MINERAL RENTS AND WEALTH
AN ANALYSIS OF THE DIAMOND MARKET AND THE
POTENTIAL TAX SPACE 2010-2019

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C-UPPSATS

LULEÅ TEKNISKA UNIVERSITET

NATIONALEKONOMI

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ABSTRACT
The aim of this thesis is to analyse resource rents in the diamond industry. Based on extensive datasets and a discussion of all relevant costs, resource rent statistics in the diamond industry is examined on a global level for the period 2010-2019. 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 operating costs, cost of capital, exploration costs, overhead costs and closure costs, must be included. The result shows that failure to include all costs inflates the potential tax-space and thus jeopardize the viability of the resource sector.
SAMMANFATTNING
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1 INTRODUCTION

1.1 Background

The extractive industries are a means to an end. Countries want minerals and metals, as well as oil and gas, to develop their societies and increase the standard of living for their populations. Countries that are resource rich can benefit from these resources through; value added from processing, as well as downstream industries, or through the export of raw materials.\(^1\) Research has shown that mining have a significant contribution to national economic development in several low- and middle-income countries rich in non-fuel mineral resources (Ericsson and Löf, 2017; 2019). These contributions mainly come in the form of job creation, taxes and royalties levied.

The World Bank in the report “The Changing Wealth of Nations, Measuring Sustainable Development in the New Millennium” (World Bank, 2011), on an aggregate level, estimates that around 20 percent of the wealth\(^2\) in developing nations are attributed to natural resources. Further, the World Bank notices a high dependence in low-income countries on natural capital.\(^3\) The report stresses the important role of natural capital in building wealth, which suggests that natural capital should receive close attention by governments. Measured as wealth per capita natural capital represents 41 percent of total wealth for low-income countries, 34 percent for lower middle-income countries, 15 percent for upper middle-income countries, but only 2 percent for high income OECD countries. According to the World Bank study there is a direct

\(^1\) It is not always so 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.
relationship between development and wealth. This, as most countries start out with a relatively high dependence on natural capital which can be used to build more wealth and, in the process, change the composition of a country’s wealth.

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

Wealth that includes natural resource stocks, since it includes a value of existing resources not yet developed, on a country level can thus be a powerful economic concept which can be used to understand and plan for a 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 generally come in the form of, amongst other, taxes, licenses, and royalties. These direct revenues from the extractive industry are often an important part of low-income and middle-income countries total revenues. However, country revenues are significantly impacted by volatility in world prices and markets for minerals, metals and oil and gas (Stevens, Lahn and Kooroshy, 2015; Sachs and Warner, 1997). 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 may yield to the state from year to year. Resource rents can in this case be seen as an indicator that can give an understanding of the total tax burden an industry can manage without jeopardizing the future of said industry.

However, calculating resource rents can be problematic and depending on whether resource rents are analysed in a short run or long run period they will display different characteristics. In the short run resource rents can be very high, if for example prices are higher than average, while they can disappear completely in the long run, if prices over the economic cycle become equal to marginal price. Economic rent can be defined as:

\[ \text{Economic rent} = \text{total revenue} - \text{total costs} \]
Total revenue can be defined as:

\[ \text{Total revenue} = \text{total production} \times \text{average price} \]

Total revenue is fairly straightforward. For most minerals and metals there exists production numbers and some form of global price. Total cost is however different. In the long-term all costs should be included when calculating a sustainable rent, the pure rent. For practical reasons all costs are seldom included in resource rent calculations. Most calculations of resource rents take as a starting point individual mines and its operating cost. This leaves out other costs linked to mining as well as cost of capital. For example, the World Bank studies ‘The Changing Wealth of Nations: Measuring Sustainability in the New Millennium’ (World Bank 2011) and ‘Changing Wealth of Nations 2018: Building a Sustainable Future’ (Lange et al. 2018) use average production costs updated with an annual index\(^4\) to compensate for inflation. There is thus no inclusion of cost of capital, overhead costs, closure costs nor exploration for example. Furthermore, the production cost is in a sense static as it is calculated from a base year, something that does not represent the true operating costs very well. Lange, Wang & Naikal (2020 p.4) acknowledge that “The resulting estimates of mineral asset value cannot be considered very accurate.” Further the World Bank reports does not acknowledge negative rents.\(^5\) Negative rents are set to zero for the calculation of national unit rent. While 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 total rents during 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 that negatively impact profitability for individual mines/projects is not fully acknowledge by the method. The conclusion is that the rent that is presented in the World Bank reports are not sustainable over the long term. This would overestimate the potentially taxable space and could lead to to little investments in sustaining operations and closed down mines or oilfields, all detrimental for a country that relies on income from the extractive sector for its societal building.

\(^4\) The index used is the Manufactures Unit Value index, 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.

\(^5\) A mine in operation may generate negative resource rents if the price of the product produced falls below the cost of production.
The diamond mining industry is interesting, even if it represents a relatively small part of the extractive industry, as it is very important for certain emerging economies such as Botswana, Lesotho, Namibia, Sierra Leone, and Angola. All these countries derive significant revenue streams from the diamond industry. For these countries, an increased understanding of the diamond rent would be of importance, especially as resource rent is directly related to the opportunity to levy taxes in a sustainable way. A thorough calculation of resource rents can also be used to calculate a country’s natural capital and give a better understanding of a country’s wealth. Diamond rents are not included in the World Bank reports Changing Wealth of Nations mentioned above, the main reason being the lack of data. There is limited knowledge of reserves and costs. Further there are limited data on resource rents in the diamond industry, all necessary to calculate the natural capital. In their paper ‘Resource rents in the diamond industry 2014-19’ (Löf et al. 2021) calculates resource rents between 2014-2019. This thesis is trying to expand on the work by the World Bank and the work done by Löf, et al. in calculating the resource rent for the diamond industry for a longer period and in discussing the difference between the long-term sustainable rent and the rent used in the world bank reports as well as implication for the potential tax space.

1.2 Purpose

The purpose of the thesis is to analyse resource rents in the diamond industry, and more specifically to; 1) establish mineral rents in the diamond industry and to 2) explore the difference in the potential tax space between the long run sustainable rent and the rent definition used in the World Bank studies The Changing Wealth of Nations: Measuring Sustainability in the New Millennium’ and ‘Changing Wealth of Nations 2018: Building a Sustainable Future’. This will enable a discussion on various mineral rents and the implication for the future viability of the industry.

1.3 Method

In order to fulfill the purpose this thesis applies a quantitative analysis of data from secondary sources. The method is chosen in consideration of existing data which is company reports. Companies that do publish annual reports generally does so according to various industry standards and rules and guidances from the exchanges where the companies are listed. This
gives the data a certain validity and comparability which lends itself well to the quantitative method.

1.4 Limitations

The 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. The study encompass the entire diamond industry and all producing countries. The paper further focuses on the limited time period 2010-2019. While a longer time period could be of interest, the thesis is primarily discussing resource rents and the difference between pure rent and other rents. For the purpose of the thesis the time period chosen should be enough. Further, at the time of writing 2019 was the latest year of available data. While the time period is not enough to analyse resource rents over an entire economic cycle it should be enough to illustrate the problems in analysing resource rents as well as the importance of using pure rent. While certain conclusions from the study might be applicable also in other minerals/metals industries only the diamond mining industry has been studied and analysed.

1.5 Outline of the study

The thesis will start with a discussion of the theory behind resource rents. Also, the taxation of resource rents will be mentioned. The paper goes on to discuss the diamond industry and will further provide statistics of global resource rents for the diamond industry for the years 2010-2019. The paper will conclude with a discussion on resource rents and the potential tax space that these can generate as well as how resource rents influence the concept “wealth” for a country within the diamond mining industry.
Economic rent can be defined as those payments to a factor of production that are in excess of the minimum payment necessary to have that factor supplied. Or as Philip Crowson (1998) 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) defines 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. Schematically it can be visualized as the difference between the opportunity cost and price at each given output, see figure 1.

![Figure 1. Schematic figure of economic rent.](image)

If the supply curve were perfectly elastic, 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 (2006 p. 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. 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 p. 1). A taxation of 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 the behaviour of the firm will not change. Thus, while economic rent can be said to be non-existent taking the true opportunity cost into account, the true opportunity cost is a function of the property value and taxing the rent lowers that value. So, a government can tax that non-existent economic rent and receive a portion of the funds that would otherwise accrue to the firm in the form of an increased value of the mine and still not alter the behaviour of the investor as long as this tax was known from the beginning of the project/mine.

Mineral deposits have different levels of quality, be they high-grade ore bodies, distance to market, valuable by-products, depth etc. For these and other reasons, production costs vary. However, the price for a metal is set globally, theoretically at the opportunity cost of the highest cost mine needed to satisfy the demand of the market. Thus, all mines except that last mine will earn a resource rent. This is called the Ricardian rent, named after the economist that first described it, or pure rent. It arises because the quality of a mineral deposit is superior to the marginal mine in relation to total costs.

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, as those seen during the “super cycle”, when demand far exceeded supply for many minerals. With increased prices resource rents will increase. However, as mines are capital intensive, large upfront investments are
needed before production can start and it will take years before that investment is recuperated. In the short run, mines have an incentive to operate as long as they are recovering their variable costs. These costs are generally referred to as operating or cash costs in the resource industry. While including such costs as labour, materials, energy and other expenses that cease when production stops, they exclude 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 losses will be even higher if production ceases. By continuing production, the mine is recovering at least some of its fixed costs. This can push prices down and periods of low prices have regularly been experienced by this cyclical industry. Rents on cyclical volatility of mineral/metal prices are referred to as other rents. Important to understand is that other rents can become negative if the price of the mined mineral/metal is below the total cost of the operation.

A mine will earn a return on its capital and other fixed costs, as long as it is producing. This is referred to as Quasi rent. In the long run, a mine not recovering its fixed costs will shut down. Thus, quasi rents only exist in the short term.

Resource rents may accrue unevenly between years. In practice, some mines will never create any economic rent, they might not even be able to cover their costs, others might generate a great deal of economic rent. In the long run a mine needs to recuperate all its costs, or it will cease to invest to remain in business. This includes, above the operating costs, the capital needed to construct the mine as well as a competitive rate of return on that capital, including a risk premium. Resource rent will accrue over the life of mine, until the ore is extracted. After mining and processing have finished, cost will be incurred in rehabilitating the mine site. Further, other costs such as exploration and overhead costs should also be included. Only some of all exploration endeavours end up as mines. If exploration related to non-mine sites is regarded as a cost of finding that specific deposit that can actually become a mine it should be considered a cost of developing that specific mine. Thus, there are other costs linked to mining but not linked to the individual mine to consider as total costs for a mine over its lifetime is calculated, see Figure 2.
Resource rents will vary over time and depending on whether resource rents are analysed in a short run or long run period they will display different characteristics. In the short run resource rents can be very high, but Otto et. al. (2006) argues that in the long run these rents tend to disappear. 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 recuperating 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 minerals/metals prices. While rents tend to increase with prices over the cycle these positive rents are often offset by negative rents when the economy is weak and metals prices low. Other rents thus also only exist in the short term. Pure rent is the rent that arises from one mine/deposit being superior to others. This pure rent is though what drives investors and 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 a government taxes pure rent. Pure rent is thus the potential tax space in the long run.
Diamonds is a relatively small part of the extractive industry. In 2019 the total production of raw diamonds was 138.2 million carats (ct). The total production value of mined raw diamonds for the same year was United States dollars (USD) 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 USD 723 billion. Diamonds are thus only 1.9 percent of the total value of the mining industry.

![Figure 3. Total diamond mine production and value 2004-2019 (Mct & MUSD).](source: The Kimberley Process 2020)

However, diamonds are very important for certain emerging 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. For these countries, an increased understanding of the diamond rent would be of importance. Maybe

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6 Carat is the unit of measurement for the physical weight of diamonds. One carat equals 1/5 gram or 200 milligrams.
especially as resource rent is directly related to the opportunity to levy taxes. But it can also be used to calculate natural capital with an increased understanding of the sustainability issues of the diamond industry. Within the World Bank report series cited above, diamonds are not included. While this is a limitation it is understandable, those mined minerals and metals included\(^7\) roughly account for 90 percent of the total value of the mining industry (Ericsson & Löf 2019). The main reason for the exclusion is however not the size of the industry but the lack of data. There is limited knowledge of reserves, resource rents and costs all necessary to calculate the natural capital. This paper is thus trying to expand on the work by the World Bank to calculate the resource rent for the diamond industry.

*Table 1. Diamond industry contribution to GDP in individual countries 2019 (%).*

<table>
<thead>
<tr>
<th>Country</th>
<th>Diamond value as % of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botswana</td>
<td>9.23</td>
</tr>
<tr>
<td>Lesotho</td>
<td>4.84</td>
</tr>
<tr>
<td>Namibia</td>
<td>4.17</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>1.54</td>
</tr>
<tr>
<td>Angola</td>
<td>0.72</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>0.36</td>
</tr>
<tr>
<td>Liberia</td>
<td>0.35</td>
</tr>
<tr>
<td>Democratic Republic of the Congo</td>
<td>0.33</td>
</tr>
<tr>
<td>Central African Republic</td>
<td>0.16</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.12</td>
</tr>
<tr>
<td>Russia Federation</td>
<td>0.11</td>
</tr>
<tr>
<td>Canada</td>
<td>0.10</td>
</tr>
<tr>
<td>Guinea</td>
<td>0.06</td>
</tr>
<tr>
<td>Tanzania</td>
<td>0.06</td>
</tr>
</tbody>
</table>


Diamonds are used either as jewellery or for industrial applications and are either mined or produced synthetically. Mined and synethetical diamonds can come in many different qualities depending on geological properties of the host rock or technology. Only high-quality diamonds are used as gemstones in jewellery. Diamonds used in the industry are mostly for cutting, grinding, drilling, and polishing procedures. Within the mining industry raw diamonds are

\(^7\) The Changing wealth of nations include data on coal, bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin and zinc.
extracted and those of high enough quality are sorted out for further processing, cutting and polishing into jewellery while the rest are sold for industrial use. The extractive diamond industry is highly concentrated to a few countries, see table 2 and 3.

*Table 2. Top ten diamond mining countries 2019 by value and percent of total (USD & %).*

<table>
<thead>
<tr>
<th>Country</th>
<th>USD million</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian Federation</td>
<td>4 117</td>
<td>30.3%</td>
</tr>
<tr>
<td>Botswana</td>
<td>3 435</td>
<td>25.3%</td>
</tr>
<tr>
<td>Canada</td>
<td>1 697</td>
<td>12.5%</td>
</tr>
<tr>
<td>Angola</td>
<td>1 266</td>
<td>9.3%</td>
</tr>
<tr>
<td>Namibia</td>
<td>1 010</td>
<td>7.4%</td>
</tr>
<tr>
<td>South Africa</td>
<td>873</td>
<td>6.4%</td>
</tr>
<tr>
<td>Lesotho</td>
<td>290</td>
<td>2.1%</td>
</tr>
<tr>
<td>Democratic Republic of the Congo</td>
<td>226</td>
<td>1.7%</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>168</td>
<td>1.2%</td>
</tr>
<tr>
<td>Australia</td>
<td>159</td>
<td>1.2%</td>
</tr>
<tr>
<td>Total value top 10 countries</td>
<td>13 241</td>
<td>97.5%</td>
</tr>
<tr>
<td>other countries</td>
<td>334</td>
<td>2.5%</td>
</tr>
<tr>
<td>Total value</td>
<td>13 574</td>
<td>100%</td>
</tr>
</tbody>
</table>


*Table 3. Top ten diamond mining countries 2017 by carat gem quality and percent of total (ct & %).*

<table>
<thead>
<tr>
<th>Country</th>
<th>ct gem quality</th>
<th>% of total</th>
<th>ct industrial</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian federation</td>
<td>26 168 400</td>
<td>28%</td>
<td>17 445 600</td>
<td>29%</td>
</tr>
<tr>
<td>Canada</td>
<td>23 200 226</td>
<td>25%</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Botswana</td>
<td>16 058 700</td>
<td>17%</td>
<td>6 882 300</td>
<td>12%</td>
</tr>
<tr>
<td>Angola</td>
<td>8 494 920</td>
<td>9%</td>
<td>943 880</td>
<td>2%</td>
</tr>
<tr>
<td>Australia</td>
<td>8 396 150</td>
<td>9%</td>
<td>8 738 850</td>
<td>15%</td>
</tr>
<tr>
<td>South Africa</td>
<td>3 879 220</td>
<td>4%</td>
<td>5 818 820</td>
<td>10%</td>
</tr>
<tr>
<td>DRC</td>
<td>2 268 332</td>
<td>2%</td>
<td>16 634 432</td>
<td>28%</td>
</tr>
<tr>
<td>Namibia</td>
<td>1 713 800</td>
<td>2%</td>
<td>90 200</td>
<td>0%</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>752 360</td>
<td>1%</td>
<td>1 755 500</td>
<td>3%</td>
</tr>
<tr>
<td>Tanzania</td>
<td>258 785</td>
<td>0%</td>
<td>45 670</td>
<td>0%</td>
</tr>
<tr>
<td>total top 10</td>
<td>91 190 893</td>
<td>99%</td>
<td>58 355 252</td>
<td>98%</td>
</tr>
<tr>
<td>other countries</td>
<td>827 694</td>
<td>1%</td>
<td>1 416 055</td>
<td>2%</td>
</tr>
<tr>
<td>total world</td>
<td>92 018 587</td>
<td>100%</td>
<td>59 771 307</td>
<td>100%</td>
</tr>
</tbody>
</table>

The diamond industry was long dominated by De Beers that had a monopoly on both the production and the sales of diamonds. The importance of de Beers has since declined, but the company, now 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).

<table>
<thead>
<tr>
<th>Company</th>
<th>Home country</th>
<th>MUSD</th>
<th>% of total value 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeBeers</td>
<td>South Africa</td>
<td>4 812</td>
<td>35.5%</td>
</tr>
<tr>
<td>Alrosa</td>
<td>Russian Federation</td>
<td>4 117</td>
<td>30.4%</td>
</tr>
<tr>
<td>Rio Tinto</td>
<td>United Kingdom</td>
<td>562</td>
<td>4.1%</td>
</tr>
<tr>
<td>Petra Diamonds</td>
<td>Jersey</td>
<td>476</td>
<td>3.5%</td>
</tr>
<tr>
<td>Dominion Diamond Mines</td>
<td>Canada</td>
<td>359</td>
<td>2.6%</td>
</tr>
<tr>
<td>Gem Diamonds</td>
<td>United Kingdom</td>
<td>187</td>
<td>1.4%</td>
</tr>
<tr>
<td><strong>Total top 6</strong></td>
<td></td>
<td>10 512</td>
<td>77.5%</td>
</tr>
<tr>
<td><strong>Total value diamond mine production</strong></td>
<td></td>
<td>13 562</td>
<td>100%</td>
</tr>
</tbody>
</table>


There are some inherent differences between the extractive part of the diamond industry and other extractive industries, while also 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 as there exists a gold price. The profitability of a mine is linked not only to the cost of production but also the quality and hence the value of the produced product which will vary from mine to mine. For example, Australia produced some 13 million carats (ct) in 2019 at a value of USD 159 million while Angola only produced 9 million ct but the value was USD 1,266 million. Generally raw diamonds are sold in lots at auctions, but the industry is experimenting with more online sales, as for example Botswana, where diamonds are sold separately by size and quality.

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8 For a more thorough history of the diamond industry recommends Todd Cleveland (2014) Stones of contention – A history of Africa’s diamonds.
Resource rent, pure rent, for diamonds \((dR)\) in an individual country \((N)\) in year \(t\) is calculated as total revenue in the diamond industry \((dI)\) in that country, less total costs in the diamond industry \((dC)\) in that country.

\[
dR_t^N = dI_t^N - dC_t^N
\]

Total revenue per country uses publicly available data provided by the *Kimberley Process*. The data includes production in carat and value in USD. Total costs per country is calculated as the product of average unit cost and national production. The latter reported by the *Kimberley Process*. The Kimberley process was set up as a non governmental organisation to stop trade in conflict diamonds. The organisation has 59 members and collect all diamond producing countries. Member states submit statistics to the organisation on production, exports, imports and revenues from the diamond industry. Thus the information is the official statistics from all member countries and should be reliable for the purpose of this thesis.

The average unit cost is derived through a series of calculations and assumptions. Total cost components are defined as:

- operating costs
- cost of capital
- exploration costs
- overhead costs
- closure costs

\[
= \text{Total costs}
\]

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9 The Kimberley Process Certification Scheme also includes data on export and imports. For the purpose of this paper the production in carat and value is enough. See https://kimberleyprocessstatistics.org/public_statistics for data and more information.
All of 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. It is thus necessary to gather data directly from company and industry sources. Publications such as annual reports, quarterly reports, presentations, and other company materials have been used to collect information and data from which average unit cost could be calculated. All companies do not report costs. It is thus 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 where 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 cost for an open pit mine can say something about an underground mine is a simplification. But as information is not available for all individual mines, it is necessary to make some estimates based on data available. Diamond rent is further calculated not on individual mines but on a global level, such numbers should be less problematic than if a resource rent per mine would have been calculated.

4.1 Resource rents and costs

Pure rent is calculated as total revenue in an industry less total costs. Within this paper these costs are defined as, operating costs, cost of capital, exploration costs, overhead costs and closure costs. Quasi rent and other rents are rents that arises in the short term if all costs are not accounted for. Quasi rents reflect a mine’s return on capital and fixed investments. Calculating the quasi rent thus leaves out from the total costs such costs. Within the paper that would be equal to excluding cost of capital, exploration costs and closure costs.

The most important component of other rent is the cyclical volatility of minerals/metals prices. While rents tend to increase with prices over the cycle these positive rents are often offset by negative rents when the economy is weak and minerals/metals prices low. Thus, for the entire industry if other rents are to be zero over the long term, then a positive price compared to the average price over the period means that other rents are positive and the opposite. Figure 4 shows the average value per carat over the period 2004-2019 as an index (2010=100) and the trendline of the curve. As can be noticed prices are above the trendline between 2014-2015 and

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10 This is also the reason why rent on diamonds is not included in the World Bank studies on wealth.
below between 2016-2019. However, the average price over the period 2014-2019 was USD 103.7 per average carat while it was slightly less, at USD 101.7 per average carat, for the period 2004-2019. It thus seems like the prices currently are somewhat elevated and might give rise to positive other rents.

![Figure 4. Average value per carat index 2010=100.](image)


Understanding other rents properly though, requires an analysis over the lifetime of a mine or company. Within this paper a time period of six years is analysed. This is not enough to draw to many conclusions of other rents. However, the paper discusses the entire diamond industry and all mines, this somewhat alleviates the problem. While certain mines might experience negative rents from time to time it is less probable that the entire industry experiences negative rents. Thus, other rents while existing in the short term, is more a problem in calculating rent per individual mine. Other rents will not be further discussed as it has to do with the price of the mineral/metal over the long term rather than costs.

### 4.2 Operating Cost

Data on operating cost are available from a number of companies.\(^{11}\) Production representing around 60 percent of the total world production 2019 gives operating cost, by mine or by

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\(^{11}\) Within this thesis all publicly available data for all operating diamond producers have been consulted. The companies included within the analysis of operating costs are: Alrosa, Anglo American Plc, Debswana,
company. As a measurement of total value this number is higher at around 70 percent. A weighted average operating cost in USD per carat using all available data per year is calculated and this number is then applied to the entire industry, see figure 5.

![Weighted average global diamond operating costs per carat per year 2010-2019 (USD/ct)](image)

Figure 5. Weighted average global diamond operating costs per carat per year 2010-2019 (USD/ct).


4.3 Cost of capital

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

To estimate the investment cost per carat, a number of current projects and recently constructed mines has been analysed and their investment cost per carat capacity has been calculated. Based on these figures an average cost per carat capacity is calculated. This figure is assumed to be the current cost per unit capacity. While each individual dataset from any given project only represents that project in a certain period of time, using several projects from various parts of the world arguably increase the reliability of the number given. As all other costs are in current
USD the current cost per carat capacity needs to be compensated in earlier years for inflation. Within the report the Manufactures Unit Value (MUV) index\(^\text{12}\) has been used. For such a specific cost as capacity cost in the mining industry using readily available indices can be a blunt instrument.\(^\text{13}\) However, there are not that many diamond projects thus it is not feasible to establish a value for each year and hence the chosen index is used as a means to make sure costs are more representative over time and not distorted by inflation.

A mine will have a value as long as it is operating. This value should generate a return in the long term to an investor. Exchanging existing capacity for new capacity would be equal to the product of current cost per carat capacity and production. Therefore, the cost per carat capacity is considered as the value of operating capacity per carat. Thus, for calculating this total investment value of the industry the cost per carat capacity is applied to total industry production.

The minimum return required by an investor to make an investment is not fixed but vary with prevailing interest rates, expectations of financial outcomes of the project as well as which risk premium that should be applied. Rio Tinto states that any project with an internal rate of return (IRR) of less than 15 percent will not be considered (Rio Tinto 2016) while BHP when listing their projects under implementation have none below an IRR of 12 percent (BHP 2019). The Russian diamond producer Alrosa has an investment target of IRR 20 percent (Alrosa 2019). A well-known consultancy firm knowledgeable in valuation of mining projects states that they would assume around 8.5-10 percent weighted average cost of capital plus a country risk premium of 0-6.5 percent.\(^\text{14}\) Another way of analysing the cost of capital is to use the rate of interest on risk-free long-term borrowing plus whatever margin an investor would consider necessary to compensate for the technical, commercial and political risks associated with the specific investment. The long-term interest rate in the United States is given in figure 6. For

\(^{12}\) The MUV index is the unit value index in USD terms of manufactures exported from fifteen countries calculated by the world bank. See https://openknowledge.worldbank.org/bitstream/handle/10986/34621/CMO-October-2020.pdf for more information.

\(^{13}\) For example, during the height of the super cycle the cost of increasing capacity increased more than general inflation as there was a sever lack of almost everything needed to construct a mine, from equipment, spare parts and tires to engineers and truckdrivers etc.

\(^{14}\) Personal interview.
comparison the 10-year returns annualized on all companies included in the S&P 500 is 11.9 percent. 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 6. Long-term United States interest rates (%).
Source: OECD 2020.
Crowson (1998) argues that resource rents are partly subjective. Since rents, which is the residual after all costs, including the required return on capital will vary from investor to investor depending on risk appetite. In his study Crowson uses 10-15 percent.

Through weighting the numbers presented above an average return of 12.5 percent can be established. This percentage applied on the cost per carat capacity thus gives an average cost of capital. The product of this average cost of capital and total production will give total cost of capital for the diamond industry.

4.4 Exploration costs
Exploration is a necessary cost in constructing a mine but is most often not included fully in cost calculations of establishing the mine, the cost per carat capacity discussed above. This since when the decision to invest or not is taken part of the exploration is already done and considered a sunk cost. Further, most of the exploration projects will not result in a mine being

constructed at all in the short to mid-term. Nevertheless, it is a cost for the mining company and should thus be included in total costs.

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

Data used for diamond exploration is derived from S&P Global exploration expenditure figures, see figure 7. Total exploration expenditure per year is divided by total carat production for that same year. This number is calculated for the years 2004-2019 to be used as an estimation of an exploration cost per carat. This does not take into account the country where exploration takes place but assumes that exploration is proportional to production. Lacking granularity to divide the costs by country the assumption that exploration takes place where mining takes place is employed. There are several reasons for this assumption. First, exploration will take 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 in opposition to looking at completely new regions, countries and areas. Third, in a country where there is an existing mining infrastructure in a broad sense, universities, R&D, laboratories, advantageous tax regime etc. more exploration is likely to take place. Thus, assuming that exploration is linked to production is a simplification but will most probably give an estimate close to facts.

16 If mine site exploration is not undertaken, and reserves are not replenished, a further cost 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 is incurred. This opportunity cost is commonly referred to as Hotelling rent, scarcity rent or user cost (Otto et. al 2006). This Hotelling rent reflects a real cost, although a future cost, and is thus not a rent at all.

Figure 7. Total exploration cost & exploration as percent of total value of diamond industry 2004-2019 (MUSD & %).


4.5 Overhead costs

Overhead costs or selling, general and administrative costs, are those costs that are incurred in the day-to-day business but 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 these costs are on a corporate level they are most often not included in the cash/operating cost. There is relatively little data on overhead costs relating only to diamond production. Most diamond producing companies are involved in the production of other commodities as well. However, Alrosa, the Russian diamond producer, reports an overhead cost between 9.7-9.8 percent of total operating costs (Alrosa 2018). The Mining Valuation Handbook (Rudenno 2012) further reports on a specific diamond project and notices an administrative and overhead cost of between 4.0-6.7 percent, while the same cost for the entire mining industry would be an average 8.2 percent of total operating cost. The mining consultant SRK, when analysing the total mining industry obtains a higher cost at 13 percent (SRK 2016). In analysing the diamond industry costs the Alrosa figure will be used. This increases the operating cost with 11 percent on average. While there are arguments for both higher and lower overhead costs this number is derived from a diamond producer, that represents roughly 25 percent of the total value of the market. Further the figure
is generally in line with industry standards presented above and is reasonable for the purpose of the study.

4.6 Closure costs

Closure and rehabilitation costs are part of the total costs of operating a mine. Most jurisdictions demand that provisions are made for expected costs for the closure of mines and the deactivation of related assets. Closure cost can vary considerably both between individual mine sites and jurisdictions. There are substantial difficulties in collecting data that represents the diamond industry on a mine by mine case. Instead, yearly total provisions for the three largest mining companies, Vale, BHP and Rio Tinto as well as the diamond mining companies Alrosa and Petra Diamonds have been analysed and their costs have been used as a proxy for the entire diamond mining industry. The three largest companies – Vale, BHP and Rio Tinto – average annual provision for closure was around 0.7 percent of total revenues. While only part of the industry, the three major companies, Vale, BHP and Rio Tinto, together account for around 15 percent of the total metal industry in value terms and are represented in most of the minerals mined, including diamonds, as well as in most jurisdictions. The two diamond mining companies have an average annual closure provision of around 0.4 percent. The two companies account for roughly 27 percent 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 percent of total revenues.

Closure costs are particularly complex and difficult to estimate before the closure phase of a mine’s life actually starts. The true closing cost 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 and changing chemical composition of ores mined over the life of mine and last but not least by total volume of ore mined. Costs for decommissioning and rehabilitation of mines have in general increased during the last couple of decades. Driving forces are increased volumes of material put into tailings dams and rock dumps because of lower ore grades and new legal requirements because 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. Analysing the diamond industry 0.5 percent of total
revenues is used as a proxy for, not actual cost of closure, but of provisions from the companies per year to cover future costs of closure. It is thus 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 society in the host country. This cost will have to be covered by taxes. Calculating resource rent is calculating a potential tax space. Applying a higher cost than mining companies have lowers this tax space and shifts profit to the mining company. However, it is probable that provisions to cover future closure costs will increase for mining companies in the years to come.
Resource-rich countries have an apparent advantage over other countries as they could use the 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 only pure rent can be taxed without investors changing their behaviour, knowledge of costs and revenues are of greatest importance. The following section presents 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 under section 5 on the diamond industry gives all costs, a necessity for the calculation of pure rent. Figure 8 shows total cost by component for the years 2010-2019. Total costs increased over the first years 2010-2014 after which it decreased between 2014-2016 an increase in 2017 was followed by another period of falling costs 2017-2019. However, the reason for the falling costs are different between the two periods. Figure 9 shows the total cost per carat and total production of raw diamonds. Cost per carat declined over the years 2014-2016 while they have stayed almost the same between the years 2016-2019. At the same time production was stable between 2014-2016 while an initial increase in production in 2017 has been followed by a slow decline for the rest of the period. Total costs thus declined 2014-2016 because of falling average costs while the 2017 increase was mostly due to increased production and the subsequent fall in total costs are linked to lower production per year. For the period prior 2010-2014 costs per carat increased while while production was stable.
Figure 8. Total costs per component 2010-2019 (MUSD).


Figure 9. Total costs per carat & total production 2010-2019 (USD/ct & Mct).


5.2 Global diamond rent

Global diamond mineral rent for the years 2010-2019 are presented in figure 10. Diamond rents spiked in 2011 on account of increased diamond prices while costs were stable thus pushing rents up. For the years 2012-2014 increased rents where experienced and a peak was reached
2014. During the next four years rents decreased but has since 2017 started to increase again. The total value of diamond rent per year fluctuates and was USD 5,574 million at its top, in 2011, and USD 2,142 million at its lowest, in 2017. The total diamond rent during the ten-year period amounted to USD 34,214 million. The figure also shows the average value of mined raw diamonds per carat per year. Not surprisingly the two, diamond rent and the average value of mined raw diamonds (the average diamond price), display similar patterns.

![Diamond rent & average value of raw diamond 2010-2019 (MUSD & USD/ct).](image)

*Figure 10. Diamond rent & average value of raw diamond 2010-2019 (MUSD & USD/ct).*


Rent as percentage of total value of diamond mine production has fluctuated over the period (2010-2019), see figure 11. At its peak in 2011 the figure was 40 percent and in 2017, at its lowest, it was 15 percent. Over the last two years the industry has increased its margins and in 2019 diamond rent as percentage of total value was up, reaching 24 percent.
Figure 11. Diamond rent as percentage of total value of diamond industry 2010-2019 (%).


5.3 Global diamond quasi rent

In the previous section the pure global diamond rent over the period 2014-2019 was calculated. However, most calculations of resource rents do not fully account for total costs but limit themselves to operating costs, ie. cash costs. This is for example true in the World Bank series *The Changing Wealth of Nations*. What is thus reported as resource rent in these studies are in fact the pure rent plus quasi rent. Through the calculation of a total rent only applying operating costs/cash costs and subtracting the pure rent, the quasi rent is given (shown in figure 12). Applying this method would give a total diamond rent during the six-year period of USD 75,050 million.

Further as negative rents are not accounted for other rents may be included as well but as this rent do not have to do with costs but prices primarily they are left out of the discussion.
The quasi rent combined with pure rent as a percentage of total value of diamond mine production over the period (2010-2019) is shown in figure 13. Included is also the pure rent as a percentage of total value of diamond mine production. Clearly rents are much higher if all costs are not accounted for, in fact the rent is on average 119 percent higher.

Figure 12. Diamond pure rent and quasi rent 2010-2019 (MUSD).


Figure 13. Diamond rents as percentage of total value of diamond industry 2010-2019 (%).

6 DISCUSSION

This thesis presents a detailed analysis of costs and revenue in the diamond industry. As complete data on the cost side of the diamond industry is lacking, some assumptions and generalizations had to be made to establish an overall cost for the diamond mining industry. With more data a better understanding of costs in diamond mining could be reached. However, the data used should be sufficient to determine and discuss the level of the pure rent for the diamond mining industry.

Earlier research related to resource rent has focused on other minerals/metals and thus omitted diamonds. In discussing the theory of resource rent and how this rent has been calculated in other reports, this theses argues for using pure rent. Most often it is not however the pure rent which is calculated, but a rent generally including quasi rents and other rents. This is because costs are defined on a mine by mine basis, leaving out some costs linked to companies and investors and not on individual mines. These costs are however still part of the total cost of mining. Resource rents are generally discussed as a potential tax space in the host country. The reason for advocating the use of pure rent when discussing resource rent is to avoid overestimates. Long-term, only pure rent can be taxed without investors changing their investment behaviour. Overestimating the pure rent by leaving out certain costs inflates the tax space. Should taxes be levied based on an inflated tax space the long-term viability of a mining industry could be affected through demanding higher taxes than profits can allow.

An efficient taxation of the resource rent, without jeopardizing the future of the mining industry, demands a good knowledge of revenues and costs. For all governments interested in these questions, information pertaining to all relevant revenues and costs at appropriate granularity is of essence.
Understanding rents is important for such policy development as for example mineral policies, policies related to the taxation of the minera and, oil and gas industries, etc. The thesis has presented the pure rent 2010-2019 for the diamond industry. While costs and revenues are the basis for a resource rent calculation, which factors that influences costs and revenue and how these factors work has not been studied. For example, the price of raw diamonds influence rents directly but how large this influence is and how it has changed over time is yet to be established. An interesting topic for further analysis, within the diamond industry, would be the effects of the monopoly, which has historically been in place. How did rent change in the transition period, from a monopoly to a less concentrated market and how did this change affect the host countries?

This study has not analysed taxes, rather the focus has been to establish the pure diamond rent. Some of this rent will already be taxed in most jurisdictions. The pure diamond rent which has been calculated should thus not be interpreted as the capacity for additional taxation. All taxes, and especially taxes such as income tax, excess profit taxes and additional profit taxes do appropriate at least some economic rent for the benefit of the state. Some of these taxes are already included among costs in the analysis. For example, a competitive rate of return on invested capital should be considered a cost prior to resource rent being calculated. This competitive return is a profit and will theoretically be taxed as such. Other costs may also be taxed in various ways. Operating costs, for example, could include taxes on such items as labour, energy, etc. Consequently, as pure rent is taxable without investors changing their investment behaviour and there exists other additional taxes on cost of capital and other costs, an amount equal to the pure rent could be argued to be the minimum amount that should be levied as tax in the host country.

With the dataset provided in the paper a more thorough natural capital can further be calculated for those countries where the diamond industry is of importance. This increases the reliability of calculations of wealth of the same countries. By extension this could potentially lead to a more sustainable economic development in these countries as policies can be adapted to best fit the fundamentals of each host country.
Pure rent can be taxed without jeopardizing the long-term future of an industry, the thesis does however, not discuss which country should tax the rent. Since all taxes transfers funds, and at least partly rents, to a government it is of interest to analyse who gets 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. But where the home and host country are different the effects are less clear. It would be of interest to analyse (i) the total amount that is taxed and the amount that is (ii) taxed in the host and home country.

The thesis has argued consistently that all costs should be included in rent calculations. If all environmental costs incurred during the life of mine is actually taken into account is, however, far from certain. If price is set at marginal cost, not fully accounted for costs 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 equals the excluded costs no gains or losses have been 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 consumption takes place in the host country and is invested for future gains the postponed environmental costs can be thought of as a loan. However, mining often takes place in lower- and middle-income countries while consumption is concentrated to high income countries. This gives rise to an environmental debt shifting. The host country takes responsibility for future potential environmental degradation while the consumer country appropriates the benefit from cheap raw materials. Higher raw materials 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 an analysis of the long-term true environmental costs of the diamond industry would be of interest to compare with the costs used in the 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 etc.

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19 This excludes any discussion of losses related to substitution as the environmental costs discussed applies to all minerals/metals.
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## Annex

### Results of analysis

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<td>Mct</td>
<td>128.3</td>
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<td>MUSD</td>
<td>11392.9</td>
<td>14065.2</td>
<td>12645.6</td>
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<td>USD/ct</td>
<td>88.8</td>
<td>114.5</td>
<td>98.8</td>
<td>104.6</td>
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<td>USD/ct</td>
<td>4666.2</td>
<td>4490.1</td>
<td>5221.4</td>
<td>5870.5</td>
<td>7078.9</td>
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<td>USD/ct</td>
<td>36.4</td>
<td>36.6</td>
<td>40.8</td>
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<td>MUSD</td>
<td>513.3</td>
<td>493.9</td>
<td>574.4</td>
<td>645.8</td>
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<td>749.9</td>
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<td>MUSD</td>
<td>359.7</td>
<td>457.1</td>
<td>519.0</td>
<td>487.8</td>
<td>425.0</td>
<td>367.0</td>
<td>290.0</td>
<td>207.6</td>
<td>230.0</td>
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<td><strong>Closure costs</strong></td>
<td>MUSD</td>
<td>57.0</td>
<td>70.3</td>
<td>63.2</td>
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<td><strong>Cost of capital</strong></td>
<td>MUSD</td>
<td>2803.9</td>
<td>2980.3</td>
<td>3082.3</td>
<td>3113.8</td>
<td>2966.7</td>
<td>2743.7</td>
<td>2596.8</td>
<td>3208.4</td>
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<td>9460.3</td>
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<td>10748.7</td>
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<td>USD/ct</td>
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<td>69.1</td>
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<td>3733.9</td>
<td>4001.6</td>
<td>4238.8</td>
<td>4315.2</td>
<td>4248.5</td>
<td>3931.7</td>
<td>3595.7</td>
<td>4328.6</td>
<td>4373.1</td>
</tr>
<tr>
<td><strong>Diamond pure rent</strong></td>
<td>MUSD</td>
<td>2992.8</td>
<td>5573.6</td>
<td>3185.3</td>
<td>3395.9</td>
<td>4299.0</td>
<td>3492.3</td>
<td>2786.1</td>
<td>2142.0</td>
<td>3119.3</td>
</tr>
<tr>
<td><strong>Diamond short-term rent as percentage of total value of diamond industry</strong></td>
<td>%</td>
<td>59.0%</td>
<td>68.1%</td>
<td>58.7%</td>
<td>56.8%</td>
<td>54.7%</td>
<td>52.1%</td>
<td>52.0%</td>
<td>45.8%</td>
<td>51.8%</td>
</tr>
<tr>
<td><strong>Diamond pure rent as percentage of total value of diamond industry</strong></td>
<td>%</td>
<td>26.3%</td>
<td>39.6%</td>
<td>25.2%</td>
<td>25.0%</td>
<td>27.5%</td>
<td>24.5%</td>
<td>22.7%</td>
<td>15.2%</td>
<td>21.6%</td>
</tr>
</tbody>
</table>