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BETTER POLICIES FOR BETTER LIVES

Determining the Price of Minerals

A transfer pricing framework for bauxite

BAUXITE



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Introduction

In the mining sector, royalties and corporate income taxes are generally based on the value of the mineral transacted. Consequently, it is critically important that any transactions involving the purchase and sale of minerals are valued correctly. Due to the frequency and scale of related party transactions, the potential risk to tax revenues posed by transfer pricing non-compliance can be high, particularly around the value of the extracted minerals.

The transfer price is the price of a transaction between two entities that are part of the same economic group of companies. The price transacted between the two related entities is the “transfer price,” and the process for setting the price is referred to as “transfer pricing.” Whereas commercial transactions between independent enterprises are generally determined by market forces, transactions between associated enterprises may not be, giving rise to concerns about the potential for “transfer mispricing” and posing significant challenges for tax authorities in monitoring and assessing such transactions.

The arm’s length principle is the international standard that determines transfer prices for corporate income tax purposes by multinational enterprises (MNEs) and tax administrations. When independent enterprises transact with each other, the conditions of their commercial and financial relations (e.g., the price of the good) are generally determined by market forces. However, when associated enterprises transact with each other, their commercial and financial relations may not be directly affected by external market forces in the same way as transactions between independent enterprises. Therefore, for corporate income tax purposes, the profits of associated enterprises may be adjusted as necessary to ensure that the arm’s length principle is satisfied, that is, the conditions of the commercial and financial relations that they would expect to find between independent enterprises in comparable circumstances.

Establishing the arm’s length conditions involves gathering vast amounts of information (both publicly available and in the taxpayer’s possession) in order to determine what independent parties would have agreed to in comparable circumstances, that is, the conditions that might be expected to operate between independent entities dealing wholly independently with another in comparable circumstances. When applied to the mining sector, particularly in relation to minerals where publicly available information on industry and pricing data is not readily available, there are both practical and technical challenges in applying the arm’s length principle. These challenges are further amplified in resource-constrained and lower-capacity tax administrations in developing countries.

In recognition of this, the Organisation for Economic Co-operation and Development (OECD) Centre for Tax Policy and Administration Secretariat and the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable

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Development (IGF) have prepared this practice note to address the transfer pricing challenges faced when pricing minerals from an administrative and policy perspective.

About This Schedule

This mineral pricing schedule complements the practice note *Determining the Price of Minerals: A Transfer Pricing Framework*. The practice note provides a framework to identify the primary economic factors that can influence the pricing of minerals (“mineral pricing framework”) using transfer pricing principles. This schedule shows how the framework can be applied to bauxite.

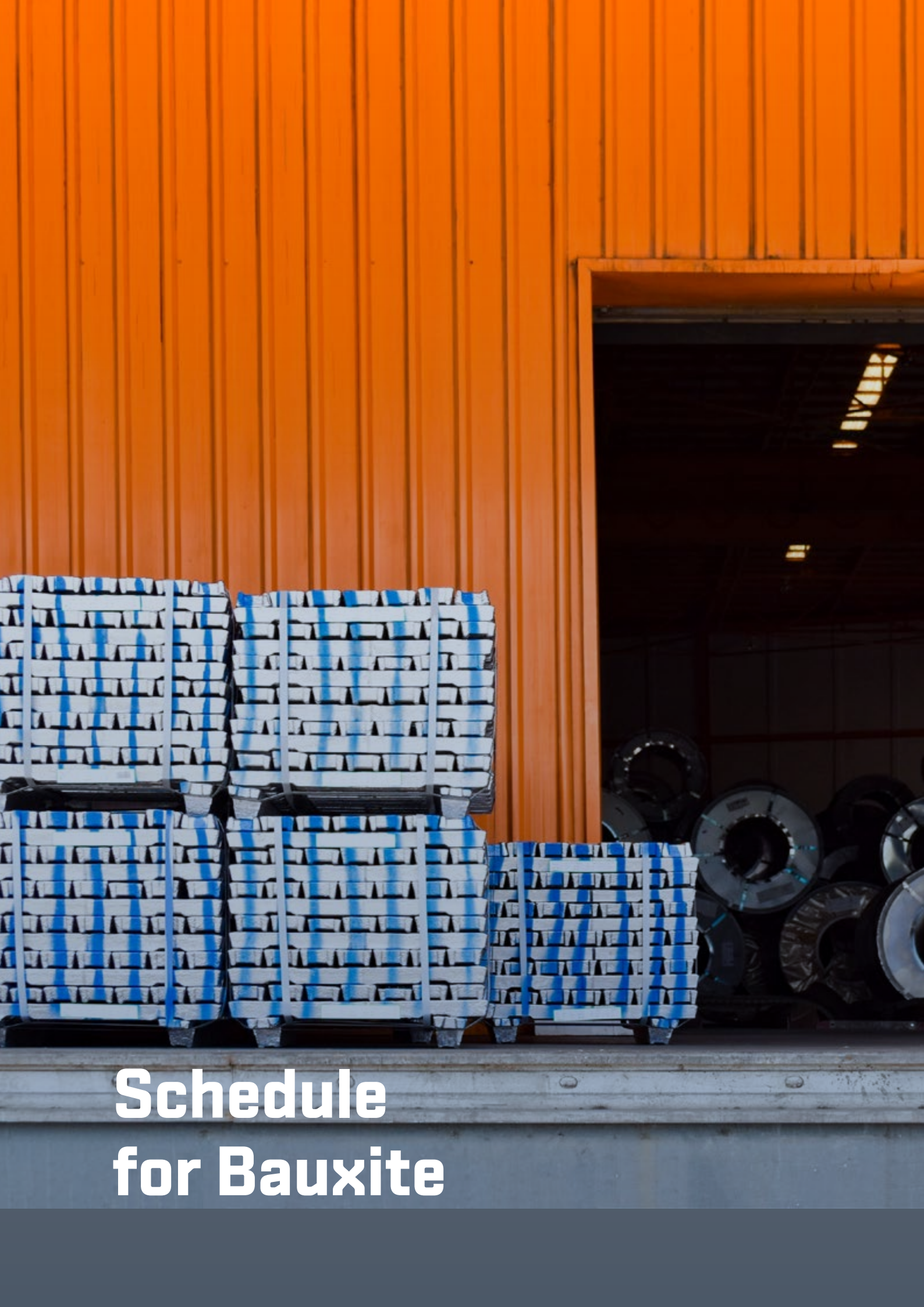
Framework: Using the Comparable Uncontrolled Price Method to Determine the Price of Minerals Sold

There are three primary comparability or economically relevant factors that are particularly relevant to consider when applying the comparable uncontrolled price (CUP) method to scenarios involving related-party mineral sales. These are:

1. The characteristics of the product, such as the physical features and quality of the commodity.
2. The economic circumstances that existed at the time the sales agreement was entered into, i.e., the period of the arrangement.
3. Contractual terms such as quantity transacted, transportation terms, payment terms, insurance, quotation periods, foreign exchange, and treatment and refining charges.

Importantly, this framework is premised on the following overarching conditions:

- a. The associated mining enterprise, i.e. the seller is treated as a mining enterprise that is part of a larger multinational mining group.
- b. Being part of the multinational group, the mining enterprise would have access to knowledge and intelligence of the commodity market conditions from its sister companies or its parent entity. This market knowledge and intelligence could include an awareness that the producing mine is one of a finite number of production entities in the world, and it produces a finite resource that is the primary source of value creation.
- c. It is on this basis that the associated mining enterprise, operating wholly independently, would assess all of the options realistically available to it with the full benefit of market intelligence and knowledge that the wider MNE group has access to, and sell at the highest possible price, taking into account its commercial objectives.



Schedule for Bauxite

Schedule for Bauxite

Bauxite and Market Conditions

Bauxites are residual rocks in which alumina trihydrate and monohydrate minerals are predominant, typically as gibbsite, boehmite, and diaspore.

Bauxites are the main sources of aluminum. Bauxite is refined using the Bayer process to produce aluminum oxide, typically called alumina. Alumina is used predominately in the smelting of aluminum metal; however, there are many industrial uses for alumina.

Physical Characteristics of Bauxite

Bauxite is an important ore of aluminum, composed mainly of Al, Fe, Si, Ti oxide, and hydroxide minerals. Bauxite ores are typically reddish brown, but pure bauxite ores may be white or buff brown. There are two types of bauxite, of lateritic or karstic origin. Lateritic bauxite is the most common, around 90% of global resources, and is formed by the intense weathering of surface rocks. In geosciences, lateritic bauxites (silicate bauxites) are distinguished from karst bauxites (carbonate bauxites). Lateritic bauxites were formed by lateritization of various aluminum silicate rocks, such as granites, gneisses, basalts, syenite, clays, and shales. The aluminum hydroxide in the lateritic bauxite deposits is almost exclusively gibbsite, and boehmite in some regions.

FIGURE 1. Bauxite extraction, Brazil



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In lateritic bauxite, the mineral is typically formed through unique aluminous rock weathering events in a tropical environment where the hydrology allows the removal of silica. The weathering may form the principally economically significant ores of gibbsite and boehmite, which are amenable to the production of alumina through an industrial transformation known as the Bayer process. As bauxites have formed from a variety of rock types, there are usually minor quantities of residual mineral elements that may become concentrated in bauxites.

The economic value of bauxite is dictated by its behaviour in the Bayer process. Gibbsitic and diasporic ores are more valuable than boehmitic ores because they are less expensive to process. Processing gibbsitic bauxite can be done at low temperature, whereas boehmitic and diasporic bauxite require high-temperature processing. Although high-temperature processing in theory requires more energy, the biggest determinant of energy costs is the refinery technology and design.

The tropic and sub-tropic regions appear to provide the ideal climatic conditions for bauxitization. Gibbsitic bauxite is only found in these areas.

This process of bauxitization leaves behind traces of silica, moisture, organics and other impurities that negatively affect the cost of refining the commercially valuable mineral components and therefore can attract a discount to the market price.

Bauxite Production and Reserves

The following tables provide an overview of the top bauxite-producing and consuming countries. The top bauxite-producing countries are outlined in Table 1. The largest producer of bauxite is Australia, and the largest exporter is Guinea, with the product predominantly being sold to China. China is the world's largest consumer of bauxite (to produce alumina), followed by Australia, as seen in Table 2.

TABLE 1. Bauxite production and reserves (thousand tonnes)¹

Country	2020	2021	2022	Reserves
Australia	110,000	103,000	102,000	5,100,000
China	92,700	90,000	90,000	710,000
Guinea	86,000	86,000	86,000	7,400,000
Brazil	31,000	33,000	33,000	2,700,000
India	20,200	17,400	17,000	660,000
Indonesia	20,800	21,000	21,000	1,000,000
Jamaica	7,550	5,950	3,900	2,000,000

¹ United States Geological Survey. (2021). *Bauxite and alumina*. <https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-bauxite-alumina.pdf>

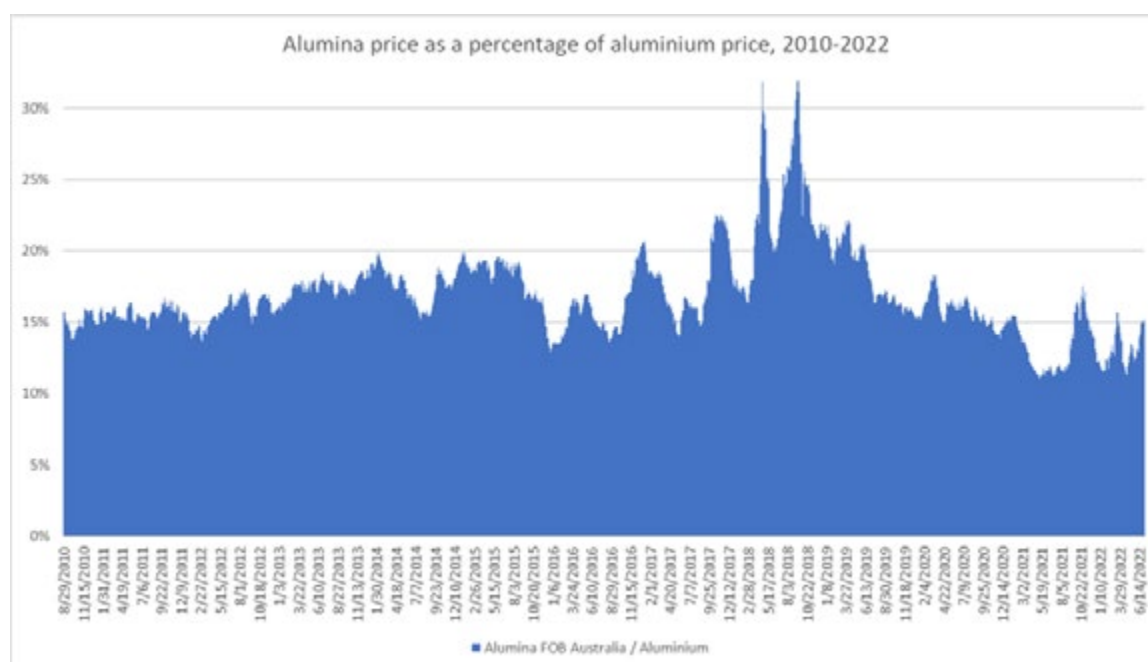
TABLE 2. Alumina production (thousand tonnes)²

Country	2020	2021	2022
China	73,100	75,200	76,000
Australia	20,800	20,400	20,000
Brazil	10,300	12,000	11,000
India	6,560	7,000	7,400
Russia	2,870	3,050	3,100
Jamaica	1,620	1,160	480
Saudi Arabia	1,810	1,920	2,000

Bauxite Pricing Fundamentals

Bauxite is a mineral that is valued for its aluminum oxide (alumina) content, with the vast majority of bauxite used for aluminum production. Historically, this has meant that demand for bauxite has had a close linkage to alumina production and subsequently aluminum production. Outside of alumina, bauxite is used in other industrial applications, such as calcined products, aluminum cement, and chemical products.

FIGURE 2. Alumina as a percentage of the aluminum price, 2011–2022



Source: Fastmarket - Alumina index, fob Australia, \$/tonne and LME Aluminium 3M Official, accessed July 2022, <https://www.fastmarkets.com/>.

² United States Geological Survey. (2023). Bauxite and alumina. <https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-bauxite-alumina.pdf>

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Since 2010, however, the connection between bauxite, alumina, and aluminum has started to diverge for a number of reasons. For example, the correlation between alumina and aluminum pricing started to see fractures as alumina input costs, such as caustic soda, increased, while demand for aluminum was conversely dampened by the secondary aluminum recycling market, which was less cost intensive than producing fresh aluminum.

In 2018, the alumina market also experienced one of its most volatile years resulting from sanctions imposed on US Rusal by the United States, force majeure leading to a partial closure at Norsk Hydro's Alunorte mine, and a worker's strike at an Alcoa facility in Australia. This combination of events pushed alumina prices to record highs of over USD 700, while aluminum products remained static between USD 2,000 and USD 2,100. This underscored the trend toward an independent demand and supply dynamic for alumina and aluminum and subsequently has led to physical alumina contracts being priced on alumina indexes calculated by pricing agencies rather than as a percentage of an aluminum LME price. Recent price variations confirmed the trend, as primary aluminum prices rose to new heights in 2021 and 2022 without as significant an increase in alumina prices.

The integration of bauxite and alumina production remains stronger, but the bauxite market varies by region. As Table 1 and Table 2 illustrate, most bauxite-producing countries also produce alumina. Countries like Brazil, Jamaica, India, and Indonesia mostly produce bauxite for their domestic alumina industry and sometimes downstream aluminum smelters. They export minimal quantities of bauxite, if any. Australia, China, and Guinea stand out and dominate the bauxite-alumina market. Australia produces and exports both bauxite and alumina. Guinea almost exclusively produces and exports bauxite. China is by far the largest producer of alumina and aluminum. However, despite being the second largest producer of bauxite, China has a significant shortfall and imports the vast majority of its bauxite from Australia and Guinea. These commercial relationships shape the global bauxite market at the time of writing.

Components for an Agreement for the Sale of Bauxite

As with any commodity, the terms and conditions of a sales and purchase agreement are specific to that commodity, that is, terms that impact price, logistics, and risk transfer. The key components of a bauxite sales and purchase agreement are:

- Payable mineral—the commercial value of bauxite is determined primarily from the quantity of **available alumina**.
 - Available alumina³ is defined as the portion of the total amount of alumina in a bauxite that can be extracted through digestion

³ Available alumina is different from total alumina: the content of alumina oxide measured in respect to the chemical determination.

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by a commercially viable process. Available alumina has a direct impact on alumina production costs and, at the time of writing, each 1% of reduction results in a reduction of about USD 4–8 per tonne of alumina production. The available alumina in bauxite typically ranges from 33% to 55%, which varies depending on the mine and country the bauxite is extracted from.

- Penalty and premium adjustments are made based on the actual bauxite quality, that is, available alumina in each shipment and any impurities that are present.
- Impurities have an impact on the price of bauxite:
 - Reactive silica is the most economically significant impurity due to the direct impact it has on the cost of refining. Higher-reactive silica content leads to higher requirements of caustic soda when refining bauxite to alumina. At the time of writing, each 1% increase in reactive silica in bauxite increases the consumption of more than 20 kg of caustic soda, although this ratio may not apply to all types of bauxites. The reactive silica content in the bauxite typically ranges from 1% to 12%, which varies depending on the region and the mine. The lower the reactive silica, the more desirable the bauxite is. There are price premiums and discounts for bauxites depending on the levels of reactive silica. The premiums and discounts associated with the levels of reactive silica will depend on the base silica content of the price benchmarks, which will vary by origin.
 - Iron oxide (hematite and goethite)—Iron oxides typically pass through the alumina refining process in a benign manner and accumulate as a waste stream known as “bauxite residue” or “red mud.”
 - Titanium dioxide (rutile and anatase)—Titanium dioxide (TiO₂) also concentrates in the bauxite residue during the Bayer process of alumina production along with iron minerals. High titanium dioxide content can result in excessive and tenacious scales forming inside refining equipment and can occasionally result in price discounts for bauxites.
 - Other contaminants with negative economic impacts during refining include organic material (total organic carbon), sulphur-containing minerals (e.g., pyrite), and phosphorous-containing compounds.
 - In practice, for a given type of bauxite, reactive silica is the only impurity that generates a price discount, if its content is high, or a price premium, if it is low.
- By-products—Special techniques can recover commercial quantities of minor elements, such as gallium and vanadium, from the red mud residue. Gallium is a rare metal that is used in electronics and

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is critical to the manufacture of semiconductors. Many bauxite miners lack the know-how and techniques to commercially recover vanadium or gallium; therefore, this factor generally does not need to be accounted for.

- **Moisture**—Moisture has no value in alumina production but may create additional costs. It can pose problems in handling and crushing as well as high evaporation load in the refinery. Higher moisture content also adds to the cost of transportation by increasing the weight of the bauxite. In some cases, it is necessary to dry bauxite prior to exporting in order to reduce weight. However, completely dry bauxite is also not preferred as this can cause heavy dusting during handling and transportation. The moisture in bauxite generally ranges from 7% to 15%, with moisture from Indonesian bauxite being around 15%. Some arm's length contracts will have moisture rejection clauses due to the refineries being in colder climates such as Russia, China, and Canada, where bauxite can freeze if the moisture content is higher than 6%, making it difficult to handle the ore.
- While the buyers of bauxite are concerned with available alumina and reactive silica, most bauxite mining companies prefer to sell their ore based on total alumina and total silica content. They do not guarantee actual levels of available alumina and reactive silica. Contracts are, therefore, based almost exclusively on total alumina and silica content, as well as moisture. A bauxite sales contract does not typically incorporate all the metallurgical parameters, including organics and minor elements.
- To assess the available alumina and reactive silica of a particular bauxite ore, alumina refineries request representative samples and check the metallurgical and mineralogical characteristics before importing the ore from a particular mine. Contracts may stipulate which party is responsible for sampling and testing, how the information is to be shared, and a resolution in cases of contradictory results between the parties.
- **Volumes**—Volumes to be sold are typically specified in contracts, in dry metric tons of bauxite ore, or in wet metric tons with a maximum percentage of moisture. There may be tolerance around the target volume, e.g., plus or minus 10%, specified in the contract. Contracts may also cover how and at which point the volume is measured. For example, by a draft survey at the load port or the discharge port, or an average between the two surveys.
- **Parcel size**, typically in bulk. Commercial exports of bauxite are done on very large bulk cargo ships to minimize transport cost per ton; e.g., capesize vessels, 160,000 tons and up.

- Incoterms—Depending on the arrangements negotiated between the buyer and seller bauxite can be sold at the load port (free on board, or FOB) or delivery port (cost and freight [CFR] or cost, insurance, and freight [CIF] basis). The shipping costs are generally referenced to a dry bulk carrier freight (Capesize, Supramax, and Panamax) rate given the quantity of bauxite transacted.
- Time and date—A contract typically includes the date of the transaction, which defines the start of the contract term, and may make reference to the date of export, or the date the bill of lading is signed, to set payment terms, e.g. a payment shall be made no later than twenty-one (21) calendar days from the bill of lading date.
- Quotational period—The price is generally negotiated between the buyer and seller directly; hence, there is no standard or requirement for a quotational period.
- Duration—Contracts may be for one cargo or for many millions of tonnes delivered on a multi-year contract. Typically, multi-year contract prices are negotiated periodically or linked to indexes such as the London Metal Exchange (LME) aluminum price.

Determining the Price of Bauxite

Historically, determining a price for bauxite given its unique characteristics was inherently difficult due to the lack of global seaborne trade for bauxite and the degree of vertical integration in the aluminum value chain, which meant the price discovery process for bauxite was not well established. The only point of reference on the market was the price of aluminum on the LME, which was used in bauxite and alumina contracts in Jamaica and Guinea, for example.

In recent years, though, several pricing data agencies have started collecting price intelligence and publishing bauxite prices due to the growth of seaborne bauxite trade. Driven largely by Chinese imports, the availability of pricing data has increased, thereby facilitating the price discovery process and allowing the development of bauxite price indexes. Examples of bauxite pricing data can be found published by Asian Metal, CRU Group, Fastmarket, and the CM Group. Each of these is accessible through a subscription service.

The availability of pricing indexes themselves does not represent a substitute for an arm's length price that would be agreed between independent parties. It does, however, present a reliable starting point to compute an arm's length price. In order to determine whether it is appropriate to be using such indexes, it must be first established whether independent parties in negotiations in fact use these indexes and, if so, to what extent.

To answer this question, collaborative interviews were undertaken with industry participants directly involved in bauxite contract negotiations. All industry participants confirmed that these indexes were used as a form

of intelligence (in addition to internal company intelligence gathering and industry knowledge) on what the indicative market price of bauxite would be at any given time. Although not determinative of the contracted price of bauxite for a given purchase, the indexes nonetheless provided valuable pricing information and discovery.

It is, therefore, reasonable, practical, and in accordance with the arm's length principle that tax authorities similarly are able to use these indexes as a starting point to determine an arm's length price for bauxite.

Bauxite Price Indexes

CBIX, Fastmarket, and CRU publish one, or two, composite index price(s), which represent a trade-weighted aggregate price, with standard specifications of 50% alumina and 5% silica. All trades are adjusted to the index specifications. These price indexes can be useful indicators of the overall market conditions and price discovery but may not be representative of specific bilateral arrangements. CBIX and Asian Metals also publish price assessments specific to major bilateral trading relationships in the bauxite market: bauxites from Australia, Guinea, and Indonesia delivered to China. These assessments are made for specifications that reflect the origin of each bauxite, e.g., high alumina and high silica for Australian bauxites, low alumina and low silica for Guinean bauxites.

The price assessments may reflect the price of specific bauxite sales, with each price reporting agency publishing its own pricing methodology. The price assessments can be based on a combination of data points such as actual transactions, interviews, bids and offers and other modes of data gathering, such as trade data. This is why tax administrations should be cautious in using such indexes in a transfer pricing analysis; only in certain circumstances may they be considered arm's length.⁴

Furthermore, it is important to test the extent to which the index is used to price transactions between unrelated parties: if it is not being used in the market, then questions arise regarding its appropriateness for use between related parties. The market indexes for bauxite have developed over time and currently provide guidance for price discovery; however, the lack of verifiable data that supports these market indexes makes their use for commercial contracts challenging. This may evolve over time, as the market continues to grow, and they are sufficiently reliable to be used in commercial third-party contracts.

CBIX

CBIX is a price reporting agency dedicated to bauxite and alumina. It has a calculator tool whereby the user is able to enter the physical characteristics of the bauxite, and adjustments are able to compute the indicative market price on a given day.

⁴ Refer to the OECD/IGF's publication on *Determining the Price of Minerals: A Transfer Pricing Framework* for further guidance on this topic.

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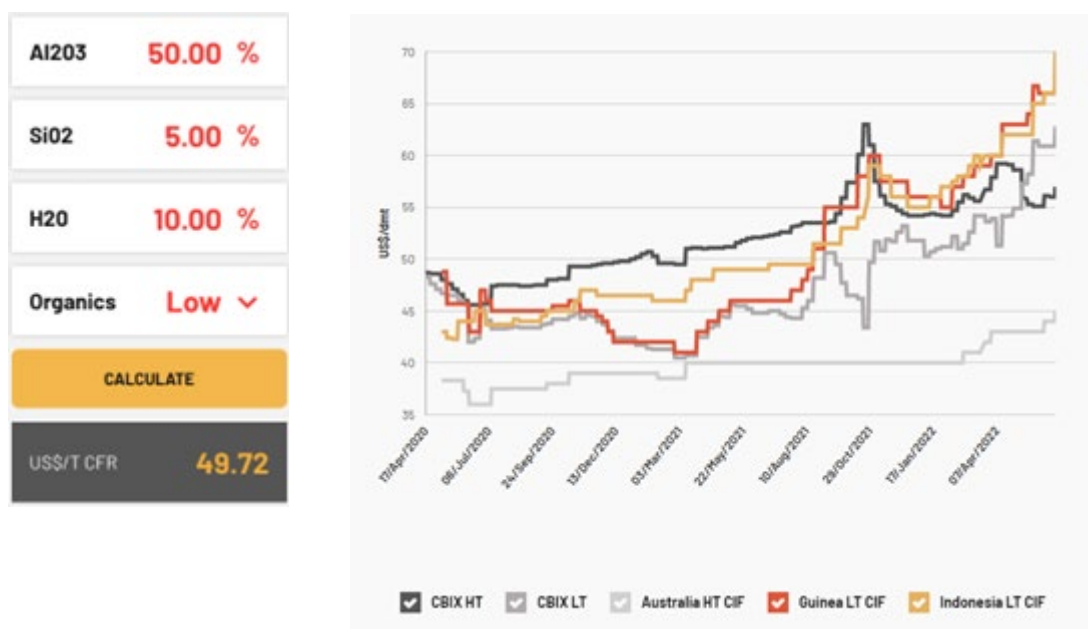
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In addition, CBIX publishes index prices for the following five types of bauxites:

- Guinea LT (T.Alumina 45%, T.Silica 3%)—standard Guinea ore CIF Qingdao, low-temperature refining.
- Indonesia LT (T.Alumina 48%, T.Silica 8%)—standard Indonesian ore CIF Qingdao, low-temperature refining.
- Australia HT (T.Alumina 54%, T.Silica 9%)—standard Australian ore CIF Qingdao, high-temperature refining.
- CBIX LT (T.Alumina 50%, T.Silica 5%)—trade-weighted aggregate of all low-temperature refining ores CIF Qingdao ViU adjusted to the standard CBIX grade reference ore.
- CBIX HT (T.Alumina 50%, T.Silica 5%)—trade-weighted aggregate of all high-temperature refining ores CIF Qingdao ViU adjusted to the standard CBIX grade reference ore.

These prices are updated weekly and available retrospectively. Figure 3 presents the five pricing indexes published by CBIX as described above. There is significant variation in the pricing of the indexes, which highlights the importance of selecting the most appropriate index and conducting the required comparability adjustments to achieve an arm's length price.

FIGURE 3. Bauxite pricing indexes



Note: The Bauxite Index, CBIX, CM Group⁵.

⁵ The Bauxite Index. (n.d.). *Guinea's booming bauxite industry – 2023 update report*. <https://thebauxiteindex.com/>.

Fastmarket

Fastmarket is another price-reporting agency which reports bauxite index prices on a FOB basis for production from Brazil and Guinea. The specifications and details regarding the indexes are presented in Table 3. However, Fastmarket decided to discontinue the Guinea FOB index price and replace it with an index price on a China CIF basis instead,⁶ confirming that the most accurate market prices are found at the point of import into China.

FIGURE 4. Fastmarket bauxite index



Source: Fastmarkets, 2022.

⁶ Fastmarkets. (2022). Proposal to launch bauxite cif China price assessment, discontinue fob bauxite prices. <https://www.fastmarkets.com/insights/proposal-to-launch-bauxite-cif-china-price-assessment-discontinue-fob-bauxite-prices>

TABLE 3. Fastmarket bauxite index

MB-BX-0015 - Bauxite FOB Trombetas, Brazil	MB-BX-0016 Bauxite, CIF China, USD per dry metric ton (dmt)
<ul style="list-style-type: none"> • Units: USD per tonne per dry metric tonne • Basis: FOB Brazil (other delivery terms normalized) • Chemical specifications: Total alumina – min 50.5%; max 55%; total silica – min 4.3%; max 5.6%; reactive silica – min 4%; max 5%; Fe – max 12%); Ti – max 1.5%; moisture content – min 9%; max 10% • Trade size: Minimum 20,000 tonnes • Payment terms: 30 days after loading (other payment terms normalized) • Loading port: Trombetas (other ports normalized) • Loading window: Within 2 months • Delivery method: Bulk carrier • Publication: Fortnightly on Thursdays between 2 p.m. and 3 p.m. London time 	<ul style="list-style-type: none"> • Quality: Total alumina 50%; total silica 5%; Fe 20% max; moisture content 7% min, 10% max; organic carbon 0.15% max • Quantity: Min 40,000 tonnes • Location: CIF China • Timing: Within 2 months • Unit: USD per dmt • Payment terms: LC (other payment terms normalized) • Publication: Monthly; third Thursday of the month, 3 pm–4 pm London time • Notes: Bulk carrier; accepted origins—Guinea, Australia, and Indonesia

Asian Metal

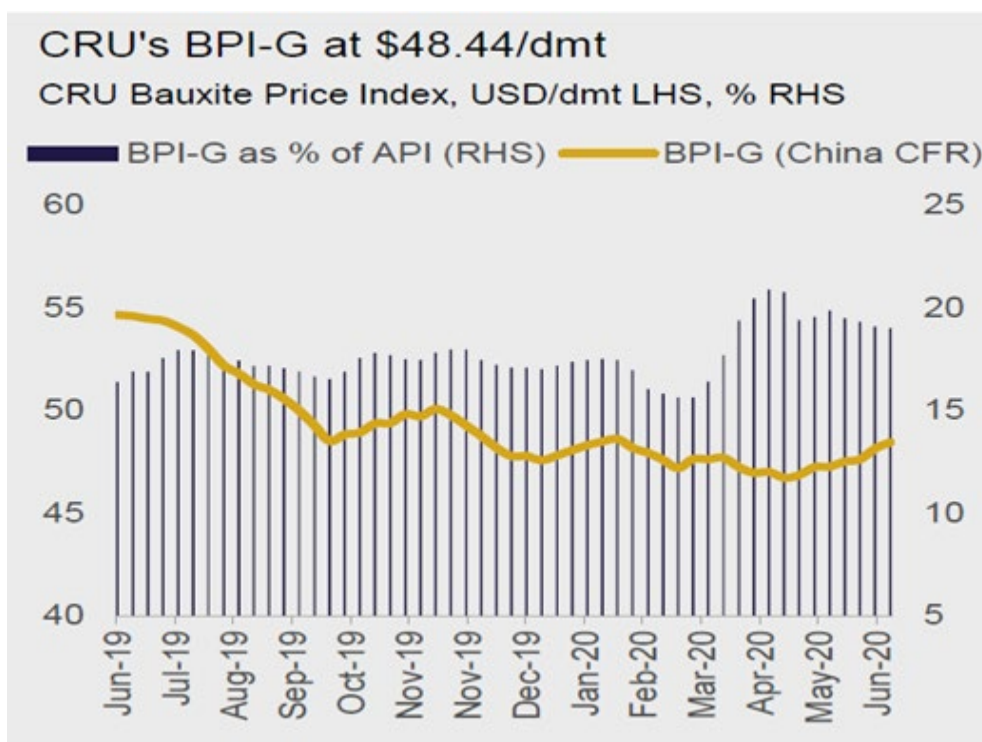
Asian Metal is a price reporting agency specializing in the Chinese minerals market. It publishes the following bauxite price indexes collected from Chinese customs data:

- Indonesian 47% min CIF China, USD/dt: Al₂O₃ 47% min, reactive SiO₂ 5% max, Lot: 55,000–110,000 mt (daily)
- Indonesian 49% min CIF China USD/dt: Al₂O₃ 49% min, SiO₂ 3.5% max, Lot: 150,000–200,000 mt (daily)
- Guinean 45% min CIF China, USD/dt: Al₂O₃ 45% min, SiO₂ 3% max, H₂O 12% max, Lot: 200,000–500,000 mt (daily)
- Chinese bauxites Al₂O₃ 60% min, Al/Si 5.0, SiO₂ 12% max, Ex-VAT Delivered China Lot: 10,000–300,000 mt.

CRU

CRU also publishes a price index for bauxite. According to the company, CRU's bauxite price assessments are based on a combination of primary research and trade data, which are adjusted based on freight rates, caustic soda prices and value in use. The prices published are a 30-day trailing average of imports to China. Information on prices is gathered and normalized to a benchmark specification of 50% available alumina, 5% reacting silica, on a dry tonne basis, using CRU's bauxite and alumina cost model.

FIGURE 5. CRU Bauxite Index⁷



Note: Bauxite Price Index for Gibbsite (BPI-G), Left hand side (LHS), right hand side (RHS), dry metric ton (DMT), cost and freight (CFR).

Comparability Adjustments

Characteristics of the Product

Bauxite is a mineral that is valued for its aluminum oxide (alumina) content, specifically available alumina, as defined above. However, in practice, the value of the bauxite is adjusted based on the total payable alumina in each shipment. From the percentage of total alumina and silica, buyers can deduct available alumina. If referencing a bauxite price index from a reputable

⁷ Ling, W. (2023). *Aluminium raw materials*. <https://www.crugroup.com/analysis/aluminium-raw-materials/>.

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price-reporting agency, such as the ones listed in the previous section, with a baseline total payable alumina figure that is different to the controlled transaction, then an adjustment is required to account for this difference. The most accurate method of conducting this adjustment is by reviewing arm's length sales and purchase agreements of bauxite and identifying how this adjustment is conducted between independent parties in comparable circumstances. From a limited access to such contracts, we have concluded that the adjustments for the payable alumina tend to be:

- For each 1% of Al_2O_3 above or below the applicable benchmark, the price shall be increased or decrease by (fractions pro rata) USD 1 per dmt. Such an adjustment may be limited to a small range of alumina content around the benchmark that fit within the specifications of the buyer, for example, plus or minus 2% to 3% Al_2O_3 around the target grade.

The most economically significant impurity in bauxite is silica (SiO_2) due to the direct impact it has on the cost of refining, specifically reactive silica, as defined above. However, in practice, it is the total level of silica present in the bauxite that impacts pricing. Similar to the adjustment for total payable alumina, the most accurate method of accounting for different levels of silica is by reviewing arm's length sales and purchase agreements of bauxite and identifying how the pricing methodology operates in relation to the presence of silica. The rule of thumb is that, on a weight basis, any mass of silica that reacts in the refining process will cause an equal loss of caustic soda, and an equal loss of alumina to the red mud. Thus, silica is a key determinant of any bauxite's economic value.⁸ From a limited access to such contracts, we have concluded that the adjustments for the silica tend to be:

- For each 1% of total silica (SiO_2) above or below the applicable benchmark, the price shall be increased or decreased by (fractions pro rata) USD 1 to USD 4 per dmt, depending on the cost of caustic soda associated with the reactive silica in a specific bauxite ore. Such an adjustment may be limited to a small range of silica content around the benchmark that fits within the specifications of the buyer, for example, 1%–4% SiO_2 around the target grade.

The other determinant of the price of bauxite is moisture (the H_2O content). The level of moisture present in the bauxite ore and its impact on pricing will vary. Similar to the adjustment for payable alumina and silica, the most accurate method of accounting for different levels of silica is by reviewing arm's length sales and purchase agreements of bauxite and identifying how the pricing methodology operators in relation to the presence of moisture.

The rule of thumb is that small changes in moisture content from the benchmark do not affect processing costs like alumina or silica content do. Therefore, the moisture content should not affect pricing. However, some contracts contain rejection clauses for very high moisture levels, e.g., over

⁸ The Bauxite Index. (n.d.). *Bauxite 101*. <https://thebauxiteindex.com/about/bauxite-101/>

12%–25%, depending on the origin and destination of the bauxite.⁹ There is generally no need for a specific pricing adjustment for moisture content in bauxite ore because when calculating the price of bauxite ore from benchmark prices, only the dry ore is valued, which excludes the moisture content; all prices are on a dry metric tonne basis.

Economic Circumstances

As outlined earlier, the bauxite market has followed that sectoral trend with the advent of the growing seaborne bauxite market trade and the creation of bauxite price indexes. From a transfer pricing perspective, this allows tax administrations to account for the temporal factors arising from global supply and demand by referencing index prices that correspond to the period in which related-party sales contracts are entered into, as long as the index prices are sufficiently reliable and comparable to the controlled transaction.

In short, by referencing a bauxite price index from a reputable price-reporting agency, one is able to account for both global supply and demand factors as well economically significant aspects of the payable aluminum content and penalties for silica and moisture.

Factors around the general structure of the production and consumption entities are not expected to have a material bearing on the bauxite prices. Although there are some dominant players in the bauxite industry, the market is fragmented enough that there is no singular or small group of producers or consumers that are able to influence the market price of bauxite.

The production history, the general reliability of a producer, and the size of the production mine itself may have an influence on price. As a general rule, a track record of stable production (including stable quality of bauxite) and larger mines can attract a premium on price. Smaller mines or newly developed mines may offer discounts to attract buyers or may only be able to sell to traders who can consolidate production with another mine in order to sell to an alumina refinery. This would be expected to decrease over time as a mine established its supplier credentials. An adjustment for this factor can only be thought of as a directional quantity, and there is insufficient empirical evidence to suggest a precise adjustment. Therefore, for practical reasons, it may be reasonable to have no adjustment for this economic factor.

Contractual Terms

Outside of the factors discussed earlier in this framework, the other economically significant adjustment relevant to the sale and purchase of bauxite is the assignment of transportation responsibilities. The quantum of this adjustment is dependent on the proximity of the mine to the alumina refinery.

⁹ Some buyers in colder climates may require a moisture content under 6% to prevent the ore from freezing.

For seaborne trade made between related parties on an FOB basis, it would be necessary to consider adjustments from the bauxite index price. Some indexes, for example, represent the CFR landed price into a particular port.

The other consideration is if the related-party trade is delivered into another port on a CFR basis. If this is the case, the freight component of the index needs to be stripped out completely to compute a FOB price, before “adding back” the CFR component calculated for the shipping route from the origin and destination port. This can be done by using internal shipping costs from the multinational enterprise (internal CUP). If a sales contract references a particular pricing index, the contract may contain a shipping adjustment to account for different load ports than the index. Alternatively, one can use a shipping index such as the Baltic Dry Index, a shipping index that reports on the dry bulk carrier costs for shipping raw materials.¹⁰ Using the former is preferable as it more accurately reflects the actual costs incurred by the MNE, whereas the Baltic Dry Index is more reflective of quoted market prices at a certain period as opposed to actual costs. Freight deals negotiated for longer-term contracts can vary significantly from the spot market, which can be quite volatile.

FIGURE 6. CBIX bauxite freight indexes¹¹

GUINEA China Capesize	INDONESIA China Supramax	NORTHERN AUSTRALIA Panamax
USD 34/wmt	USD 19/wmt	USD 17/wmt

Other companies publish bulk freight index prices for minerals, such as S&P Platts, for many routes and a variety of mineral commodities transported in bulk worldwide. They publish a Time Charter Equivalent assessment in USD/day and price indexes of USD/MT for each route.¹²

Specifically for bauxite, CBIX publishes freight rates per tonne for three popular transport routes of bauxite to China: Guinea–China via Capesize, Indonesia–China via Supramax, and Northern Australia–China via Panamax as outlined in Figure 6 as an example. They are based on Baltic Exchange Indices and Singapore Bunker Prices, updated weekly and available retrospectively.

However, not all shipping routes are covered by these freight indexes, which might limit their use outside of the major bauxite or bulk mineral trading routes (i.e. Brazil–China, Guinea–China and Australia–China), or they may require adjustments. Another source of information is the actual shipping costs that were incurred by the shipping entity for the journey, i.e., from the load to discharge port.

¹⁰ Baltic Exchange. (n.d.). *Independent information for the dry bulk market*. <https://www.balticexchange.com/en/data-services/market-information0/dry-services.html>

¹¹ The Bauxite Index. (n.d.). *Guinea’s booming bauxite industry – 2023 update report*. <https://thebauxiteindex.com/>. Offered as an example only.

¹² S&P Global. (n.d.). *Shipping price assessments catalog*. <https://www.spglobal.com/commodityinsights/en/our-methodology/price-assessments/shipping>

Worked Example

A practical example is applying a bauxite index on the main trading route for bauxite: from Guinea to China. This example may not apply to all bauxites from Guinea, or to bauxites from other regions. For each specific case, it will be important to assess whether the index is an appropriate benchmark for the bauxite production under analysis.

On July 25, 2022, there was a sale of bauxite from Guinea.

The sale of 1 metric tonne of bauxite had the following characteristics:

- Al_2O_3 – 44%
- SiO_2 – 2%
- Moisture – 8%
- Transport cost on Capesize vessel that week (CBIX): USD 33.30/wmt

The CBIX Guinea LT Index (45% min CIF China, Al_2O_3 45%, SiO_2 3%) was USD 67/dmt.

Sample sales contracts use the following adjustments:

- Al_2O_3 :
 - For each 1% of Al_2O_3 above 45%, the price shall be increased by (fractions pro rata) USD 1 per dmt.
 - For each 1% of Al_2O_3 below 45%, the price shall be decreased by (fractions pro rata) USD 1 per dmt.
- SiO_2 :
 - For each 1% of total silica (SiO_2) below 3% the price shall be increased by (fractions pro rata) USD 1 per dmt.
 - For each 1% total silica (SiO_2) above 3% the price shall be reduced by (fractions pro rata) USD 1 Per dmt.
- Moisture above 15% will lead to the rejection of the shipment.

A sales and purchase price at the point of export (FOB) Guinea would be:

Price =

1. CBIX Guinea LT Index Price: USD 67/dmt
2. Al_2O_3 Adjustment: -USD 1 (1% less than the standard 45% Al_2O_3)
3. SiO_2 Adjustment: +USD 1 (1% less than the standard 3% SiO_2)
4. Freight Adjustment: USD 33.30/wmt
5. Freight Adjustment on a dry ton basis: $\text{USD } 33.30 / (1\% - 8\%)$
= USD 36.20/dmt
6. Guinea FOB price: $\text{USD } 67 - 1 + 1 - 36.20 = \text{USD } 30.8/\text{dmt}$

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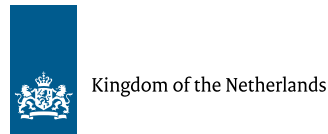


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Appendix 1. Sources of Information for Bauxite

Provider	Use	Reference
Asian Metals	Bauxite pricing information	https://www.asianmetal.com/Aluminum/
Bloomberg	Commodity, pricing, and company information	Commodities - Bloomberg
CBIX	Bauxite pricing information	The Bauxite Index Bauxite Industry News, Prices and Trends
CRU	Bauxite pricing information	Bauxite Price & Market News Alumina Market & Price Index Carbon News & Pricing CRU (crugroup.com)
Fastmarkets	Bauxite pricing information	https://www.fastmarkets.com/insights/proposal-to-launch-bauxite-cif-china-price-assessment-discontinue-fob-bauxite-prices
Guinea safe harbour	Example of bauxite safe harbour	https://www.itie-guinee.org/arrete-relatif-au-prix-de-reference-applicable-a-la-vente-de-la-bauxite-en-republique/
Platform for collaboration on Tax (IMF, OECD, UN & WBG)	Additional information on commodity pricing	Addressing Difficulties in Accessing Comparables Data for Transfer Pricing Analyses (oecd.org)
S&P Capital IQ	Commodity, pricing, and company information	S&P Capital IQ Pro S&P Global Market Intelligence (spglobal.com)
USGS	Bauxite production and reserves information	https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-bauxite-alumina.pdf

Note: Websites accessed in January 2023.

Determining the Price of Minerals: A transfer pricing framework for bauxite

In the mining sector, government revenue depends on mineral products being priced and measured accurately, but complexities around pricing arise from various factors. This publication applies the mineral pricing framework – as documented in the joint OECD-IGF work *Determining the Price of Minerals: A Transfer Pricing Framework* – to identify the primary economic factors that influence the price of bauxite in applying the Comparable Uncontrolled Price method to ensure that developing countries are able to tax bauxite exports appropriately. It also provides worked examples of how to accurately apply the mineral pricing framework to bauxite.



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