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Resource rents in the diamond industry 2014-19: Rents, issues, methods, and data availability

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WIDER Working Paper 2021/39

Resource rents in the diamond industry 2014–19

Rents, issues, methods, and data availability

Anton Löf, Olof Löf, and Magnus Ericsson*

February 2021

Abstract: The focus of this study is rent in the diamond industry. Based on extensive datasets and a discussion of all relevant costs, we present resource rent statistics from the diamond industry in key producer countries in emerging economies such as Angola, Botswana, Democratic Republic of the Congo, Lesotho, Namibia, Sierra Leone, and South Africa, as well as the Russian Federation. Resource rents give an indication of the available space for taxation. To use this potential tax space effectively in the long term without changing the investment behaviour of the mining companies and the long-term viability of the industry, all costs, such as environmental and financial costs, must be included. The study attempts to expand on earlier work by the World Bank to calculate mineral rents for mining industries other than the diamond industry. Rent calculated as precisely as possible is an important basis for wealth calculations and for mineral policy development.

Key words: resource rent, diamond, tax, mineral policy, World Bank, Africa

JEL classification: C81, C82, L72, Q32

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1 Introduction

This paper discusses and analyses the questions and problems that arise in the calculation of resource rents, using the case of diamonds to illustrate the issue. It reviews existing definitions, methods, and data for calculating resource rents. Further, the paper provides statistics for the resource rents from the diamond industry in certain countries for the years 2014–19. It concludes with a summary of the main results and issues that arise in the calculations and makes some recommendations for data collection within the diamond sector.

1.2 Background

The extractive industries are a means to an end. Countries want to use minerals and metals and oil and gas to develop their societies and increase the standard of living of their populations. Countries that are resource rich can benefit from these resources through value-added processing as well as downstream industries, or through the export of raw materials.¹ Research has shown that in several low- and lower middle-income countries (LICs and LMICs respectively) that are rich in non-fuel mineral resources mining makes significant contributions to national economic development (Ericsson and Löf 2017, 2019).

In its report *The Changing Wealth of Nations, Measuring Sustainable Development in the New Millennium* (World Bank 2011), the World Bank estimates, on an aggregate level, that around 20 per cent of the wealth² of developing nations is attributable to natural resources. Further, the World Bank report notes that there is a high dependence of LICs on natural capital.³ Indeed, the report stresses that the important role of natural capital in building wealth suggests that it should receive close attention. Measured as wealth per capita, natural capital represents 41 per cent of the total wealth of LICs, 34 per cent of LMICs, 15 per cent of upper middle-income countries, but only 2 per cent of high-income OECD countries. According to the study, there is a direct relationship between development and wealth. Most countries start out with a relatively high dependence on natural capital, which they use to build more wealth and, in the process, change the composition of the country's wealth.

The traditional indicator of economic progress, growth in gross domestic product (GDP), is problematic for countries with extractive sectors as they can grow their GDP by diminishing stocks of non-renewable resources. Without new investments in the sector and a balanced tax regime, the sector will slowly die out (Otto et al. 2006).

Wealth that includes natural resource stocks at the country level is thus a powerful economic concept which can be used to understand and plan for sustainable economic growth. Calculating a value for the extractive sector inevitably means calculating the future flow of rents (economic profits) that the sector can sustain in the future. Direct revenues from the extractive industries to a government are generally in the form of payments, taxes, licences, and royalties, etc. These direct revenues from the extractive industry are often an important part of the revenues of LICs and LMICs. However, country revenues are significantly impacted by volatility in world prices and

¹ It is not always the case that downstream processing increases the value, as discussed by Östensson and Löf (2017), because of alternative costs.

² Wealth includes produced capital, natural capital, and human social and institutional capital. Changes in wealth can be used to measure the sustainability of development (World Bank 2011).

³ Natural capital is defined in the World Bank report as agricultural land, protected areas, forests, minerals, and energy.

markets for minerals, metals, and oil and gas (Sachs and Warner 1997; Stevens et al. 2015). It is important for individual countries and governments to have a clear understanding of what the national extractive resources are, how much they can produce, and how much they can yield to the state from year to year. In this case, resource rents can be seen as an indicator which can contribute to understanding the total tax burden an industry can manage without jeopardizing the future of that industry.

However, it is important to understand that this wealth needs to be harnessed for a country to be able to use it because, as Philip Crowson (2008: 308) argues, ‘orebodies are worthless until they are discovered ... their full value is only realizable when mines and processing plants have been developed to exploit them’.

Wealth and income are, however, not enough; they must be wisely invested and used for progress.^{4,5} This is often easier said than done, and the issue of managing the extractives industries to achieve sustainable and inclusive development is not straightforward.⁶

1.3 Limitations of this study

This study is limited to the diamond mining industry and more specifically to the resource rents created in that specific part of the diamond value chain. We did not undertake research on the causes and effects of the diamond rent, price, value, or production volumes. The study’s conclusions and methods may be applicable to other minerals/metals industries but we do not discuss this further in this paper.

Although the paper generally relates to the global level, it also discusses implications for host countries where a mine is located and home countries where a mining company is domiciled.

2 Economic rents in the mineral industry

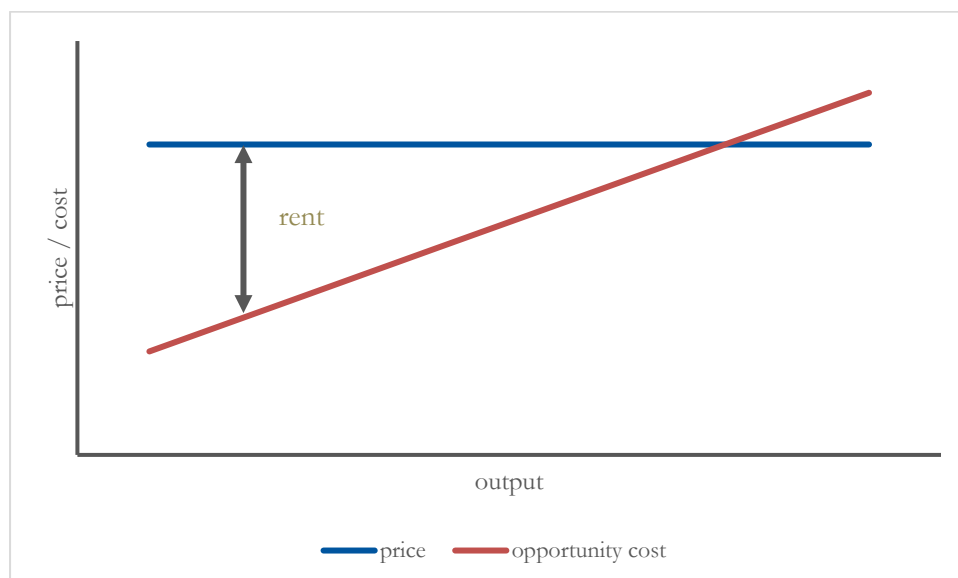
Economic rents can be defined as those payments to a factor of production that are in excess of the minimum payment necessary for that factor to be supplied. Or, as Philip Crowson (1998: 22) argues, ‘economic rent is that portion of value added which exceeds the costs of all the factors of production’ including return on capital. Otto et al. (2006: 20) define it as ‘a payment or monetary return to the owner of a factor of production or to a firm (which controls a bundle of factors of production) that does not alter its economic behaviour’. It can be visualized schematically as the difference between the opportunity cost and price at each given level of output (see Figure 1).

⁴ It has been argued that one of the reasons for the resource curse is dissipation of resource rents on current consumption rather than investment (World Bank 2011).

⁵ See, for example, Collier (2010), which contains recommendations for maximizing the benefits from an extractive sector. The author advocates long-term, often local, investments in infrastructure, education, etc. to build the basis for further economic activities domestically outside of the extractive sector.

⁶ These issues are discussed in Addison and Roe (2018).

Figure 1: Schematic figure of economic rent.



Source: authors' calculations.

If the supply curve in Figure 1 were perfectly elastic, then the economic rent would be zero. Rents arise only when supply is somewhat inelastic. In the mineral resource sector, such constraints can, for example, be geological, technical, and geographical.

If the value of the factor of production that produces the rent is considered at its market value, the opportunity cost will increase as profits are driven towards zero and the rent will disappear. That is, in the resource sector, a mine will be valued for its ability to produce rent; high rents will give the mine a high value, which increases the opportunity cost and thus decreases the rent. Theoretically, as rents in the resource sector are, in Crowson's words (2008: 306), 'a reward solely for the possession of a property, as distinct from the compensation required for the various factors of production used to develop and work the resource', the value of the property will increase until the opportunity cost equals the price received for the factor of production, and with that the economic rent is cancelled out.

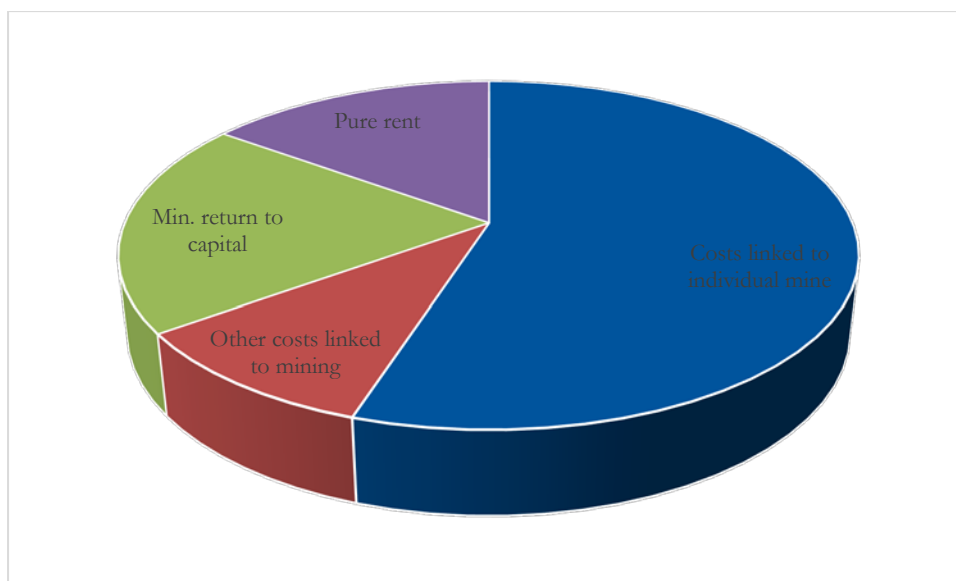
It is interesting, however, that, from a taxation point of view, economic rent can be defined as 'a surplus of income that can theoretically be taken away from an investor without altering its economic behaviour' (Otto 2017: 1). Taxing the mineral rent will lower the value of the factor of production that produces the rent, but, as long as it is only the economic rent that is taxed, then the behaviour of the firm will not change. Thus, while economic rent can be said to be non-existent, when taking the true opportunity cost into account, then the true opportunity cost is a function of the property value, and taxing the rent lowers the value. So, a government can tax that non-existent economic rent and receive a portion of the funds which would otherwise accrue to the firm in the form of increased value of the mine.

Mineral deposits have different levels of quality, related, for example, to their depth and whether they are high-grade ore bodies with valuable by-products, and their distance to the market, which all determine the value of a particular deposit. For these and other reasons, production costs vary. However, the price of a metal is set globally, theoretically at the opportunity cost of the highest-cost mine needed to satisfy the market demand. Thus, all mines—except that last mine—will earn a resource rent. In practice, some mines will never create any economic rent, some may not even be able to cover their costs, and others may generate a great deal of economic rent.

Mines take a long time to develop, and barriers to entry are usually high. In the short run, capacity is limited. This can lead to large increases in prices, such as those seen during the ‘super cycle’ between 2005 and 2012 when demand exceeded supply. With increased prices, resource rents will also increase. However, as mines are capital intensive, large upfront investments are needed before production can start and it takes years before that investment is recovered. In the short run, mines have an incentive to operate for as long as they are recovering their production costs or variable costs. These costs are generally referred to as operating or cash costs in the resource industry. While these costs include the costs of labour, materials, energy, and other expenses that cease when production stops, they exclude the cost of capital and other fixed costs. Therefore, when the market price is below total costs but above the variable cost, the individual mine has a short-term incentive to continue operation as the losses will be even higher if production ceases. By continuing production, the mine is recovering at least some of its fixed costs. This pushes prices down and periods of low prices have regularly been experienced by this cyclical industry.

Resource rents may accrue unevenly between years. However, in the long run, a mine needs to recover all its costs or it will stop investing to remain in business. Over and above the operating costs, these include the capital needed to construct the mine and a competitive rate of return on that capital, including a risk premium. Resource rents accrue over the life of a mine until the ore is extracted. After mining and processing have finished, costs are incurred in rehabilitating the mine site. These costs should be included with all other costs. Further, other costs such as exploration and overhead costs should also be included. Only some exploration endeavours end up as mines. If exploration related to non-mine sites is regarded as a cost of finding that deposit which can actually become a mine, it should be considered as a cost of developing that mine. Thus, there are other costs that are linked to mining, but not linked to the individual mine, that should be considered when calculating the total costs of a mine over its lifetime (see Figure 2). The exploration costs per kilogram of metal or carat diamond discovered have been increasing in recent decades (Schodde 2019) for a host of reasons. While advances in exploration due to big data, artificial intelligence, and other IT developments will increase exploration productivity, they are unlikely to reverse the trend of increasing costs, although they will reduce the pace of increase.

Figure 2: Total project lifetime value components



Source: authors' calculations.

Resource rents vary over time and display different characteristics depending on whether they are analysed over the short run or the long run. In the short run, resource rents can be very high, but

Otto et al. (2006) argue that in the long run these rents tend to be substantially lower and for some mines they disappear altogether. It is necessary to differentiate between quasi rent, other rent, and pure rent. Quasi rent reflects the mine's return on capital and fixed investments; this only exists in the short run as any mine which is not recovering its total investment will shut down in the long run. Other rent can arise from several factors. The most important is the cyclical volatility of metal prices. While rents tend to increase with prices over the cycle, these positive rents are often offset by negative rents when the global economy is weak and metal prices are low. Pure rent is the rent that arises from one mine/deposit being superior to others; this is also the only resource rent that can exist in the long run. This pure rent is what drives the industry to find and develop new deposits. Remove it and the mining industry is seriously affected. However, no operating mine should close down, even in the long run, because the government taxes pure rent.

2.1 Problems in calculating resource rent

Economic rent can be defined as:

$$\text{Economic rent} = \text{total income} - \text{total costs}$$

Total income can be defined as:

$$\text{Total income} = \text{total production} * \text{average price}$$

Total income is fairly straightforward. There are production figures and some form of global price for most minerals and metals. However, total costs is different. All long-term costs should be included. For practical reasons, all costs are seldom included in resource rent calculations. Most calculations of resource rents take individual mines and their operating costs as a starting point, leaving out other costs linked to mining as well as the cost of capital. For example, World Bank studies (Lange et al. 2018; World Bank 2006, 2011) use average production costs updated with the annual Manufactures Unit Value (MUV) index⁷ to compensate for inflation. The cost of capital, overhead costs, closure costs, and exploration costs are therefore not included. Furthermore, the production cost is, in a sense, static as it is calculated from a base year, which does not represent the true operating costs very well.

In preparing its 2021 edition of the World Bank's wealth report *The Changing Wealth of Nations*, the authors have revised the methodology for rent calculation. The new methodology will take account of additional cost components. These components will include total mine site costs (operating costs), transportation costs, smelting and refining, reclamation and closure provision, depreciation and amortization, deferred stripping amortized, and inventory change.⁸ The costs are also updated based on data per year rather than indexed, which should increase the reliability of the calculations considerably.

Overhead costs and non-mine site exploration are not included. The reason for this is that the data source models the costs from the bottom up and each cost is thus linked to a mine. Overhead cost is a top-down cost, which is difficult to allocate to a specific mine, and non-mine site exploration, by its nature, is not linked to an operating mine.

⁷ The MUV index, is a composite index that tracks inflation in the price of manufactured goods imported by developing countries. This index is a weighted average of export prices of manufactured goods produced by 15 major economies. It is calculated by the World Bank.

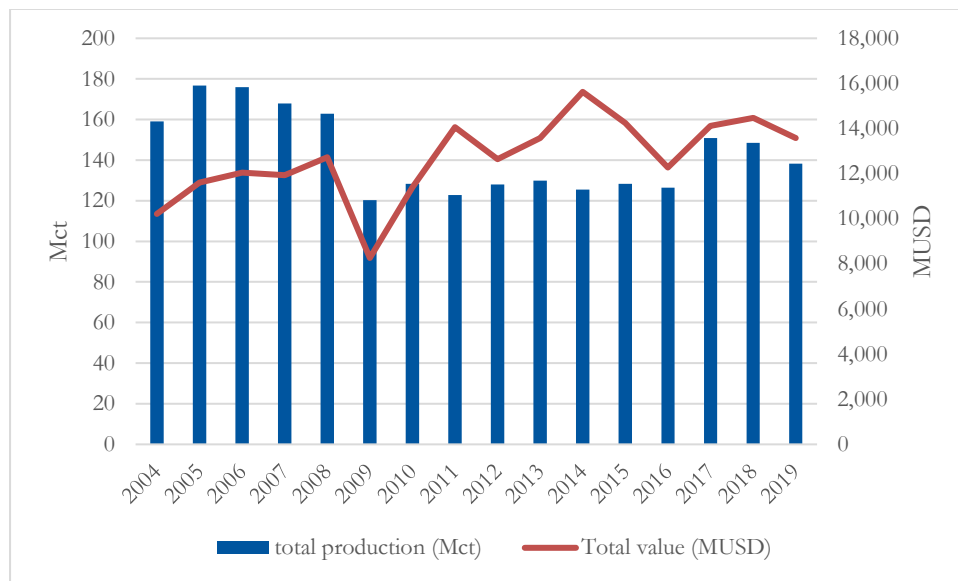
⁸ The costs are derived from S&P Global (2020a) and its database.

Resource rent can be considered as three separate rents—quasi, other, and pure rent—where the pure rent can be taxed sustainably over the long term. The updated methodology for the *The Changing Wealth of Nations* report will thus exclude quasi rents, with the exception of overhead costs and non-mine site exploration. However, the new methodology does not acknowledge negative rents.⁹ Negative rents are set to zero for the calculation of the national unit rent. Although a smoothing process averages rents over five years, which means that the rent in any given year is less likely to be negative, it does not automatically mean that the total rent over the time period is not negative. This means that other rent may be included in the calculated resource rent in the report, as price fluctuations which negatively impact the profitability of individual mines/projects are not fully acknowledge by the method.

3 The diamond industry

The diamond sector is a relatively small part of the extractive industry. In 2019, its total value was US\$13.6 billion (see Figure 3). The total production value of the mining industry for metals and industrial minerals excluding coal for the same year was US\$723 billion. Diamonds are thus only 1.9 per cent of the total value.

Figure 3: Total diamond mine production and value 2004–19 (Mct & MUSD)



Note: Mct = million carat, MUSD = million \$.

Source: authors' calculation based on The Kimberley Process (2020).

However, diamonds are very important for some developing economies. Botswana, Lesotho, Namibia, Sierra Leone, and Angola all derive significant revenue streams from the diamond industry. Table 1 shows the countries where diamonds contribute most to GDP.

⁹ A mine in operation can generate negative resource rents if the price of the product produced falls below the cost of production.

Table 1: Diamond production value as % of total GDP in individual countries 2019

Country	Diamond value as % of GDP
Botswana	9.23
Lesotho	4.84
Namibia	4.17
Sierra Leone	1.54
Angola	0.72
Zimbabwe	0.36
Liberia	0.35
Democratic Republic of the Congo	0.33
Central African Republic	0.16
South Africa	0.12
Russian Federation	0.11
Canada	0.10
Guinea	0.06
Tanzania	0.06

Source: authors' calculations based on data from World Bank (n.d.) and The Kimberley Process (2020).

For these countries, an increased understanding of the diamond rent would be of considerable importance, especially as the resource rent is directly related to the opportunity to levy taxes.¹⁰ But it can also be used to calculate natural capital, which will increase our understanding of the sustainability issues of the diamond industry. Diamonds are not included in the World Bank report series cited above. While this is a limitation, it is understandable as the mined minerals and metals that are included¹¹ account for approximately 90 per cent of the total value of the mining industry (Ericsson and Löf 2019). The main reason for this exclusion is, however, not the size of the industry but the lack of data. There is limited information on the reserves, resource rents, and costs that are necessary to calculate the natural capital value of the diamond sector. This paper therefore aims to expand on the work by the World Bank to calculate the resource rent for the diamond industry.

Diamonds are used for jewellery or for industrial applications and are mined or produced synthetically. Mined and synthetic diamonds can come in many different qualities depending on the geological properties of the host rock or the technology used to produce the synthetic diamonds. Only high-quality diamonds are used as gemstones in jewellery. Diamonds used in industry are mostly for cutting, grinding, drilling, and polishing procedures. Within the mining industry, raw diamonds are extracted and those of high enough quality are selected for further processing, cutting, and polishing for jewellery, while the rest are sold for industrial use. The extractive diamond industry is highly concentrated in a few countries (see Tables 2 and 3).

¹⁰ A rich literature further discusses resource rent taxation. See, for example, Boadway and Keen (2013), Cordes (1995), Daniel et al. (2010), Land (1995, 2010), Otto (1995, 2017), and Otto et al. (2006).

¹¹ The *Changing Wealth of Nations* report includes data on coal, bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin, and zinc.

Table 2: Top ten diamond mining countries 2019 by value (USD) and % of total

Country	USD million	% of total
Russian Federation	4,117	30.3
Botswana	3,435	25.3
Canada	1,697	12.5
Angola	1,266	9.3
Namibia	1,010	7.4
South Africa	873	6.4
Lesotho	290	2.1
DRC	226	1.7
Sierra Leone	168	1.2
Australia	159	1.2
Total value top 10 countries	13,241	97.5
Other countries	334	2.5
Total value	13,574	100

Source: authors' calculation based on data The Kimberley Process (2020).

Table 3: Top ten diamond mining countries 2017 by carat (ct) gem quality and % of total

Country	ct gem quality	% of total world production	ct industrial	% of total world production	gem quality as % of total ct production
Russian Federation	26,168,400	28.4	17,445,600	29.2	60.0
Canada	23,200,226	25.2	-	0.0	100.0
Botswana	16,058,700	17.5	6,882,300	11.5	70.0
Angola	8,494,920	9.2	943,880	1.6	90.0
Australia	8,396,150	9.1	8,738,850	14.6	49.0
South Africa	3,879,220	4.2	5,818,820	9.7	40.0
DRC	2,268,332	2.5	16,634,432	27.8	12.0
Namibia	1,713,800	1.9	90,200	0.2	95.0
Zimbabwe	752,360	0.8	1,755,500	2.9	30.0
Tanzania	258,785	0.3	45,670	0.1	85.0
Total top 10	91,190,893	99.1	58,355,252	97.6	61.0
Other countries	827,694	0.9	1,416,055	2.4	36.9
Total world	92,018,587	100	59,771,307	100	60.6

Source: authors' calculations based on Reichl and Schatz (2019).

The diamond industry was long dominated by De Beers, which had a monopoly in both the production and the sale of diamonds.¹² The importance of De Beers has since declined, but the company, now wholly owned by Anglo American, is still the largest producer of diamonds by value. Table 4 lists the most important diamond-producing mining companies.

Table 4: Most important diamond-producing mining companies 2019 (MUSD & %)

Company	Controlling company/entity	Home country	MUSD	% of total value 2019
De Beers	Anglo American	South Africa	4,812	35.5
Alrosa	State of Russia	Russian Federation	4,117	30.4
Rio Tinto	Na	United Kingdom	562	4.1
Petra Diamonds	Na	Jersey	476	3.5
Dominion Diamond Mines	Na	Canada	359	2.6
Gem Diamonds	Na	United Kingdom	187	1.4
Total top 6			10,512	77.5
Total value diamond mine production			13,562	100

Note: Na = not applicable, MUSD = million \$.

Source: authors' calculation based on data from company annual reports and The Kimberley Process (2020).

There are some inherent differences between the extractive part of the diamond industry and other extractive industries, as well as many similarities. The main difference between the diamond industry and other gemstone industries, compared to other mining industries, is the product. Metals are essentially fungible; they have a uniform global price. Diamonds and gemstones command different prices depending on quality and size. There is thus no price for diamonds in the same way that there is a price for gold. The profitability of a mine is linked not only to the cost of production but also to the quality, and hence the value of the product will vary from mine to mine. For example, Australia produced some 13 million carats¹³ (ct) in 2019 at a value of US\$159 million, while Angola only produced 9 million ct, but the value was US\$1.26 billion. Raw diamonds are generally sold in lots at auction, but the industry is experimenting with more online sales, as is the case in Botswana where diamonds are sold separately by size and quality. A factor which simplifies the calculations of the costs and incomes of diamond mines is that a diamond mine only produces diamonds; there are no by-product metals to take into account (for example cobalt in the case of some copper deposits).

4 Method and data

In this section, we discuss the method used to calculate diamond rent and the data used. The entire section deals with the diamond industry. The discussion revolves solely around diamonds, thus, for example, total income is the total income from diamond mining only.

¹² For a more thorough history of the diamond industry see, for example, Cleveland (2014).

¹³ The carat is the unit of measurement for the physical weight of diamonds. One carat equals 1/5 gram or 200 milligrams.

We calculate the resource rent for diamonds (dR) in an individual country (N) in year t as total income in the diamond industry (dI) in that country, less total costs in the diamond industry (dC) in that country:

$$dR_t^N = dI_t^N - dC_t^N$$

We use publicly available data provided by the Kimberley Process to calculate total income per country.¹⁴ The data includes production in carats and the value in USD. The total costs per country are calculated as the product of the average unit cost and national production. The latter is reported by the Kimberley Process.

We derive the average unit cost through a series of calculations and assumptions. Total cost components are defined as:

operating costs	
+ cost of capital	
+ exploration costs	
+ overhead costs	
+ closure costs	
= Total costs	

All these cost components must be addressed to arrive at the total cost. No uniform data on costs exist and there is no readily available database on costs in the diamond sector.¹⁵ It is thus necessary to gather data directly from company and industry sources. We used publications, such as annual reports, quarterly reports, presentations, and other company materials, to collect information and data from which the average unit cost can be calculated. As not all companies report costs, it is necessary to calculate an average using those figures that can be found. The report implicitly assumes that the average cost per unit in those mines for which data is available can be used to estimate the costs in all mines. However, this is not necessarily true; for example, an open pit mine is generally less costly per mined carat of diamonds than an underground mine. Thus, the assumption that the average costs for an open pit mine can say something about an underground mine is a simplification. However, as information is not available for all individual mines, it is necessary to make some estimates based on the available data. Diamond rent is further calculated at the country level, rather than based on individual mines, using average figures for costs and is thus less problematic than if a resource rent per mine were calculated.

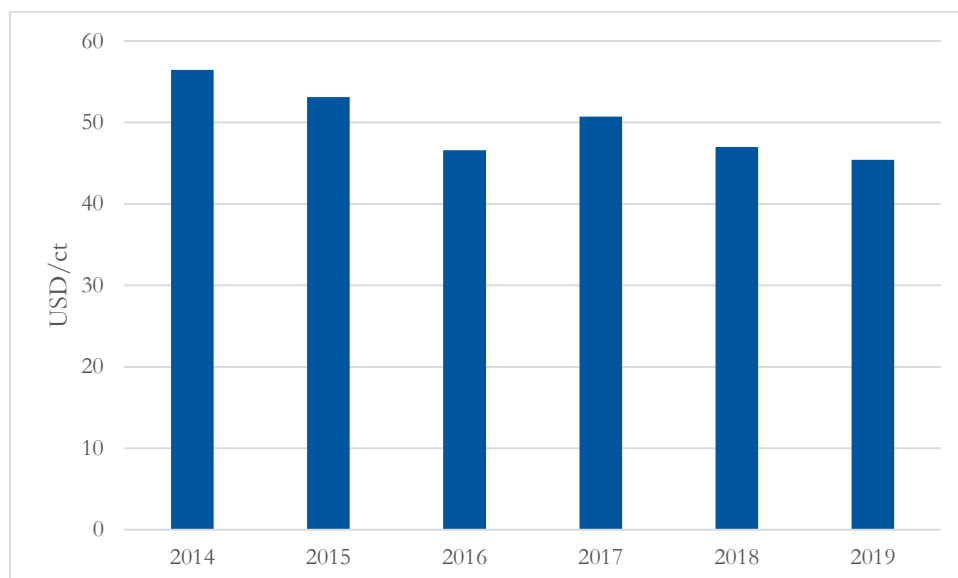
4.1 Operating costs

Data on operating costs is available from a number of companies, and data for around 60 per cent of the total world production in 2019 gives operating costs by mine or by company. As a measurement of total value, this figure is higher at around 70 per cent. We calculate an average operating cost in USD per carat per year, using all the available data and then apply this figure to the entire industry (see Figure 4 for global figures).

¹⁴ The Kimberley Process Certification Scheme also includes data on exports and imports. For the purpose of this paper, the production in carat and value is enough.

¹⁵ This is also why the rent on diamonds is not included in the World Bank studies on natural wealth.

Figure 4: Average global diamond operating cost per carat per year 2014–19 (USD/ct)



Source: authors' calculations.

The average operating cost per country is based on actual figures when available or on the global average operating cost compensated for individual differences related to total value of the diamond industry in each country and mine type.

4.2 Cost of capital

The cost of capital is defined as the return (in USD) demanded by investors to invest in the diamond industry. To calculate this figure, two pieces of information are needed: i) the investment cost per carat capacity and ii) the percentage return demanded by investors.

To estimate the investment cost per carat, we analysed a number of current projects and recently constructed mines and we calculated their investment cost per carat capacity (see Table A1 in the Appendix). We calculated an average cost per carat capacity using these figures. This is assumed to be the current cost per unit capacity. While each individual dataset from any given project only represents that project at a certain point of time, using several projects from various parts of the world arguably increases the reliability of the figure given. As all other costs are in current USD, the current cost per carat capacity needs to be compensated for inflation in earlier years. To do this, we use the MUV index as it is used for similar calculations by the World Bank in its *Changing Wealth of Nations* reports. Using readily available indices can be a blunt instrument for such a specific cost as capacity cost in the mining industry.¹⁶ However, there are not many diamond projects and thus it is not feasible to establish a value for each year, and hence the chosen index is used as a means to ensure that costs are more representative over time and not distorted by inflation.

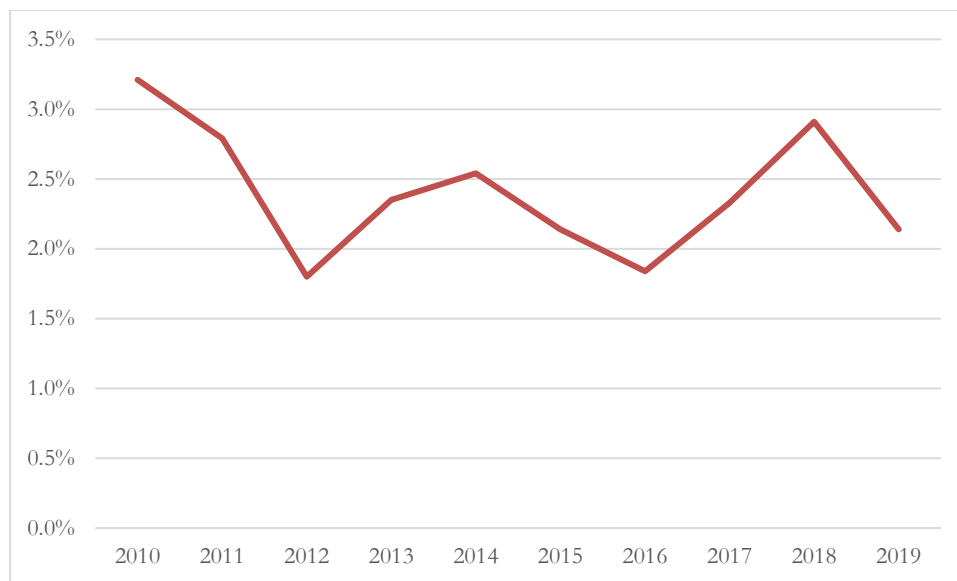
A mine has a value for as long as it is operating. This value should generate a continuous return to an investor. Exchanging existing capacity for new capacity is equal to the product of the current cost per carat capacity and production. Therefore, we consider the cost per carat capacity as the

¹⁶ For example, during the height of the super cycle the cost of increasing capacity increased more than general inflation as there was a severe lack of almost everything needed to construct a mine, ranging from equipment, spare parts, and tyres to engineers and truckdrivers, etc.

value of operating capacity per carat. Thus, to calculate the total investment value of the industry, we apply the cost per carat capacity to total industry production. This total investment value is equal to the total investment needed to keep the industry operating at the current level of production, whether individual mines get depleted or not.

The minimum return required by an investor to make an investment is not fixed but varies with prevailing interest rates, expectations of the financial outcomes of the project, and which risk premium should be applied. Rio Tinto (2016) states that it will not consider any project with an internal rate of return (IRR) of less than 15 per cent, while BHP, when listing its projects under implementation, has none below an IRR of 12 per cent (BHP 2019). The Russian diamond producer Alrosa has an investment target of an IRR of 20 per cent (Alrosa 2019). A well-known consultancy firm knowledgeable in the valuation of mining projects states that it would assume around 8.5–10 per cent weighted average cost of capital plus a country risk premium of 0–6.5 per cent.¹⁷ Another way to analyse the cost of capital is to use the rate of interest on risk-free long-term borrowing plus whatever margin an investor considers necessary to compensate for the technical, commercial, and political risks associated with the specific investment. Figure 5 gives the long-term interest rate in the United States. For comparison, the ten-year returns annualized on all companies included in the S&P 500 is 11.9 per cent (S&P Global 2020). Most investors would argue that investing in diamond mining is riskier than investing in the S&P 500, thus the reward needs to be higher.

Figure 5: Long-term United States interest rates (%)



Source: authors' calculation based on data from OECD (2020).

Crowson (1998) argues that resource rents, which are the residual after all costs (including the required return on capital), are partly subjective as rents will vary from investor to investor by 10–15 per cent, depending on their risk appetite.

By weighting the numbers presented above, we establish that a return of approximately 12.5 per cent is required. Applying this percentage on the cost per carat capacity thus gives an average cost of capital. The product of this average cost of capital and total production gives the total cost of capital for the diamond industry. As long as the individual investor gets this return on the value of

¹⁷ Personal interview.

the individual investment, they will continue to invest in the diamond industry and keep production at the current level.

4.3 Exploration costs

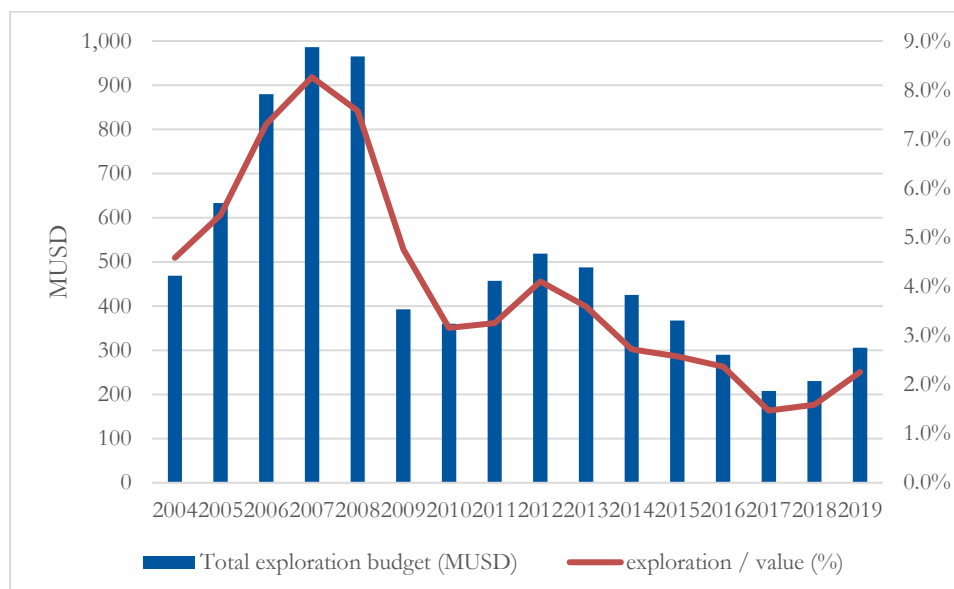
Exploration is a necessary cost of constructing a mine, but it is generally not fully included in calculations of the costs of establishing the mine, i.e. the cost per carat capacity discussed above. This is because, when the decision to invest or not is taken, part of the exploration has already been done and is therefore considered to be a sunk cost. Further, most exploration projects do not result in a mine being constructed at all in the short to medium term. Nevertheless, it is a cost for the mining company and should thus be included in total costs.

Further, for a mine to continue operation, new reserves need to be developed at the same speed as reserves are mined out or the mine will eventually cease operation. This cost, mine site exploration, is generally not included in operating costs.¹⁸ However, this is also a cost for the mining company.

The data used for diamond exploration is derived from S&P Global Exploration Expenditure (S&P Global 2020b) figures (see Figure 6). Total exploration expenditure per year is divided by total carat production for that same year. We calculate this figure for the years 2004–19 to be used as an estimation of an exploration cost per carat. This does not take account of the country where exploration takes place but assumes that exploration is proportional to production. As there is a lack of granularity to divide the costs by country, we assume that exploration takes place where the mining takes place. There are several reasons for this assumption. First, exploration takes place in or near existing mines to guarantee continued operation. Second, if the geology proves favourable in a certain geographical area, the chances of finding similar deposits are higher close to that area compared to looking at completely new regions, countries, and areas. Third, more exploration is likely to take place in a country where there is existing mining infrastructure in a broad sense, such as universities, R&D, laboratories, and an advantageous tax regime. This will inevitably lead to overestimated costs linked to exploration in some countries as it ignores potential exploration costs in countries where there is no current production. Thus, while assuming that exploration is linked to production is a simplification, it is likely to give an estimate close to the facts.

¹⁸ If mine site exploration is not undertaken, and reserves are not replenished, a further cost is incurred in the form of an opportunity cost of producing and selling non-renewable resources today in comparison with producing and selling it in the future. This opportunity cost is commonly referred to as hoteling rent, scarcity rent, or user cost (Otto et. al 2006).

Figure 6: Total exploration costs and exploration as % of total value (MUSD of diamond industry) 2004–19



Note: MUSD = million \$.

Source: authors' calculations based on data from S&P Global (2020b).

4.4 Overhead costs

Overhead costs, or selling, general, and administrative (SG&A) costs, are those costs that are incurred in the day-to-day business but that are not linked to a specific department in the company or to the operating costs in production. These costs can be, for example, sales-related, technical overhead, management, administration, and general overhead costs. As they are corporate-level costs, they are generally not included in the cash/operating costs. There is relatively little data on the SG&A costs related only to diamond production. Most diamond-producing companies are also involved in the production of other commodities. However, the Russian diamond producer Alrosa reports an SG&A cost of between 9.7 and 9.8 per cent of total operating costs (Alrosa 2018). The *Mining Valuation Handbook* (Rudenno 2012) further reports on a specific diamond project and notes administrative and overhead costs of between 4.0 and 6.7 per cent, while the same costs for the entire mining industry would be an average of 8.2 per cent of total operating costs. The mining consultant SRK, when analysing the total mining industry, obtains a higher cost of 13 per cent (Poxleitner 2016). Our analysis uses the Alrosa figure. This increases the operating cost by 11 per cent on average. While there are arguments for both higher and lower overhead costs, this figure is derived from a diamond producer which represents roughly 25 per cent of the total value of the market. Further, the figure is generally in line with the industry standards presented above and is reasonable for the purpose of this study.

4.5 Closure costs

Closure and rehabilitation costs are part of the total costs of operating a mine. Most jurisdictions demand that provision is made for the expected costs of the closure of mines and the deactivation of related assets. Closure costs can vary considerably between individual mine sites and jurisdictions. We found substantial difficulties in collecting mine-by-mine data for the diamond industry. Instead, we analysed yearly total provisions for the three largest mining companies—Vale, BHP, and Rio Tinto—and the diamond mining companies Alrosa and Petra Diamonds, and we use their costs as a proxy for the entire diamond mining industry. The average annual provision for closure of these three largest companies was around 0.7 per cent of total revenues (BHP 2015–

2019; Rio Tinto 2015–2019; Vale 2015–2019). Although they only make up part of the industry, these three major companies together account for around 15 per cent of the total metal industry in value terms and are represented in most of the minerals mined as well as in most jurisdictions. The two diamond mining companies have an average annual closure provision of around 0.4 per cent (Alrosa 2015–2019; Petra Diamonds 2015–2020) and account for roughly 27 per cent of the total value of the diamond industry. Weighting the figures together, accounting for the larger share of the mining industry in the form of the three larger companies while compensating for the fact that the two diamond producers have a lower cost, gives a closure cost of 0.5 per cent of total revenues. This figure should be sufficient given that most diamond mines do not cause such severe emissions to the environment as many metal mines do because of the nature of the kimberlite ore with limited amounts of sulphur and other detrimental compounds.

Closure costs are particularly complex and difficult to estimate before the start of the closure phase of a mine's life. The true closure costs can only be established after mining has stopped. Closure costs are influenced by a host of factors, such as new and more strict environmental standards, the changing chemical composition of ores mined over the life of mine, and, last but not least, the total volume of ore mined. The costs of decommissioning and rehabilitating mines have generally increased over the last couple of decades because of the increased volumes of material put into tailings dams and rock dumps due to lower ore grades and new legal requirements as a result of increasing governmental and societal expectations for reduced environmental impacts. This is part of an overall trend and could further increase closure costs in the future. In analysing the diamond industry, we use 0.5 per cent of total revenues as a proxy for the annual provisions made by companies to cover the future costs of closure rather than the actual costs of closure. These are the closure costs set aside by the mining company from year to year. If a mine is not properly rehabilitated, any additional costs will have to be covered by the host country where the mine is located. If the costs of closure are not adequately provided for by the company, then they will ultimately have to be borne by the state, entailing the expenditure of public money (i.e. a claim on taxes). Calculating resource rent is the same as calculating a potential tax space. Applying a higher cost than mining companies incur lowers this tax space and shifts profits to the mining company. However, it is likely that provisions to cover future closure costs will increase for mining companies in the future, thereby reducing their economic rent.

5 Mineral rent in the diamond mining industry

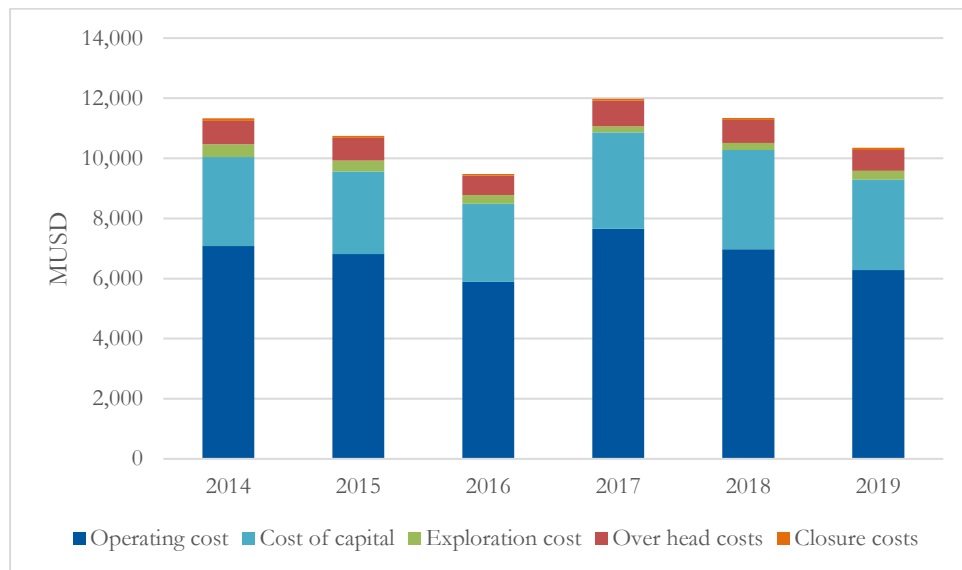
Resource-rich countries have an apparent advantage over other countries as they can use resource rent to build prosperity. The ability to use resource rent over the long term for any socioeconomic development depends on a viable resource sector. If it is only pure rent that can be taxed without investors changing their behaviour, then knowledge of costs and incomes are of the greatest importance. The following section presents calculations for diamond pure rents globally and by country, applying the methods discussed in the previous section.

5.1 Costs in the diamond industry

Applying the method developed in Section 5 for the diamond industry gives all costs—a necessity for the calculation of pure rent. Figure 7 shows total costs by component for the years 2014–19. Total costs decreased over the years 2014–16, increased in 2017, and fell over 2017–19. However, there are different reasons for the falling costs in the two periods. Figure 8 shows the total costs per carat and total production of raw diamonds. The costs per carat declined over the years 2014–16 and stayed almost the same over 2016–19. At the same time, production was stable between 2014 and 2016, while an initial increase in production in 2017 was followed by a slow decline for

the rest of the period. Total costs thus declined over 2014–16 because of falling average costs, while the 2017 increase was mostly due to increased production, and the subsequent fall in total costs is linked to lower annual production.

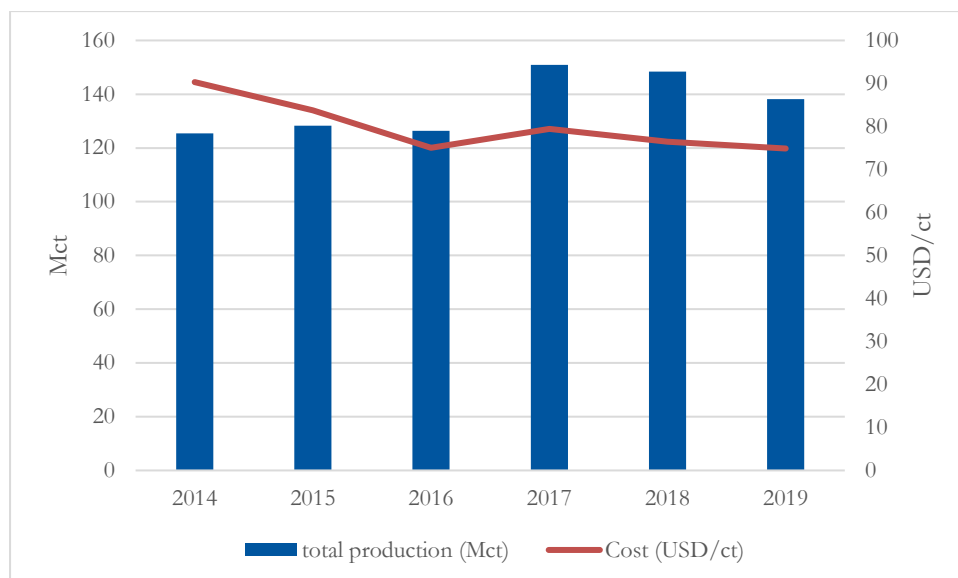
Figure 7: Total costs per component 2014–19 (MUSD)



Note: MUSD = million \$.

Source: authors' calculations.

Figure 8: Total costs per carat and total production 2014–19 (USD/ct & Mct)



Note: Mct = million carat.

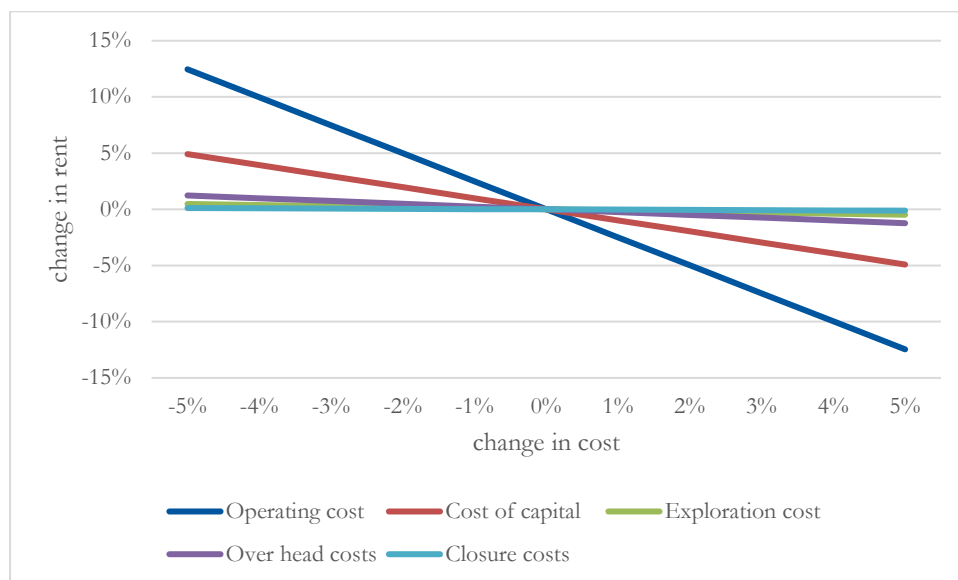
Source: authors' calculations.

Sensitivity analysis of various costs

All the costs of diamond mining are a function of many variables. The operating cost, which is a variable cost, is directly influenced by production. However, operating costs are also a function of

the quality of the ore. If a mine produces from a section where the grade is higher than usual, the average operating cost per carat decreases. Costs per carat are not static but fluctuate with overall trends in the industry and the specific circumstances of each mine. To assess the impact of changes in costs, Figure 9 depicts the percentage change in average pure rent over the period 2014–19 if an individual cost is changed by 1 per cent.

Figure 9: Average percentage change over the period 2014–19 in pure diamond rent from changing each cost component by 1%



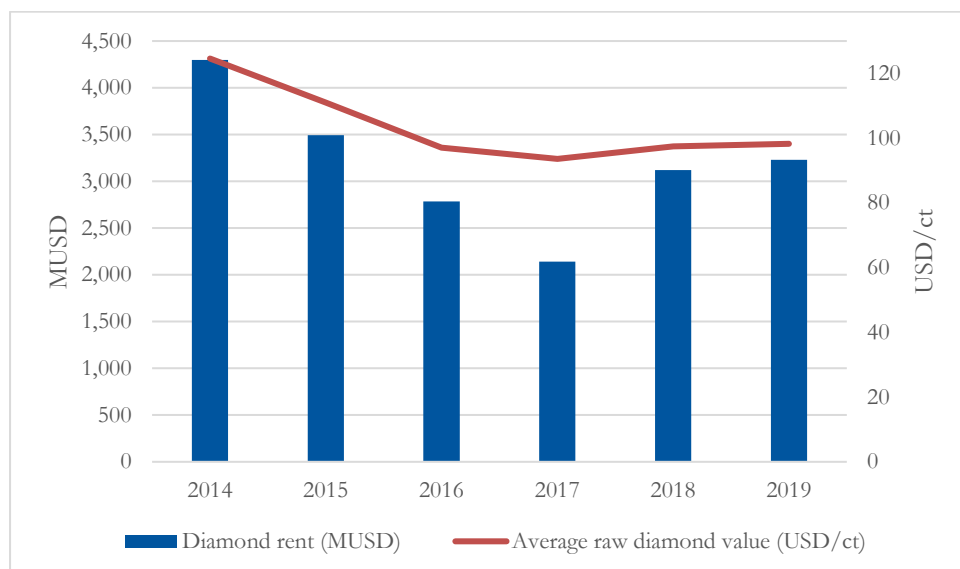
Source: authors' calculations.

The operating cost is the most important cost factor. A 1 per cent change in operating cost changes the rent by 2.5 per cent. Operating costs are twice as important as the costs of capital, ten times more important than overhead costs, 20 times more important than exploration costs, and roughly 100 times more important than closure costs.

5.2 Global diamond rent

Global diamond mineral rents for the years 2014–19 are presented in Figure 10. Diamond rents decreased over the first four years of the period but have started to increase again since 2017. The total annual value of diamond rents fluctuates and was at a high of US\$4.299 billion in 2014 and a low of US\$2.142 billion in 2017. The total diamond rents over the six-year period amounted to US\$19.067 billion. Figure 10 also shows the average value of mined raw diamonds per carat per year. Not surprisingly, both the diamond rent and diamond price display similar patterns.

Figure 10: Global diamond rent and average value of mined raw diamond 2014–19 (MUSD & USD/ct)

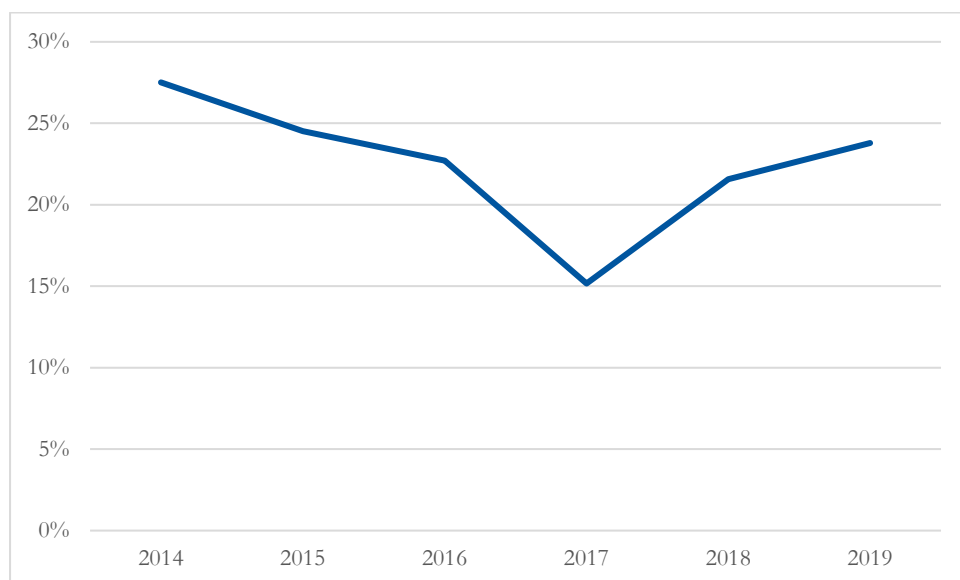


Note: MUSD = million \$.

Source: authors' calculations.

Rent as a percentage of the total value of diamond mine production fluctuated over the period (2014–19) (see Figure 11). At its peak in 2014, the figure was 28 per cent and it was 15 per cent in 2017, at its lowest. Over the last two years the industry has increased its margins and in 2019 diamond rent as a percentage of total value was up, reaching 24 per cent.

Figure 11: Diamond rent as % of total value of diamond industry 2014–19



Source: authors' calculations.

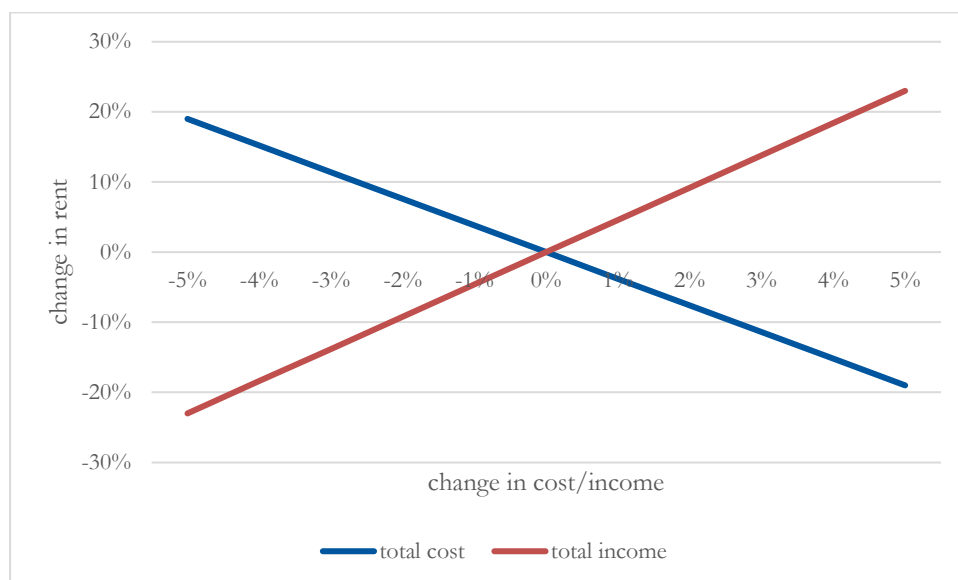
Sensitivity analysis

Rent is a function of income and costs. Income depends on the price of raw diamonds, a factor which is beyond the influence of each mining company. Costs on the other hand are something that a mining company can influence. A mining company will adapt costs as the economic cycle progresses. If prices are high, then an increase in average cost is not a problem if the increased

cost generates more than the cost. Income and cost are thus variables that change with the business cycle. To assess the impact of changes in income and costs, Figure 12 depicts the percentage change in average pure rent over the period 2014–19 if income and total costs are changed by 1 per cent.

Changing the total cost by 1 per cent changes rent by 3.8 per cent. Changing total income by 1 per cent changes rent by 4.6 per cent.

Figure 12: Average percentage change over the period 2014–19 in pure diamond rent from changing total cost and income by 1%



Source: authors' calculations.

5.3 Rent by country

At the rent by country level, the analysis is restricted to those low-, middle-, and upper middle-income countries where the diamond industry contributes the most to GDP.¹⁹ We used the cost model described and discussed above to calculate the rent by country. When granularity of data so permitted, we made adjustments to individual countries. The production and value data for individual countries are derived from the Kimberley Process. For Botswana, Lesotho, Namibia, the Russian Federation, South Africa, and Tanzania, we analysed data on operating costs by mine and calculated an average production cost per individual country. We used an average global operating cost for the rest of the countries. We, further, calculated country risk, both political and economic, in relation to other diamond-producing countries and adjusted the cost of capital to reflect this risk.²⁰

For two countries, the Democratic Republic of the Congo (DRC) and Zimbabwe, the model results are less than satisfactory. As the average value of the raw diamonds produced in the DRC were US\$16 in 2019 and US\$67 in Zimbabwe, incomes are not enough to compensate for the modelled costs.

¹⁹ See Table 1.

²⁰ Country risk calculations are based on research by MineHutte (Mining Journal Intelligence 2020).

There are several reasons why the modelled costs are too high, the most obvious being that operating costs in an individual country are lower than the calculated global average. However, other costs generated by the model may also be too high. The overhead costs and the exploration costs of very small mining companies, particularly artisanal mining companies, can be almost non-existent. Closure costs in countries with legislation that lacks adequate environmental and rehabilitation laws may also be close to zero. Further, the model may overestimate the cost of capital in relation to the actual cost of capital. The model stipulates that the value of capacity is equal to the cost of replacing capacity. However, if the replaced capacity is inferior to the new capacity in terms of machines, structures, and equipment, then the value is not comparable and the cost of capital is overestimated.

The examples of the DRC and Zimbabwe indicate that the modelled costs are too high. However, the operating costs collected represent more than 60 per cent of production volumes and more than 70 per cent in value terms. It is those countries with an especially low production value per carat that the model cannot accommodate. Almost all countries produce a mix of gem quality and industrial diamonds where the value of the former is much higher than the latter. The production volume of industrial diamonds is, however, more than seven times the volume of the production of gem quality diamonds in the DRC. In Zimbabwe, the production volume of industrial diamonds is twice that of gem quality diamonds. All the other countries analysed produce, in carats, more gem quality than industrial diamonds. The operating costs in the analysis are based mostly on mines that produce a larger share of gem quality diamonds than industrial diamonds. A mine that produces a high share of gem quality diamonds can afford higher costs as its income is higher than a mine which produces a smaller share of gem diamonds. The higher value of the product compensates for the higher costs. Assuming average costs in all mines overestimates costs in the mine where the production value is lower than average. The costs in the DRC and Zimbabwe are therefore likely to be lower than average, and their costs must therefore be adjusted in the analysis. We calculated a factor proportional to the per carat production value in relation to average global production and applied it to these two countries. Total global rent and the total sum of rents by country may therefore differ, as the model presented for a global rent calculation is not rigorously applied on a country-by-country basis.

Table 5 presents the diamond pure rent by country for the years 2014–19. In Botswana, where it was highest, the rent was fairly stable over the period and reached US\$2.133 billion in 2019. The Russian Federation experienced a 66 per cent increase over the period, and the rent reached US\$1.077 billion in 2019. In South Africa, the rent decreased substantially over the period from US\$1.296 billion to US\$0.203 billion, down 84 per cent.²¹ A total of nine out of 13 countries showed a decrease in diamond rent over the period. Only Angola, the Central African Republic, DRC, and Russian Federation saw increases in rent. The average total change in rent for the 13 countries was a decrease of 36 per cent. Those countries that experienced a decline in rent had an average decline of 57 per cent.

²¹ Clarifying the reasons for this would be an important and interesting follow-up question which, however, is outside the scope of this study.

Table 5: Diamond pure rent by country 2014–19 (MUSD)

Country	2014	2015	2016	2017	2018	2019
Angola	531	434	410	363	588	589
Botswana	2,141	1,715	1,941	2,107	2,221	2,133
Central African Republic	0	0	1	3	-1	4
DRC	71	66	66	66	66	107
Guinea	9	0	14	5	-5	0
Lesotho	249	206	288	70	84	45
Liberia	178	27	25	33	25	15
Namibia	550	466	446	456	400	340
Russia Federation	648	1,427	932	1,255	1,096	1,077
Sierra Leone	162	110	115	98	96	103
South Africa	1,296	1,069	361	231	382	203
Tanzania	15	-6	24	7	8	12
Zimbabwe	103	68	38	37	63	45

Note: MUSD = million \$.

Source: authors' calculations.

6 Conclusions

This paper presented a detailed analysis of costs and income in the diamond industry. As there is a lack of complete data for the cost side of the diamond industry, we had to make some assumptions and generalizations to establish an overall cost for the diamond mining industry. A better understanding of costs in diamond mining, especially at the country level, could be reached with more data. However, the data used was sufficient to determine and discuss the level of the pure rent for the diamond mining industry.

Earlier research related to resource rent, for example by the World Bank, has focused on other minerals/metals and has omitted diamonds. In discussing the theory of resource rent and how resource rent has been calculated in these reports, this paper argues for the calculation and use of pure rent. However, it is mostly not the pure rent which is calculated but one which generally includes quasi rents and other rents.²² This is because costs are defined on a mine-by-mine basis, leaving out some of the costs linked to companies and investors rather than to individual mines. However, these costs are still part of the total costs of mining. Resource rents are generally discussed as a potential tax space in the host country. To avoid overestimates, we advocate the use of pure rent when discussing resource rent. In the long term, it is only pure rent that can be taxed without investors changing their investment behaviour. Overestimating the pure rent by leaving out certain costs inflates the tax space. If taxes are levied based on an inflated tax space then the long-term viability of a mining industry could be affected through demands for higher taxes than profits can allow.

²² Quasi and other rents represent short-term returns and profits which tend to disappear in the long run or when all costs are accounted for.

Efficient taxation of the resource rent without jeopardizing the future of the mining industry demands good knowledge of incomes and costs. For all governments interested in these questions, it is essential to have information pertaining to all relevant incomes and costs at appropriate levels of granularity.

Understanding rents is important for any related policy development. This paper presented pure rent over the 2014–19 period. Although costs and incomes are the basis of calculations of resource rent, there have been no studies on what factors influence costs and income and how these factors work. For example, the price of raw diamonds influences rents directly but how large this influence is and how it has changed over time is yet to be established. It would be interesting to analyse the effects within the diamond industry of the monopoly which has historically been in place and to examine how rent changed in the transition period from a monopoly to a less concentrated market and how this change affected host countries.

Rather than analysing taxes, our study established the pure diamond rent, some of which is already taxed in most jurisdictions. The pure diamond rent which we calculated should therefore not be construed as the capacity for additional taxation. All taxes, especially income tax, excess profit taxes, and additional profit taxes, do appropriate at least some economic rent for the benefit of the host country. Some of these taxes are already included in the costs in our analysis. For example, we argue that a competitive rate of return on invested capital should be considered as a cost prior to resource rent being calculated. This competitive return is a profit and will theoretically be taxed as such. Other costs could also be taxed in various ways. Operating costs, for example, could include taxes on such items as labour and energy. Consequently, as pure rent can be taxed without investors changing their investment behaviour and there are other additional taxes on the cost of capital and other costs, it could be argued that an amount equal to the pure rent should be the minimum that should be levied as tax in the host country.

The dataset we provide in this paper will enable a more correct value of natural capital to be calculated for those countries where the diamond industry is important and will increase the reliability of the calculations of wealth for the same countries. By extension, this could lead to a more sustainable economic development path in these countries, as policies could be adapted to best fit the fundamentals of each host country.

While pure rent can be taxed without jeopardizing the long-term future of an industry, the paper does not discuss which countries should tax this rent. As all taxes transfer funds and, at least partly, rents to a government, it would be interesting to analyse who receives the benefits from mining. If the mine and the operating company are based in the same country, taxation should also take place in that country. However, the effects are less clear when the home and host countries are different. It would be interesting to analyse 1) the total amount that is taxed and 2) the amounts that are taxed in the host and home countries.

The paper has argued consistently that all costs should be included in rent calculations. However, environmental costs, in particular, are uncertain. It is difficult to know whether all environmental costs incurred during the life of a mine are actually taken into account. If the price is set at marginal cost, costs that were not fully accounted for would lower the price below the theoretical price needed to supply the market. The difference between the actual price and the theoretical price would turn into a consumer benefit. If that benefit equalled the excluded costs, no gains or losses would be incurred. However, environmental degradation caused by mining is limited to the host country, while the consumer benefits accrue to the country where consumption takes place. If the mined raw materials are used in the host country, any consumer benefit will stay in that country. If funds saved from the lower costs of raw materials are invested, then the postponed environmental costs could be compensated for by future gains. However, the mining often takes

place in LICs and LMICs, whereas the consumption is often concentrated in high-income countries. This leads to environmental debt shifting. The host country takes responsibility for any future environmental degradation, while the consumer country benefits from cheap raw materials.

Higher raw material prices, efficient tax laws, and increased transparency could, at least partly, alleviate this situation for the host country. However, the true costs are of importance when setting the global price of a raw material. With this in mind, it would be interesting to conduct an analysis of the long-term true environmental costs of the diamond industry to compare them with the costs used in our analysis to establish the rent. These long-term costs should, for example, include maintenance of tailings dams, costs related to CO₂ emissions and global warming, mine closure and rehabilitation, and the cost of irreversible changes such as loss of biodiversity, etc.

Our study may have underestimated the true environmental costs, which would lower the rent. However, this would be a theoretical problem that should not influence the potential tax levied, as the underestimation of the true environmental costs benefit the mining company rather than the host country. Thus, the rent calculated in this paper is valid for the understanding of a tax space.

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Appendix

Table A1: Average cost per capacity carat.

Name	Country	World region	Type	Controlling company (% controlled)	Main metal	Project cost (est/actual) (MUSD)	Carat capacity/ year Mct	Project cost USD per carat
Argyle Diamond Mine	Australia	Oceania	OP & UG	Rio Tinto Group (100%)	Diamond	2,200	12.0	183
Chidliak	Canada	North America	UG	Anglo American (100%)	Diamond	464	1.3	362
Cullinan Diamond Mine	South Africa	Africa	UG	Petra Diamonds (100%)	Diamond	632	1.0	632
Diavik Diamond Mine	Canada	North America	UG	Rio Tinto Group (60%)	Diamond	928	7.0	133
Ekati Diamond Mine	Canada	North America	OP & UG	Dominion Dia (100%)	Diamond	182	3.5	52
Gahcho Kue Diamond Deposits	Canada	North America	OP	Anglo American (51%)	Diamond	1,000	4.5	222
Ghaghoo Diamond Deposit	Botswana	Africa	UG	Gem Diamonds (100%)	Diamond	96	10.0	10
Jwaneng Diamond Mine	Botswana	Africa	OP	Anglo American (50%)	Diamond	500	11.0	45
Liqhobong (Main) Diamond Deposit	Lesotho	Africa	OP	Pacific Road (75%)	Diamond	185	0.8	231
Snap Lake Diamond Mine	Canada	North America	UG	Anglo American (100%)	Diamond	975	1.2	813
Venetia Diamond Mine	South Africa	Africa	OP	Anglo American (74%)	Diamond	2,000	4.5	444
Victor Diamond Mine	Canada	North America	OP	Anglo American (100%)	Diamond	834	0.7	1,191
							Average weighted USD cost per carat	174

Note: OP = open pit, UG = underground, MUSD = million \$, Mct = million carat.

Source: authors' calculations based on company reports.