11.8%
Exploration	17.3%
Development	45.6%

[a] Capital weights derived from top 40 mining company balance sheets and Canadian sources for 2017–2019.

Description and Source

The weighting of capital assets (shares of investment across asset classes) is one of the primary factors that impacts the final METRR. The same weighting shares are applied across jurisdictions and the various mineral products. This approach assumes a similar project structure and allows for a comparative analysis of the tax system across jurisdictions. Another approach could allow for the capital weighting to vary by jurisdiction and even mineral product. However, at this time the required data for such a comparison is not publicly available (to our knowledge). In addition, the second approach arguably obscures the comparative value of the results, in that it would not allow for the same isolation of tax impacts across tax regimes since each METRR result would vary according to project structure in addition to tax regime structure.

The capital weighting data used for this report is based primarily on Natural Resource Canada data for capital investment in the Canadian mining industry. In addition, this data is augmented using additional capital investment data from Statistics Canada as well as recent data for the top 40 mining companies as published by PWC.

https://mmsd.nrcan-rncan.gc.ca/expl-expl/ExploTable.aspx?FileT=112020&Lang=en

https://mmsd.nrcan-rncan.gc.ca/expl-expl/ExploTable.aspx?FileT=342019&Lang=en

https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=3410003601

https://www.pwc.com/gx/en/industries/energy-utilities-resources/publications/mine.html

Price-Cost Margin by Resource

Bauxite	62.1%
Copper	49.3%
Gold	46.1%
Iron Ore	52.8%
Lead	10.6%
Lithium (Carbonate)	88.4%
Manganese	44.6%
Molybdenum	62.1%
Nickel	44.6%
Silver	38.6%
Tin	49.3%
Zinc	23.1%

Description and Source

Price-cost margin (PCM) is calculated on a per-mineral product basis. PCM is another of the primary factors that can have a significant impact on the final METRR for jurisdictions with a revenue-based royalty or mining tax.

PCM is a simple measure of the margin of profit and is derived as [(unit price – unit cost)/unit price]. For instance, if the PCM for a particular mineral is 10 percent and a revenue-based royalty is applied at 10 percent, then the royalty rate on profits is effectively 100 percent. If the PCM were 50 percent, the same 10 percent royalty on revenue would represent an effective royalty rate of 20 percent.

PCM is calculated using realized unit prices derived from USGS Mineral Commodity Summaries averaged over the five most recent years available. Unit costs are derived from the miningdataonline.com database containing unit costs on a per project basis across a number of mineral products and jurisdictions. Unit costs for a particular mineral product were averaged across projects and jurisdictions over the five most recent years available. The data used to derive costs queried mining projects from all of the available jurisdictions included in this report.

https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries

https://miningdataonline.com/property/623/New-Liberty-Mine.aspx

Average Life of Mine by Resource (Years)

Bauxite	35.3
Copper	17.5
Gold	16.5
Iron Ore	18.5
Manganese	26.3
Nickel	19.5
Silver	22.0
Cross-mineral Average	20.5

Description and Source

The life of the mine is used to determine the depreciation of exploration and development expenses in jurisdictions where such costs are amortized over the operational life of the mine.

The data represents a simple average for the life of mine duration as published by Anglo American on a per-product basis. https://www.angloamerican.com/~/media/Files/A/Anglo-American-Group/PLC/investors/annual-reporting/2013/annual-report2012.pdf.


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