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PRODUCTION, INTERNATIONAL TRADE AND EXPORT RESTRICTIONS

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Raw Materials Critical for the Green Transition: Production, International Trade and Export Restrictions

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The challenge of achieving net zero CO2 emissions will require a significant scaling up of production and international trade of several raw materials which are critical for transforming the global economy from one dominated by fossil fuels to one led by renewable energy technologies. This report provides a first joint assessment of data on production, international trade, and export restrictions on such critical raw materials from the OECD's Inventory of Export Restrictions on Industrial Raw Materials covering the period 2009-2020. It presents data on production and trade concentrations, sheds early light on the impact of export restrictions, and discusses possible directions of further work in this area. The evidence presented suggests that export restrictions may be playing a non-trivial role in international markets for critical raw materials, affecting availability and prices of these materials. OECD countries have been increasingly exposed to the use of export restrictions for critical raw materials.

Key words: Global value chains; GVCs; international supply chains; export taxes; licensing requirements; OECD's Inventory of Export Restrictions on Industrial Raw Materials

JEL codes: F13, F14, F18

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Executive Summary

This report provides a first comprehensive assessment of data on production, international trade and export restrictions from the OECD's Inventory of Export Restrictions on Industrial Raw Materials covering the period 2009-2020. It sheds early light on the impact of export restrictions on raw materials critical for green technologies and discusses possible directions of further work in this area.

Production and trade

- *Lithium*, *rare earth elements*, *chromium*, *arsenic*, *cobalt*, *titanium*, *selenium* and *magnesium* recorded largest production volume expansions ranging between 33% (for magnesium) and 208% (for lithium) in the last decade, but even these pale in comparison with the projected four- to six-fold increases in demand projected for the green transition. At the same time, global production of some critical raw materials, such as *lead*, *natural graphite*, *zinc*, *precious metal ores and concentrates* as well as *tin* declined over the last decade.
- The value of global trade in critical raw materials has been expanding faster than that of overall merchandise trade (38% increase between 2007-09 and 2017-19, compared to 31% for all products). *Lithium* trade recorded the largest increase of all critical raw materials (438%), while *manganese*, *natural graphite*, *cobalt*, *titanium*, *lead*, *and rare earths elements* as well as *arsenic* and *zinc* all recorded growth rates which were higher than the average for all critical raw materials.
- Global production of critical raw materials has become more concentrated amongst producing countries in the last decade and it tends to be more concentrated than their global imports and exports. This underscores the critical role of international trade and supply chains play in processing and delivering these materials to users but also indicates exposure to disruptions in upper segments of these supply chains. Production of critical raw materials is concentrated among a few producing countries, some of whom account for large shares of production of more than one critical raw material. The People's Republic of China (hereafter "China"), for example, is among top three producers of six out of ten most production-concentrated critical raw materials, while Australia and Russian Federation (hereafter "Russia") appear three times, and South Africa and Zimbabwe twice.
- While both imports and exports of critical raw materials have become increasingly concentrated amongst countries, trade of these materials remains generally relatively well diversified. This may suggest that the possibility of significant disruption to the global green transition by disturbances to import or export flows of critical raw materials is limited. That said, concentrations of exports and imports are significant in some specific cases, notably in upstream segments of supply chains for some critical raw materials (ores and minerals), in particular for *lithium*, *borates*, *cobalt*, *colloidal precious metals*, *manganese* and *magnesium*.
- For some critical raw materials, such as *waste and scrap of arsenic, mercury*, *thallium*, *gold*, *silver*, *platinum*, *iridium*, *osmium*, *palladium*, *rhodium*, *ruthenium* and *rare earths elements*, global imports are more concentrated than exports, suggesting significant market power for buyers. This may also suggest that, in so far as concentrated exports can be a source of disruptions in some supply chains, import concentration can in principle also have important impacts in some critical raw materials supply chains.
- While global concentration in trade of critical raw materials appears to be modest overall, some countries depend on supplies from a small number of partners. Using a simplified definition of trade dependencies (high partner shares with limited diversification options) reveals that import dependencies of OECD countries on non-OECD suppliers are on average more frequent for critical raw materials than for merchandise products as a whole. The critical raw materials dependencies of OECD countries are concentrated in terms of supplying non-OECD countries, China, Russia, Brazil, South Africa and India accounting for half of all such dependencies. These dependencies exist across a range of different critical raw material products, but they are most prevalent around traditional metals such as *iron and steel*, *copper* and *aluminium* which are also used intensively in green technologies.

Export restrictions

- The global incidence of export restrictions on critical raw materials increased more than five-fold in the last decade, with several countries significantly intensifying use of these measures. In recent years, about 10% of global value of exports of critical raw materials faced at least one export restriction measure. The overall global economic impact of these measures can thus be sizable, even if the nature and magnitude of impacts is likely to be product and country-specific.
- The evidence presented in this report suggests that the use of export restrictions is motivated by a complex mix of economic and non-economic considerations.
- The high concentration of global imports of, and a prominent increase in export restrictions on, *waste and scrap* of different metals possibly reflects, in some cases, environmental concerns, but also a desire to draw on the potential of the circular economy as a source of supply of particular metals and minerals. Nevertheless, these policies disadvantage foreign users and may well be sub-optimal from a global point of view as they may prevent recycling in potentially more efficient foreign locations as well as wider deployment of recycling technologies in countries which need trade in waste and scarp to achieve the right level of economies of scale.
- Restrictions on *ores and minerals*—i.e. raw materials located upstream in critical raw material supply chains—grew faster than restrictions in the other segments of the critical raw materials supply chain. This correlates with the higher levels and a relatively faster increase of the global concentration of their production, import and export, and is broadly consistent with the logic of supporting domestic downstream industries through restrictions on exports of upstream products.
- Despite the marked increase in use of export restrictions, the ranking of *products* with the highest global incidence of such restrictions has remained relatively stable over the last decade, while more heterogeneity in incidence and changes in rankings is observed across the *implementing countries*. This may suggest that the use of export restrictions is not driven only by microeconomic or business considerations (e.g. market power of key suppliers in a specific industry) but also by country-wide factors (e.g. the need for export taxes to raise government revenue or for taxes or restrictions as part of industrial policies) or indeed by non-economic factors.
- China, India, Argentina, Russia, Viet Nam, and Kazakhstan are the top six countries in terms of number of new export restrictions over the period 2009 to 2020 and some of these countries also account for the highest shares of critical raw material import dependencies of OECD countries. In other words, OECD countries have been increasingly exposed to the use of export restrictions for critical raw materials.
- *Export taxes* were the largest contributor to the increased global stock of export restrictions and became the most frequently used type of restriction in 2020. This may be related to the fact that, under WTO rules, *quantitative restrictions on exports* are generally prohibited while *export taxes* are not.
- Overall, the research so far suggests that export restrictions may be playing a non-trivial role in international markets for critical raw materials, affecting availability and prices of these materials. Taking into account OECD dependencies on relevant imports described in this paper, this situation warrants scrutiny.

1. Introduction

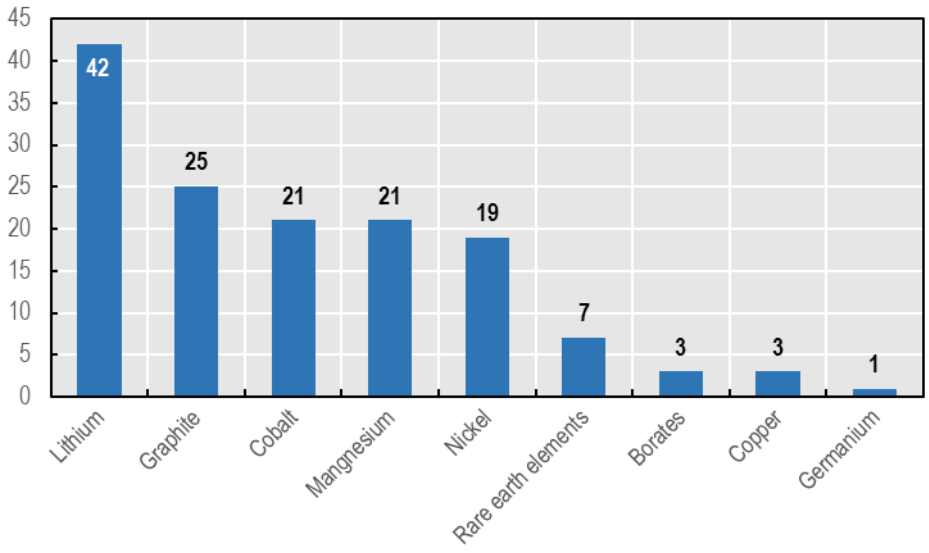
Industrial raw materials are once again at the forefront of policy discussions, for several reasons.

The challenge of achieving net zero CO2 emissions by 2050 will require a significant scaling up of production and international trade of several raw materials which will be critical for transforming the global economy from one dominated by fossil fuels to one led by renewable energy technologies (IEA, 2021[1]). Such technologies make generally more intensive use of minerals than their fossil fuel counterparts. For example, a typical electric car requires six times the mineral inputs of a conventional car and an onshore wind plant requires nine times more mineral resources than a gas-fired plant (IEA, 2021[2]). Therefore, while the green transition will reduce the global dependence on fossil fuels, it will intensify the pressure on the production and efficient international exchange of other raw materials. For example, because of the increasing share of renewables in new investment in the energy sector, the average amount of minerals needed for a new unit of power generation capacity has increased by 50% since 2010 (IEA, 2021[2]).

Some relatively abundant raw materials, which have traditionally underpinned industrial production (e.g. *aluminium*, *copper* and *iron ore* and *steel*) will also remain essential in green sectors and their enabling technologies. Other materials, such as *rare earth minerals* (notably *neodymium* and *dysprosium*), *lithium*, *cobalt* or *nickel*, are also prevalent in new technologies and thus their demand is expected to grow substantially (Gielen, 2021[3]). The IEA projects, for example, that in the next twenty years the clean energy sector's demand for materials such as *cobalt*, *natural graphite* or *lithium* will increase from twenty to more than forty times (Figure 1.1). Overall, depending on the assumed pace of green transition, it is estimated that the demand for minerals (from the energy as well as other sectors) will grow by on average four to six times between 2020 and 2030 (IEA, 2021[2]).

Figure 1.1. Projected global demand growth for certain raw materials by 2040

Projected increase factor (1= current demand)



Note: International Energy Agency's Sustainable Development Scenario, which indicates what would be required in a trajectory consistent with meeting the Paris Agreement goals.
Source: (IEA, 2021[2]).

Meanwhile, prices of many raw materials, including some of those critical to the green transition (critical raw materials thereafter), are at, or close to, historical highs. They have increased visibly since the beginning of 2000s, particularly during and in the aftermath of the Global Financial Crisis of 2008-2009 (GFC) and during the recent COVID-19 pandemic, and more so than average commodities prices (Figure 1.2).

During the COVID-19 pandemic, in contrast to the GFC, prices of imported precious stones, minerals, and non-ferrous and ferrous metals decreased only a little at the beginning of the pandemic (first half of 2020), before increasing very significantly in the second half of 2020 and throughout 2021. As a result, the values of trade of some raw materials, such as precious stones and ores and slags actually increased in the period of the generalised trade collapse in the first year of the pandemic, while iron, steel and aluminium products were among product categories with some of the smallest declines in this period (Arriola, Kowalski and van Tongeren, 2021[4]). The evolution of trade of raw materials contrasted also with that of fuels, trade and prices of which declined more significantly in the first year of the COVID-19 pandemic.

The significant increase in prices of non-energy raw materials during the COVID-19 pandemic can be partly explained by a shift of global demand from services to goods. Demand shifted away from transportation, recreation and hospitality services, which were affected the most by the pandemic-related social distancing restrictions, towards goods, in particular towards 'home nesting' products, products required to renovate homes, and products consumable from home such as electronic equipment, recreational equipment, food, and beverages as well as retail trade (Arriola, Kowalski and van Tongeren, 2022[5]). These types of products rely on raw materials needed for their production. In addition, supplying raw materials depends crucially on international trade and transport, particularly sea transport, which were significantly perturbed during the pandemic and have not yet fully recovered.

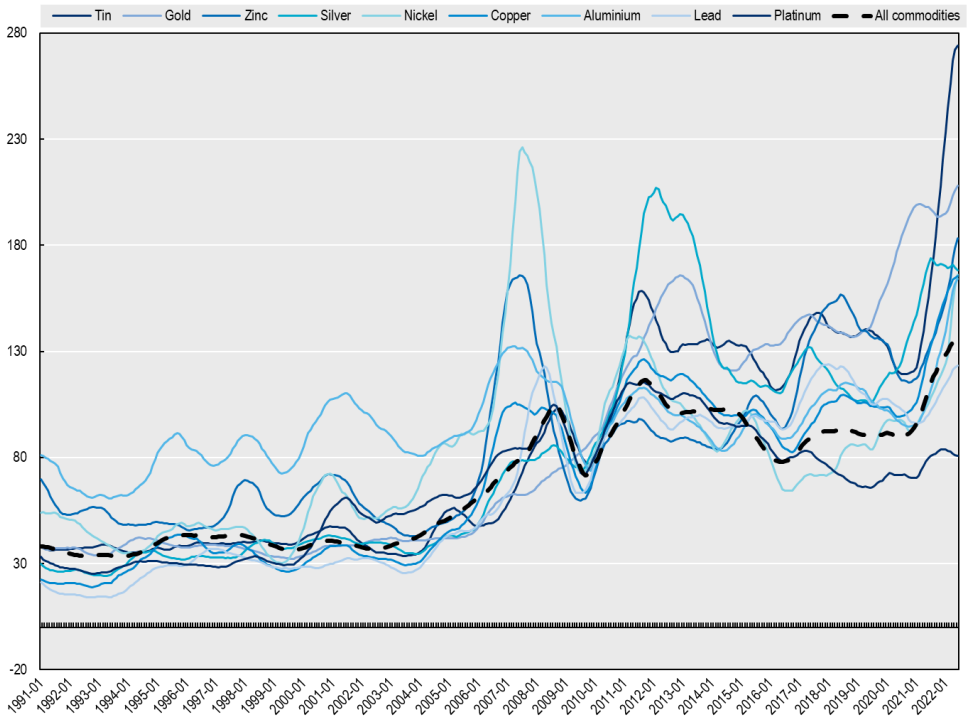
In addition, amidst the partial recovery from the impact of the COVID-19 pandemic, the Russian invasion of Ukraine in February 2022 resulted in new challenges to international trade and the global economy, and to international supply of those agricultural and industrial raw materials for which the two countries are historically important traditional suppliers.[1] As of mid-2022, prices of many kinds of imported non-energy commodities were at, or close to, their historically high levels. This was the case for all major categories of industrial raw materials, including precious metals, non-ferrous minerals and ores, minerals and ferrous metals (INSEE, 2022[6]). *Aluminium*, *copper*, *tin*, *gold*, *zinc*, for example, recorded the highest price levels since the early 1990s (and higher than on average all traded commodities, Figure 1.2), while for other metals such as *lead* or *silver*, prices are approaching historical highs recorded in the aftermath of the GFC.

More broadly, as a repercussion of some of the disruptions during the COVID-19 pandemic as well as Russia's invasion of Ukraine in February 2022 and other growing geopolitical tensions, some countries have started analysing their reliance on different imported products, including on raw materials, to identify those that could cause disruption in production or consumption in case of unexpected interruptions of supply, or those that could be used as tool of coercion or might create national security risks. Analysing such dependencies is challenging because there is no common understanding at what point trade linkages—for raw materials or other products—might give a rise to a concern. Some new on-going work is being undertaken, including by individual countries and international organisations such as the OECD (e.g. in Section 3.4 of this report) to explore how different types of dependencies have developed historically, what the main drivers have been for changes, and at what point such dependencies could give rise to concern.

Some traits of industrial raw materials make them more prone to both production and trade concentration and policy intervention than other sectors. State intervention, including in the form of special regulation (e.g. natural monopolies, licenses), state ownership, investment restrictions, strategic policies, and export measures, is pervasive in the raw materials sector. Evidence has also been emerging that states have become more interventionist in terms of management of such resources, one indication of which is the growth in use of restrictions on exports of raw materials during the last decade as monitored in the OECD's Inventory of Export Restrictions on Industrial Raw Materials (Figure 1.3).

[1] As far as critical raw materials are concerned, in the period 2017-19, Ukraine and Russia jointly accounted for more than 5% of global exports of: pig iron (the two countries accounted together for 25% of global exports); palladium (23%); chromium (17%); precious metals ores and concentrates (13%); chromium (9%); titanium (8%); selenium (6%) and iron and steel (5%); phosphates (5%); lithium and nickel (5%). Ukraine on its own accounted for 8% of global exports of pig iron, 6% of exports of titanium (6%) and 2% of selenium and iron and steel.

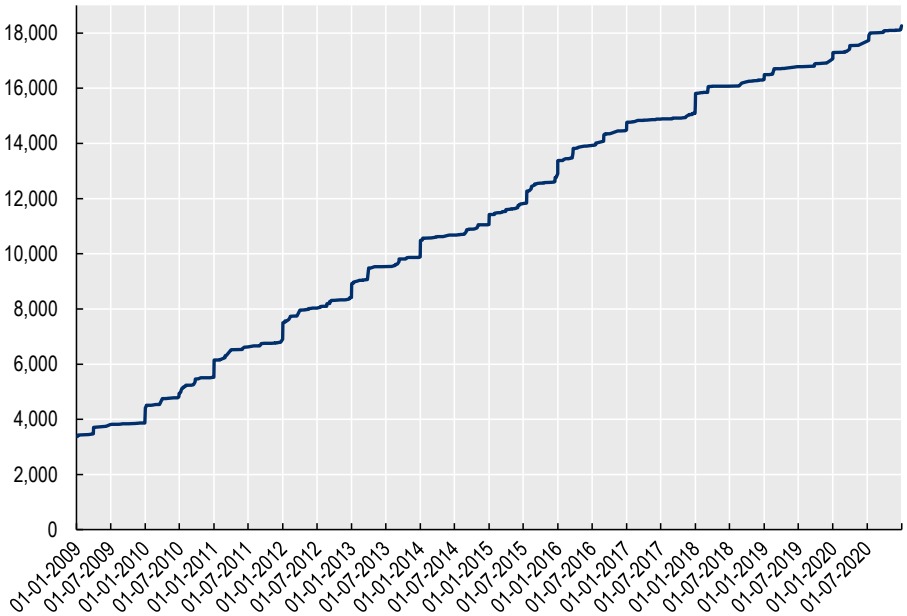
Figure 1.2. Historical prices of selected metals



Note: 12-month moving averages of original monthly indices, where base = 100 in 2010. *All commodities* covers prices of all traded merchandise products, including agricultural raw materials, food products, minerals, industrial products and energy.
Source: OECD calculations based on INSEE's *Raw materials price indices and international prices* database.

Figure 1.3. Count of export restrictions on industrial raw materials

Count of export restrictions in place by month



Note: The count of all types of measures in place across all covered raw materials and all implementing countries taking into account the stock of measures in place at the beginning of the period as well as new additions and eliminations.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

The Inventory documents information on different types of export-related regulations concerning major industrial raw materials in OECD and selected non-OECD economies in the period 2009 to 2021.[2] The Inventory is a rich source of qualitative and quantitative information on export restrictions which was conceived to improve the transparency of governments' practises in this area and to serve as a data bank for empirical analysis advancing the understanding of the economic effects of export restrictions (Fliess and Mård, 2012[7]). The Inventory can be used to assess how existing export restrictions may be contributing to shortages and high prices of raw materials and how policy reforms may ease tensions and help ensure secure and efficient supply of raw materials. While several previous studies drew on the information in the Inventory to provide assessments or industry-specific case studies[3], the Inventory has so far not been used for a more comprehensive assessment of the incidence of exports restrictions that would encompass different raw materials, implementing countries and its evolution in time.

It is in this context that this report provides a comprehensive assessment of data on production and international trade of critical raw materials and the information on export restrictions contained in the OECD Inventory to gauge the impact of export restrictions concerning raw materials that are critical for green technologies. At this stage, the analysis mainly uses descriptive statistics to first describe the concentration of production and international trade of critical raw materials, and then to juxtapose these with the information on export restrictions, including their evolution in time, by material and main imposing countries. The overall objective is to consider what broad trends can readily be seen from relatively unrefined data comparisons and whether, and if so how, the data might be used further to make a more rigorous assessment of causal mechanisms underlying the relationships between export restrictions and green raw materials markets, and to generate further findings and recommendations that may be relevant for policy making. The analysis complements work on critical raw materials at the IEA[4] and other parts of the OECD.[5]

In the remainder of the paper, Section 2 describes the data and concordances used. Section 3 gives an overview of reserves, production and international trade of critical raw materials in the last decade. Section 4 presents the corresponding data on export restrictions and Section 5 discusses the potential economic impacts of export restrictions and concludes. Annexes contain support information and data.

[2] Data on export restrictions for 2021 is available since December 2022. The analysis in this report is based on export restriction data through to 2020.

[3] An explanation of construction of the inventory and first stocktaking of incidence of different types of export restrictions for 2009 and 2010 is provided by Fliess and Mård (2012[8]). Based on an early version of the inventory, (Fung and Korinek, 2013[18]) provide a summary of export restrictions applied to selected industrial raw materials in 2010. Other studies focus on a subset of countries or raw materials. (Fliess, Idsardi and Rossouw, 2017[19]) analyse export restrictions applied to manganese in Gabon, lead in South Africa, copper in Zambia and chromite in Zimbabwe. In the context of the circular economy, (Korinek and Sa, 2021[17]) analyse export restrictions in metallic waste and scrap.

[4] Following up on the 2022 IEA Ministerial Communiqué (paras 25 and 26), a Working Party on Critical Minerals has been created by the IEA members to work on availability, security and responsible sourcing of energy-specific critical minerals and materials.

[5] Related work at the OECD includes, for example, the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, the OECD work on Arrangement on Officially Supported Export Credits in particular its Renewable Energy, Climate Change Mitigation and Adaptation and Water Projects Sector Understanding (CCSU) as well as the planned work on this topic in the Working Party on Climate, Investment and Development (ENV/EPOC/WPCID(2022)20], which will also focus on supply-side risks regarding critical raw materials.

2. Data and concordances

In order to facilitate an analysis of the possible impact of export restrictions on raw materials critical for the green transition, this analysis uses three principal data sources: OECD Inventory on Export Restrictions on Industrial Raw Materials; the Centre d'études prospectives et d'informations internationals (CEPII) BACI data on bilateral trade at 6-digit level of HS classification;[6] and the United States Geological Survey (USGS) data on production and known reserves of some of these materials.

For the purposes of this analysis, critical raw materials are defined following (Bobba et al., 2020[8]) as those which were found to be used intensely in the green transition technologies such as li-ion batteries, fuels cells, wind energy, electric traction motors and photo-voltaics (Table 2.1).[7]

The data contained in the OECD Inventory cover most commodities in their unprocessed as well as in their semi-processed form, focusing on industrial raw materials that are considered strategic or critical[8] and including also waste and scrap of metals. Included are products (at 6-digit HS code level) in their raw and semi-processed forms from the following HS chapters (2-digit level of HS 2007 classification) and their sub chapters (4-digit HS): 25, 26, 27 (270112, 270400 only), 28, 31 (310420, 310430 and 310490 only), 4403, 4407, 4412, 71-81 (see Annex A for more information on specific products covered).

The OECD Inventory data on export restrictions is collected at the 6-digit level of HS classification (HS6 codes) and is therefore directly compatible with the BACI data on bilateral trade at the product level. However, for presentational purposes, two more aggregated categories grouping HS6 codes are defined. These categories group HS6 codes that describe specific products (e.g. in terms of degree of processing or different forms in which they are traded) that may refer to the same specific type of raw material. For example, the product category *aluminium* encompasses, among others, tariff lines such as *HS260600 Aluminium ores and concentrates*, but also *HS 760200 Aluminium: waste and scrap* (Figure 2.1). For those larger categories of raw materials, collecting sometimes many different HS6 codes, correspondence was established with the list of the critical raw materials used intensely in the green transition as posited by (Bobba et al., 2020[8]) (Table 2.1).

In addition, broader categories of 'sectors' were defined in order to distinguish broadly between the segments or degrees of processing of different 'products', that is: ores and minerals (mainly HS 6-digit codes belonging to HS chapters 25, 26 and 27); chemicals and compounds (mainly HS 6-digit codes belonging to HS chapter 28); ferrous metals (*iron and steel*); non-ferrous base metals (e.g. *aluminium*, *copper*, *lead*, *nickel*); non-ferrous minor metals (e.g. *cobalt*, *molybdenum*); precious metals and stones (e.g. *gold*, *silver*); and waste and scrap (Figure 2.1). This categorisation allows distinguishing between different kinds of the same 'products' (e.g. distinguishing between *aluminium ores*, *aluminium oxides*, *basic aluminium products*, or *waste and scrap of aluminium*). In addition, the 'sector' approach allows to group different classes of raw materials which share some of the broad stage of processing characteristics (e.g. ores of different metals as compared with the actual metals produced from these ores and with waste and scrap containing these metals).

The notional classification of raw materials used by the USGS is different from the HS methodology and it is more aggregated. Therefore, only a broad correspondence between the USGS data and OECD export restrictions and BACI trade data can be established. The USGS data is also provided in physical units

[6] This dataset is derived from the UN Comtrade data with some adjustments, see: http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele_item.asp?id=37

[7] Note that this is different from lists of critical raw materials established by individual OECD countries. For example, the list is different from the one used by the EU: it includes ten raw materials which are also on the EU list as well as seventeen other which were not considered critical in the 2020 EU assessment (see https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en). While there is an overlap, this current list is also different from the list of materials analysed in the US Strategic and Critical Materials 2013 report (U.S. Department of Defense, 2013[20]).

[8] There is no commonly accepted definition of what is strategic or critical. The list of products covered in the Inventory reflects a series of discussions among OECD countries since the conception of the Inventory on which products should be included. It contains most products covered, for example, in the EU Raw Materials Initiative or products listed in the US Strategic and Critical Materials 2013 report.

(e.g. tonnes of production or known reserves) while trade data is available in values.[9] Descriptive statistics on production and reserves are therefore not directly comparable with those on restrictions or trade, although they can still be used for broad comparisons.

In general, the analysis aims to cover the last decade but there are differences in periods for which different data is available.[10] In addition, the period of the COVID-19 pandemic is excluded from the analysis of trade and production data because of the large shifts in production and trade structures observed in that period. In addition, the calculation of rates of increase and concentration ratios of production and trade at the beginning and at the end of the covered periods is averaged over the first and last three years of available data in order to minimise the influence of unusual years (i.e. 2012-14 and 2017-19 for production data and 2007-09 and 2017-19 for trade data).

Table 2.1. List of critical raw materials for green technologies

Sorted by the number of green technologies in which the raw material is applied

Material	Li-ion battery	Fuels cells	Wind energy	Electric traction motors	Photo-voltaic	Number of technologies
Aluminium	x	x	x	x	x	5
Copper	x	x	x	x	x	5
Iron ore	x	x	x	x	x	5
Borates		x	x	x	x	4
Germanium and other*	x	x	x		x	4
Cobalt	x	x	x			3
Rare earth elements	x	x	x	x		3
Lead	x		x		x	3
Manganese	x	x	x			3
Molybdenum		x	x		x	3
Nickel	x	x			x	3
Chromium		x	x			2
Lithium	x	x				2
Natural graphite	x	x				2
Selenium	x	x				2
Silver		x			x	2
Tin	x				x	2
Titanium	x	x				2
Arsenic		x				1
Cadmium					x	1
Gold		x				1
Magnesium		x				1
Palladium and platinum		x				1
Phosphorus	x					1
Zinc					x	1
Zirconium		x				1
Iron ore and steel products**			x		x	

Note: * “Germanium and other” is a group of materials including germanium, niobium, vanadium, gallium, indium and hafnium. **Iron ore and steel are not on the original list of Bobba et al. but have been included in the analysis because of their intense use in some green technologies such as for example wind and solar energy.
Source: Based on Bobba et al. (2020[8]).

[9] BACI also provides quantities, but this data is more patchy and units are different from these in the USGS.

[10] The USGS production and reserves data is available for the period 2012-2020 while the OECD Inventory of export restrictions covers the period 2009-2020. The BACI data for trade covers the period 2007-2020.

Figure 2.1. Approach to categorising raw materials for green technologies

Exemplary correspondence of selected HS 6-digit codes with wider green raw materials product and sector categories

Source: Authors' elaboration based on the OECD Database on Export Restrictions on Industrial Raw Materials.

3. Reserves, production and international trade of critical raw materials

Concentration of production and trade are some of the key dimensions through which the global critical raw materials markets are portrayed in this report. While there are of course other relevant dimensions, such as, for example, industry-specific investment and profitability perspectives or technology outlooks, the approach taken here allows identifying key producers and traders of critical raw materials and shedding comprehensive (i.e. encompassing a wide variety of critical raw materials)—and at the same time detailed—light on market powers on the one hand and potential 'exposures' and 'vulnerabilities' on the other.[11]

Extraction of raw materials occurs mainly in places where they are the most naturally abundant or where the natural conditions (and available technology) make extraction the most economically viable. Hence, there are 'natural' reasons for concentration of production and international trade of raw materials that may be absent in the case of products that can in principle be manufactured anywhere. Also, economies of scale are significant in industries with high fixed capital costs, such as mining and quarrying, and in some cases this may result in high and persistent concentration of production and trade of even relatively ubiquitous raw materials. These concentrations sometimes give rise to market powers which can be exploited for economic and non-economic reasons, e.g. through restrictions on output or trade, especially in the context of the upstream position of these products in international supply chains. The demand side, which is not the main focus of the current analysis, is also a potentially important driver of market conditions and policy landscape (Box 1).

Box 1. Mining and quarrying of raw materials — a glimpse at the demand side in international supply chains

Focusing on export restrictions, this paper concentrates on structure and evolution of production and international trade in critical raw materials, i.e. predominantly on the supply side of critical raw material value chains. However, the availability of critical raw materials--and thus the policy responses—are also clearly shaped by demand and the latter tends to be concentrated among a few using industries and countries.

The OECD Trade in Value Added (TiVA) data allows to trace value added by country and industry of origin and country and industry of final demand, including indirect links. While the industry classification and the level of aggregation of this data does not allow to separate out the critical raw materials from other raw materials, analysis of a broader category of non-energy producing mining and quarrying products indicates that in the period 2006-09 to 2016-18 the global value of value added embodied trade of such products increased by 32% (USD 355 bln).

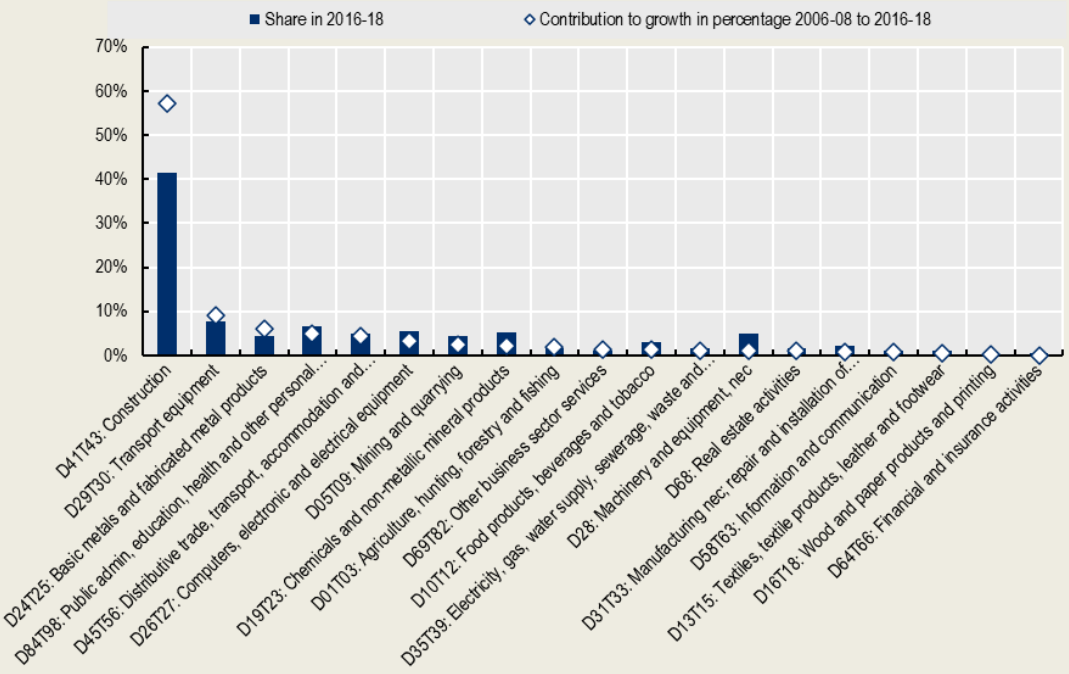
The construction industry accounted for 57% of this increase, while the transport equipment and basic, fabricated metals industries and computers and electronic equipment accounted for, respectively, additional 9, 6 and 3% of the increase (Figure 3.1).

As a country of final demand, China accounted for 58% of the increase while Indonesia for 11% and the rest of non-OECD countries for 31%. OECD as a group recorded a negative contribution which was mainly driven by decreased demand for this kind of products by EU27, although demand by the United States recorded positive growth and growth of demand by Japan accounted by 9% of the total increase (Figure 3.2).

[11] Note that in many economies production occurs in a global value chains with inputs and capital (both tangible – machines and equipment – and intangible – R&D, data) coming from a variety of countries. Thereby, even the countries that come across as accounting for high shares of production or exports may be highly dependent on other economies.

Figure 3.1. Contribution to growth in value added embodied in internationally traded non-energy producing mining and quarrying products

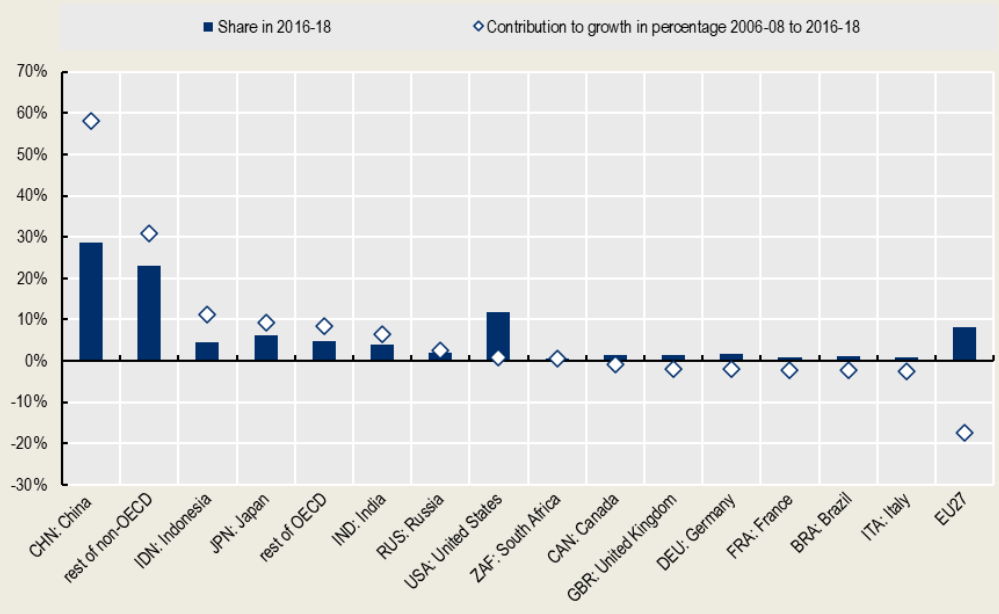
By industry of final demand (2006-09 to 2016-18)



Source: OECD Trade in Value Added database.

Figure 3.2. Contribution to growth in value added embodied in internationally traded non-energy producing mining and quarrying products

By country of final demand (2006-09 to 2016-18



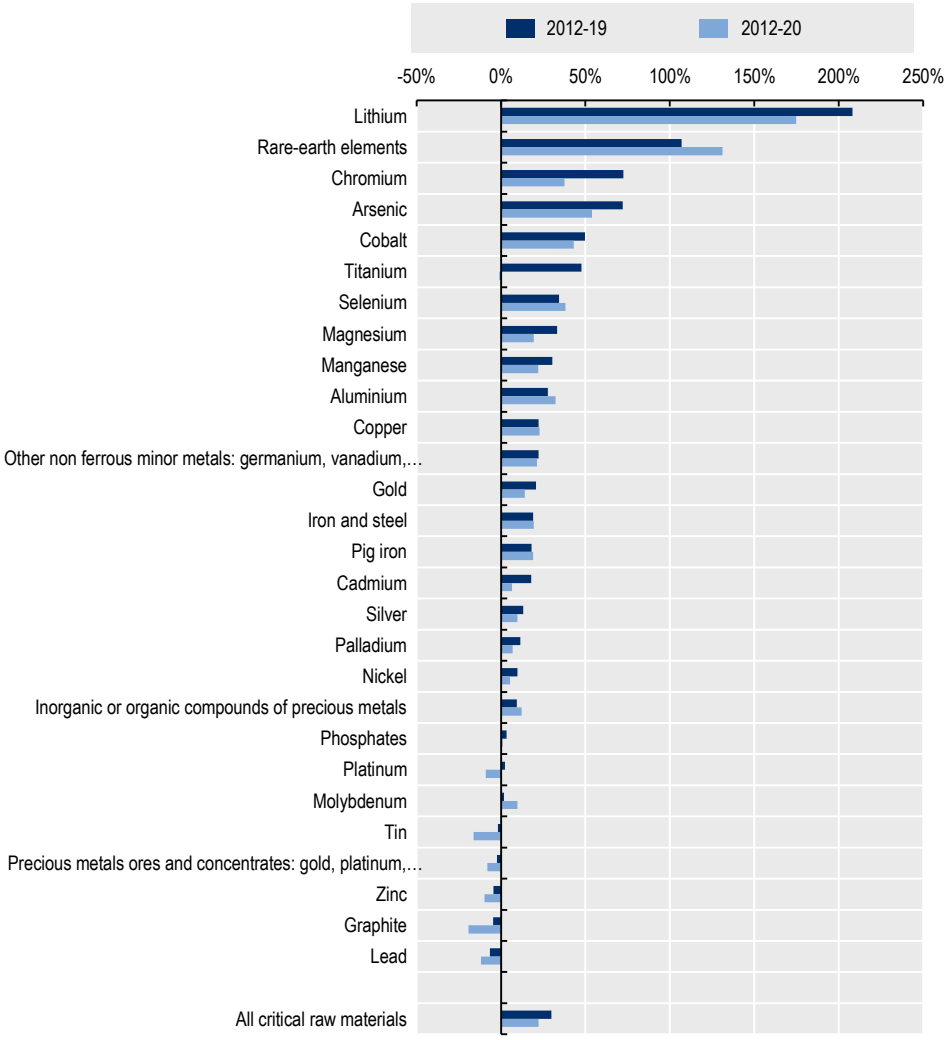
Source: OECD Trade in Value Added database.

3.1. Production of critical raw materials

On average, global production of critical raw materials increased by 30% in the period 2012-19 (22% if the period 2012-20 is considered instead).[12] *Lithium*, *rare earth elements*, *chromium*, *arsenic*, *cobalt*, *titanium*, *selenium* and *magnesium* are the critical raw materials global production of which grew faster than on average. Some of these growth rates suggest dynamic growth (global production of *lithium* more than tripled, and production of *rare earths* more than doubled) but even for these fast-growing materials the growth rates pale in comparison with the projected increases in demand associated with green transition (compare with estimated increase factors in Figure 1.1). In addition, global production of some critical raw materials, such as *lead*, *natural graphite*, *zinc*, *precious metal ores and concentrates* as well as *tin*, actually declined (Figure 3.3).

Figure 3.3. Production of critical raw materials – growth rates

Growth rates of the volume of world production between the period 2012-19 and 2012-20 (%)



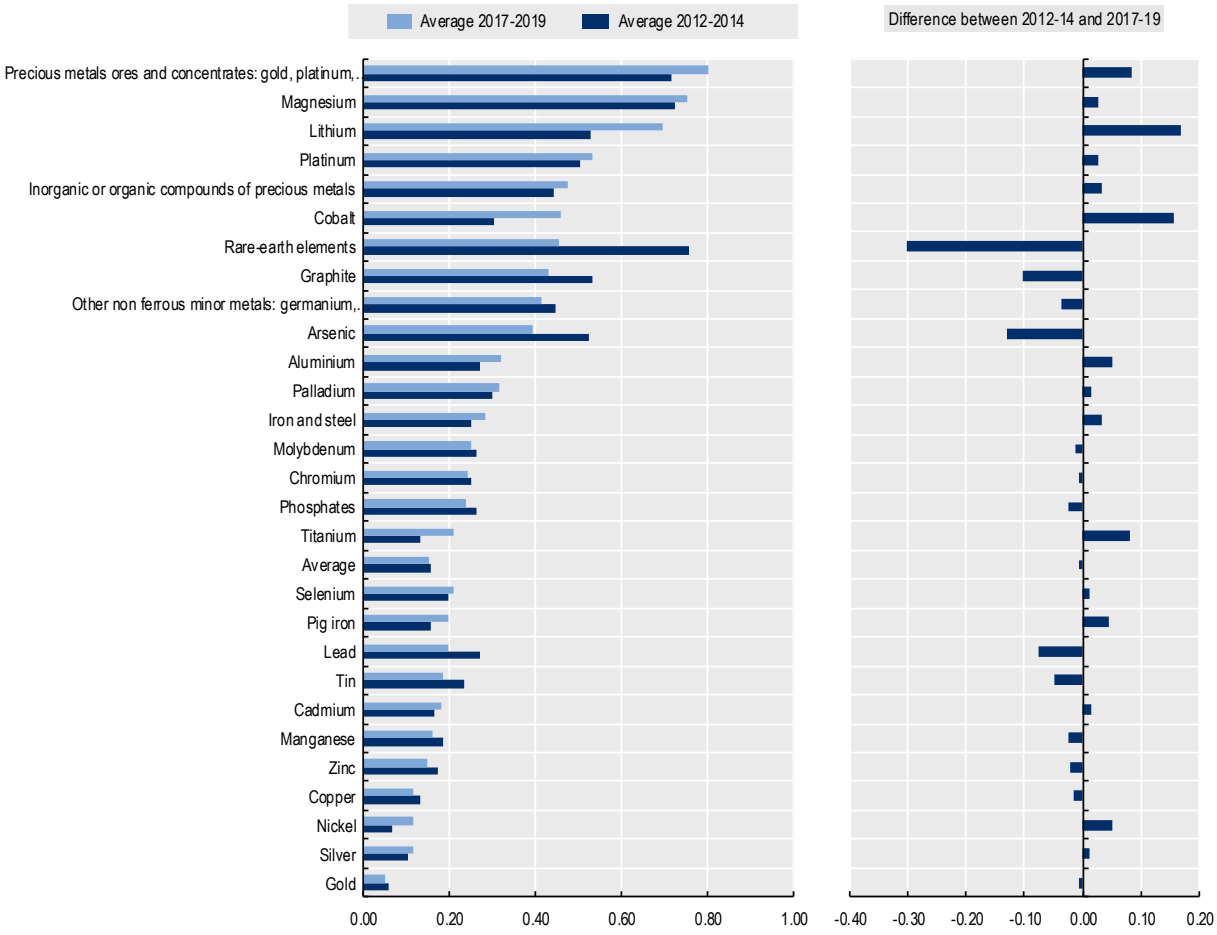
Source: OECD calculations based on the United States Geological Survey data.

[12] In the USGS, production is measured in physical units (tonnes or kilogrammes depending on the product) and the production growth rates reported here refer to these quantities.

Concentration of production across producing countries appears relatively high as illustrated by the values of Herfindahl-Hirschman Index (HHI)[13] which stood at around 0.3 on average across all the critical raw materials in both the 2012-14 and the 2017-19 periods. Production of some materials appears particularly concentrated. For example, *precious metals ores and concentrates*, *magnesium*, *lithium*, *platinum* and *cobalt* all recorded values of HHI of at least 0.5 in 2017-19 and all experienced growth in concentration of production in the last decade. At the same time, *rare earths elements*, *natural graphite*, *other non-ferrous minor metals* and *arsenic*, belong to the group of materials with also relatively high but declining concentration indices (Figure 3.4).

Figure 3.4. Concentration of production of critical raw materials

Global HHI index of production concentration across producing countries and critical raw materials



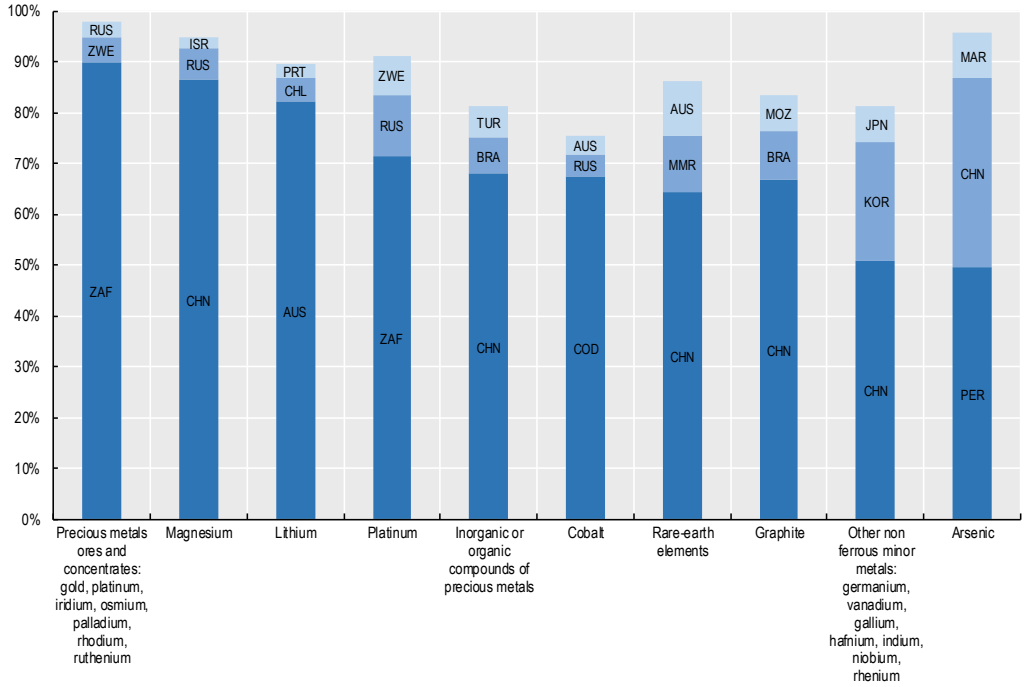
Note: Ordered by the value of the HHI index in 2017-19.
Source: OECD calculations based on the United States Geological Survey data.

[13] In this paper, concentration is measured using the Herfindahl-Hirschman Index (HHI). The index can be calculated for global production (exports or imports) of a product to measure global concentration across all producing (exporting, importing) countries, or, in the case of exports and imports, it can be calculated for a given country, where it measures the concentration of this country's exports of a given product across the different destinations to which this country exports or, for imports, it measures the concentration of imports across all countries from which the given country imports. The index is defined as the sum of squared individual market shares and lies between 1/n, when all of the n suppliers have equal shares, and one, in a monopoly. Interpretation of the values of the index is not strict and may depend on context. The US Department of Justice and US Federal Reserve, for example, consider markets with a HHI between 0.15 and 0.25 to be moderately concentrated and markets with HHI equal to or more than 0.25 to be highly concentrated.

Production of critical raw materials is concentrated among a few producing countries, some of whom account for large share of production of more than one critical raw material (see also Box 2). China is among top 3 producers of six out of ten most production-concentrated critical raw materials, while Australia and Russia appear three times and South Africa and Zimbabwe twice (Figure 3.5).

Figure 3.5. Top 3 producers of the top 10 most production-concentrated critical raw materials

Shares in global production (%)



Note: AUS – Australia; BRA – Brazil; CHN - China; CHL – Chile; COD – Democratic Republic of Congo; ISR – Israel; KOR – Korea; MAR – Morocco; MMR – Myanmar; MOZ – Mozambique; PER – Peru; PRT – Portugal; TUR – Türkiye; RUS – Russian Federation; ZAF – South Africa; ZWE – Zimbabwe.
Shares in global production based on gross weight of production.
Source: OECD calculations based on the United States Geological Survey data.

Data on known reserves of critical raw materials are also provided by the USGS and in principle they can be used for a similar analysis. However, the reserves data are less complete than the production data and are not available for all products. For those critical raw materials for which reserve data exist, a comparison of concentration of production and reserves concentration among the top 3 producers or reserve holders is presented in the Annex Figure A C.1. and Annex Table A C.1. These show that the biggest producers are typically also the largest reserves holders although the country shares differ and whether production is concentrated more among the top 3 players than reserves varies across products.

Box 2. Country of production and trade *vis-à-vis* ownership and control of critical raw material value chains

One important caveat attached to the analysis presented in this report is that it concentrates on countries in which production and trade occur. This is justified by the availability of data as well as by the focus of the study on export restrictions, which are maintained by exporting countries.

However, the availability of critical raw materials depends not so much on country policies but rather on companies which own deposits, invest in mining and processing capacity, apply specific environmental, social and governance standards and market the extracted and processed materials in international markets.

Recent analysis by the Peterson Institute for International Economics suggests that enterprises that engage in mining and processing of some critical raw materials are often incorporated in foreign countries or owned and controlled by foreign actors, including foreign states (Leruth et al., 2022[9]).Using the concept of ultimate beneficial owners and accounting for direct and indirect ownership links in the cobalt, copper, lithium and nickel industries, these authors show that the ownership and control perspective is important for understanding the control of supply chains of critical raw materials.

In the case of cobalt, for example, although 69% of global cobalt production originates in the Democratic Republic of Congo, firms incorporated there control the exploitation of only 3.5% of global output, while Chinese firms control 24% and firms about which little is known control 42% of global production. In contrast, lithium mines tend to be incorporated where they are located, that is predominantly in Australia, which produces the bulk of world's lithium. However, according to this study, through direct and indirect ownership links, Chinese entities control about 33% of global lithium production.

Source: Leruth et al. (2022[9]).

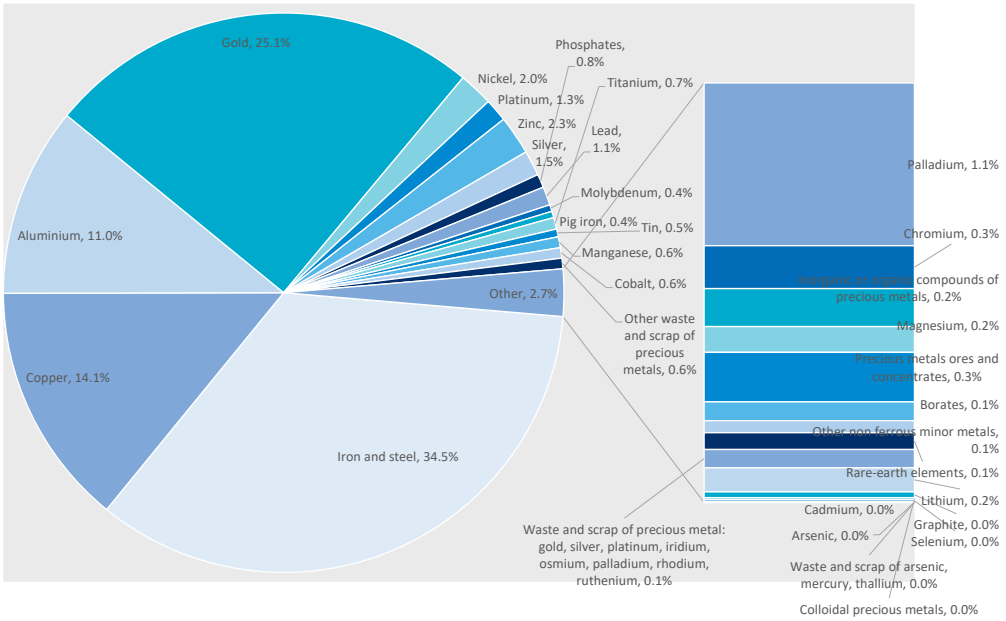
3.2. International trade

A few metals continued to dominate the value of global exports of the critical raw materials in the last decades. The top 10 traded critical metals (*iron and steel*, *gold*, *copper*, *aluminium*, *zinc*, *nickel*, *silver* and *platinum*, *lead* and *palladium*) accounted for on average 94% of the value of global exports of critical raw materials in both 2007-09 and 2017-19. The remainder was accounted for by the other twenty three materials on the critical raw materials list (right panel of Figure 3.6) and there was very little change in the ranking of shares of trade of these less traded materials (compare Figure 3.6 with Annex Figure A C.2.). *Lithium*, *cobalt*, *silver*, *manganese*, *titanium* and *palladium* saw their shares increase, but from very small bases. In contrast, the share of *gold* increased from 11.4% of the value of global trade in critical raw materials in 2007-09 to 25.1% in 2017-19. At the same time, relatively large decreases in shares were recorded for *nickel* (-1.7 percentage points), *platinum* (-0.9), *aluminium* (-0.9), *molybdenum* (-0.5) and *pig iron* (-0.3) (Annex Figure A C.2).

Zooming in on growth rates reveals that the value of trade of critical raw materials was expanding faster (average growth rate of 38%) between 2007-09 and 2017-19 than trade of all merchandise products (31%) and trade of all raw materials (35%) (Figure 3.7). Trade of some of the critical raw materials, which currently account for small shares of global critical raw material trade, has been increasing the most rapidly. For example, *lithium*—which still accounted for only 0.2% of the value of global critical materials trade in 2017-19—recorded the largest increase of all critical raw materials (438%) in the investigated period, and *manganese*, *natural graphite*, *cobalt*, *titanium*, *lead*, *rare earths elements* as well as *arsenic* and *zinc* all recorded higher than average growth rates.

Figure 3.6. Global trade in critical raw materials – average shares in the 2017-19

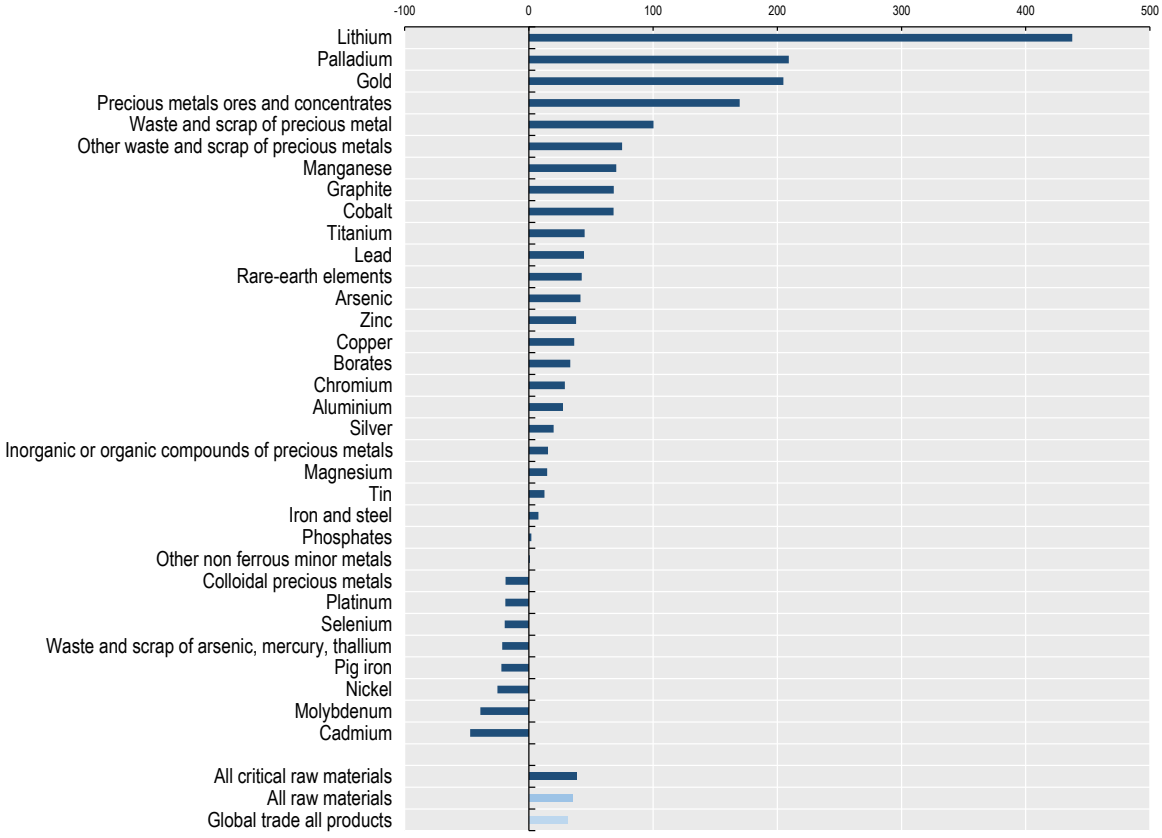
Shares in global value of trade in all critical raw materials



Source: OECD calculations using the BACI data.

Figure 3.7. Global trade in critical raw materials – growth rates, by product

Increase in the value of trade between the period 2007-09 and 2017-19 (%)

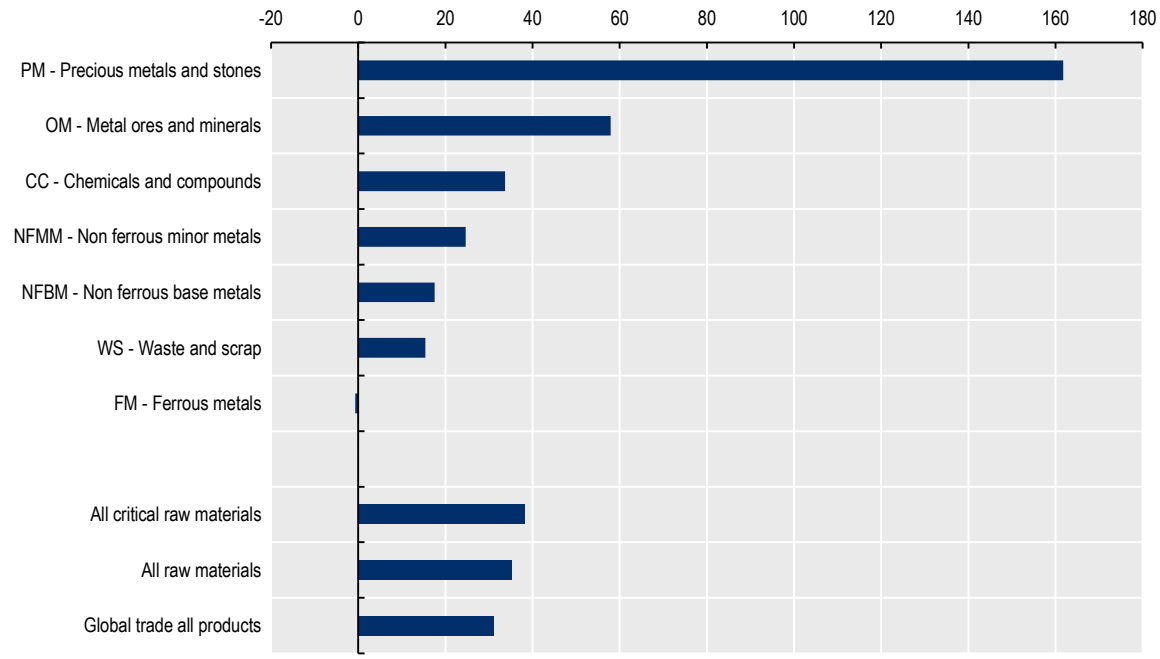


Source: OECD calculations using the BACI data.

Distinguishing simultaneously between 'products' and 'sectors' (see Section 2 for the explanation of the concept of 'sector' as used in this study), in addition to confirming the expansion of trade of several precious metals, reveals even higher growth rates of several types of critical raw materials which were not detected in the earlier comparison. In particular, these include chemicals and compounds as well as ores and minerals of: *cobalt*; *manganese*; *tin*; *titanium*; *borates*; *magnesium*; *natural graphite* and many others (Figure A C.3). This reflects a broader tendency for trade of ores and minerals to on average grow faster (57%) than trade of critical raw materials as a whole (38%) (Figure 3.8).[14] For all the other sectors growth was slower than the average and ferrous metals actually recorded a small decline. While for the moment the data at hand cannot tell us whether these developments were driven by increasing volumes or prices[15] it tells us that trade of ores and minerals – that is the kind of products which are less processed and located in the upper echelons of raw materials supply chains – has gained in importance in value terms in the last decade. For example, trade of chemicals and compounds of *cobalt* grew several times faster than trade of the *cobalt* as a metal and of waste and scrap containing *cobalt*. Similarly, trade of *copper* ores grew almost two times faster than chemical compounds containing *copper* and more than three times faster than waste and scrap of *copper* (Figure A C.3.).

Figure 3.8. Global trade in critical raw materials – growth rates 2017-19, by sector

Growth rates of the value of trade between the period 2007-09 and 2017-19 (%)



Source: OECD calculations using the BACI data.

[14] This can be seen for by grouping all tariff lines belonging to a specific 'sector' category across the different 'products' and calculating the relevant growth rates (as presented in Figure 3.4).

[15] This distinction if, of course, key as in the former case this could suggest increased supply (and therefore better availability of these materials) while in the latter case, quite to the contrary, this could suggest restrictions on production and lower availability.

3.3. Export and import concentration

Generally, imports of products tend to be less concentrated across importing countries than exports are across exporting countries and this is also the case for critical raw materials (HHI values of 0.14 for exports and 0.9 for imports, Figures 3.9 and 3.11). The tendency for exports to be more concentrated can be explained by the predisposition of trading countries to differ more with respect to what they supply to world markets (i.e. production specialisation) than with respect to what they consume (i.e. consumption preferences). This is in line with the key analytical assumption of standard international trade theory where consumption preferences are assumed to be the same across countries but endowments or technologies are assumed to differ and determine comparative advantage and patterns of specialisation and trade.

In the last two decades, concentration has increased marginally—but consistently—for both exports and imports of critical raw materials and the same was observed for all merchandise products.

Despite the fact that a number of characteristics that distinguish natural resources and raw materials suggest that their exports could in principle be more concentrated than trade of a wider range of merchandise products, they are not (HHI indices of 0.17, 0.15 and 0.14 for, respectively, all merchandise tariff lines, all raw materials and critical raw materials in 2017-19, Figure 3.9).

Assuming the values of HHI of 0.25 or higher are indicative of high concentration, global exports of most categories of the critical raw materials considered in this report do not seem overly concentrated, although, again, this concentration increased fairly consistently across the different critical raw materials in the last decade. In 2017-19, for 27 out of the 33 critical raw material products, export concentration ratios remained below the 0.25 threshold and for 15 out of the 33 products they remained below 0.15, suggesting moderate to low concentration of exports. *Lithium*, with an average HHI of 0.35, was the most globally concentrated exported critical raw material, followed by *borates* (0.34), *cobalt* (0.33), *colloidal precious metals* (0.25), *manganese* (0.25) and *magnesium* (0.25). In addition, all of the highly export-concentrated materials recorded also increases in the concentration in the last decade as did 20 out of all 33 (i.e. 60%) of critical raw material products (right-hand panel in Figure 3.9).

Distinguishing by ‘product’ and ‘sector’ reveals however some higher concentrations and starker increases in their values for some types of raw materials (Annex Figure A C.4). For example, exports of metals and ores of cobalt recorded a high HHI of 0.75 and several other ‘product-sector’ categories recorded HHIs equal to or above 0.4 (manganese-NFMM 0.53; borates-OM 0.51; cobalt-CC 0.46; chromium-OM 0.41 and magnesium-NFMM 0.37). Overall, concentration ratios increased in the last decade for 42 of 78 of such ‘product-sector’ categories. This suggest that concentrations are higher—and are increasing at higher rates—in some segments of critical raw material supply chains. In particular, exports of ores and minerals, non-ferrous minor metals, chemicals and compounds and precious metals record higher than average concentration ratios (Figure 3.9, Panel B).

There is quite a bit of variation when it comes to which countries account for the largest shares of global exports of the different critical raw materials, as would be expected in the case of natural resources. For natural resources in particular, one could expect a more irregular production distribution across the countries than with products which do not depend on natural endowments and production of which can be in principle undertaken anywhere. For example, in the case of the ten critical raw material products with highest global export concentration ratios presented in Figure 3.10, Chile, Türkiye and Democratic Republic of Congo are endowed with important reserves of, respectively, lithium, borates and cobalt and they are also identified among the global top 3 producers of these materials.[16]

However, the more conventional economic factors such as for example economies of scale, size of national economy and technology as well as policies also seem to play an important role. The latter is illustrated by the fact that some countries are identified among top exporters more often than others. China appears in

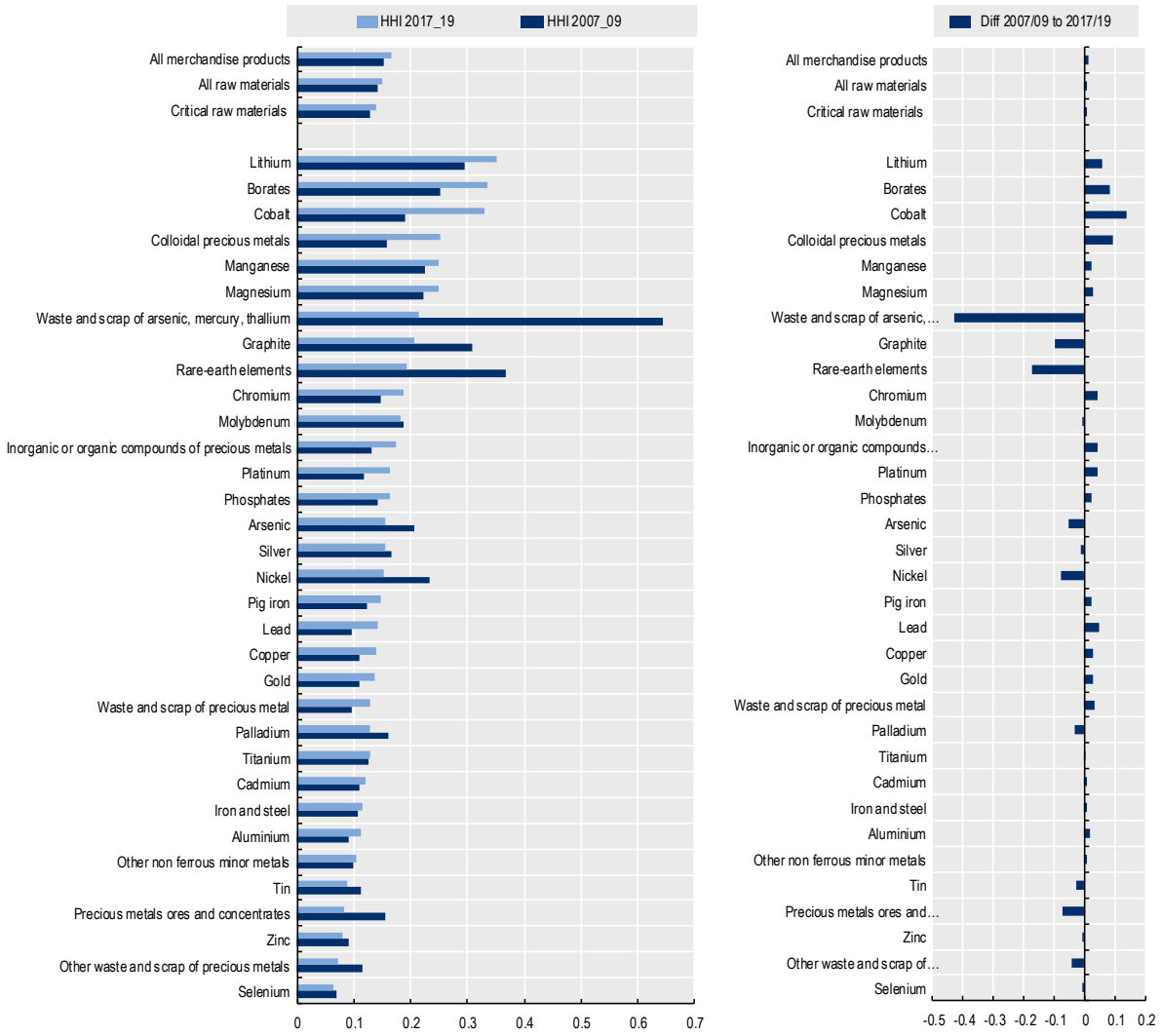
[16] Note also that differences in classification and unit of account differences between the different data sources used explain some of the discrepancies in concentration ratios calculated for the same critical materials based on production or trade data. Australia, for example, is the top producer of lithium in gross weight terms, but it exports primarily lithium in the form of spodumene concentrate which is not included in the UN’s Harmonised System trade classification in any of the two lines referring to lithium exports, namely lithium hydroxide (used in batteries) or lithium carbonate (used in medicine or fabrication of glass). However, several Australian lithium mines are starting to produce lithium hydroxide.

the top 3 exporter lists for 6 out of the 10 most concentrated exports and the United States, Germany and Japan appear each among top 3 exporters for 2 out of the 10 most concentrated exports.

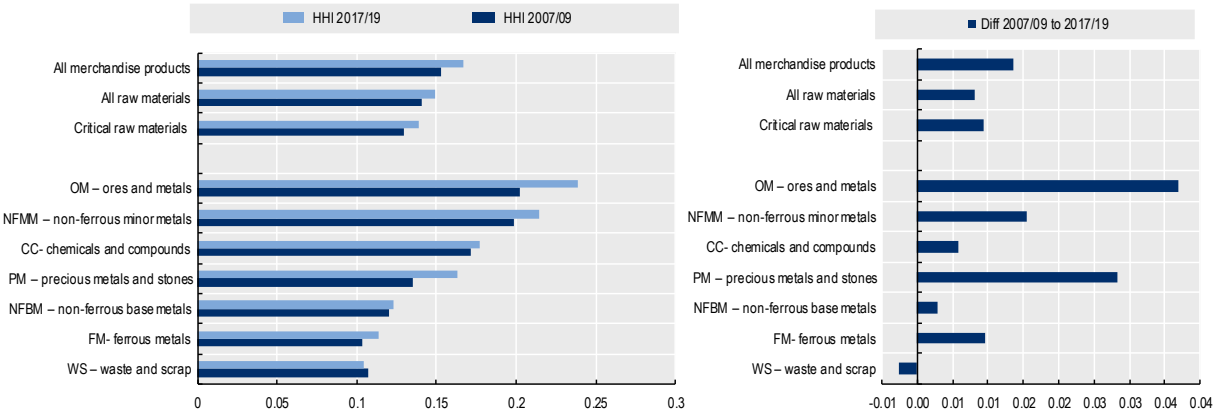
Looking across all critical raw material 'products' and 'product-sectors' and assessing the ranks of country export shares in global exports of these materials, the United States records the highest average ranks of global trade shares, followed by Germany and China. While overall fairly small, average shares are highest for China and there is considerable degree of variation in leading export positions across countries. In addition, several countries which do not hold significant reserves and are not large producers are also on this list. The latter reflects the fact that many of the products on the critical raw materials list are semi-processed as well as the fact that some economies serve as important trade hubs where products are intensely imported and re-exported with little or no processing (Table 3.1 and Annex Table A C.2.).

Figure 3.9. Concentration of global exports of critical raw materials across all exporting countries in the period 2007-09 and 2017-19

Panel A. Global HHI index of export concentration across exporting countries and critical raw material 'products'



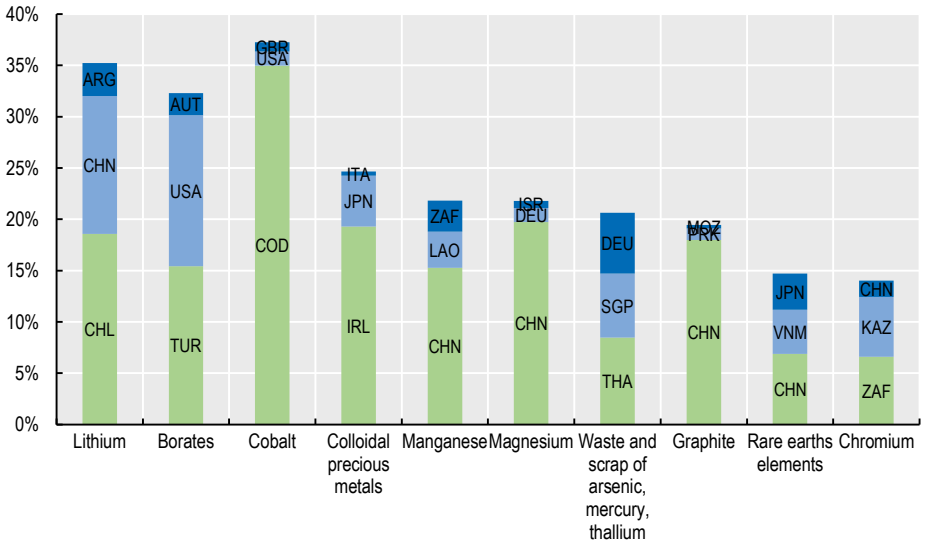
Panel B. Global HHI index of export concentration across exporting countries and critical raw material 'sectors'



Note: HHI indices for these product categories are averages of the relevant HHI indices computed at the HS6 digit level.
Source: OECD calculations using the BACI data.

Figure 3.10. Top 3 exporters of the top 10 most export-concentrated critical raw materials

Top 10 critical raw material 'products'—export shares of top 3 exporters



Note: ARG – Argentina; AUS – Australia; AUT- Austria; CHN - China; CHL – Chile; COD – Democratic Republic of Congo; DEU – Germany; GBR – United Kingdom; ITA - Italy; ISR – Israel; JPN – Japan; KAZ – Kazakhstan; LAO – Lap People's Democratic Republic; MAR – Morocco; MMR – Myanmar; MOZ – Mozambique; PER – Peru; PRT – Portugal; TUR – Türkiye; RUS - Russian Federation; USA – United States; VNM – Viet Nam; ZAF – South Africa; ZWE – Zimbabwe.
Source: OECD calculations using the BACI data.

Table 3.1. Ten exporters with highest shares of exports of critical raw material products

All critical raw material 'products'—10 exporters with top average ranks of shares

	Average rank of trade share	St. dev. of rank of trade share	Average share	Median share
USA	5	3	1.6%	0.6%
DEU	7	6	1.2%	0.7%
CHN	10	13	3.2%	0.6%
JPN	13	14	0.9%	0.3%
FRA	15	9	0.3%	0.1%
GBR	16	10	0.4%	0.1%
CAN	17	10	0.2%	0.1%
RUS	17	14	0.6%	0.1%
BEL	18	12	0.2%	0.1%
NLD	18	9	0.1%	0.1%

Note: BEL – Belgium; CAN- Canada; CHN - China; DEU – Germany; GBR – United Kingdom; FRA – France; JPN – Japan; NLD- Netherlands; RUS - Russian Federation; USA – United States.
Source: OECD calculations using the BACI data.

While imports of critical raw materials are on average even less globally concentrated than exports (HHI of 0.09 compared to one of 0.14, respectively), for some products imports are more concentrated than exports, suggesting significant market power of buyers. This is the case for several categories of the most import-concentrated product categories such as: *waste and scrap of arsenic, mercury, thallium*; *waste and scrap of precious metals such as gold, silver, platinum, iridium, osmium, palladium, rhodium, ruthenium*; and *rare earths elements* (compare Panels A of Figures 3.11 and 3.9).[17] Overall, imports of ores and minerals of critical raw materials are on average as concentrated as exports (equal HHIs of 0.24 in 2017-19, Panels B of Figure 3.11 and 3.9).

For some of the most import-concentrated materials, the top-3 importer shares are also higher than top-3 exporter shares. This is the case for both of highly import-concentrated *waste and scrap* categories where the top 3 importers account for more than 70 of global imports, and for *lithium*, *precious metals ores and concentrates*, *cadmium* and *rare earths* where the top-3 import shares exceed 50% (Figure 3.12).

This may suggest that, first, for some raw materials major importers may have similar levels of economic leverage to key exporters (and incentives to exploit it, for example with the use of policies that influence prices of these imports). Second, this suggests that in so far as concentrated exports can be a source of disruptions in some supply chains, import concentration can in principle also have important effects in some critical raw materials supply chains. Similarly, concentration of imports of critical raw materials has increased in the last decade.

China appears in the top 3 lists for 6 out of the 10 most import-concentrated critical raw material products (7 out of 10 for 'product-sectors'), while the United States appears in 5 (1 for 'product sectors') and Germany in 2 (1 for 'product-sectors'). Similarly to exports, as described above, in terms of average ranks of export shares, United States and Germany lead the lists of top importers of critical raw materials, followed by China (Table 3.2), although China's shares are on average the highest.

As for exports, the relatively more frequent counts of China than the United States and Germany among the top 3 importers, contrasted with lower average export share ranks suggest that, while the latter two countries are still dominant players in trade of critical raw materials, China tends to be particularly present in the most concentrated imported (and exported) critical raw materials.

The top 3 exporter and importer lists feature some smaller economies such as, for exports, Argentina, Congo, South Africa, Israel, Thailand, Singapore, Mozambique, Viet Nam, Kazakhstan, Pakistan, and for

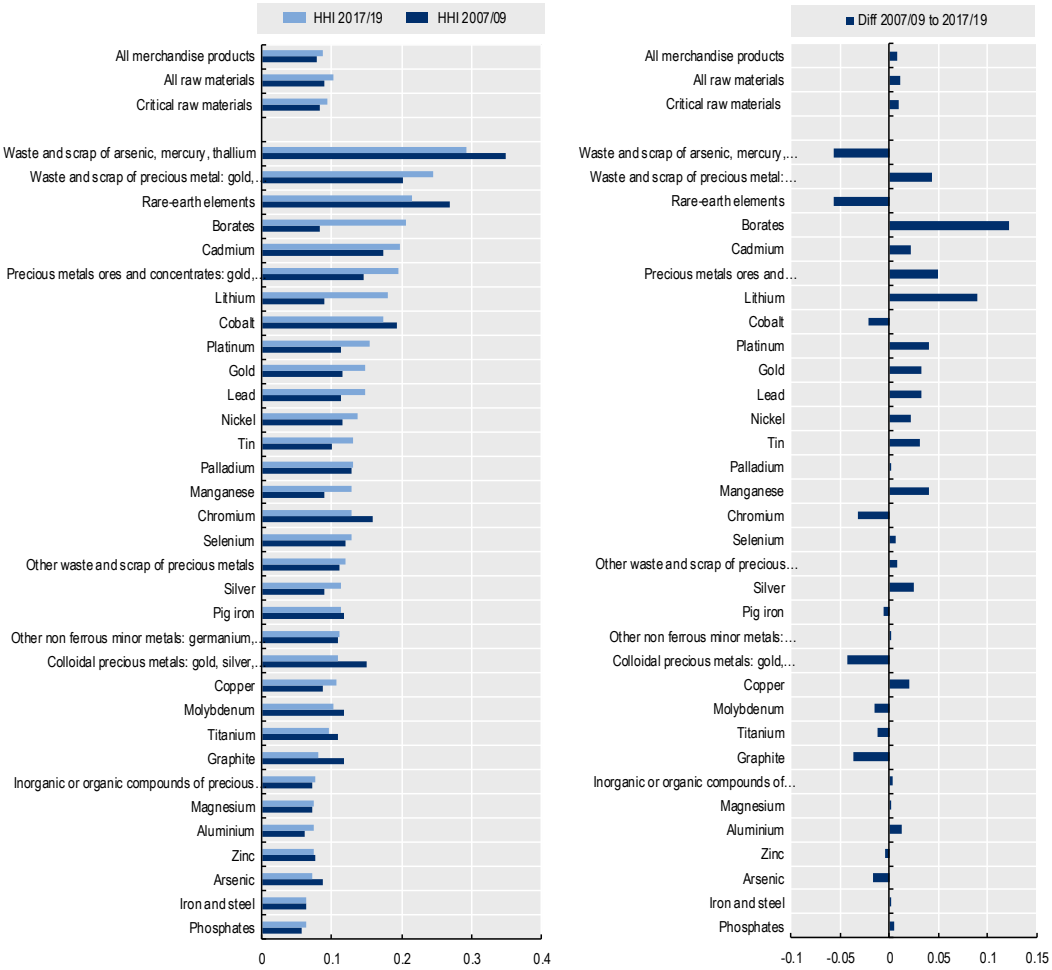
[17] Imports of several 'product-sectors' are also more globally concentrated than exports. This is the case for example for: ores and minerals (OM) of aluminium; tin; nickel; and manganese (see Annex Figure A C.3.).

imports Laos, Slovakia, Guyana, Singapore, Zimbabwe. This suggests that global trade of some of the critical raw materials depends significantly on otherwise relatively small economies.

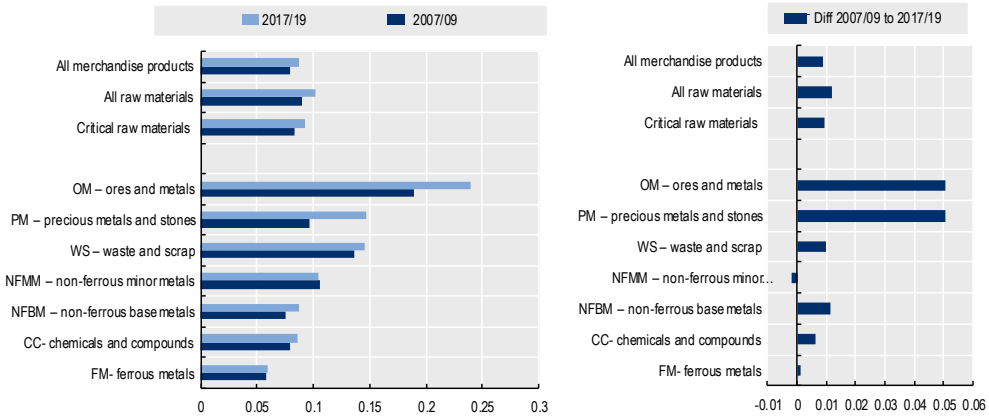
Overall, the evidence presented in this section suggests that while country concentration of both imports and exports of critical raw materials has been increasing, trade of these materials seems diversified. This may suggest that the possibility of a significant disruption of the green transition by disturbances to specific import or export flows concerning critical raw materials are relatively limited. The relatively low concentration indices reported here can be interpreted as implying that even disruptions of supply (or demand) affecting top players would occur in the market context characterised by relatively high shares of other players, suggesting relatively good prospects of adjustment, especially in the medium to long term. Nevertheless, concentrations of exports and imports are significant in some specific cases, particularly in upstream segments of some critical raw materials supply chains.

Figure 3.11. Concentration of global imports of critical raw materials across all exporting countries in the period 2007-09 and 2017-19

Panel A. Global HHI index of import concentration across importing countries



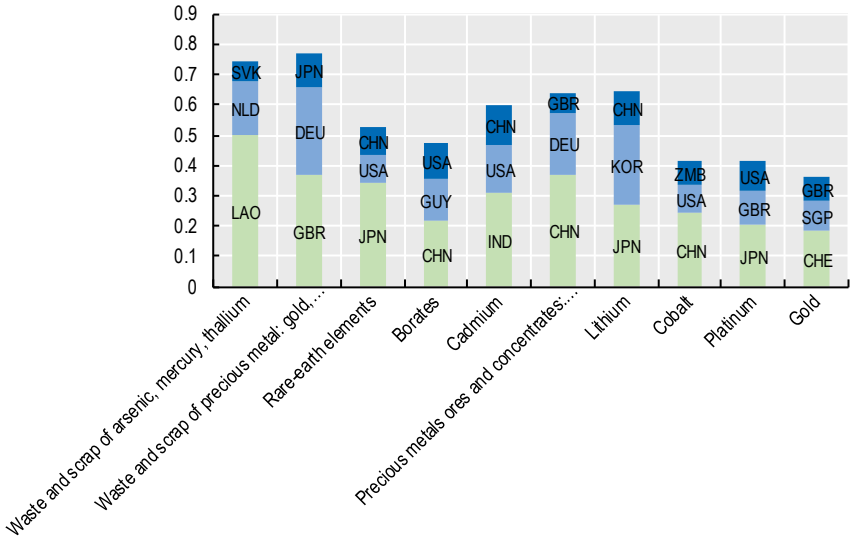
Panel B. Global HHI index of import concentration across importing countries and critical raw material 'products' and 'sectors'



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

Figure 3.12. Top 3 importers of the top 10 most import-concentrated critical raw materials

Top 10 critical raw material 'products'—import shares of top 3 importers



Note: CHN - China; DEU– Germany; GBR – United Kingdom; GUY – Republic of Guyana; IND- India; JPN – Japan; KOR- Korea; LAO – Lap People's Democratic Republic; NLD – Netherlands; SGP – Singapore; SVK – Slovak Republic; USA – United States; ZMB – Republic of Zambia.
Source: OECD calculations using the BACI data.

Table 3.2. Ten importers with shares of imports of critical raw material products

All critical raw material 'products' – 10 importers with top average ranks of shares

	Average rank	Standard deviation of rank	Average share	Median share
USA	4	5	9%	9%
DEU	4	4	9%	8%
CHN	7	9	10%	7%
GBR	9	7	6%	4%
JPN	9	8	7%	4%
KOR	9	6	4%	3%
IND	11	8	4%	3%
NLD	12	6	3%	3%
FRA	13	7	3%	2%
BEL	13	9	4%	3%

Note: BEL – Belgium; CHN - China; DEU – Germany; GBR – United Kingdom; FRA – France; IND – India; JPN – Japan; KOR –Korea; NLD-Netherlands; USA – United States.
Source: OECD calculations using the BACI data.

3.4. Bilateral trade dependencies of OECD countries on imports of critical raw materials

3.4.1. Dependencies on non-OECD exporters

While concentration of global trade of critical raw materials seems modest overall it may be more significant in some specific cases. In particular, some importers of certain critical raw materials can depend more significantly on specific suppliers and they may have fewer diversification options than suggested by average global concentration figures. Such concentrated bilateral dependencies might in principle be associated with more acute impacts and slower adjustments in the case of shocks, unexpected policy developments or disruptions due to geopolitical tensions or conflicts.

To shed more light on critical raw material import dependencies that might be of concern to OECD countries, the remainder of this sub-section explores a proposed simplified definition of 'trade dependencies'. For the purposes of analysis here, bilateral import dependencies are defined by combining three sets of criteria: (i) importing OECD countries source relatively high shares of imports of products from specific non-OECD countries[18] (e.g. Russia or China, i.e. criterion of a high partner share where the value of the import from a specific non-OECD country exceeds or equal to 10% of the OECD's country's overall value of imports of the product); (ii) they cannot easily replace these shares with imports from alternative countries because of the high concentration of these imports (criterion of high concentration);[19] and (iii) other OECD countries are currently not viable alternatives (criterion of an additional low share of other OECD suppliers). Note also that the fact that other OECD countries may be supplying high shares of a given product does not automatically mean they would be able to easily scale up this supply even further. It merely means alternative OECD suppliers are already present in the market (See Annex Box A C.1. for more information on this definition).

Looking at detailed gross import data, as is the approach here, allows a reasonably comprehensive coverage of countries and specific products at a good level of detail but suffers from many limitations. For example, it does not account for where the value added embodied in the imports originates, or for the extent to which imports are actually retained or used for exports or further processing in other countries. In a world of complex international supply chains, the weakest link can sometimes determine the vulnerability of the whole chain. The methodology applied also abstracts from how much is produced and

[18] While a broad "non-OECD" grouping is used for the analysis, it should be noted that concerns about potential concentration have tended to focus on relatively few economies at the centre of geopolitical tensions.

[19] Here, concentration is defined again as HHI of imports of a given product calculated across all supplying countries exceeding or equal to 0.2. Similarly to earlier sections, the level of concentration has been calculated here using CEPII's BACI dataset and are averages of bilateral trade values in years 2017, 2018 and 2019 (i.e. the three years preceding the COVID-19 pandemic to assume away the pandemic-related abnormalities).

consumed in the importing countries and whether trade links concern intra or extra-firm trade flows. This approach can therefore miss some dependencies while overstating others. Other methodological approaches, most notably the OECD's Inter-Country Input-output and Trade in Value Added (TiVA) data, or related sector specific work can be explored further to arrive at a more comprehensive assessment.

The counts (and shares of counts) of bilateral trade flows of specific products are principal indicators of dependencies considered here. This is motivated by the fact that even flows which are small in terms of value, when disrupted, can be of concern. Alternative indicators that take the shares of values of relevant trade flows into account certainly could shed more light on the economic significance of the dependencies and can be usefully explored in future work on this topic.

Looking across all merchandise products and all trading partners, the estimated import dependencies defined in this way are modest overall. Dependent trade relationships with non-OECD countries (24 486 bilateral relationships meeting these criteria) account for only 0.4% of all bilateral trade relationships involving OECD countries as importers (1.4% if imports from non-OECD countries are concentrated but alternative OECD suppliers account for relatively high market shares). In value terms, they account for, respectively, 8% and 16% of OECD imports (Table 3.3). Overall, even with the relatively broad definition of trade dependencies used here, close to 99% of all bilateral OECD merchandise import links (and 84% of the value of imports) is not characterised by high shares of imports of products from specific non-OECD countries nor high overall concentration of imports (Table 3.3).[20]

Table 3.3. Counts and shares of OECD countries' bilateral imports meeting different 'dependency' criteria

Description	Number of concerned tariff lines	% of all tariff lines	Value (USD bln)	% of total value
All bilateral flows of OECD countries as importers	5 765 589	100.0	11 328	100
Of which meeting the following criteria				
Imports are overall highly concentrated (HH1>=0.2)	3 332 786	57.8	6 252	55
Imports from any partner accounts for a high share in country's imports (>=0.1)	474 697	8.2	7 610	67
Flows with high HHI and bilateral share	295 538	5.1	4 816	43
Of which				
OECD exporters	214 454	3.7	3 023	27
Non-OECD exporters	81 084	1.4	1 792	16
Of which critical raw materials	6 154	0.1	118	1
Non-OECD exporters and share of other OECD exporters <0.2	24 486	0.4	899	8
Of which critical raw materials	1 738	0.03	56	0.5

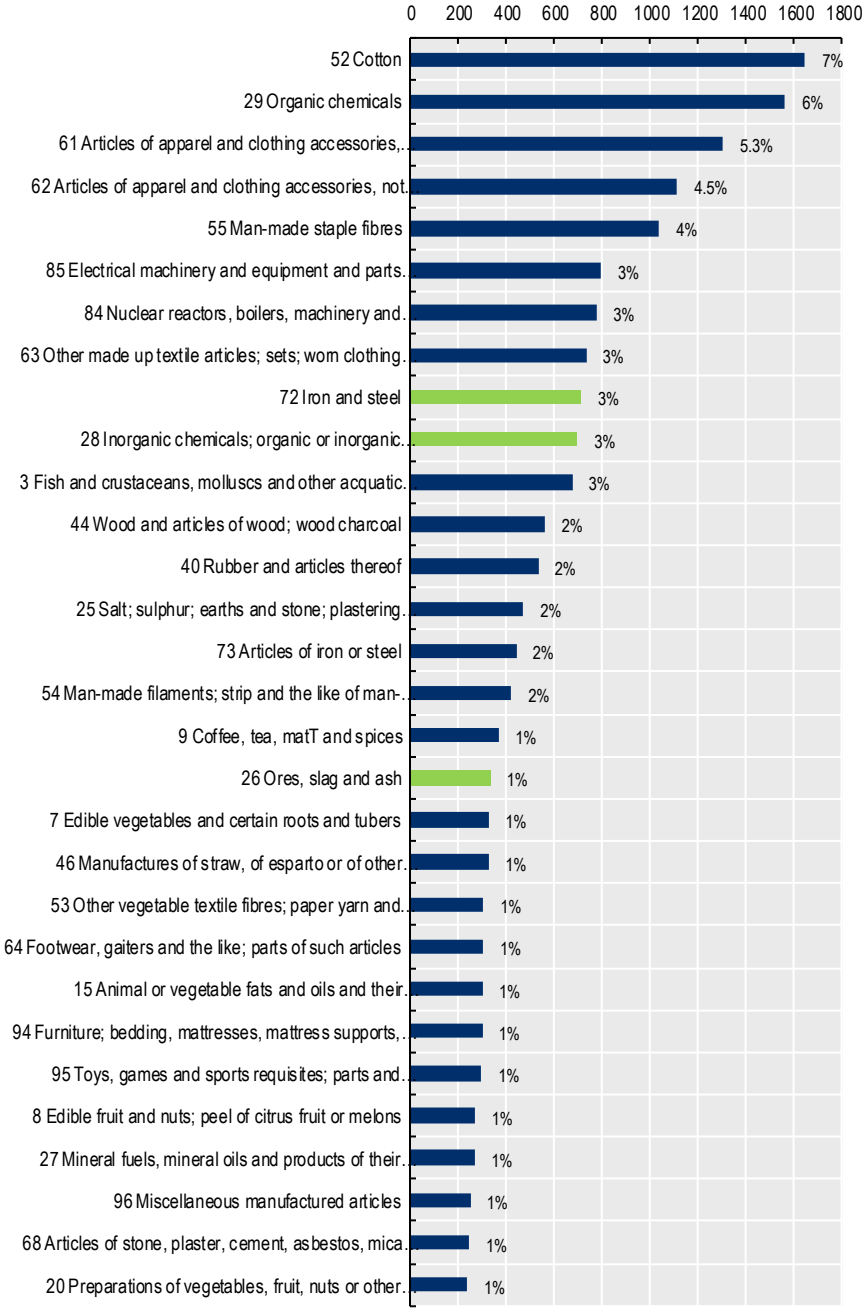
Source: OECD calculations using the BACI data.

Critical raw materials account for 'only' 1 784 of dependent bilateral import links, i.e. for 0.03% of all bilateral merchandise import links of OECD countries (0.5% in value terms). However, they account for 7% (6% in value terms) of dependencies of OECD countries on non-OECD suppliers, which means that OECD dependencies are relatively concentrated in the critical raw materials sector.

Most of the dependent critical raw material import links fall into the three HS chapters that qualify as the top 30 HS chapters with highest counts of dependent trade links. These are: *iron and steel* (i.e. HS chapter number 72); *inorganic chemicals* (HS29) and *ores, slag and ash* (HS26) (Figure 3.13).

[20] Note that counts (and shares of counts) of bilateral trade flows of specific products imply a smaller degree of dependency than value shares. However, both approaches can be informative. Analysis based on counts is justified if one believes even flows which are small in terms value, when disrupted, can be of concern (as can be the case for example with some consumer products or intermediate inputs which are considered critical. Analysis based on values may be more informative for assessing the overall economic significance of such dependencies.

Figure 3.13. Count of dependencies for all importing OECD countries across broad products (top 30 HS2 product categories)



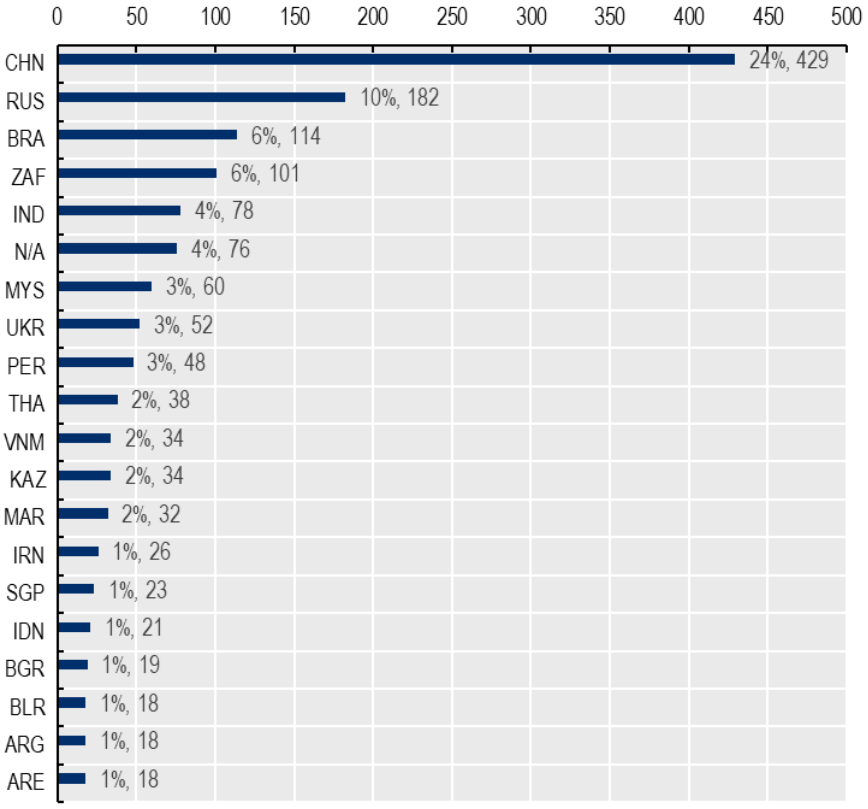
Note: Data labels give shares of dependencies involving a given product as % of all dependencies in point. Bars in green denote broad products (HS 2-digit chapters) which also contain products belonging to the critical raw materials covered here.
Source: OECD calculations using the BACI data.

Critical raw material import dependencies of OECD countries on non-OECD economies are concentrated in terms of countries. China accounts for 24% of the total, while the next country, Russia, accounts for 10%, followed by Brazil (6%), South Africa (6%) and India (4%) (Figure 3.14).

Moreover, these dependencies are not evenly distributed across importing OECD countries, with Japan, for example, accounting for 9% of all OECD dependencies, followed by Chile, Colombia and Australia (8% each) (Figure 3.15). The results for the latter three countries may be surprising given that some of them are themselves large raw materials exporters but they show that these countries also depend on foreign supplies for some critical raw materials. For Chile and Australia, for example, these dependencies are concentrated mainly in *iron and steel* and *inorganic chemicals* imported again mainly from China and other BRIICs countries, while for Colombia *aluminium* materials are also significant.

Figure 3.14. Count and share of dependencies in critical raw materials across supplying countries (top 20 exporting countries)

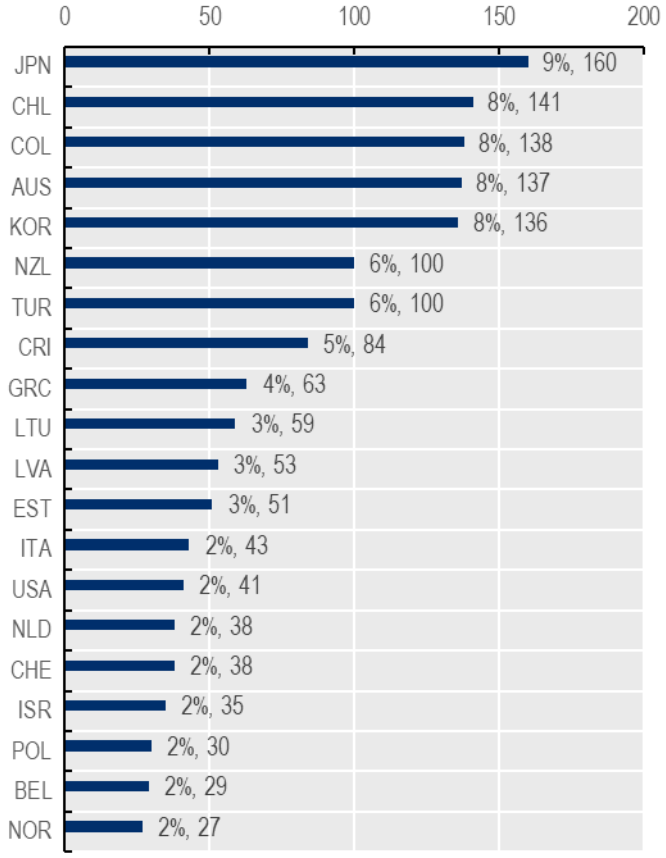
Count of relevant dependencies



Note: N/A indicates imports which have been reported by reporting countries but where the exporter was not identified. Axis scale – count of relevant dependencies; label – share of dependencies involving a given country (product) as % of all dependencies in point.
Source: OECD calculations using the BACI data.

Figure 3.15. Count of dependencies in critical raw materials across importing OECD countries (top 20 importing countries)

Count of relevant dependencies



Note: Data labels give shares of dependencies involving a given country (product) as % of all dependencies in point.
Source: OECD calculations using the BACI data.

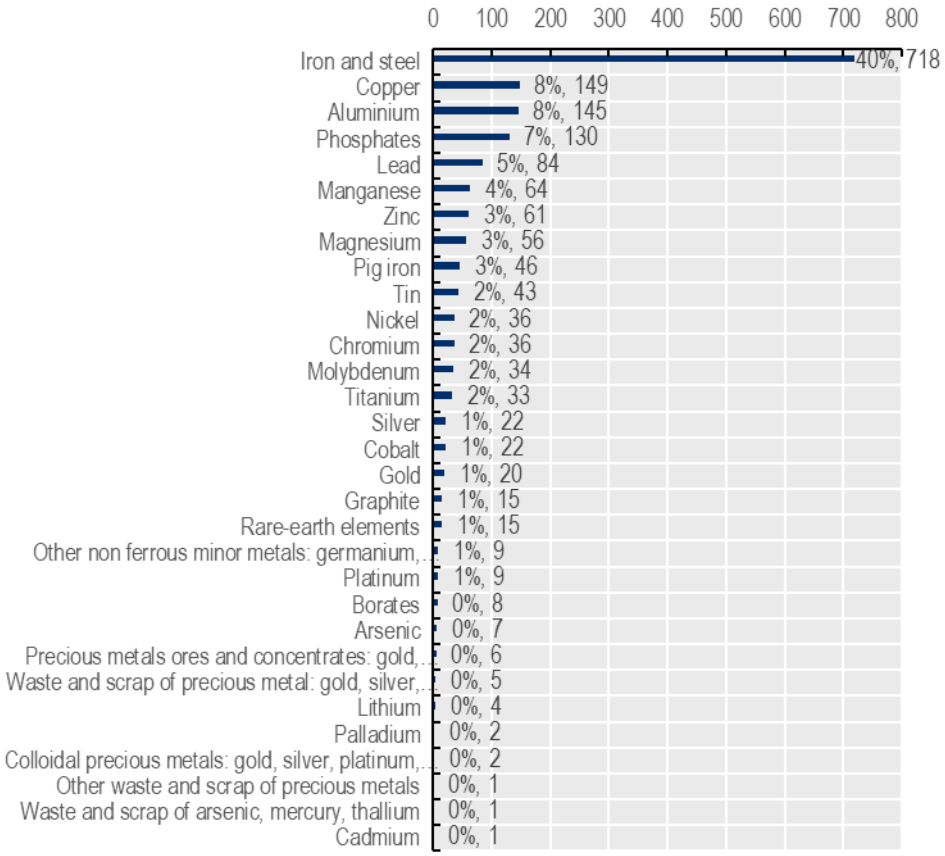
Dependencies exist across a range of different products but they are concentrated heavily around traditional metals such as *iron and steel* (count of 718 corresponding to 40% of all OECD dependencies in critical raw materials), *copper* and *aluminium* (8% each) (Figure 3.16). Dependencies for the most dependent categories of products are concentrated in China, Russia, Brazil and other BRIICS countries, although for *iron and steel* the non-BRIICS economies account for a sizeable 40% of dependencies (Figure 3.17). Counting dependencies across our 'sectors' confirms that close to 60% of dependencies of OECD countries are in *ferrous and non-ferrous metals* and additional 18% of dependencies are in *metal ores and minerals* (Figure 3.18).

Relatively small numbers of dependencies are recorded for *cobalt* (22 dependencies), *borates* (8) and *lithium* (4). This may come across as surprising because these materials were identified in earlier sections of this paper as some of the globally most export-concentrated critical raw materials (Section 3.3). Nevertheless, this is not inconsistent with the moderate export concentration ratios of critical raw materials overall and with the fact that OECD imports of these relatively more export-concentrated products are relatively well diversified and that OECD importers are sourcing relatively significant shares of these products from other OECD countries. For example, Japan and Korea, which together accounted for 65% of OECD's imports of *lithium* in 2017-19, were sourcing the products from both non-OECD and OECD countries. Thirty-six per cent of the value of *lithium* imported by Korea comes from China and for Japan imports from China accounted for 45%, but in the case of Korea 56% of the value of imported *lithium* comes

from Chile and an additional 1% from the United States, and in the case of Japan, 33% comes from Chile and 12% from the United States.[21]

Figure 3.16. Count of dependencies across different critical raw material products

Count of relevant dependencies



Note: Data labels give shares of dependencies involving a given product as % of all dependencies in point.
Source: OECD calculations using the BACI data.

In addition to the already mentioned caveats that are associated with defining trade dependencies in this way, the example of *lithium* shows that the criteria used—while informed by the literature—are necessarily arbitrary. If adjusted, they would give different counts and distribution of dependent products. For example, if the import share criterion from other OECD countries is lifted more (37 instead of 4) bilateral trade links involving *lithium* would qualify as 'dependent'. However, the approach allows to clearly and transparently identify some specific trade links at the fine level of product disaggregation which could be of concern. Ultimately, a sensitivity analysis involving different sets of criteria may be an interesting avenue for further research and it may, or may not, change the key qualitative findings of this analysis.

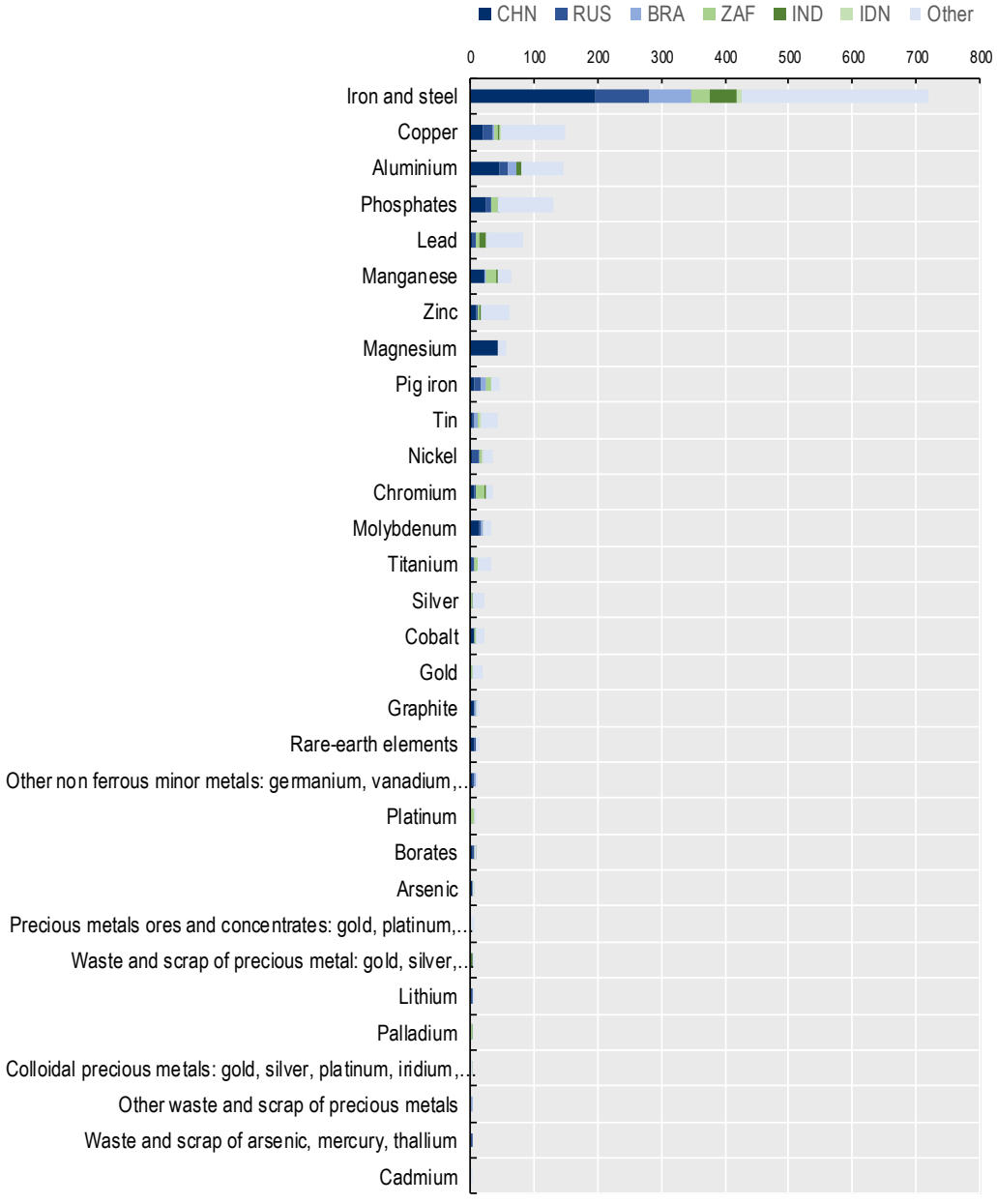
An illustration is provided in Annex figures A C.8. through to A C.11 which are replicates of Figures 3.14 through to Figure 3.17, but when the criterion of a low share of imports from other OECD countries is lifted. Unsurprisingly, the counts and shares of dependencies change, but the overall picture remains rather

[21] In addition to the already mentioned caveats that are associated with defining trade dependencies in this way, the example of lithium shows that the criteria used—while informed by the existing literature--are necessarily arbitrary. If adjusted, they would give different counts and distribution of dependent products. For example, if the import share criterion from other OECD countries is lifted more bilateral trade links involving lithium would qualify as 'dependent'. On the other hand, the approach allows to clearly and transparently identify some specific trade links at the fine level of product disaggregation which could be of concern.

similar: the ranking of products with the most OECD dependencies is very similar (*iron and steel*, *copper*, *aluminium*, *phosphates* and *lead* record the five highest counts, and in the same order); the ranking of exporting countries is similar (China, Russia, Brazil, South Africa and India record the five highest counts, although the order is marginally altered); and the ranking of the top five most depend OECD countries (Japan, Korea, Australia, Colombia and Chile) is also very similar.

Figure 3.17. Count of dependencies across different critical raw material products and supplying individual BRIICS* and other countries

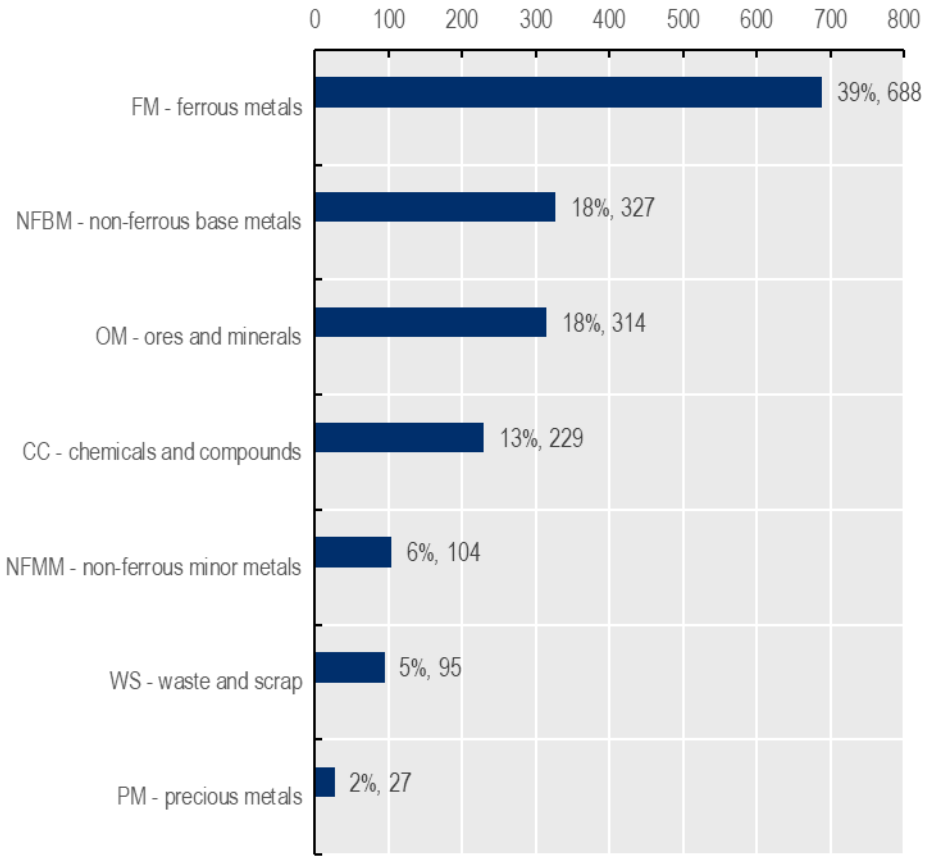
Count of relevant dependencies



Note: *BRIICS countries are Brazil, China, India, Indonesia and South Africa.
Source: OECD calculations using the BACI data.

Figure 3.18. Count of dependencies across different critical raw material 'sectors'

Count of relevant dependencies



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

4. Export restrictions on critical raw materials

4.1. Export restrictions in a broader policy context

Raw materials are mainly used as inputs into production of other goods and services—i.e. they are positioned 'upstream' in domestic and international supply chains—implying that disruptions or policies affecting their supplies may have important systemic implications. This is sometimes stated as a justification for state intervention, e.g. in the form of subsidies, restrictions on exports or foreign ownership in order to support downstream domestic sectors, and makes critical raw materials prone to be targeted in economic coercion and geopolitical rivalries.

As far as economic effects of such state interventions are concerned, a subsidy to raw material production which is passed on to downstream users in the form of lower material prices will put the competing foreign producers at a disadvantage and will benefit downstream users, both domestic and foreign ones if the material is exported. However, a restriction on exports of a raw material which results in lowering of a domestic price relative to world market prices will normally disadvantage the domestic material producer, but it will benefit domestic downstream users to the detriment of foreign users. In addition, such diversion of raw materials to domestic use by imposing export taxes or quantitative export restrictions may also contribute to the rise of world market prices, in particular if the exporter holds a large share of the market.

Such restrictions create incentives for other producing countries to introduce similar restrictions, putting yet more upward pressure on international prices and ultimately creating more incentives to restrict exports. Such spiralling increases in commodity prices have indeed sometimes been both a reflection of, and a factor behind, escalating export restrictions on raw materials in countries seeking to develop domestic processing industries.

Beyond the objectives of supporting downstream industries, export restrictions in the form of export taxes are sometimes used to address environmental or social externalities of raw material production or to raise tax revenue. Raising government revenue through export taxes on raw materials can be particularly attractive for countries which have significant market power or those with underdeveloped tax systems where taxing natural resources is often one of the few available sources of government revenue.

The upstream positioning in supply chains may also mean that raw materials may be subject to economic mechanisms which are characteristic to upper segments of supply chains. For example, the "bullwhip effect" has been posited in the business literature to magnify the amplitude of shocks in the upper echelons of value chains (Forrester, 1961[10]). More generally, as relatively undifferentiated products in highly competitive markets, raw materials are known to be characterised by high price and volume volatility, which can be another reason for state intervention, particularly in countries which rely significantly on exports of these natural resources.

Finally, national natural resources are customarily seen as publicly owned but exploitation rights are often private, and their extraction often creates significant environmental and social externalities, implying the need for regulation and state control. This implies also that some types of measures considered conventionally as export restrictions, such as for example licensing requirements motivated by a need to register or monitor exports of some materials for environmental or social purposes, may have no—or only a small—negative impact on exports. At the same time, environmental or social objectives of licensing requirements do not exclude a more significant impact on exports.

A comprehensive analysis of the policy environment in the critical raw material sectors would have to cover a broad set of trade and other policies, including regulation of the mining industry, social, environmental and governance standards, state ownership, government support and investment and financial policies. This is beyond the scope of this report which instead focuses on the narrower export restrictions dimension of the broader policy landscape. It draws on the OECD's Inventory of Export Restrictions on Industrial Raw Materials which covers the period from 2009 to 2021[22] and contains unique information that allows a characterisation of some important elements of this broader environment.

The description of the approach to collecting data on export restrictions on industrial raw materials, as well as an early stocktaking of the measures in place on waste and scrap of metals and selected minerals and metals was provided in (Fliess and Mård, 2012[7]). An updated description of the data collection process, product and country coverage as well as the type of included export restrictions is provided in Annex A. Notwithstanding some of the limitations related to the stage of development of the Inventory at the time, this earlier work reported on a number of characteristics some of which are still visible in the data today and are documented below.

4.2. Incidence of export restrictions across the different critical raw materials

The incidence of export restrictions applied to all industrial raw materials covered in the OECD Inventory has been increasing steadily[23] in the last two decades. That is, introductions of new restrictions have been consistently outnumbering eliminations and the total count of measures in force across all industrial raw

[22] Currently, the latest update of the export restrictions data covers measures in place up until the end December 2021. The analysis in this report is based on export restriction data available at the time of its preparation, i.e. covering data up to 2020.The process of updating the Inventory with data on restrictions in place in 2022 is currently under way.

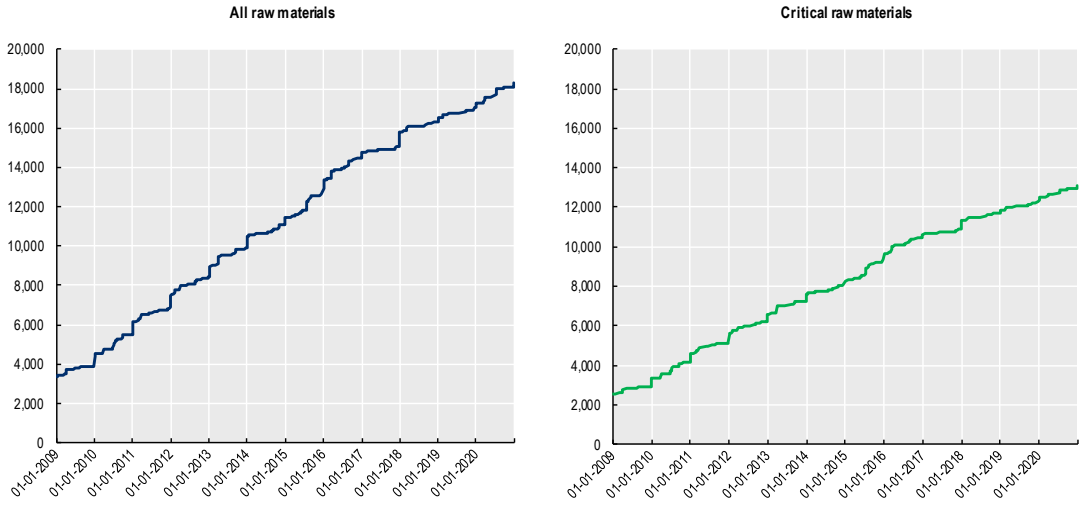
[23] There do not seem to be big developments in the pace of changes although a slightly higher pace of increase can perhaps be observed in the first part of that period, in the years immediately following the Global Financial Crisis until about the end of 2016, and a lower one afterwards. Still, relatively steep increases are also observed at the beginning of 2018 and in 2019 and 2020.

materials and all countries covered in the OECD database grew from 3 337 measures[24] at the end of January 2009 to 18 263 in December 2020—the last period covered in the analysis here, i.e. by more than five-fold (Figure 4.1). This corresponds to a compound growth rate of the number of measures in force of 1% each month since 2009.

In the same period, the total count of measures in place across critical raw materials—a subset of all raw materials covered in the Inventory—grew from 2 518 measures at the end of January 2009 to 13 102 in December 2020, also more than five-fold but slightly less than for all raw materials (Figure 4.1).

Figure 4.1. The incidence of export restrictions has been increasing steadily in the last decade

Total count of export restrictions in place



Note: The count of all types of measures in place across all covered raw materials and all implementing countries taking into account the stock of measures in place at the beginning of the period as well as new additions and eliminations.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Export restrictions are not distributed evenly across the different critical raw materials but the ranking of products with the highest per HS code incidence[25] of restrictions in 2020 is very similar to that at the beginning of 2009 (see the right- and left-hand side panels of Figure 4.2; the coefficient of correlation of ranks in the two periods is equal to 92%).

Three waste and scrap product categories (*other waste and scrap of precious metals*; *waste and scrap of precious metal: gold, silver, platinum, iridium, osmium, palladium, rhodium, ruthenium* and *waste and scrap of arsenic, mercury, thallium*) recorded the highest incidence of export restrictions per HS code across all critical raw materials in both 2009 and in 2020. *Tin*, *titanium*, *gold*, *platinum* and *cobalt* were also among the top 10 highest incidence products, and with the same ranks in both periods, while *cadmium* and *copper* swapped between each other the 10th and 11th places. The ranking of products with the smallest incidence of export restrictions (*arsenic*, *lithium*, *borates*, *selenium* and *inorganic or organic compounds of precious metals*) has also remained fairly stable.

[24] The term 'measures' is used throughout the report in reference to actual HS codes that are covered by different export restriction measures. I.e. one export restriction measure (e.g. a legal act establishing an export tax) can apply to several HS codes.

[25] As discussed in Section 2, the OECD export restrictions data are collected at the level of HS codes and the different critical raw materials products are typically represented by different numbers of such codes. At the product level, the counts of export restrictions are therefore scaled by the corresponding number of relevant HS codes. These 'scaled' counts of restrictions thus give an average incidence of restrictions per HS code.

This is illustrated also by the relatively uniform increase factors across the different critical raw material products[26] (middle panel in Figure 4.2) and a lack of strong correlation between increase factors and the initial and current incidence scores which means that products with the highest or lowest initial (or current) incidence of export restrictions did not experience particularly strong increases in that period.

Still, some materials have seen larger increases in the global incidence of restrictions than others (middle panel of Figure 4.2). *Pig iron* recorded the largest increase across all raw materials covered (approximately 11-fold) while thirteen other product categories recorded factors equal to or higher than the average (5.5): *selenium* (9); *silver* (8.7); *borates* (8.3); *rare-earth elements* (7.8); *phosphates* (7.3); *molybdenum* (7.2); *titanium* (7.1); *aluminium* (6.5); *natural graphite* (6.3); *tin* (5.6); *waste and scrap of precious metal* (5.9); *other non-ferrous minor metals* (5.6). *Lithium*, was the material with the lowest increase (2.7) followed by *inorganic or organic compounds of precious metals* (2.8), *colloidal precious metals: gold, silver, platinum, iridium, osmium, palladium, rhodium, ruthenium* (3.3) and *palladium* (3.4).

Organising the export restrictions data by 'sector' reveals that both in 2009 and 2020, the highest number of export restrictions measures concerned *waste and scrap* (Figure 4.3). Annex Figure A D.4, which plots the same data across both products and sectors, shows further that this phenomenon concerns waste and scrap of a broad range of critical metals. This possibly underscores a broadly shared appreciation of the potential of the circular economy as an alternative to extraction or imports. Nevertheless, these policies may still be sub-optimal from a global point of view as they may prevent recycling in potentially more efficient foreign locations.

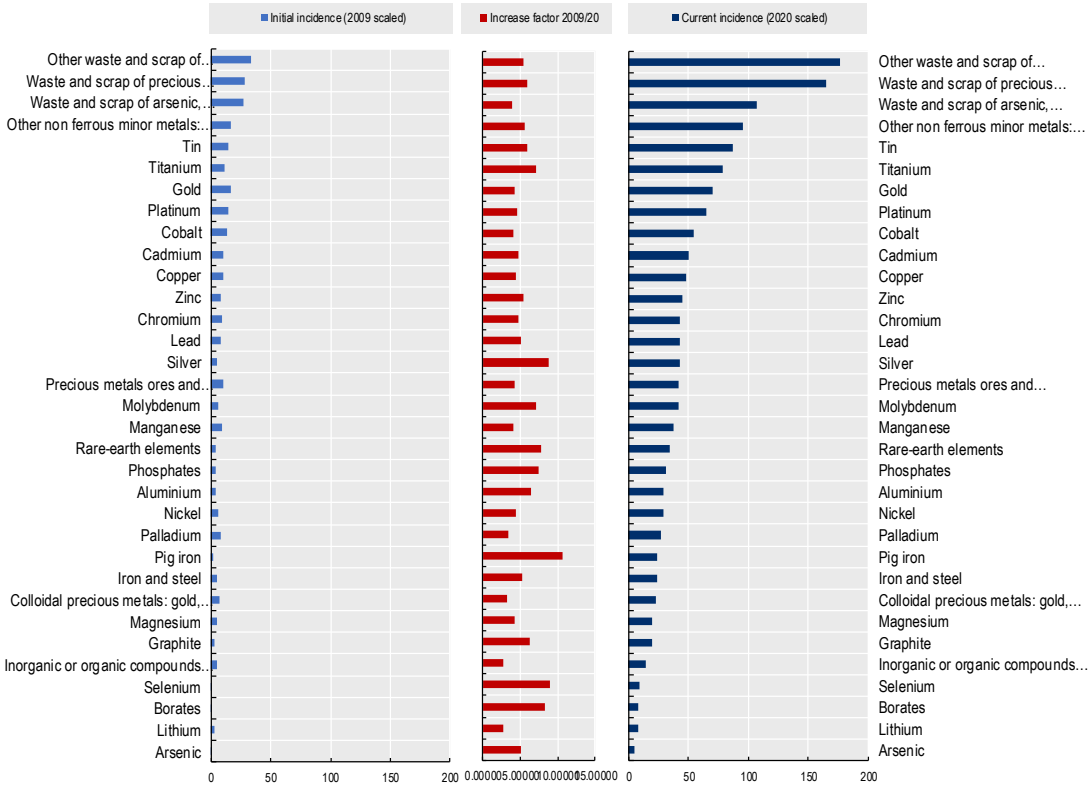
Restrictions on ores and minerals – i.e. raw materials located in upper segments of critical raw material supply chains – grew visibly faster than restrictions in the other sectors (Figure 4.3) and this phenomenon was observed for a broad range of ores and minerals (Annex Figure A D.4). While this descriptive statistical analysis cannot prove causal links, the marked increase in restrictions on ores and minerals correlates with the relatively faster increase of the global concentration of imports and exports of this sector presented in Section 3. It is also consistent with the logic of supporting domestic downstream industries through restrictions on exports of upstream products.

When trade values are taken into account, it is estimated that, in recent years, about 10% of global value of exports of critical raw materials faced at least one export restriction measure (up from 8% at the beginning of the period) (Figure 4.4). However, for several minerals, such as *cobalt*, *inorganic or organic compounds of precious metals, precious metals ores and concentrates, tin, palladium* and *rare earths* these shares exceeded 30% and there were also significant changes in shares of exports facing export restrictions for specific raw materials between the beginning and the end of the analysed period (Figure 4.4). It is also interesting to see that the share of exports of waste and scrap products—the category with relatively high incidence of export restrictions per HS code (Figure 4.2) is relatively low (4%). This suggests that countries that impose export restrictions on waste and scrap are relatively small players in the global market for these products.

[26] There is more heterogeneity in the scores increase factor among all the 382 critical raw material HS codes (Annex Figure A D.1.). The median, average and standard deviation of the increase factor are, respectively, 5.0 (i.e. five-fold), 5.5 and 2.8. However, for 62 HS codes the increase factor exceeded the average plus on standard deviation (increase of more than 8.3 fold) and sixteen products have seen increases larger than the average plus two standard deviations (more than 11.1 fold) (these codes are shown in Annex Figure A D.2 together with those with the smallest factor increases).

Figure 4.2. Initial and current incidence of export restrictions across critical raw material products

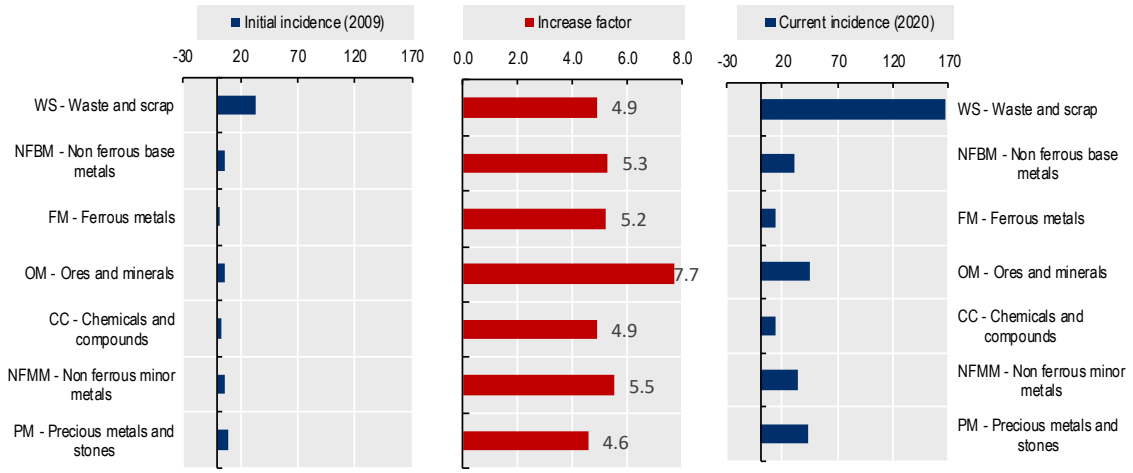
Initial scaled ('per HS code') incidence* of export restrictions by product, increase factor and current scaled incidence



Note: *The scaled incidence is the number of export restrictions recorded for the product divided by the number of HS codes that describe that product. Products are ordered by the scaled incidence in 2020. Increase factor = scaled count of measures in place in December 2020 / scaled count of measures in place in January 2009.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 4.3. Initial and current incidence of export restrictions across critical raw material sectors

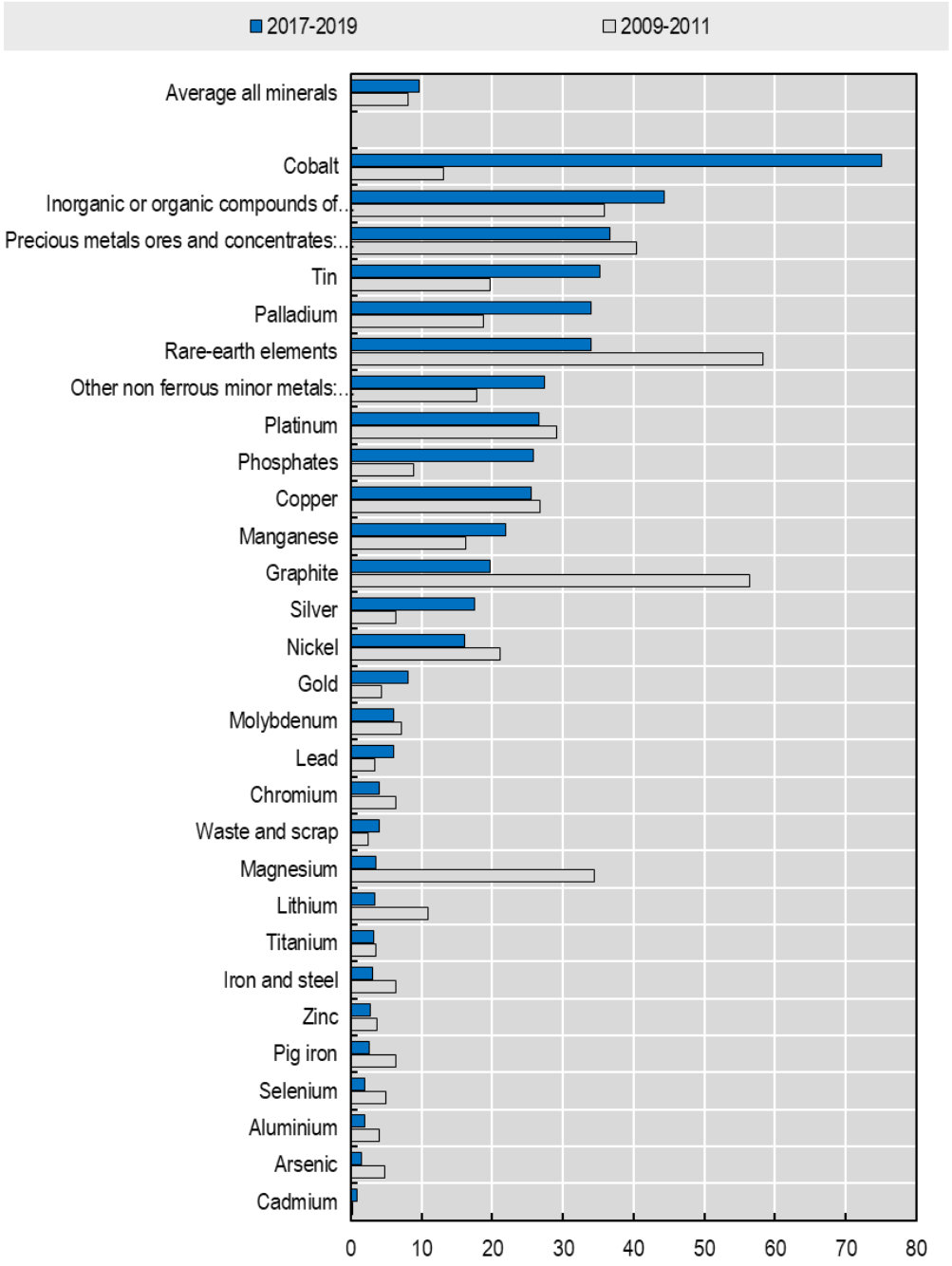
Initial scaled ('per HS code') incidence* of export restrictions by sector, increase factor and current scaled incidence



Note: *The scaled incidence is the number of export restrictions recorded for the product divided by the number of HS codes that describe that product. Products are ordered by the scaled incidence in 2020. Increase factor = scaled count of measures in place in December 2020 / scaled count of measures in place in January 2009.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 4.4. Global trade of critical raw materials facing at least one export restriction

Share in global exports of a given mineral (%)



Source: OECD Database on Export Restrictions on Industrial Raw Materials and BACI.

4.3. Incidence of export restrictions across imposing countries

More heterogeneity in changes over time is detected when the same data is plotted across implementing countries,[27] as testified by the much lower coefficient of correlation of ranks of 66% as compared to the one calculated across products (92%). Note that only countries which are in scope of the Inventory and had export restrictions measures in 2009 or introduced them between 2009 and 2020 are included in the database. Other major exporters of some of the critical raw materials, most notably many OECD countries, are in scope of the Inventory but do not have export restricting policies and do not appear in figures below.

While the five countries with the highest incidence of export restrictions in 2020 are the same as in 2009 (China, India, Russia, Argentina and the Democratic Republic of Congo) their rankings have changed, especially in the case of China which increased the number of its restrictions by a factor of 9 and became the country with the largest number of restrictions in 2020. Restrictions of India, Russia and Argentina also grew faster than on average across all countries but restrictions imposed by the democratic Republic of Congo—the country with the most restrictions in 2009 -'only' doubled between 2009 and 2020 when the country recorded the fifth highest count.

The five largest increase factors are recorded for developing country producers such as Senegal (factor increase of 221)[28], Guatemala (160), Sierra Leone (77), Belarus (71), although it has to be acknowledged that in most of these cases this was from small bases. Israel,[29] Japan Nigeria and Philippines had the same number of restrictions in 2009 and 2020 and therefore recorded the lowest increase factors equal to one.

Compared with the results across products, the bigger differences in initial and current incidence ranks and the heterogeneity in the increase factors seen across the export restrictions imposing countries suggest that the reported overall increase in the incidence of restrictions was not driven so much by industry or economic factors (for example, and hypothetically, an increased concentration of production of a certain raw material which may have led to higher market power and more incentives to introduce export restrictions) but seemingly rather by changing attitudes to using export restrictions by specific countries.

To account for the fact that some of the countries with largest increase factors had very low numbers of restrictions in 2009 (and therefore did not contribute much to the overall global increase in such measures), Figure 4.5 shows the breakdown of the increase in the number of measures between 2009 and 2020 by contributing country for top 10 contributors. China leads the list with 20% of the newly recorded measures, followed by India (15%), Argentina (7%), Russia (7%), Viet Nam (6%), and Kazakhstan (5%). Together the top 10 contributing countries accounted for 78% of the new additions to the stock of export restrictions between 2009 and 2020. The country breakdown and the importance of the top-10 contributors was broadly similar across the different critical raw materials (Annex Figure A D.5.) although the new introductions by China, India and Saudi Arabia were strongly concentrated in *iron and steel* (Annex Figure A D.6.).

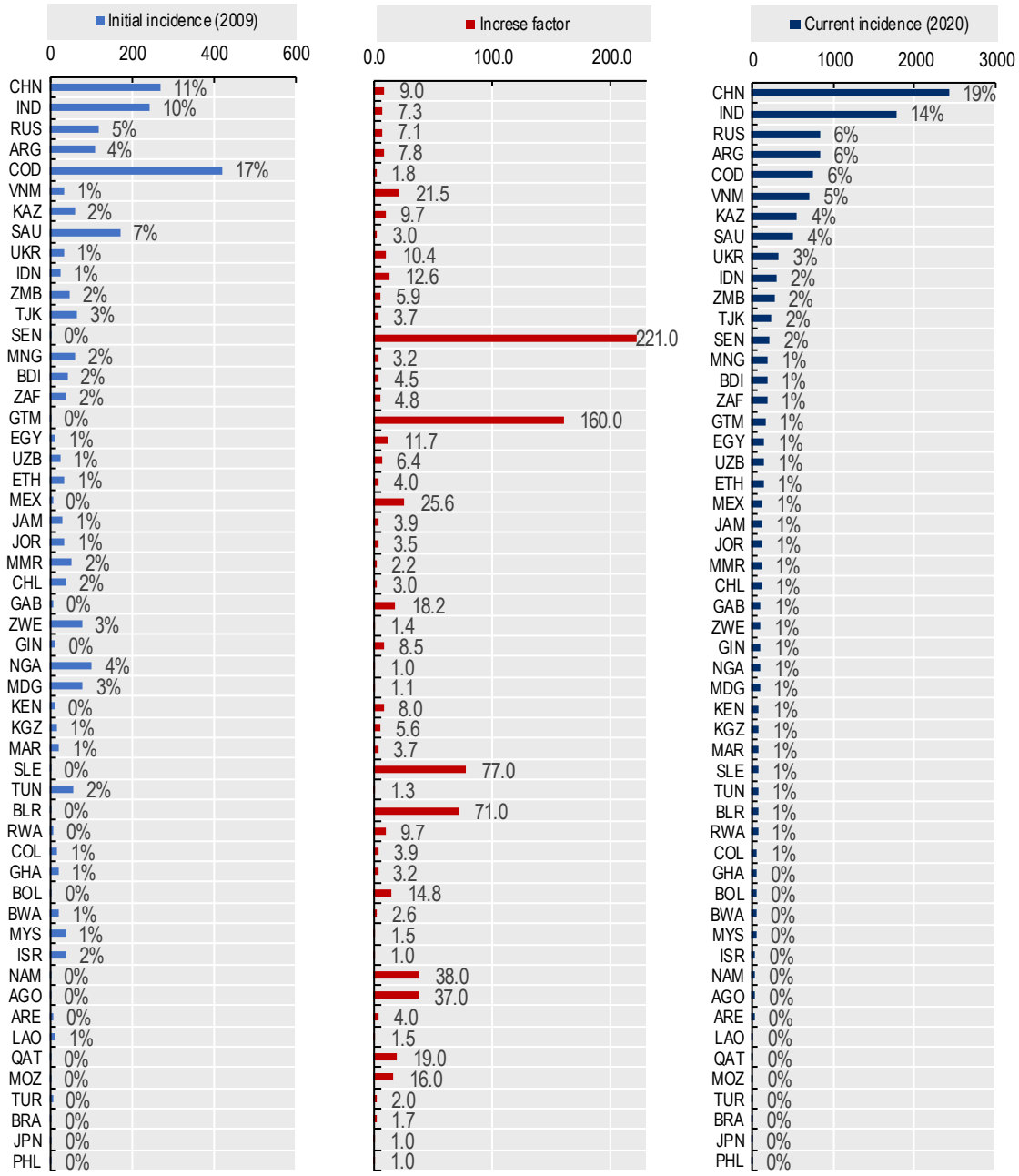
[27] Countries were included in the Inventory if they either produced at least 3% of 2012 global production (in volume terms) or were among the top five producers of any of products listed in Section 2. The country scope was reviewed in 2021 to include seven additional countries which fit these criteria in 2018. For more information see Annex A.

[28] Note that for some countries with a zero initial count of restrictions a value of 1 was inserted in the database in order to calculate the meaningful increase factors. Here, in the case of Senegal, in reality the number of restrictions increased from 0 in 2009 to 221 in 2020 (implying an infinite increase factor) while the factor calculated with the artificially substituted initial number of measures is 221. Other countries for which the initial number of restrictions was changed in this way are: Angola, Belarus, Guatemala, Mozambique and Qatar.

[29] The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Figure 4.5. Initial and current incidence of export restrictions across imposing countries

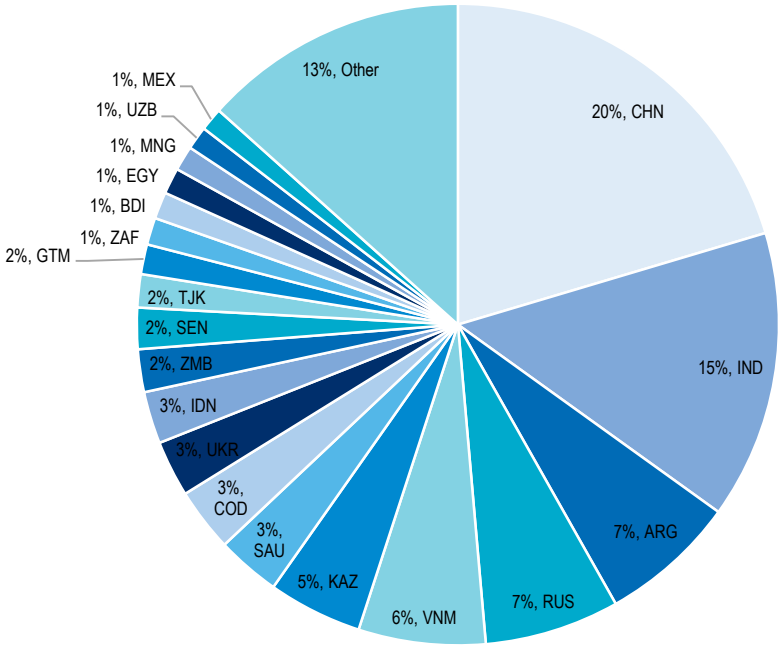
Initial incidence of export restrictions by imposing country, increase factor and current incidence



Note: Countries are ordered by the incidence in 2020.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 4.6. Breakdown of the global increase in the export restriction count in the period 2009-2020 by 'contributing' country

Country shares in the increase in the total number of export restriction measures between 2009 and 2020



Source: OECD Database on Export Restrictions on Industrial Raw Materials.

4.4. Export restriction on critical raw material by type of measure and stated purpose

A dissection of the data across the different types of export restrictions monitored in the Inventory (see Annex Table A A.1), indicates that, accounting for 36% of all measures in place, *export taxes* were the most recently used type of export restrictions in 2020 (Figure 4.6). This is also the type of measure which contributed the most (38%) to the increase between 2009 and 2020 (Figure 4.7). Cobalt, natural graphite and inorganic or organic compounds of precious metals were the materials for which the highest shares of world exports were subject to export taxes (66, 60 and 39%, respectively) (Figure 4.9).

The prominence of *export taxes* might reflect a combination of two factors: (i) the apparent growing interest in the use of export restrictions and (ii) the legal status of different types of export restrictions in WTO Agreements where quantitative restrictions on exports are generally prohibited while export taxes are not (e.g. (Mendez Parra, Schubert and Brutschin, 2016[11]). This status is related to a less distortive nature of export taxes as compared to quantitative export restrictions, but export taxes still affect prices and quantities of trade. There is some controversy whether the existing preferential trade agreements (PTAs) add more discipline to the use of export restrictions. A 2012 OECD study investigated disciplines pertaining to export restrictions in 93 PTAs and found that these agreements generally maintain the WTO provisions of general prohibition of export restrictions as well as a list of exceptions that are either product-specific or situational, although it also found that some PTAs allowed export restrictions on products that would be prohibited under WTO while others added more disciplines (Korinek and Bartos, 2022[12]). More recently, (Pauwelyn, 2020[13]) argued that in the area of export restrictions the existing preferential trade agreements add little discipline to what is already in the WTO.

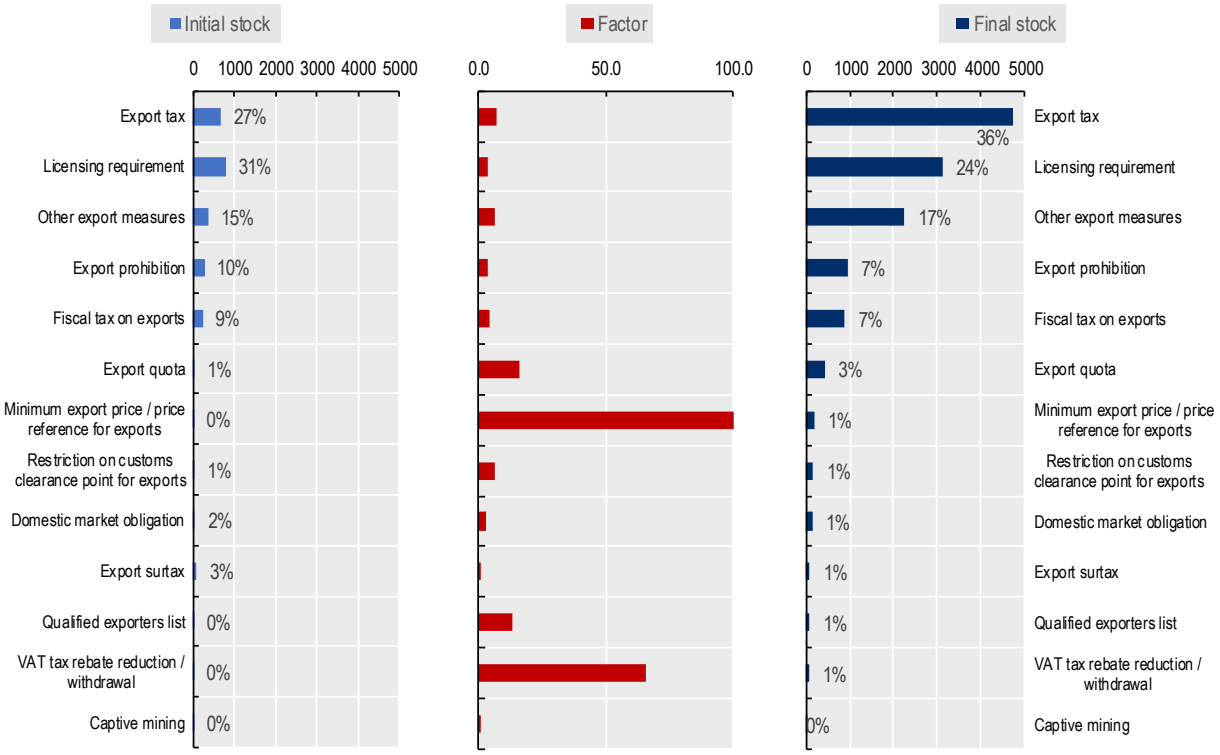
Accounting for 31% of all measures, *licensing requirements* were the most used type of export restriction in 2009 and they were the second most used type in 2020 (24% of all measures). Their count almost quadrupled and they accounted for 22% of the total increase in export restrictions between 2009 and 2020.

Accounting for 17% of all measures in 2020, *Other export measures* were the third. These refer to measures not elsewhere specified, but which influence *de jure* or *de facto* the level or direction of exports of industrial raw materials, such as for example India's congestion surcharge which was introduced in 2015 is levied on applicable base freight rates for all traffic to Bangladesh an applies to several critical raw materials [for details, see OECD (2022[14])].

Export prohibitions and *fiscal taxes on exports* accounted each for 7% of all export restrictions in 2020, and they each contributed 7% to the total increase in export restrictions between 2009 and 2020. The use of *Minimum export price / price reference for exports* and *VAT tax rebate reduction or withdrawal* increased markedly (the largest and the second largest increase factor respectively) but from very small bases and in 2020 these types of measures each accounted only for 1% of total measures.

Figure 4.7. Initial and current incidence of export restrictions by type of measure

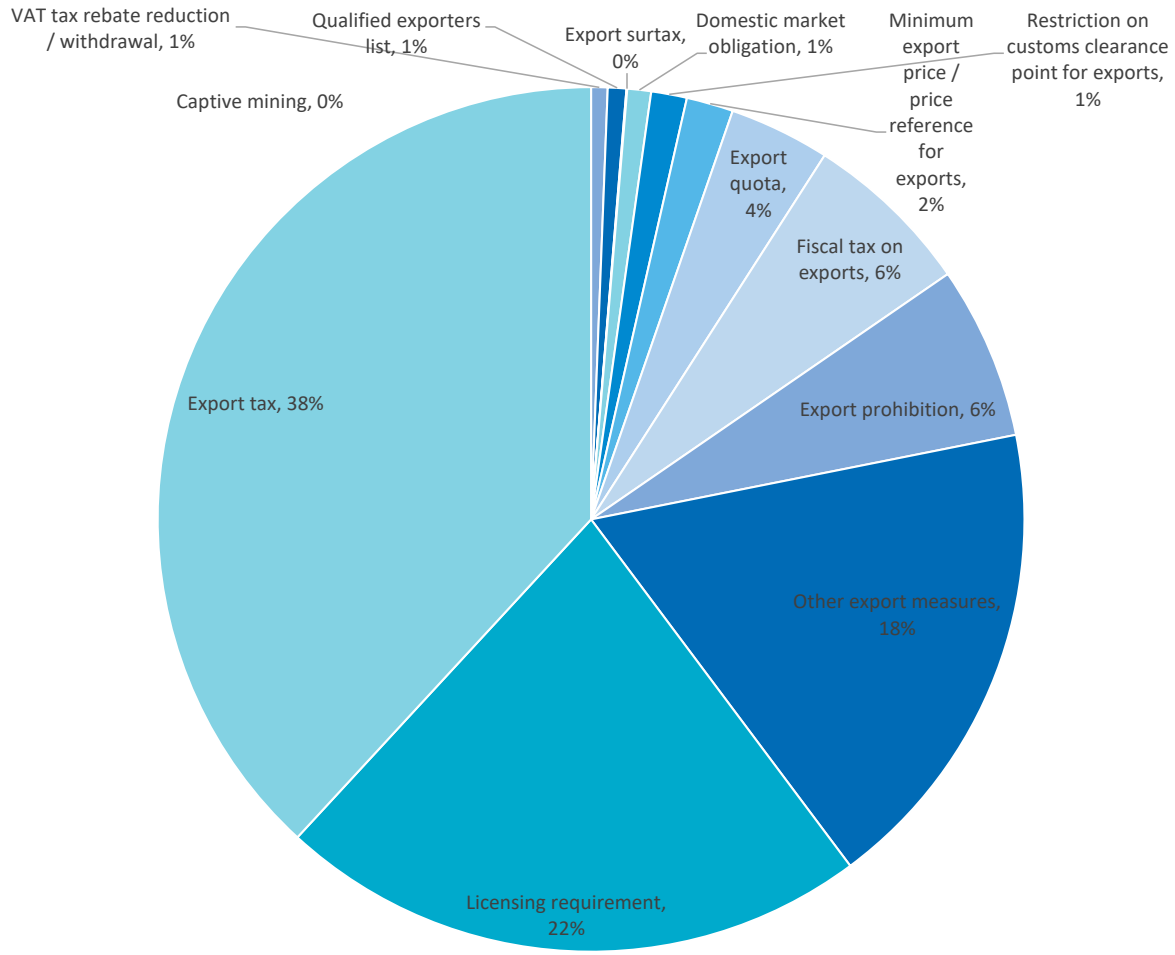
Initial incidence of export restrictions by imposing country, increase factor and current incidence



Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 4.8. Breakdown of the global increase in the export restriction stock in the period 2009-2020 by type of measure

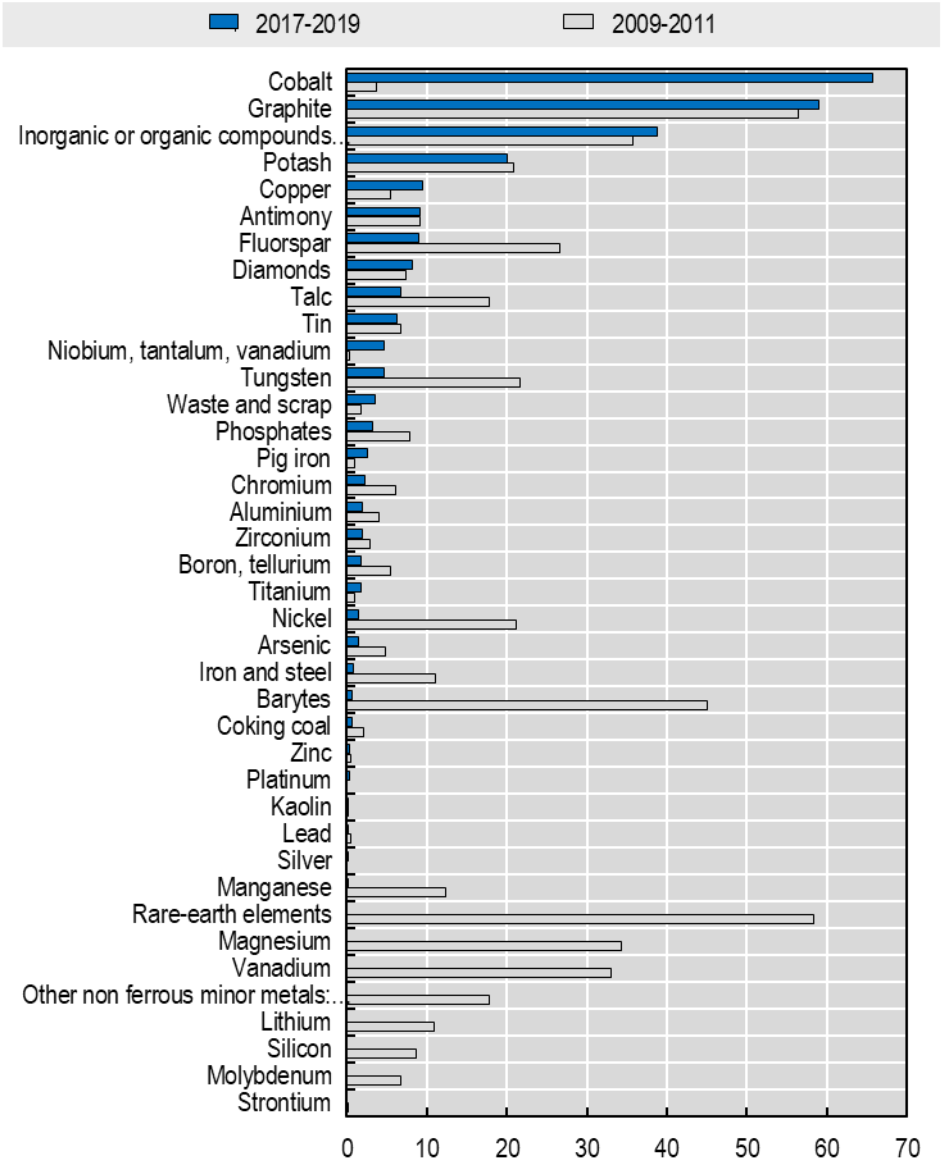
Type of export restriction shares in the increase in the total number of export restriction measures between 2009 and 2020



Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 4.9. Global trade of critical raw materials facing export tax measures

Share in global exports of a given mineral (%)



Source: OECD Database on Export Restrictions on Industrial Raw Materials and BACI.

Wherever available, the Inventory includes information on purposes of export restrictions as stated in relevant legal acts using a pre-defined menu of options (Figure 4.10). However, for 12 out of 53 countries which maintain or maintained export restrictions – including important export restriction users such as China, Russia, Viet Nam, Kazakhstan or Saudi Arabia—legislation habitually does not contain information on purposes of export restrictions, and for some countries for some measures can such purposes be established. Overall, for 35% and 47% of measures in place in, respectively, 2009 and 2020, the main stated purposes cannot be established, suggesting that the information contained in this part of the Inventory has to be treated cautiously.

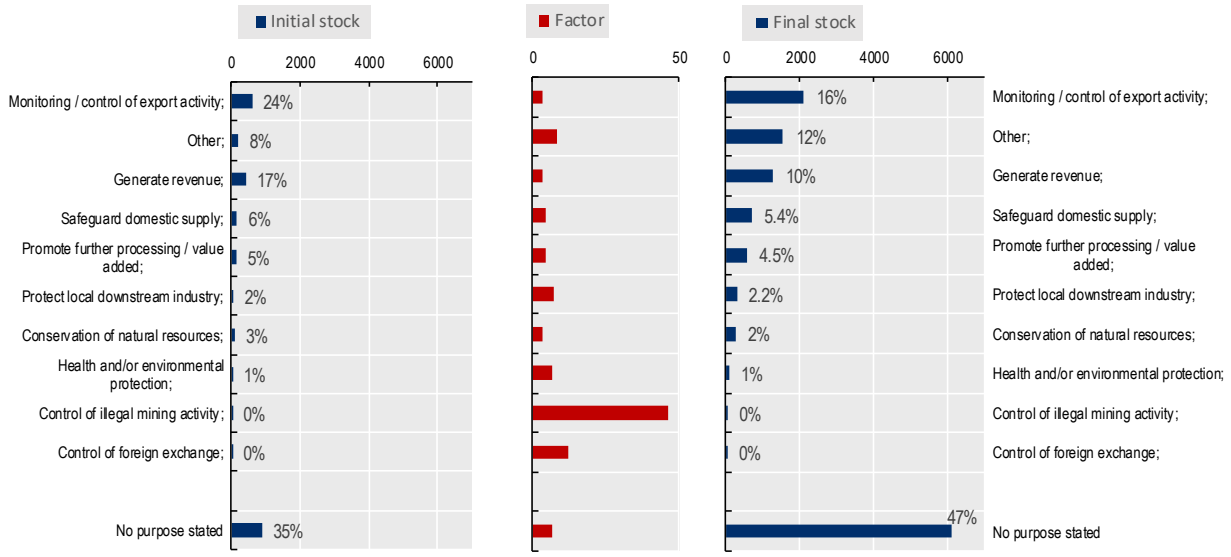
For measures for which such information is available, *Monitoring / control of export activity* was the most frequently stated purpose in both 2009 and 2020 and it was the known purpose which accounted for the largest share of measures added between 2009 and 2020 (14% of all new measures, Figure 4.10). This is consistent with the licensing requirements being the second most important type of restriction, as reported above. Purposes *Other* than on OECD's predefined list where the second most significant purpose,

followed by *Generate revenue* which is consistent with high scores of other types of measures and export taxes reported above.

The three purposes related to supporting downstream industries (*Safeguard domestic supply*; *Promote further processing / value added*; and *Protect local downstream industry*) [30] accounted together for more than 12% of all measures and 23% of measures with stated purposes in 2020. In contrast, *Control of illegal mining activity* and *Health and/or environmental protection* were stated rarely as a purpose (Figure 4.10).

Figure 4.10. Initial and current incidence of export restrictions by stated purpose

Initial incidence of export restrictions by imposing country, increase factor and current incidence



Source: OECD Database on Export Restrictions on Industrial Raw Materials.

5. Possible economic impacts

The empirical literature on the economic impact of export restrictions on trade is scarce. There are many case studies of a particular policy but very few that provide systematic evidence. A few working papers provide some such evidence. For instance, (Beckman et al., 2018[15]) show that an increase in export taxes raised international prices of ten selected agricultural products. (Solleder, 2013[16]) shows that export taxes decrease trade volume, with a larger effect in extractive industries. The descriptive statistics approach of the current report does not allow to rigorously quantify the impact of export restrictions on trade or prices of critical raw materials but it is a first step in analysis of export restrictions data included in the Inventory, and some of the tendencies and correlations it documents can inform such possible future work.

Analysis of global production of critical raw materials presented in this paper suggests that *lithium*, *rare earth elements*, *chromium*, *arsenic*, *cobalt*, *titanium*, *selenium* and *magnesium* recorded the highest global production growth rates in the last decade but even for these critical minerals the growth rates pale in comparison with the projected increases in demand associated with green transition. At the same time, global production of some critical raw materials, such as *lead*, *natural graphite*, *zinc*, *precious metal ores and concentrates* as well as *tin*, actually declined. The value of global trade in critical raw materials has been expanding faster than overall merchandise trade. *Lithium* trade recorded the largest increase of all critical raw materials, and *manganese*, *natural graphite*, *cobalt*, *titanium*, *lead*, *rare earths elements* as well

[30] Note, however, that other types of restrictions, such as for example export taxes, can also lower domestic prices for domestic downstream users and can be used for this purpose.

as *arsenic* and *zinc* all recorded growth rates which were higher than the average for all critical raw materials.

Global production of critical raw materials has become more concentrated amongst producing countries in the last decade and it tends to be more concentrated than their global imports and exports. This underscores the critical role of international trade and supply chains play in processing and delivering these materials to users but also indicates exposure to disruptions in upper segments of these supply chains. Production of critical raw materials is concentrated among a few producing countries, some of whom account for large share of production of more than one critical raw material. China for example is among top 3 producers of six out of ten most production-concentrated critical raw materials, while Australia and Russia appear three times and South Africa and Zimbabwe twice.

While country concentration of both imports and exports of critical raw materials has been increasing, global trade of these materials remains generally relatively well diversified. This may suggest that the possibility of significant disruption to the global green transition by disturbances import or export flows of critical raw materials is limited. That said, concentrations of exports and imports are significant in some specific cases, notably in upstream segments of supply chains of critical raw materials.

For some critical raw materials global imports are more concentrated than exports, suggesting significant market power for buyers. This may suggest that, first, for some raw materials major importers may have similar levels of economic leverage to key exporters (and incentives to exploit it, for example with the use of policies that influence prices of these imports). Second, this suggests that, in so far as concentrated exports can be a source of disruptions in some supply chains, import concentration can in principle also have important impacts in some critical raw materials supply chains.

While concentration in global trade of critical raw materials appears to be modest overall, some countries depend on supplies from a small number of partners. Using a simplified definition of 'trade dependencies' of OECD countries on non-OECD which combines quantitative information on concentration of bilateral imports and possibilities to source from alternative OECD suppliers, OECD import dependencies are relatively more concentrated in critical raw materials. These dependencies are also concentrated in terms of supplying non-OECD countries, with top 5 countries (China, Russia, Brazil, South Africa and India) accounting for half of all such dependencies. These dependencies exist across a range of different critical raw material products but they are concentrated heavily around traditional metals such as *iron and steel*, *copper* and *aluminium*.

Raw materials are mainly used as inputs into production of other goods and services – i.e. they are positioned 'upstream' in domestic and international supply chains – implying that disruptions or policies affecting their supplies may have important systemic implications. This is sometimes stated as a justification for state intervention, e.g. in the form of subsidies or restrictions on exports in order to support downstream sectors, and makes critical raw materials prone to be targeted in economic coercion and geopolitical rivalries.

The more than five-fold increase in the global incidence of export restrictions on critical raw materials in the last decade shows, first, that several countries significantly intensified the use of these measures. Second, in recent years, about 10% of the value of global exports of critical raw materials faced at least one export restriction measure. The global economic impacts of these measures can therefore be sizable, although the unequal distribution of these measures and different industry contexts suggest also that nature and magnitude of these impacts is likely to be product and country-specific. The economic effects of the observed increase in the use of export restrictions will also depend on several confounding factors which have not been investigated in detail in this report. These include technological developments and other relevant trends and policies which influence the demand for critical raw materials and competitive conditions in these industries (e.g. subsidies, tariffs and regulation and non-tariff measures, investment restrictions).

The evidence presented in this report suggests also that the use of export restrictions may be motivated by a complex a mix of economic and non-economic considerations.

Three *waste and scrap* product categories recorded the highest incidence of export restrictions across all critical raw materials in both 2009 and in 2020 and they were the categories that accounted for the largest share of newly added restrictions. This possibly reflects, in some cases, environmental concerns[31], but also a desire to draw on the potential of the circular economy as a source of supply of particular metals and minerals. Nevertheless, these policies may still be sub-optimal from a global point of view as they may prevent recycling in potentially more efficient foreign locations as well as wider deployment of recycling technologies in countries which need trade in waste and scarp to achieve the right level of economies of scale.

Restrictions on ores and minerals – i.e. raw materials located upstream in critical raw material supply chains – grew faster than restrictions in the other non-waste and scrap segments of the critical raw materials supply chains. This correlates with the higher levels and a the relatively faster increase of the global concentration of production, imports and exports of this segment and is broadly consistent with the logic of supporting domestic downstream industries through restrictions on exports of upstream products.

Juxtaposing the global incidence of export restrictions with the global concentration of exports across the different critical raw materials shows that the most export-concentrated products face on average fewer export restrictions in global markets (Figure 5.1). While the level of this comparison may be too high to draw any firm conclusions, at face value this evidence does not immediately support the hypothesis that export restrictions are used so as to exploit exporters' market powers and maximise export tax revenue or other economic rents that may be associated with such export restrictions. To the contrary, it is seemingly the most import-concentrated critical raw materials that face the most export restrictions in global markets (Figure 5.2) suggesting that export restrictions may rather be used to counterbalance the market power of buyers of critical raw materials.

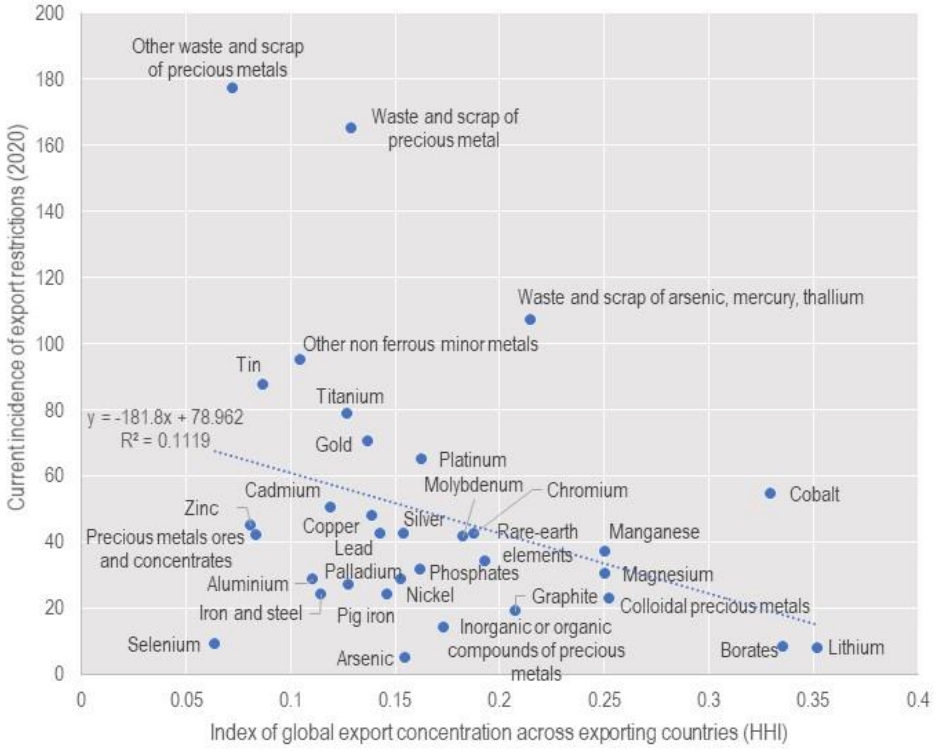
Overall, the ranking of products with the highest global incidence of export restrictions in 2020 is quite similar to that in 2009. More heterogeneity in incidence and changes in rankings are observed when data on export restrictions is analysed across the implementing countries. This might suggest that the use of export restrictions is not driven only by microeconomic or business considerations (e.g. market power of key suppliers in a specific industry) but also by country-wide factors (e.g. the need for export taxes to raise government revenues or for taxes or restrictions as part of industrial policies) or indeed by non-economic factors.

China, India, Russia, Argentina and the Democratic Republic of Congo were the countries with the highest incidence of export restrictions in both 2009 and 2020. China increased the number of its restrictions by a factor of 9 in that period which made it the country with the largest number of restrictions in 2020 and the country which contributed the highest share of new export measures between 2009 and 2020 (20% of the global increase). China and the other top five contributing countries (India, Argentina, Russia, Viet Nam, and Kazakhstan) together accounted for 60% of newly introduced export restrictions. At the same time, the countries accounting for the highest shares of global export restrictions in 2020 also tended to be those which highest shares of OECD import dependencies in critical raw materials (Figure 5.3) suggesting again that export restrictions may be related to import concentrations.

Export taxes, which contributed the most to the increase in the global stock of export restrictions, surpassed licensing requirements and became the most frequently used type of export restriction in 2020. This may be related to the fact that, under WTO and existing PTA rules, quantitative restrictions on exports are generally prohibited while export taxes are not.

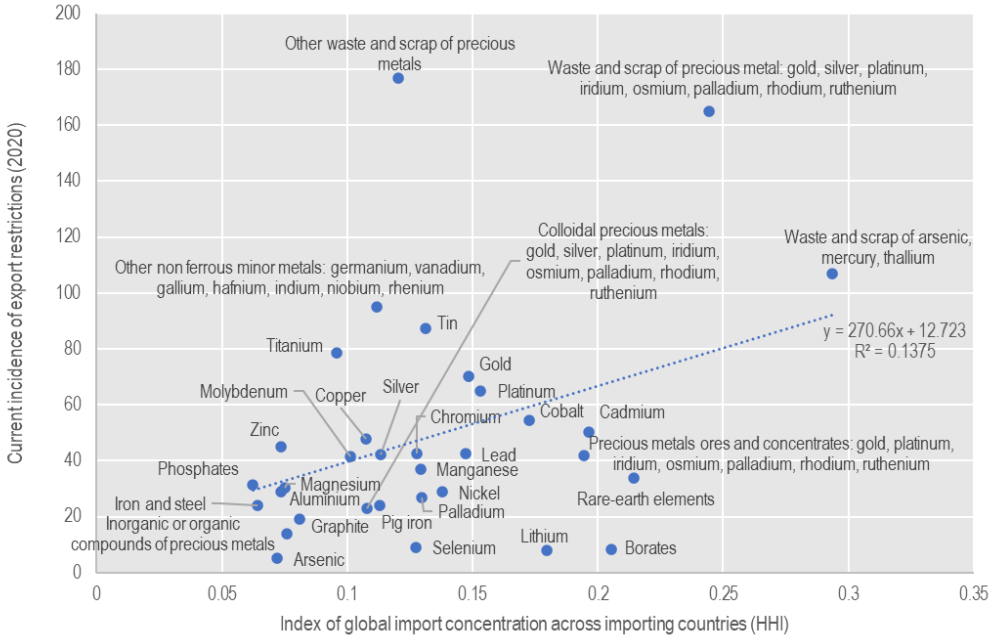
[31] A fair share of restrictions on waste and scrap of metals included in the Inventory are licensing requirements which may have as their purpose protection of environmental standards. For example, some metal bearing wastes are listed as wastes subject to amber control procedure in the OECD Control System for waste recovery as wastes presenting sufficient risk to justify their control. Similar considerations might underpin some of the export restrictions recorded in the OECD Inventory of export restrictions.

Figure 5.1. Global incidence of export restrictions and global export concentration of critical raw materials



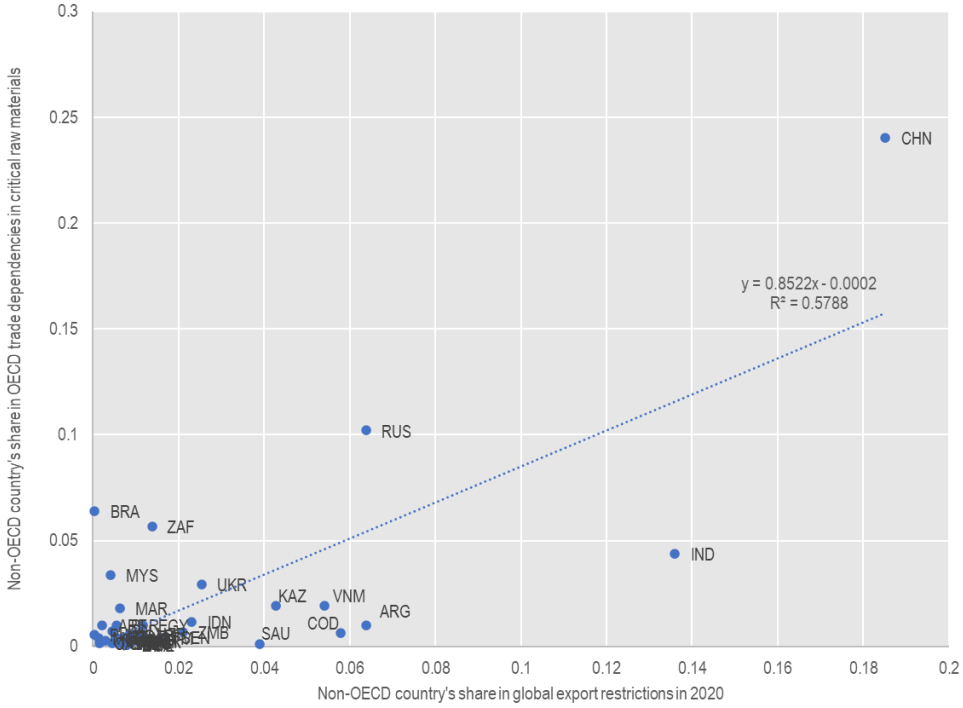
Source: OECD calculations using the BACI data and OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 5.2. Global incidence of export restrictions and global import concentration of critical raw materials



Source: OECD calculations using the BACI data and OECD Database on Export Restrictions on Industrial Raw Materials.

Figure 5.3. OECD dependencies on imports of critical raw materials from non-OECD countries and export restrictions



Source: OECD calculations using the BACI data and OECD Database on Export Restrictions on Industrial Raw Materials.

6. Conclusions and implications for future work

Overall, the analysis presented in this report suggests export restrictions may be playing a non-trivial role in international markets for critical raw materials, affecting availability and prices of these materials. A more rigorous future assessment of economic effects of export restrictions is therefore warranted and their distribution across products, countries and measure types suggests such research is also promising.

The current evidence on production trade and export restrictions concerning critical raw materials paints a rather multifaceted market and policy pictures. Some relevant tendencies emerge from the broad comparisons and correlations presented here but they can also be deceiving because of the possibly confounding factors at play. In principle, the data contained in the OECD Inventory could be used in a more rigorous econometric assessment of the impact of export restrictions on quantities and prices of traded raw materials but there are many possible avenues and each of them face challenges related to both the nature of export restrictions as well as trade and production data.

A broad empirical analysis of the trade effect of export restrictions across different raw materials would ideally require a dataset that includes both international and domestic production and trade values and volumes. The product disaggregation of the domestic and international trade data would additionally need to be high enough to match the product-specific nature of export restrictions. Working with a simple count of export restrictions at a more aggregate level would likely lead to poorly identified effects. Moreover, it is of policy interest to understand differences in the effect of export restrictions in different sectors. However, a trade dataset that meets these conditions is currently unfortunately not available.

A product-specific approach, on the other hand, which would have to necessarily be limited to a few key raw materials or supply chains, could enable a construction of a fuller cross-country data set comprising indicators such as reserves, production capacity, production, stocks, consumption, domestic investment and FDI, and exports and, possibly including supply chain and network indicators. A broader set of policy measures shaping market conditions could also be assessed, including a broader set of trade and industrial

policy instruments (e.g. tariffs, government support). A product-specific approach could also include some elements of supply chain analysis of impacts on transformed raw materials which may be affected by export restrictions and other policy measures maintained up or down the value chain.[32]

The Programme of Work and Budget of the OECD Trade Committee for the biennium 2023-24 envisages further work in this area. This will include an annual update of the Inventory, the associated on-line data visualisation tool, and an analytical report which will follow up on some of the issues identified in this paper.

[32] For example, approximately half of the volume of battery cells is graphite. Exports of battery cells do not register as exports of raw materials, but may be affected by export restrictions on graphite. Export restrictions can thus arguably be used as instruments of 'upgrading' in value chains.

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Annex A. OECD Inventory of Export Restrictions on Industrial Raw Materials

Initiated by the OECD's Trade Committee in 2010, OECD Inventory of Export Restrictions on Industrial Raw Materials is meant to build a factual inventory of border and domestic measures that restrict the export of industrial raw materials, as part of a larger effort to take stock of such measures in the raw materials sector. From its conception, key aims of the Inventory were to improve the transparency of governments' practises in this area and to serve as a data bank for empirical analysis advancing the understanding of the economic effects of export restrictions (Fliess and Mård, 2012[7]).

Meaningful product and country coverage, and consistency across time, have been principal methodological standards of the Inventory, but the approach to data collection and verification by countries, as well as product and country coverage of the Inventory, has evolved over time in order to improve the quality of the data.

Data collection process

At the beginning of construction of the Inventory, the OECD was first searching online for national official information on the use of export restrictions and subsequently verifying the information through requests for clarifications and further inputs addressed to officials of relevant governments. Quality of information about export restrictions available on government websites varied across countries and, in regard to the verification process, responses to requests for additional information or clarifications were difficult to obtain form some governments. As a result, at the time the quality of data tended to vary across countries and materials covered (Fliess and Mård, 2012[7]).

Since 2018, the database is updated annually or biannually using a structured questionnaire accompanied by detailed guidelines and instructions, for OECD countries, by national contact points identified for this purpose by these countries, and for non-OECD countries, by dedicated external consultants. The information obtained by consultants is later also checked and completed by the OECD.

In the latter case, the information on export restrictions is collected from official websites and documents issued by the governments of the producing countries. These can include Ministries in charge of economy, trade, industry, mining, forestry or foreign affairs as well as customs agencies. Sources of information on policies that restrict exports include legal acts, rules, regulations, public notices, circulars and notifications by ministries published on their websites. Secondary sources, such as news articles, were used to identify export measures applied by a country or changes made to measures during the survey year. However, only measures that can be substantiated from official sources are entered into the database.

Product coverage

From the beginning of the data collection efforts, the exercise covered most commodities in their unprocessed as well as in their semi-processed form, focusing on industrial raw materials that were considered strategic or critical, as in the EU Raw Materials Initiative or listed in the US Strategic and Critical Materials 2013 report, and including also waste and scrap of metals. Included are products in their raw and semi-processed forms from the following HS chapters (2-digit of HS 2007 classification) and their sub chapters (4-digit HS):

- HS25 (Salt; sulphur; earths and stone; plastering materials, lime and cement) – all HS 6-digit codes
- HS26 (Ores, slag and ash) – all HS 6-digit codes
- HS27 (Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes): only HS270112 (Bituminous coal, whether/not pulverised but not agglomerated) and HS270400 (Coke & semi-coke of coal/lignite/peat, whether/not agglomerated; retort carbon)
- HS28 (Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes) – all HS 6-digit codes
- HS31 (Fertilisers): only HS310420 (Potassium chloride), HS310430 (Potassium sulphate) and HS310490 (Mineral/chemical fertilisers, potassic (excl. of 3104.20 & 3104.30)

- HS44 (Wood and articles of wood; wood charcoal): all HS6codes in the following sub-chapters: HS4403 (Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared); HS4407 (Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6mm) and HS4412 (Plywood, veneered panels and similar laminated wood)
- HS71 (Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal, and articles thereof; imitation jewellery; coin) – all HS 6-digit codes
- HS72 (Iron and steel) – all HS 6-digit codes
- HS73 (Articles of iron or steel) – all HS 6-digit codes
- HS74 (Copper and articles thereof) – all HS 6-digit codes
- HS75 (Nickel and articles thereof) – all HS 6-digit codes
- HS76 (Aluminum and articles thereof) – all HS 6-digit codes
- HS78 (Lead and articles thereof) – all HS 6-digit codes
- HS79 (Zinc and articles thereof) – all HS 6-digit codes
- HS80 (Tin and articles thereof) – all HS 6-digit codes
- HS81 (Other base metals; cermets; articles thereof) – all HS 6-digit codes

In 2015, the scope of the Inventory was revised to ensure a systematic overview of export-restricting measures by metals and minerals exporting countries. In 2020, the scope of products included for each country in the Inventory was updated to ensure the product scope reflected current patterns of production and exports. In 2021, the country coverage of the inventory was extended to cover one additional product, bismuth (and also seven new countries).

Currently, the list of covered materials encompasses 65 strategic, industrial commodities, including 58 mineral and metals, six wood products, and metallic waste and scrap for all minerals and metals covered in the Inventory.

Minerals and Metals (57)

Aluminium	Antimony	Arsenic	Barytes	Bentonite
Beryllium	Bismuth	Borates	Cadmium	Chromium
Cobalt	Coke	Coking coal	Copper	Diamonds
Diatomite	Feldspar	Fluorspar	Gallium	Garnet
Germanium	Gold	Natural graphite	Gypsum	Indium
Iron and steel	Kaolin	Lead	Limestone	Lithium
Magnesite	Magnesium	Manganese	Mercury	Molybdenum
Nickel	Niobium	Perlite	Phosphates	Pig iron
Platinum group metals (PGMs)[1]	Potash	Rare earths (REE)	Rhenium	Selenium
Silica	Silicon	Silver	Strontium	Talc
Tantalum	Tellurium	Tin	Titanium	Tungsten
Vanadium	Zinc	Zirconium		

1. Platinum group metals (PGM) that include platinum, palladium, and all other PMG metals (rhodium, iridium, osmium and ruthenium).

Wood (6)

Industrial roundwood coniferous	Sawnwood coniferous
Industrial roundwood non-coniferous non-tropical	Sawnwood non-coniferous non-tropical
Industrial roundwood non-coniferous tropical	Sawnwood non-coniferous tropical

Other

Metal waste and scrap for all metals and minerals included in the Inventory

Export restrictions are recorded in the database at the 6-digit level using the Harmonised System (HS) 2007 nomenclature.[33] If a measure is applied at the HS8 or HS10 digit level and the information is available in the data source, this information is recorded in the respective field in the Inventory.

See Annex B for the list of HS 2007 codes included in the Inventory along with the associated product name.

Country coverage

In the first versions of the database, countries were included in the Inventory if they either produced at least 3% of 2012 global production (in volume terms) or were among the top five producers of any of the raw materials covered in the Inventory. The country scope was reviewed in 2021 to include seven additional countries which fit the 3% global production criterion in 2018. This determined the scope of countries surveyed. For each of the countries in the scope of the Inventory, other commodities on the raw materials list where these countries produced at least 1% of global production were surveyed for the existence of export-restricting measures.

The information for countries and products not covered in the earlier versions of the Inventory has been supplemented accordingly for the earlier periods so that the product, country and time coverage in the current database is consistent.

In this way the country coverage, while not full, allows monitoring of export restrictions of all significant raw materials producers around the world. Eighty OECD and non-OECD countries producing industrial raw material commodities are currently being surveyed. These countries accounted for 97% of the world production of minerals and metals and 82% of world production of wood in 2020.

Types of measures covered

The Inventory records measures known or suspected to restrain export activity. These measures typically increase the relative price of exported products, decrease the quantity supplied or change the terms of competition among suppliers. The list of surveyed measures is relatively exhaustive, including export taxes, prohibitions and non-automatic licensing requirements, and any other export restricting measure. Definitions of the measures covered are provided below in Table A A.1.

Export controls that are in place to comply with international conventions and agreements limiting trade in certain goods such as the Kimberley Process for diamonds, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for some wood products, the Rotterdam Convention as regards some chemical products and the Basel Convention regarding metallic waste and scrap are not included in the Inventory of export restrictions on industrial raw materials. Note that the export controls in place in the context of these agreements and conventions are generally expressed at a more detailed level than HS 6-digit products, and most national regulations indicate that such restrictions are in place in order to comply with these international agreements.

Dual-use items are goods, software and technology that can be used for both civilian and military applications. Many countries control exports of dual-use items which are included in international treaties, conventions and resolutions such as UN Security Council Resolution 1540, the Nuclear Non-Proliferation Treaty, the Chemical Weapons Convention, the Wassenaar Arrangement, the Nuclear Suppliers Group and the Missile Technology Control Regime. Export licenses and bans on goods that can be identified within the scope of these regimes are not included in the OECD Inventory of export restrictions. Similarly, the Minamata Convention regulates trade in mercury so those export controls should not be recorded.

[33] The Inventory uses the HS 2007 nomenclature. If a country has moved to using the HS 2012 nomenclature, the 6-digit level code is converted back to the HS2007 nomenclature. Among the products in the scope of the Inventory, only two were revised between the two HS classification versions: borates and mercury.

Export controls that are implemented in the context of bilateral sanctions, in particular in the context of United Nations monitored trade with select countries, are not included in the Inventory of export restrictions on industrial raw materials.

Table A A.1. Measures restricting exports and their definitions

Export restriction	Definition
Export tax	A tax collected on goods or commodities at the time they leave a customs territory. This tax can be set either on a *per unit* basis or an *ad valorem* (percentage of value) basis. Other terms equivalent to export tax: *export tariff, export duty, export levy, export charge*.
Fiscal tax on exports	A tax not paid at the border, but which applies only or discriminates against goods or commodities intended for export. An example is when the *sales tax* which a government charges is higher for goods or commodities intended for export than when these goods or commodities are offered for sale in the domestic market. Another term equivalent to fiscal tax on exports: *export royalty*.
Export surtax	A tax collected on goods or commodities at the time they leave a customs territory, and which is applied in addition to the normal export tax rate. They can be part of a progressive tax system or can be adapted to price trends and thus be of a temporary nature. Example: a USD 10 surcharge is applied on each ton of a commodity exported when the world price of this commodity exceeds USD 1 800 a ton. Other terms equivalent to export surtax: *export surcharge*.
Export quota	A prescribed maximum volume of permitted exports.
Export prohibition	No exports are permitted. Exceptions may be granted through export licences. Other terms equivalent to export prohibition: *export ban, export embargo*.
Non-automatic export licensing requirement (M6)	Exporters must obtain prior approval, in form of a license, to export a good or commodity. This practice requires submission of an application or other documentation as a condition for being authorised to export. Although export licensing regimes may vary in their impact on exports, with some regimes that have a fairly small economic impact, at the very least, such regimes increase the amount of time needed to engage in trade. Licensing schemes can operate on the basis of product lists of various types, usually lists of restricted products that require licences be applied to restrict exports by destination (e.g. specific countries) or have other conditions attached, such as a requirement that exportation may only be for a specified purpose. Other terms equivalent to non-automatic licensing: *export permit*.
Minimum export price / price reference for exports	A minimum allowable price for a good being exported. This practice is often used in conjunction with export taxes in order to prevent under-invoicing and can be used as a base to calculate export taxes. In some cases, minimum export prices are not binding but are used as reference prices. Other terms equivalent to minimum export price: *administered pricing*.
VAT tax rebate reduction / withdrawal	Most countries with a VAT system will rebate the VAT on exports. By denying VAT reimbursement in whole or part, it is relatively less advantageous to export a product than to sell it domestically. This measure is usually used to encourage downstream production of products produced locally that use the raw material input. A variant is the removal or reduction of rebate from *other sales taxes* on exports of a product.
Restriction on customs clearance point for exports	The government specifies ports or customs offices through which export of a good or commodity is to be channeled.
Qualified exporters list	The right to export a certain commodity are allocated to specific companies by the government, through a process of application and registration.
Domestic market obligation	The requirement for producers to allocate a proportion of their annual production output for sale to the domestic market. Domestic market obligations are sometimes part of production sharing contracts or contracts allowing extraction by foreign firms.
Captive mining	When a processing company is required to own the mine, which produces its inputs or has been awarded captive mining rights with the intent that the company will mine the commodity for use in its own domestic processes and not trade it. Captive mining is a form of government support for firms with access to captive supplies, as well as a means to control the price and availability of a commodity. When captive mining concessions increase (as a share of production), exports are likely to fall.
Other export measures	Measures not elsewhere specified, but which influence *de jure* or *de facto* the level or direction of exports of industrial raw materials.

Source: Adapted from OECD, Analysis of non-tariff measures: the case of export restrictions (TAD/TC/WP(2003)7/FINAL, April 4, 2003, p.8; Joanna Bonarriva et al, Export controls: An overview of their use, economic effects, and treatment in the global trading system, Office of Industries Working Paper No. ID-23, US International Trade Commission, August 2009, p. 2; Jeonghoi Kim, Recent trends in export restrictions on raw materials OECD Trade Policy Working Papers, No. 101, OECD Publishing, 2010, p 6 and 12.

Annex B. HS2007 code and product name used in the Inventory

Note that an HS code could cover more than one product

Product	HS2007	HS Description	Product	HS2007	HS Description
Aluminium	260600	Aluminium ores & concentrates	Aluminium	760519	Wire of Aluminium, not alloyed (excl. of 7605.11)
Aluminium	262040	Ash & residues (excl. from the manufacture of iron/steel) containing mainly Aluminium	Aluminium	760521	Wire of Aluminium alloys, of which the maximum cross-sectional dim. exceeds 7mm
Aluminium	281810	Artificial corundum, whether/not chemically defined	Aluminium	760529	Wire of Aluminium alloys (excl. of 7605.21)
Aluminium	281820	Aluminium oxide (excl. artificial corundum)	Aluminium	760611	Plates, sheets & strip, rectangular (incl. square), of a thickness >0.2mm, of Aluminium, not alloyed
Aluminium	281830	Aluminium hydroxide	Aluminium	760612	Plates, sheets & strip, rectangular (incl. square), of a thickness >0.2mm, of Aluminium alloys
Aluminium	282612	Flourides, of Aluminium	Aluminium	760691	Plates, sheets & strip other than rectangular (incl. square), of a thickness >0.2mm, of Aluminium, not alloyed
Aluminium	282732	Aluminium chlorides	Aluminium	760692	Plates, sheets & strip other than rectangular (incl. square), of a thickness >0.2mm, of Aluminium alloys
Aluminium	283322	Sulphates of Aluminium	Aluminium	760711	Aluminium foil, whether/not printed, not backed, of a thickness not >0.2mm, rolled but not further worked
Aluminium	283330	Alums	Aluminium	760719	Aluminium foil, whether/not printed, not backed, of a thickness not >0.2mm (excl. of 7607.11)
Aluminium	760110	Aluminium, not alloyed, unwrought	Aluminium	760720	Aluminium foil, whether/not printed, backed with paper/paperboard/plastics/similar backing materials, of a thickness (excl. any backing) not >0.2mm
Aluminium	760120	Aluminium alloys, unwrought	Antimony	261710	Antimony ores & concentrates
Aluminium	760200	Aluminium waste & scrap	Antimony	262091	Ash & residues (excl. from the manufacture of iron/steel) containing antimony/beryllium/cadmium/chromium/their mixtures
Aluminium	760310	Powders of non-lamellar structure, of Aluminium	Antimony	282580	Antimony oxides
Aluminium	760320	Powders of lamellar structure, of Aluminium; flakes of Aluminium	Antimony	811010	Unwrought antimony; powders
Aluminium	760410	Bars, rods & profiles, of Aluminium, not alloyed	Antimony	811020	Antimony waste & scrap
Aluminium	760421	Hollow profiles of Aluminium	Antimony	811090	Antimony & articles thereof , n.e.s. in 81.10
Aluminium	760429	Bars, rods & profiles (excl. hollow profiles) of Aluminium alloys	Arsenic	262060	Slag,ash & residues (excl. from the manufacture of iron/steel) containing arsenic/mercury/thallium/their mixtures, of a kind used for the extraction of arsenic/those metals /for the manufacture of their chemical compounds
Aluminium	760511	Wire of Aluminium, not alloyed, of which the maximum cross-sectional dim. exceeds 7mm	Arsenic	280480	Arsenic

Product	HS2007	HS Description	Product	HS2007	HS Description
Barytes	251110	Natural barium sulphate (barytes)	Chromium	281910	Chromium trioxide
Bentonite	250810	Bentonite	Chromium	281990	Chromium oxides (excl. chromium trioxide) & hydroxides
Beryllium	262091	Ash & residues (excl. from the manufacture of iron/steel) containing antimony/beryllium/cadmium/chromium/their mixtures	Chromium	811221	Chromium, unwrought; powders
Beryllium	280519	Alkali/alkaline-earth metals other than sodium & calcium	Chromium	811222	Chromium waste & scrap
Beryllium	811212	Beryllium, unwrought; powders	Chromium	811229	Chromium & articles thereof , n.e.s. in 81.12
Beryllium	811213	Beryllium waste & scrap	Cobalt	260500	Cobalt ores & concentrates
Beryllium	811219	Beryllium & articles thereof, n.e.s. in 81.12	Cobalt	282200	Cobalt oxides & hydroxides; commercial cobalt oxides
Borates	252810	Natural sodium borates & concentrates thereof (whether/not calcined)	Cobalt	810520	Cobalt mattes & other intermediate products of cobalt metallurgy; unwrought cobalt; powders
Borates	252890	Natural borates & concentrates thereof (excl. sodium borates), whether/not calcined but not incl. borates separated from natural brine; natural boric acid containing not >85% of H3BO3 calc. on the dry weight	Cobalt	810530	Cobalt waste & scrap
Bismuth	810600	Bismuth; articles thereof, including waste and scrap	Borates	280450	Boron; tellurium
Cobalt	810590	Cobalt & articles thereof , n.e.s. in 81.05	Borates	281000	Oxides of boron; boric acids
Coke	270400	Coke & semi-coke of coal/lignite/peat, whether/not agglomerated; retort carbon	Borates	284011	Disodium tetraborate (refined borax), anhydrous
Coking coal	270112	Bituminous coal, whether/not pulverised but not agglomerated	Borates	284019	Disodium tetraborate (refined borax), other than anhydrous
Copper	260300	Copper ores & concentrates	Borates	284020	Borates other than disodium tetrborate (refined borax)
Copper	262030	Ash & residues (excl. from the manufacture of iron/steel) containing mainly Copper	Borates	284030	Peroxoborates (perborates)
Copper	282550	Copper oxides & hydroxides	Cadmium	262091	Ash & residues (excl. from the manufacture of iron/steel) containing antimony/beryllium/cadmium/chromium/their mixtures
Copper	282741	Chloride oxides & chloride hydroxides, of Copper	Cadmium	810720	Unwrought cadmium; powders
Copper	283325	Sulphates of Copper	Cadmium	810730	Cadmium waste & scrap
Copper	740100	Copper mattes; cement Copper (precipitated Copper).	Cadmium	810790	Cadmium & articles thereof , n.e.s. in 81.07
Copper	740200	Unrefined Copper; Copper anodes for electrolytic refining	Chromium	261000	Chromium ores & concentrates
Copper	740311	Cathodes & sections of cathodes, of refined Copper, unwrought	Chromium	262091	Ash & residues (excl. from the manufacture of iron/steel) containing antimony/beryllium/cadmium/chromium/their mixtures
Copper	740312	Wire-bars of refined Copper, unwrought	Copper	740313	Billets of refined Copper, unwrought
Copper	740919	Copper plates, sheets & strip, of a thickness >0.15mm, of refined Copper, other than in coils	Copper	740319	Unwrought products of refined Copper (excl. of 7403.11-7403.13)
Copper	740921	Copper plates, sheets & strip, of a thickness >0.15mm, of Copper-zinc base alloys (brass), in coils	Copper	740321	Copper-zinc base alloys (brass), unwrought
Copper	740929	Copper plates, sheets & strip, of a thickness >0.15mm, of Copper-zinc base alloys (brass), other than in coils	Copper	740322	Copper-tin base alloys (bronze), unwrought

Product	HS2007	HS Description	Product	HS2007	HS Description
Copper	740931	Copper plates, sheets & strip, of a thickness >0.15mm, of Copper-tin base alloys (bronze), in coils	Copper	740329	Other Copper alloys (other than master alloys of heading 74.05), other than Copper-zinc alloys(brass),/Copper-tin base alloys(bronze).
Copper	740939	Copper plates, sheets & strip, of a thickness >0.15mm, of Copper-tin base alloys (bronze), other than in coils	Copper	740400	Copper waste & scrap
Copper	740940	Copper plates, sheets & strip, of a thickness >0.15mm, of Copper-nickel base alloys (cupro-nickel)/Copper-nickel-zinc base alloys (nickel silver)	Copper	740500	Master alloys of Copper
Copper	740990	Copper plates, sheets & strip, of a thickness >0.15mm, of other Copper alloys (excl. of 7409.11-7409.40)	Copper	740610	Powders of non-lamellar structure, of Copper
Copper	741011	Copper foil, whether/not printed, not backed with paper/paperboard/plactics/similar backing materials, of refined Copper, of a thickness not >0.15mm	Copper	740620	Powders of lamellar structure, of Copper; flakes, of Copper
Copper	741012	Copper foil, whether/not printed, not backed with paper/paperboard/plactics/similar backing materials, of Copper alloys, of a thickness not >0.15mm	Copper	740710	Bars, rods & profiles, of refined Copper
Copper	741021	Copper foil, whether/not printed, backed with paper/paperboard/plactics/similar backing materials, of refined Copper, of a thickness (excl. any backing) not >0.15mm	Copper	740721	Bars, rods & profiles, of Copper-zinc base alloys (brass)
Copper	741022	Copper foil, whether/not printed, backed with paper/paperboard/plactics/similar backing materials, of Copper alloys, of a thickness (excl. any backing) not >0.15mm	Copper	740729	Bars, rods & profiles, of Copper alloys (excl. of 7407.21)
Diamonds	710210	Diamonds, unsorted	Copper	740811	Copper wire, of refined Copper of which the maximum cross-sectional dim. exceeds 6mm
Diamonds	710221	Industrial Diamonds, unworked/simply sawn/cleaved/bruted	Copper	740819	Copper wire, of refined Copper (excl. of 7408.11)
Diamonds	710229	Industrial Diamonds, worked but not mounted/set	Copper	740821	Wire of Copper-zinc base alloys (brass)
Diamonds	710231	Diamonds, non-industrial, unworked/simply sawn/cleaved/bruted	Copper	740822	Wire of Copper-nickel base alloys (cupro-nickel)/Copper-nickel-zinc base alloys (nickel silver)
Diamonds	710239	Diamonds, non-industrial other than unworked/simply sawn/cleaved/bruted	Copper	740829	Wire of Copper alloys (excl. of 7408.21 & 7408.22)
Diamonds	710510	Dust & powder of natural/synthetic Diamonds	Copper	740911	Copper plates, sheets & strip, of a thickness >0.15mm, of refined Copper, in coils
Diatomite	251200	Siliceous fossil meals (e.g., kieselguhr, tripolite & diatomite) & similar siliceous earths, whether/not calcined, of an apparent sp.gr. of 1/less	Feldspar	252910	Feldspar
Gold	711230	Ash containing precious metal/precious metal comps.	Fluorspar	252921	Fluorspar, containing by weight 97%/less of calcium fluoride
Gold	711291	Waste & scrap of Gold, incl. metal clad with Gold but excl. sweepings containing other precious metals	Fluorspar	252922	Fluorspar, containing by weight >97% of calcium fluoride
Natural graphite	250410	Natural graphite, in powder/flakes	Fluorspar	252930	Leucite; nepheline & nepheline syenite

Product	HS2007	HS Description	Product	HS2007	HS Description
Natural graphite	250490	Natural graphite other than in powders/flakes	Gallium	811292	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.
Gypsum	252010	Gypsum; anhydrite	Gallium	811299	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, excl. waste & scrap, powder, unwrought.
Gypsum	252020	Plasters (consisting of calcined gypsum/calcium sulphate) whether/not coloured, with/without small quantities of accelerators/retarders	Garnet	251320	Emery, natural corundum, natural garnet & other natural abrasives, whether/not heat-treated
Indium	811292	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.	Germanium	282560	Germanium oxides & zirconium dioxide
Indium	811299	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, excl. waste & scrap, powder, unwrought.	Germanium	811292	Germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.
Industrial roundwood coniferous	440310	Wood, in the rough, whether/not stripped of bark/sapwood/roughly squared, treated with paint/stains/creosote/other preservatives	Germanium	811299	Germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, excl. waste & scrap, powder, unwrought.
Industrial roundwood coniferous	440320	Wood, in the rough, whether/not stripped of bark/sapwood/roughly squared (excl. of 4403.10), coniferous	Gold	261690	Precious metal ores & concentrates (excl. silver ores & concentrates)
Industrial roundwood non-coniferous non-tropical	440391	Oak (Quercus spp.), in the rough, whether/not stripped of bark/sapwood/roughly squared	Gold	284310	Colloidal precious metals
Industrial roundwood non-coniferous non-tropical	440392	Beech (Fagus spp.), in the rough, whether/not stripped of bark/sapwood/roughly squared	Gold	284330	Gold comps.
Industrial roundwood non-coniferous non-tropical	440399	Wood, in the rough (excl. of 4403.10-4403.92), whether/not stripped of bark/sapwood/roughly squared	Gold	710811	Gold (incl. Gold plated with platinum), non-monetary, in powder form
Industrial roundwood non-coniferous tropical	440341	Dark Red Meranti, Light Red Meranti & Meranti Bakau, in the rough, whether/not stripped of bark/sapwood/roughly squared	Gold	710812	Gold (incl. Gold plated with platinum), in unwrought forms (excl. powder)
Industrial roundwood non-coniferous tropical	440349	Tropical wood spec. in SH Note 1 to Ch.44 (excl. of 4403.41), in the rough, whether/not stripped of bark/sapwood/roughly squared	Gold	710813	Gold (incl. Gold plated with platinum), non-monetary, in semi-manufactured forms
Iron and steel	250200	Unroasted iron pyrites	Gold	710900	Base metals/silver, clad with Gold, not further worked than semi-manufactured
Iron and steel	260111	Iron ores & concentrates (excl. roasted iron pyrites), non-agglomerated	Iron and steel	260112	Iron ores & concentrates (excl. roasted iron pyrites), agglomerated
Iron and steel	720299	Ferro-alloys (excl. of 7202.11-7202.93), in granular/powder form	Iron and steel	260120	Roasted iron pyrites
Iron and steel	720310	Ferrous products obt. by direct reduction of iron ore, in lumps/pellets/similar forms	Iron and steel	261800	Granulated slag (slag sand) from the manufacture of iron/steel
Iron and steel	720390	Spongy ferrous products (excl. of 7203.10), in lumps/pellets/similar forms; iron having a minimum purity by weight of 99.94%, in lumps/pellets/similar forms	Iron and steel	261900	Slag, dross (excl. granulated slag), scalings & other waste from the manufacture of iron/steel
Iron and steel	720410	Waste & scrap of cast iron	Iron and steel	282110	Iron oxides & hydroxides
Iron and steel	720421	Waste & scrap of stainless steel	Iron and steel	720211	Ferro-manganese, containing by weight >2% of carbon, in granular/powder form

Product	HS2007	HS Description	Product	HS2007	HS Description
Iron and steel	720429	Waste & scrap of alloy steel other than stainless steel	Iron and steel	720219	Ferro-manganese, other than that containing by weight >2% of carbon, in granular/powder form
Iron and steel	720430	Waste & scrap of tinned iron/steel	Iron and steel	720221	Ferro-silicon, containing by weight >55% of silicon, in granular/powder form
Iron and steel	720441	Ferrous turnings, shavings, chips, milling waste, sawdust, filings, trimmings & stampings, whether/not in bundles	Iron and steel	720229	Ferro-silicon, other than that containing >55% of silicon, in granular/powder form
Iron and steel	720449	Ferrous waste & scrap (excl. of 7204.10-7204.41)	Iron and steel	720230	Ferro-silico-manganese, in granular/powder form
Iron and steel	720450	Remelting ferrous scrap ingots	Iron and steel	720241	Ferro-chromium, containing by weight >4% of carbon, in granular/powder form
Iron and steel	720521	Powders, of alloy steel	Iron and steel	720249	Ferro-chromium, other than that containing by weight >4% of carbon, in granular/powder form
Iron and steel	720529	Powders, of Pig iron, spiegeleisen, iron/steel (excl. alloy steel)	Iron and steel	720250	Ferro-silico-chromium, in granular/powder form
Iron and steel	720610	Iron & non-alloy steel in ingots (excl. iron of 72.03)	Iron and steel	720260	Ferro-nickel, in granular/powder form
Iron and steel	720690	Iron & non-alloy steel in primary forms other than ingots (excl. iron of 72.03)	Iron and steel	720270	Ferro-molybdenum, in granular/powder form
Iron and steel	720711	Semi-finished products of iron/non-alloy steel, containing by weight <0.25% of carbon, of rectangular (incl. square) cross-section, the width measuring < twice the thickness	Iron and steel	720280	Ferro-tungsten & ferro-silico-tungsten, in granular/powder form
Iron and steel	720712	Semi-finished products of iron/non-alloy steel, containing by weight <0.25% of carbon, of rectangular (other than square) cross-section	Iron and steel	720291	Ferro-titanium & ferro-silico-titanium, in granular/powder form
Iron and steel	720719	Semi-finished products of iron/non-alloy steel, containing by weight <0.25% of carbon, n.e.s. in 72.07	Iron and steel	720292	Ferro-vanadium, in granular/powder form
Iron and steel	720720	Semi-finished products of iron/non-alloy steel, containing by weight 0.25%/more of carbon	Iron and steel	720293	Ferro-niobium, in granular/powder form
Iron and steel	720810	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled, with patterns in relief	Iron and steel	720825	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled, pickled, of a thickness of 4.75mm/more
Iron and steel	720853	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, not in coils, not further worked than hot-rolled, of a thickness of 3mm/more but <4.75mm	Iron and steel	720826	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled, pickled, of a thickness of 3mm/more but <4.75mm
Iron and steel	720854	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, not in coils, not further worked than hot-rolled, of a thickness of <3mm	Iron and steel	720827	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled, pickled, of a thickness of <3mm
Iron and steel	720890	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, n.e.s. in 72.08	Iron and steel	720836	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled (excl. pickled), of a thickness >10mm
Iron and steel	720915	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness of 3mm/more	Iron and steel	720837	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled(excl.pickled),of a thickness of 4.75mm/more but not >10mm

Product	HS2007	HS Description	Product	HS2007	HS Description
Iron and steel	720916	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness >1mm but <3mm	Iron and steel	720838	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled (excl.pickled),of a thickness of 3mm/more but <4.75mm
Iron and steel	720917	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness of 0.5mm/more but not >1mm	Iron and steel	720839	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, in coils, not further worked than hot-rolled (excl. pickled), of a thickness of <3mm
Iron and steel	720918	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness of <0.5mm	Iron and steel	720840	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, not in coils, not further worked than hot-rolled, with patterns in relief
Iron and steel	720925	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, not in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness of 3mm/more	Iron and steel	720851	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, not in coils, not further worked than hot-rolled, of a thickness >10mm
Iron and steel	720926	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, not in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness >1mm but <3mm	Iron and steel	720852	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, hot-rolled, not clad/plated/coated, not in coils, not further worked than hot-rolled, of a thickness of 4.75mm/more but not >10mm
Iron and steel	720927	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, not in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness of 0.5mm/more but not >1mm	Iron and steel	720928	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, not in coils, not further worked than cold-rolled (cold-reduced), not clad/plated/coated, of a thickness of <0.5mm
Iron and steel	721090	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, clad/plated/coated, n.e.s. in 72.10	Iron and steel	720990	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, cold-rolled (cold-reduced), not clad/plated/coated, n.e.s. in 72.09
Iron and steel	721113	Other Flat-rolled products of iron/non-alloy steel, of a width of <600mm, not clad/plated/coated, not further worked than hot-rolled/not rolled on 4 faces/in a closed box pass/not in coils & without patterns in relief (exclud. 7211.13 & .14)	Iron and steel	721011	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, of a thickness of 0.5mm/more
Iron and steel	721114	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, not clad/plated/coated, not further worked than hot-rolled (excl. of 7211.13), of a thickness of 4.75mm/more	Iron and steel	721012	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, of a thickness of <0.5mm
Iron and steel	721119	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, not clad/plated/coated, not further worked than hot-rolled, n.e.s. in 72.11	Iron and steel	721020	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, plated/coated with Lead, incl. terne-plate
Iron and steel	721123	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, not clad/plated/coated, not further worked than cold-rolled (cold-reduced), containing by weight <0.25% of carbon	Iron and steel	721030	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, electrolytically plated/coated with zinc
Iron and steel	721129	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, not clad/plated/coated, not further worked than cold-rolled (cold-reduced) (excl. of 7211.23)	Iron and steel	721041	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, othw. plated/coated with zinc (excl. electrolytically), corrugated
Iron and steel	721190	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, not clad/plated/coated, n.e.s. in 72.11	Iron and steel	721049	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, othw. plated/coated with zinc (excl. electrolytically), other than corrugated

Product	HS2007	HS Description	Product	HS2007	HS Description
Iron and steel	721210	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, plated/coated with tin	Iron and steel	721050	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, plated/coated with chromium oxides/with chromium & chromium oxides
Iron and steel	721220	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, electrolytically plated/coated with zinc	Iron and steel	721061	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, plated/coated with Aluminium-zinc alloys
Iron and steel	721230	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, othw. plated/coated with zinc (excl. electrolytically)	Iron and steel	721069	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, plated/coated with Aluminium other than with Aluminium-zinc alloys
Iron and steel	721240	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, painted/varnished/coated with plastics	Iron and steel	721070	Flat-rolled products of iron/non-alloy steel, of a width of 600mm/more, painted/varnished/coated with plastics
Iron and steel	721250	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, othw. plated/\coated (excl. of 7212.10-7212.40)	Iron and steel	721260	Flat-rolled products of iron/non-alloy steel, of a width of <600mm, clad
Iron and steel	721590	Bars & rods of iron/non-alloy steel, n.e.s.	Iron and steel	721310	Bars & rods, hot-rolled, in irregularly wound coils, of iron/non-alloy steel, containing indentations/ribs/grooves/other deformations produced during the rolling process
Iron and steel	721610	Angles, shapes & sections of iron/non-alloy steel, U / I / H sections of iron/non-alloy steel, not further worked than hot-rolled/hot-drawn/extruded, of a height of <80mm	Iron and steel	721320	Bars & rods, hot-rolled, in irregularly wound coils, of iron/non-alloy steel (excl. of 7213.10), of free-cutting steel
Iron and steel	721621	Angles, shapes & sections of iron/non-alloy steel, L sections, not further worked than hot-rolled/hot-drawn/extruded, of a height of <80mm	Iron and steel	721391	Bars & rods, hot-rolled, in irregularly wound coils, of iron/non-alloy steel (excl. of 7213.10 & 7210.20), of circular cross-section measuring <14mm in diameter
Iron and steel	721622	Angles, shapes & sections of iron/non-alloy steel, T sections, not further worked than hot-rolled/hot-drawn/extruded, of a height of <80mm	Iron and steel	721399	Bars & rods, hot-rolled, in irregularly wound coils, of iron/non-alloy steel, n.e.s. in 72.13
Iron and steel	721631	Angles, shapes & sections of iron/non-alloy steel, U sections, not further worked than hot-rolled/hot-drawn/extruded, of a height of 80mm/more	Iron and steel	721410	Bars & rods of iron/non-alloy steel (excl. of 72.13), not further worked than forged
Iron and steel	721632	Angles, shapes & sections of iron/non-alloy steel, I sections, not further worked than hot-rolled/hot-drawn/extruded, of a height of 80mm/more	Iron and steel	721420	Bars & rods of iron/non-alloy steel (excl. of 72,13), containing indentations/ribs/grooves/other deformations produced during the rolling process/twisted after rolling
Iron and steel	721633	Angles, shapes & sections of iron/non-alloy steel, H sections, not further worked than hot-rolled/hot-drawn/extruded, of a height of 80mm/more	Iron and steel	721430	Bars & rods of iron/non-alloy steel (excl. of 72.13), of free-cutting steel, not further worked than forged/hot-rolled/hot-drawn/hot-extruded but incl. those twisted after rolling
Iron and steel	721640	Angles, shapes & sections of iron/non-alloy steel, L / T sections, not further worked than hot-rolled/hot-drawn/extruded, of a height of 80mm/more	Iron and steel	721491	Bars & rods of iron/non-alloy steel (excl. of 72.13), not further worked than forged/hot-rolled/hot-drawn/hot-extruded but incl. those twisted after rolling, of rectangular (excl. square) cross-section
Iron and steel	721650	Angles, shapes & sections of iron/non-alloy steel (excl. of 7216.10-7216.40), not further worked than hot-rolled/hot-drawn/extruded	Iron and steel	721499	Bars & rods of iron/non-alloy steel (excl. of 72.13), not further worked than forged/hot-rolled/hot-drawn/hot-extruded but incl. those twisted after rolling (excl. of 7214.10-7214.91)
Iron and steel	721661	Angles, shapes & sections of iron/non-alloy steel, not further worked than cold-formed/cold-finished, obt. from flat-rolled products	Iron and steel	721510	Bars & rods of iron/non-alloy steel, of free-cutting steel, not further worked than cold-formed/cold-finished
Iron and steel	721669	Angles, shapes & sections of iron/non-alloy steel, not further worked than cold-formed/cold-finished (excl. of 7216.61)	Iron and steel	721550	Bars & rods of iron/non-alloy steel other than free-cutting steel, not further worked than cold-formed/cold-finished

Product	HS2007	HS Description	Product	HS2007	HS Description
Iron and steel	721691	Angles, shapes & sections of iron/non-alloy steel (excl. of 7216.10-7216.69), cold-formed/cold-finished from flat-rolled products	Iron and steel	721699	Angles, shapes & sections of iron/non-alloy steel, n.e.s. in 72.16
Iron and steel	721923	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, not in coils, of a thickness of 3mm/more but <4.75mm	Iron and steel	721710	Wire of iron/non-alloy steel, not plated/coated, whether/not polished
Iron and steel	721924	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, not in coils, of a thickness of <3mm	Iron and steel	721720	Wire of iron/non-alloy steel, plated/coated with zinc
Iron and steel	721931	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than cold-rolled (cold-reduced), of a thickness of 4.75mm/more	Iron and steel	721730	Wire of iron/non-alloy steel, plated/coated with other base metals
Iron and steel	721932	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than cold-rolled (cold-reduced), of a thickness of 3mm/more but <4.75mm	Iron and steel	721790	Wire of iron/non-alloy steel, n.e.s. in 72.17
Iron and steel	721933	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than cold-rolled (cold-reduced), of a thickness >1mm but <3mm	Iron and steel	721810	Stainless steel in ingots & other primary forms
Iron and steel	721934	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than cold-rolled (cold-reduced), of a thickness of 0.5mm/more but not >1mm	Iron and steel	721891	Stainless steel, of rectangular (excl. square) cross-section
Iron and steel	721935	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than cold-rolled (cold-reduced), of a thickness of < 0.5mm	Iron and steel	721899	Semi-finished products of stainless steel (excl. of 7218.91)
Iron and steel	721990	Flat-rolled products of stainless steel, of a width of 600mm/more, n.e.s. in 72.19	Iron and steel	721911	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, in coils, of a thickness >10mm
Iron and steel	722011	Flat-rolled products of stainless steel, of a width of <600mm, not further worked than hot-rolled, of a thickness of 4.75mm/more	Iron and steel	721912	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, in coils, of a thickness of 4.75mm/more but not >10mm
Iron and steel	722012	Flat-rolled products of stainless steel, of a width of <600mm, not further worked than hot-rolled, of a thickness of <4.75mm	Iron and steel	721913	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, in coils, of a thickness of 3mm/more but < 4.75mm
Iron and steel	722020	Flat-rolled products of stainless steel, of a width of <600mm, not further worked than cold-rolled (cold-reduced)	Iron and steel	721914	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, in coils, of a thickness of <3mm
Iron and steel	722090	Flat-rolled products of stainless steel, of a width of <600mm, n.e.s. in 72.20	Iron and steel	721921	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, not in coils, of a thickness >10mm
Iron and steel	722100	Bars & rods, hot-rolled, in irregularly wound coils, of stainless steel	Iron and steel	721922	Flat-rolled products of stainless steel, of a width of 600mm/more, not further worked than hot-rolled, not in coils, of a thickness of 4.75mm/more but not >10mm
Iron and steel	722211	Bars & rods of stainless steel, not further worked than hot-rolled/hot-drawn/extruded, of circular cross-section	Iron and steel	722219	Bars & rods of stainless steel, not further worked than hot-rolled/hot-drawn/extruded other than of circular cross-section
Iron and steel	722611	Flat-rolled products of silicon-electrical steel, grain-oriented (excl. stainless steel), of a width of <600mm	Iron and steel	722220	Bars & rods of stainless steel, not further worked than cold-formed/cold-finished

Product	HS2007	HS Description	Product	HS2007	HS Description
Iron and steel	722619	Flat-rolled products of silicon-electrical steel, other than grain-oriented (excl. stainless steel), of a width of <600mm	Iron and steel	722230	Bars & rods of stainless steel, n.e.s. in 72.22
Iron and steel	722620	Flat-rolled products of high-speed steel (excl. stainless steel), of a width of <600mm	Iron and steel	722240	Angles, shapes & sections of stainless steel
Iron and steel	722691	Flat-rolled products of other alloy steel (excl. stainless/silicon-electrical/high speed steel), of a width of <600mm, not further worked than hot-rolled	Iron and steel	722300	Wire of stainless steel
Iron and steel	722692	Flat-rolled products of other alloy steel (excl. stainless/silicon-electrical/high speed steel), of a width of <600mm, not further worked than cold-rolled (cold-reduced)	Iron and steel	722410	Ingots & other primary forms of other alloy steel (excl. stainless steel)
Iron and steel	722699	Other n.e.s. in 72.26 flat-rolled products of other alloy steel (excld. Stainless/silicon-electrical/high speed steel), of a width of less than 600 mm.	Iron and steel	722490	Semi-finished products (excl. ingots & other primary forms) of alloy steel other than stainless steel, n.e.s.
Iron and steel	722710	Bars & rods, hot-rolled, in irregularly wound coils, of high speed steel	Iron and steel	722511	Flat-rolled products of silicon-electrical steel, grain-oriented (excl. stainless steel), of a width of 600mm/more
Iron and steel	722720	Bars & rods, hot-rolled, in irregularly wound coils, of silico-manganese steel	Iron and steel	722519	Flat-rolled products of silicon-electrical steel, other than grain-oriented (excl. stainless steel), of a width of 600mm/more
Iron and steel	722790	Bars & rods, hot-rolled, in irregularly wound coils (excl. of 72.13 & 7221.00), n.e.s. in 72.27	Iron and steel	722530	Other flat-rolled products of other alloy steel, of a width of 600 mm/more, not further worked than hot-rolled, in coils.
Iron and steel	722810	Bars & rods of high speed steel	Iron and steel	722540	Other flat-rolled products of other alloy steel, of a width of 600 mm/more, not further worked than hot-rolled, not in coils.
Iron and steel	722820	Bars & rods of silico-manganese steel	Iron and steel	722550	Other flat-rolled products of other alloy steel, of a width of 600 mm/more, not further worked than cold-rolled (cold-reduced),
Iron and steel	722830	Bars & rods of other alloy steel (excl. of 72.27, 7228.10 & 7228.20), not further worked than hot-rolled/hot-drawn/extruded	Iron and steel	722591	Other n.e.s. in 72.25, flat-rolled products of other alloy steel, of a width of 600 mm/more, of electrolytically plated/coated with zinc.
Iron and steel	722840	Bars & rods of other alloy steel (excl. of 72.27, 7228.10 & 7228.20), not further worked than forged	Iron and steel	722592	Other n.e.s. in 72.25, flat-rolled products of other alloy steel, of a width of 600 mm/more, of othw. plated/coated with zinc.
Iron and steel	722850	Bars & rods of other alloy steel (excl. of 72.27), not further worked than cold-formed/cold-finished	Iron and steel	722599	Other n.e.s. in 72.25, flat-rolled products of other alloy steel, of a width of 600 mm/more, other than of electrolutically/othw. plated/coated with zinc/.
Iron and steel	722860	Bars & rods of other alloy steel (excl. of 72.27), n.e.s. in 72.28	Iron and steel	722870	Angles, shapes & sections of alloy steel other than stainless steel
Lithium	282520	Lithium oxide & hydroxide	Iron and steel	722880	Hollow drill bars & rods of alloy/non-alloy steel
Lithium	283691	Lithium carbonates	Iron and steel	722920	Wire of silico-manganese steel
Magnesite	251910	Natural magnesium carbonate (magnesite)	Iron and steel	722990	Other wire of other alloy steel, other than of silico-manganese steel.
Magnesite	251990	Fused magnesia; dead-burned (sintered) magnesia, whether/not containing small quantities of other oxides added before sintering; other magnesium oxide, whether/not pure	Kaolin	250700	Kaolin & other kaolinic clays, whether/not calcined
Magnesium	280519	Alkali/alkaline-earth metals other than sodium & calcium	Lead	260700	Lead ores & concentrates

Product	HS2007	HS Description	Product	HS2007	HS Description
Magnesium	281610	Hydroxide & peroxide of magnesium	Lead	262021	Leaded gasoline sludges & Leaded anti-knock compound sludges
Magnesium	282731	Magnesium chlorides	Lead	262029	Ash & residues (excl. from the manufacture of iron/steel) containing Lead (excl. of 2620.21)
Magnesium	283321	Sulphates of magnesium	Lead	282410	Lead monoxide (litharge, massicot)
Magnesium	810411	Unwrought magnesium, containing at least 99.8% by weight of magnesium	Lead	282490	Lead oxides (excl. of 2824.10);red Lead&orange Lead
Magnesium	810419	Unwrought magnesium (excl. of 8104.11)	Lead	780110	Unwrought Lead, refined
Magnesium	810420	Magnesium waste & scrap	Lead	780191	Unwrought Lead other than refined, containing by weight antimony as the principal other element
Magnesium	810430	Magnesium raspings, turnings & granules, graded according to size; magnesium powders	Lead	780199	Unwrought Lead other than refined, n.e.s. in 78.01
Magnesium	810490	Magnesium & articles thereof , n.e.s. in 81.04	Lead	780200	Lead waste & scrap
Manganese	260200	Manganese ores & concentrates, incl. ferruginous manganese ores & concentrates with a manganese content of 20%/more, calc. on the dry weight	Lead	780411	Lead sheets, strip & foil of a thickness (excl. any backing) not >0.2mm
Manganese	282010	Manganese dioxide	Lead	780419	Lead plates, sheets, strip & foil (excl. of 7804.11)
Manganese	282090	Manganese oxides other than manganese dioxide	Lead	780420	Lead powders & flakes
Manganese	284161	Potassium permanganate	Lead	780600	Other articles of Lead.
Manganese	284169	Manganites, manganates & permanganates (excl. of potassium)	Limestone	252100	Limestone flux; limestone & other calcareous stone, of a kind used for the manufacture of lime/cement
Manganese	811100	Manganese & articles thereof , incl. waste & scrap	Limestone	252210	Quicklime
Mercury	262060	Slag,ash & residues (excl. from the manufacture of iron/steel) containing arsenic/mercury/thallium/their mixtures, of a kind used for the extraction of arsenic/those metals /for the manufacture of their chemical compounds	Limestone	252220	Slaked lime
Mercury	280540	Mercury	Limestone	252230	Hydraulic lime, other than calcium oxide & hydroxide of 28.25
Mercury	285200	Compounds, inorganic/organic, of mercury, excluding amalgams.	Molybdenum	261310	Molybdenum ores & concentrates, roasted
Nickel	750620	Plates, sheets, strip & foil, of nickel alloys	Molybdenum	261390	Molybdenum ores & concentrates, other than roasted
Niobium	261590	Niobium/tantalum/vanadium ores & concentrates	Molybdenum	282570	Molybdenum oxides & hydroxides
Niobium	811292	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.	Molybdenum	284170	Molybdates
Niobium	811299	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, excl. waste & scrap, powder, unwrought.	Molybdenum	810210	Molybdenum powders
Perlite	253010	Vermiculite, perlite & chlorites, unexpanded	Molybdenum	810294	Unwrought molybdenum, incl. bars & rods obt. simply by sintering

Product	HS2007	HS Description	Product	HS2007	HS Description
Phosphates	251010	Natural calcium phosphates, natural Aluminium calcium phosphates & phosphatic chalk, unground	Molybdenum	810295	Molybdenum bars & rods (excl. those obt. simply by sintering), profiles, plates, sheets, strip & foil
Phosphates	251020	Natural calcium phosphates, natural Aluminium calcium phosphates & phosphatic chalk, ground	Molybdenum	810296	Molybdenum wire
Phosphates	280470	Phosphorus	Molybdenum	810297	Molybdenum waste & scrap
Phosphates	280920	Phosphoric acid & polyphosphoric acids, whether/not chemically defined	Molybdenum	810299	Molybdenum & articles thereof , n.e.s. in 81.02
Phosphates	283522	Phosphates of mono- /disodium	Nickel	260400	Nickel ores & concentrates
Phosphates	283524	Phosphates of potassium	Nickel	282540	Nickel oxides & hydroxides
Phosphates	283525	Calcium hydrogenorthophosphate (dicalcium phosphate)	Nickel	282735	Nickel chlorides
Phosphates	283526	Phosphates of calcium other than hydrogenorthophosphate (dicalcium phosphate)	Nickel	283324	Sulphates of nickel
Phosphates	283529	Phosphates (excl. of 2835.22-2835.26)	Nickel	750110	Nickel mattes
Phosphates	283531	Sodium triphosphate (sodium tripolyphosphate)	Nickel	750120	Nickel oxide sinters & other intermediate products of nickel metallurgy
Phosphates	283539	Polyphosphates (excl. of 2835.31)	Nickel	750210	Nickel, not alloyed, unwrought
Pig iron	720110	Non-alloy Pig iron containing by weight 0.5%/less of phosphorus, in pigs/blocks/other primary forms	Nickel	750220	Nickel alloys, unwrought
Pig iron	720120	Non-alloy Pig iron containing by weight >0.5% of phosphorus, in pigs/blocks/other primary forms	Nickel	750300	Nickel waste & scrap
Pig iron	720150	Alloy Pig iron; spiegeleisen, in pigs/blocks/other primary forms	Nickel	750400	Nickel powders & flakes
Pig iron	720510	Granules of Pig iron, spiegeleisen, iron/steel	Nickel	750511	Bars, rods, profiles & wire, of nickel, not alloyed
Potash	310420	Potassium chloride	Nickel	750512	Bars, rods, profiles & wire, of nickel alloys
Potash	310430	Potassium sulphate	Nickel	750521	Wire of nickel, not alloyed
Potash	310490	Mineral/chemical fertilisers, potassic(excl. of 3104.20 & 3104.30)	Nickel	750522	Wire of nickel alloys
Rare-earth elements	280530	Rare-earth metals, scandium & yttrium, whether/not intermixed/interalloyed	Nickel	750610	Plates, sheets, strip & foil, of nickel, not alloyed
Rare-earth elements	284610	Cerium comps.	Rare-earth elements	284690	Compounds, inorganic/organic, of rare-earth metals/yttrium/scandium/mixtures of these metals, other than cerium comps.
Sawnwood non-coniferous tropical	440726	Wood sawn/chipped length wise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of White Lauan, White Meranti, White Seraya, Yellow Meranti & Alan	Rhenium	811292	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.
Sawnwood non-coniferous tropical	440727	Wood sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of Sapelli	Rhenium	811299	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, excl. waste & scrap, powder, unwrought.
Sawnwood non-coniferous tropical	440728	Wood sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of Iroko	Sawnwood coniferous	440710	Wood sawn/chipped length wise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, coniferous

Product	HS2007	HS Description	Product	HS2007	HS Description
Sawnwood non-coniferous tropical	440729	Wood sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of tropical wood specified in Subheading Note 1 to this Ch. (excl. of 4407.21-4407.28)	Sawnwood non-coniferous non-tropical	440791	Oak (Quercus spp.), sawn/chipped length wise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm
Selenium	280490	Selenium	Sawnwood non-coniferous non-tropical	440792	Beech (Fagus spp.), sawn/chipped length wise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm
Silica	250510	Silica sands & quartz sands, whether/not coloured	Sawnwood non-coniferous non-tropical	440793	Maple (Acer spp.), sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm
Silicon	280461	Silicon, containing by weight not <99.99% of silicon	Sawnwood non-coniferous non-tropical	440794	Cherry (Prunus spp.), sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm
Silicon	280469	Silicon, containing by weight <99.99% of silicon	Sawnwood non-coniferous non-tropical	440795	Ash(Fraxinus spp.), sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm
Silicon	281122	Silicon dioxide	Sawnwood non-coniferous non-tropical	440799	Wood(excl. of 4407.10-4407.95), sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm
Silicon	283911	Sodium metasilicates	Sawnwood non-coniferous tropical	440721	Wood sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of Mahogany (Swietenia spp.)
Silicon	283919	Silicates of sodium other than sodiummetasilicates	Sawnwood non-coniferous tropical	440722	Wood sawn/chipped lengthwise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of Virola, Imbuia&Balsa
Silicon	283990	Silicates other than of sodium; commercial alkali metal silicates	Sawnwood non-coniferous tropical	440725	Wood sawn/chipped length wise, sliced/peeled, whether/not planed, sanded/end-jointed, of a thickness >6mm, of Dark Red Meranti, Light Red Meranti & Meranti Bakau
Silicon	284210	Double/complex silicates, incl. aluminosilicates, whether/not chemically defined	Silicon	284920	Carbides, of silicon, whether/not chemically defined
Tin	260900	Tin ores & concentrates	Silver	261610	Silver ores & concentrates
Tin	800110	Tin, not alloyed, unwrought	Silver	284310	Colloidal precious metals
Tin	800120	Tin alloys, unwrought	Silver	284321	Silver nitrate
Tin	800200	Tin waste & scrap	Silver	284329	Silver comps. other than silver nitrate
Tin	800300	Tin bars, rods, profiles & wire	Silver	710610	Silver (incl. silver plated with Gold/platinum), in powder form
Tin	800700	Other articles of tin	Silver	710691	Silver (incl. silver plated with Gold/platinum), unwrought
Titanium	261400	Titanium ores & concentrates	Silver	710692	Silver (incl. silver plated with Gold/platinum), in semi-manufactured forms
Titanium	282300	Titanium oxides	Silver	710700	Base metals clad with silver, not further worked than semi-manufactured
Titanium	810820	Unwrought titanium; powders	Silver	711230	Ash containing precious metal/precious metal comps.
Titanium	810830	Titanium waste & scrap	Silver	711299	Waste & scrap of precious metal/of metal clad with precious metal; other waste & scrap containing precious metal/precious metal compounds, of a kind used principally for the recovery of precious metal, other than Gold/platinum, n.e.s. of 71.12
Titanium	810890	Titanium & articles thereof , n.e.s. in 81.08	Strontium	280519	Alkali/alkaline-earth metals other than sodium & calcium

Product	HS2007	HS Description	Product	HS2007	HS Description
Tungsten	261100	Tungsten ores & concentrates	Strontium	281640	Oxides, hydroxides & peroxides, of strontium/barium
Tungsten	284180	Tungstates (wolframates)	Strontium	283692	Strontium carbonate
Tungsten	810110	Tungsten (wolfram) powders	Talc	252610	Natural steatite, whether/not roughly trimmed/merely cut, by sawing/othw., into blocks/slabs of a rectangular (incl. square) shape; talc, not crushed/powdered
Tungsten	810194	Unwrought tungsten (wolfram), incl. bars & rods obt. simply by sintering	Talc	252620	Natural steatite, whether/not roughly trimmed/merely cut, by sawing/othw., into blocks/slabs of a rectangular (incl. square) shape; talc, crushed/powdered
Tungsten	810196	Tungsten (wolfram) wire	Tantalum	261590	Niobium/tantalum/vanadium ores & concentrates
Tungsten	810197	Tungsten (wolfram) waste & scrap	Tantalum	810320	Unwrought tantalum, incl. bars & rods obt. simply by sintering; powders
Tungsten	810199	Other tungsten (wolfram) other than waste & scrap,/wire/powder.	Tantalum	810330	Tantalum waste & scrap
Vanadium	261590	Niobium/tantalum/vanadium ores & concentrates	Tantalum	810390	Tantalum & articles thereof , n.e.s. in 81.03
Vanadium	282530	Vanadium oxides & hydroxides	Tellurium	280450	Boron; tellurium
Vanadium	811292	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.	Vanadium	811299	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, excl. waste & scrap, powder, unwrought.
Zirconium	810990	Zirconium & articles thereof , n.e.s. in 81.09	Zinc	260800	Zinc ores & concentrates
Metal waste and scrap	261800	Granulated slag (slag sand) from the manufacture of iron/steel	Zinc	262011	Ash & residues (excl. from the manufacture of iron/steel), containing hard zinc spelter
Metal waste and scrap	261900	Slag, dross (excl. granulated slag), scalings & other waste from the manufacture of iron/steel	Zinc	262019	Ash & residues (excl. from the manufacture of iron/steel), containing zinc other than hard zinc spelter
Metal waste and scrap	262011	Ash & residues (excl. from the manufacture of iron/steel), containing hard zinc spelter	Zinc	281700	Zinc oxide; zinc peroxide
Metal waste and scrap	262019	Ash & residues (excl. from the manufacture of iron/steel), containing zinc other than hard zinc spelter	Zinc	790111	Zinc, not alloyed, unwrought, containing by weight 99.99%/more of zinc
Metal waste and scrap	262021	Leaded gasoline sludges & Leaded anti-knock compound sludges	Zinc	790112	Zinc, not alloyed, unwrought, containing by weight <99.99% of zinc
Metal waste and scrap	262029	Ash & residues (excl. from the manufacture of iron/steel) containing Lead (excl. of 2620.21)	Zinc	790120	Zinc alloys, unwrought
Metal waste and scrap	262030	Ash & residues (excl. from the manufacture of iron/steel) containing mainly Copper	Zinc	790200	Zinc waste & scrap
Metal waste and scrap	262040	Ash & residues (excl. from the manufacture of iron/steel) containing mainly Aluminium	Zinc	790310	Zinc dust
Metal waste and scrap	262060	Slag,ash & residues (excl. from the manufacture of iron/steel) containing arsenic/mercury/thallium/their mixtures, of a kind used for the extraction of arsenic/those metals /for the manufacture of their chemical compounds	Zinc	790390	Zinc powders & flakes
Metal waste and scrap	262091	Ash & residues (excl. from the manufacture of iron/steel) containing antimony/beryllium/cadmium/chromium/their mixtures	Zinc	790400	Zinc bars, rods, profiles & wire
Metal waste and scrap	262099	Ash & residues (excl. from the manufacture of iron/steel), n.e.s. in Ch.26	Zinc	790500	Zinc plates, sheets, strip & foil

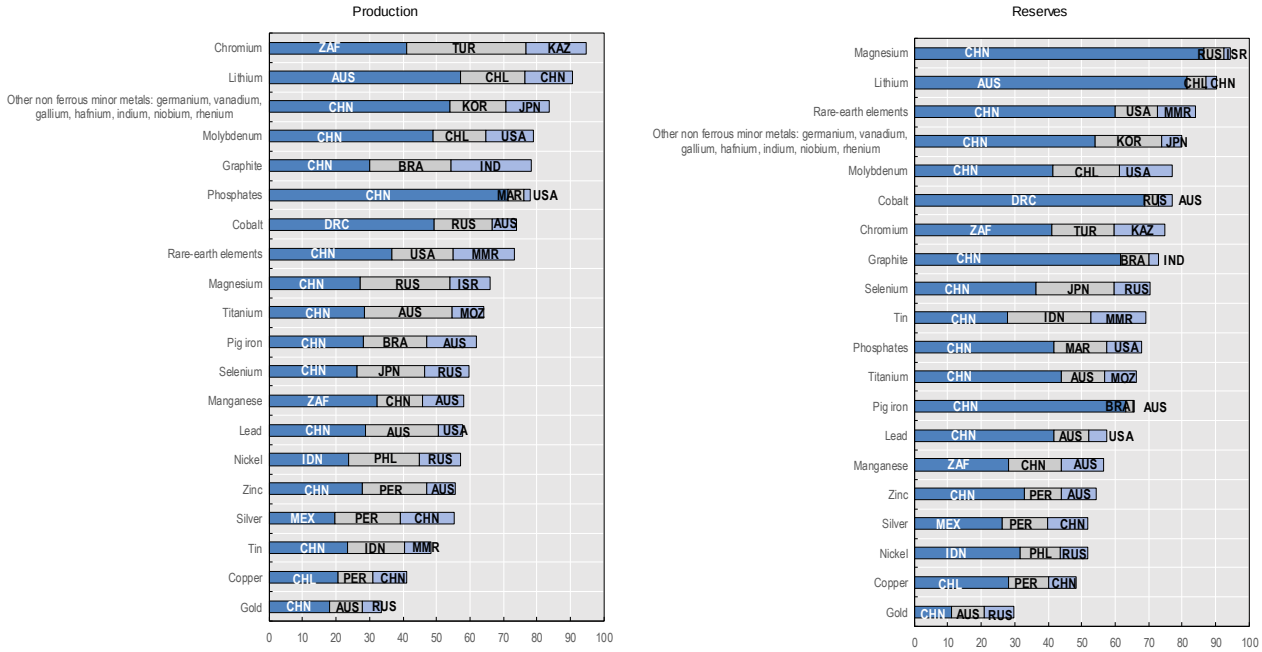
Product	HS2007	HS Description	Product	HS2007	HS Description
Metal waste and scrap	711230	Ash containing precious metal/precious metal comps.	Zinc	790700	Other articles of zinc.
Metal waste and scrap	711291	Waste & scrap of Gold, incl. metal clad with Gold but excl. sweepings containing other precious metals	Zirconium	261510	Zirconium ores & concentrates
Metal waste and scrap	711292	Waste & scrap of platinum, incl. metal clad with platinum but excl. sweepings containing other precious metals	Zirconium	282560	Germanium oxides & zirconium dioxide
Metal waste and scrap	711299	Waste & scrap of precious metal/of metal clad with precious metal; other waste & scrap containing precious metal/precious metal compounds, of a kind used principally for the recovery of precious metal, other than Gold/platinum, n.e.s. of 71.12	Zirconium	810920	Unwrought zirconium; powders
Metal waste and scrap	720410	Waste & scrap of cast iron	Zirconium	810930	Zirconium waste & scrap
Metal waste and scrap	720421	Waste & scrap of stainless steel	Metal waste and scrap	720429	Waste & scrap of alloy steel other than stainless steel
Metal waste and scrap	811020	Antimony waste & scrap	Metal waste and scrap	720430	Waste & scrap of tinned iron/steel
Metal waste and scrap	811100	Manganese & articles thereof , incl. waste & scrap	Metal waste and scrap	720441	Ferrous turnings, shavings, chips, milling waste, sawdust, filings, trimmings & stampings, whether/not in bundles
Metal waste and scrap	811213	Beryllium waste & scrap	Metal waste and scrap	720449	Ferrous waste & scrap (excl. of 7204.10-7204.41)
Metal waste and scrap	811222	Chromium waste & scrap	Metal waste and scrap	720450	Remelting ferrous scrap ingots
Metal waste and scrap	811292	germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, & articles of these metals, incl. waste & scrap, powder, unwrought.	Metal waste and scrap	740400	Copper waste & scrap
Other	250590	Natural sands other than silica & quartz, whether/not coloured, other than metalbearing sands of Ch.26	Metal waste and scrap	750300	Nickel waste & scrap
Other	253090	Mineral substance, n.e.s. in Ch.25	Metal waste and scrap	760200	Aluminium waste & scrap
Other	261790	Ores & concentrates (excl. of 2601.11-2617.10)	Metal waste and scrap	780200	Lead waste & scrap
Other	282590	Inorganic bases other than hydrazine & hydroxylamine & their inorganic salts; other metal oxides, hydroxides & peroxides, n.e.s. in Ch 28.25	Metal waste and scrap	790200	Zinc waste & scrap
Other	284990	Carbides (excl. of 2849.10 & 2849.20), whether/not chemically defined	Metal waste and scrap	800200	Tin waste & scrap
PMG (Platinum Metal Group)	261690	Precious metal ores & concentrates (excl. silver ores & concentrates)	Metal waste and scrap	810197	Tungsten (wolfram) waste & scrap
PMG (Platinum Metal Group)	284310	Colloidal precious metals	Metal waste and scrap	810297	Molybdenum waste & scrap
PMG (Platinum Metal Group)	284390	Inorganic/organic compounds of precious metals (excl. of 2843.21 - 2843.30), whether/not chemically defined; amalgams of precious metals	Metal waste and scrap	810330	Tantalum waste & scrap
PMG (Platinum Metal Group)	711011	Platinum, unwrought/in powder form	Metal waste and scrap	810420	Magnesium waste & scrap
PMG (Platinum Metal Group)	711019	Platinum, in semi-manufactured forms	Metal waste and scrap	810530	Cobalt waste & scrap

Product	HS2007	HS Description	Product	HS2007	HS Description
PMG (Platinum Metal Group)	711021	Palladium, unwrought/in powder form	Metal waste and scrap	810730	Cadmium waste & scrap
PMG (Platinum Metal Group)	711029	Palladium, in semi-manufactured forms	Metal waste and scrap	810830	Titanium waste & scrap
PMG (Platinum Metal Group)	711031	Rhodium, unwrought/in powder form	Metal waste and scrap	810930	Zirconium waste & scrap
PMG (Platinum Metal Group)	711039	Rhodium, in semi-manufactured forms	PMG (Platinum Metal Group)	711100	Base metals/silver/Gold, clad with platinum, not further worked than semi-manufactured
PMG (Platinum Metal Group)	711299	Waste & scrap of precious metal/of metal clad with precious metal; other waste & scrap containing precious metal/precious metal compounds, of a kind used principally for the recovery of precious metal, other than Gold/platinum, n.e.s. of 71.12	PMG (Platinum Metal Group)	711230	Ash containing precious metal/precious metal comps.
PMG (Platinum Metal Group)	711041	Iridium, osmium & Ruthenium, unwrought/in powder form	PMG (Platinum Metal Group)	711292	Waste & scrap of platinum, incl. metal clad with platinum but excl. sweepings containing other precious metals
PMG (Platinum Metal Group)	711049	Iridium, osmium & Ruthenium, in semi-manufactured forms			

Annex C. Tables, figures and definitions accompanying Section 3

Figure A C.1. Shares of top 3 producers and reserve holders of selected critical raw materials

2019 (%)



Source: OECD calculations based on the United States Geological Survey data.

Table A C.1. Shares of top 3 producers and reserve holders of selected critical raw materials

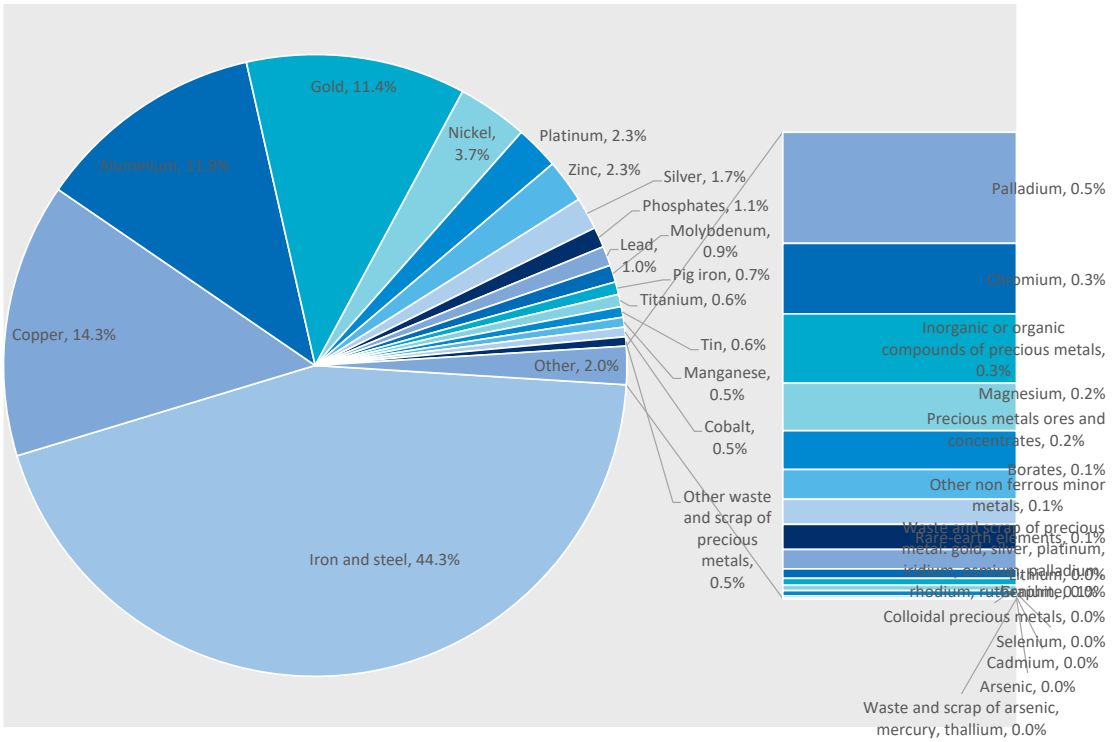
2019 (%)

	Production	Reserves
Chromium	South Africa (41.1%), Türkiye (18.7%), Kazakhstan (15.1%)	Kazakhstan (41.1%), South Africa (35.7%), India (17.9%)
Cobalt	Democratic Republic of the Congo (68.7%), Russia (4.3%), Australia (3.9%)	Democratic Republic of the Congo (49.3%), Australia (17.4%), Cuba (7.2%)
Copper	Chile (28.1%), Peru (11.9%), China (8.2%)	Chile (20.5%), Australia (10.6%), Peru (10%)
Gold	China (11.2%), Australia (9.6%), Russia (9%)	Australia (18.1%), Russia (9.8%), United States (5.6%)
Natural graphite	China (61.7%), Brazil (8.5%), India (2.8%)	Türkiye (30%), China (24.3%), Brazil (24%)
Lead	China (41.6%), Australia (10.4%), United States (5.5%)	Australia (28.9%), China (21.7%), Peru (7.2%)
Lithium	Australia (81.4%), Chile (5.8%), China (2.9%)	Chile (57.1%), Australia (19.3%), Argentina (14.3%)
Magnesium	China (86.6%), Russia (6%), Israel (1.9%)	Democratic People's Republic of Korea (27.1%), Russia (27.1%), China (11.8%)
Manganese	South Africa (28.2%), China (15.8%), Australia (12.5%)	South Africa (32.1%), Brazil (13.6%), Australia (12.3%)
Molybdenum	China (41.5%), Chile (19.8%), United States (15.7%)	China (48.8%), United States (15.9%), Peru (14.1%)
Nickel	Indonesia (31.6%), Philippines (12%), Russia (8.3%)	Indonesia (23.6%), Australia (21.3%), Brazil (12.4%)
Other non-ferrous minor metals: germanium, vanadium, gallium, hafnium, indium, niobium, rhenium	China (54.1%), Korea (19.8%), Japan (6.1%)	Chile (54.2%), United States (16.7%), Russia (12.9%)
Phosphates	China (41.7%), Morocco (15.7%), United States (10.4%)	Morocco (71.4%), China (4.6%), Egypt (1.9%)
Pig iron	China (63.2%), Brazil (2%), Australia (0.3%)	Australia (28.2%), Brazil (18.8%), Russia (14.7%)
Rare-earth elements	China (60%), United States (12.7%), Myanmar (11.4%)	China (36.7%), Brazil (18.3%), Viet Nam (18.3%)
Selenium	China (36.2%), Japan (23.3%), Russia (10.9%)	China (26.3%), Russia (20.2%), Peru (13.1%)
Silver	Mexico (26.3%), Peru (13.5%), China (12.1%)	European Union (19.6%), Peru (19.6%), Australia (15.9%)
Tin	China (27.8%), Indonesia (25.1%), Myanmar (16.2%)	China (23.4%), Indonesia (17%), Australia (7.9%)
Titanium	China (43.9%), Australia (13.1%), Mozambique (9.3%)	Australia (28.4%), China (26.1%),India (9.7%)
Zinc	China (32.9%), Peru (11%), Australia (10.4%)	Australia (27.8%), China (19.1%), Mexico (8.7%)

Note: The calculated shares are based on gross weight of production.
Source: OECD calculations based on the United States Geological Survey data.

Figure A C.2. Global trade in critical raw materials

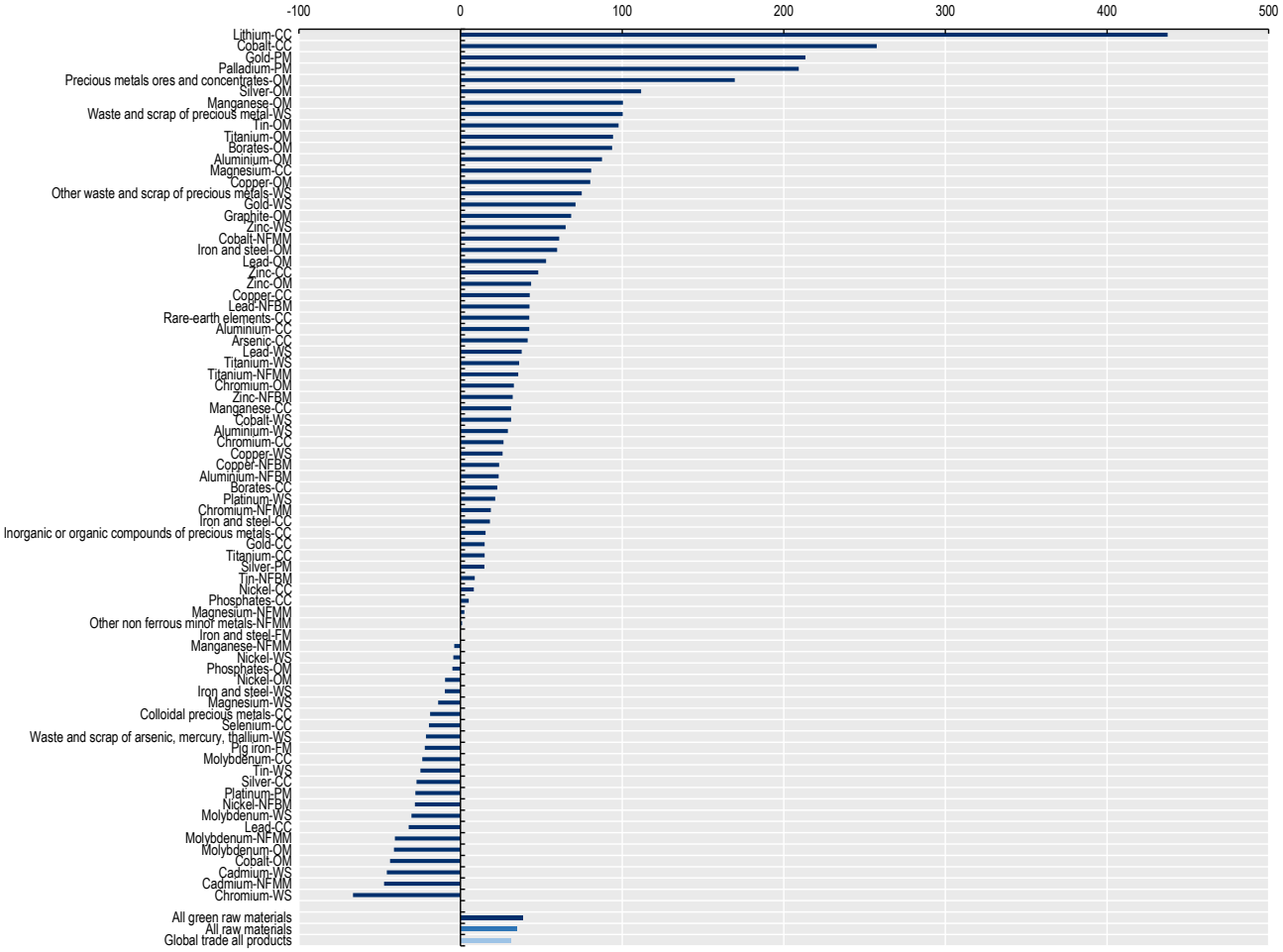
Shares in value of global exports during the period 2007-09



Source: OECD calculations using the BACI data.

Figure A C.3. Global trade in critical raw materials – growth rates 2017-19, jointly by product and sector

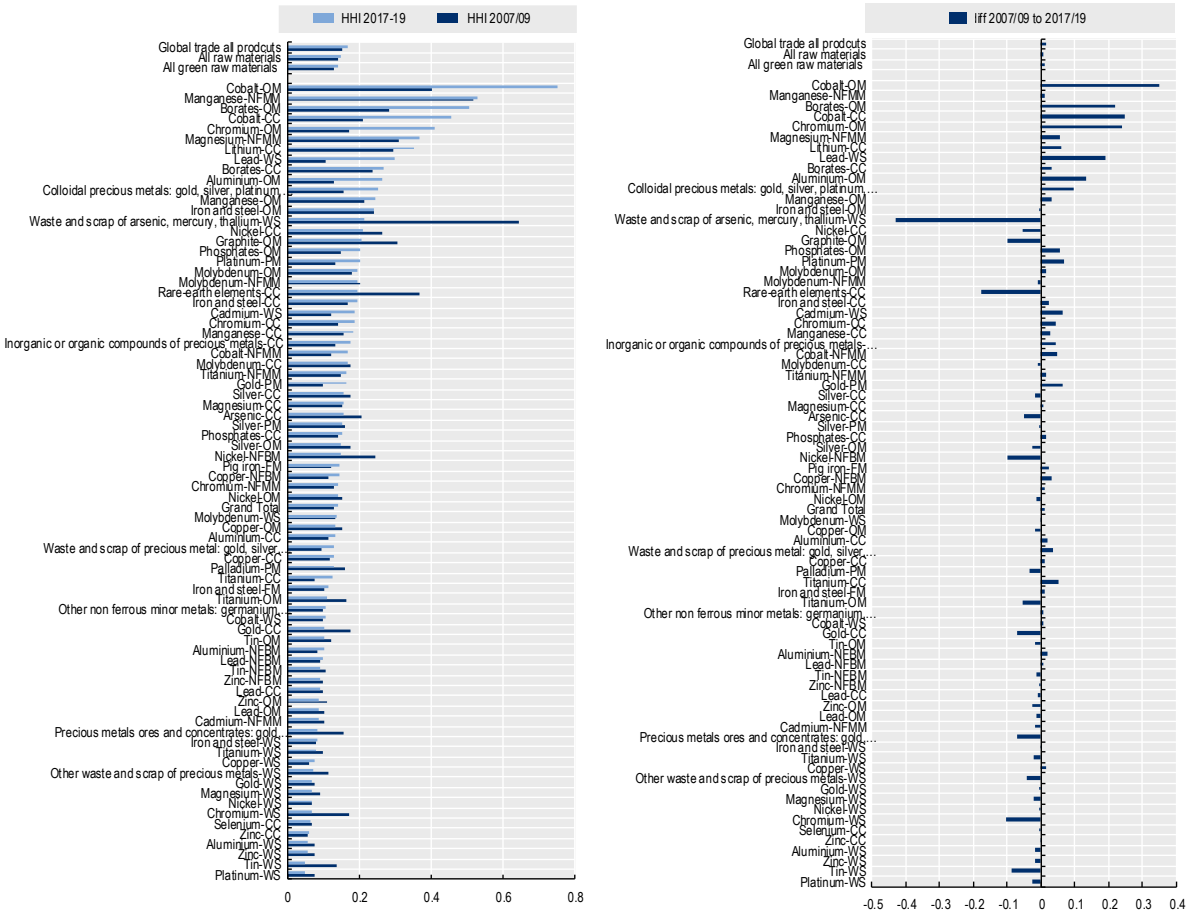
Growth rates of the value of trade between the period 2007-09 and 2017-19 (%)



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

Figure A C.4. Concentration of global exports of critical raw materials across all exporting countries in the period 2007-09 and 2017-19

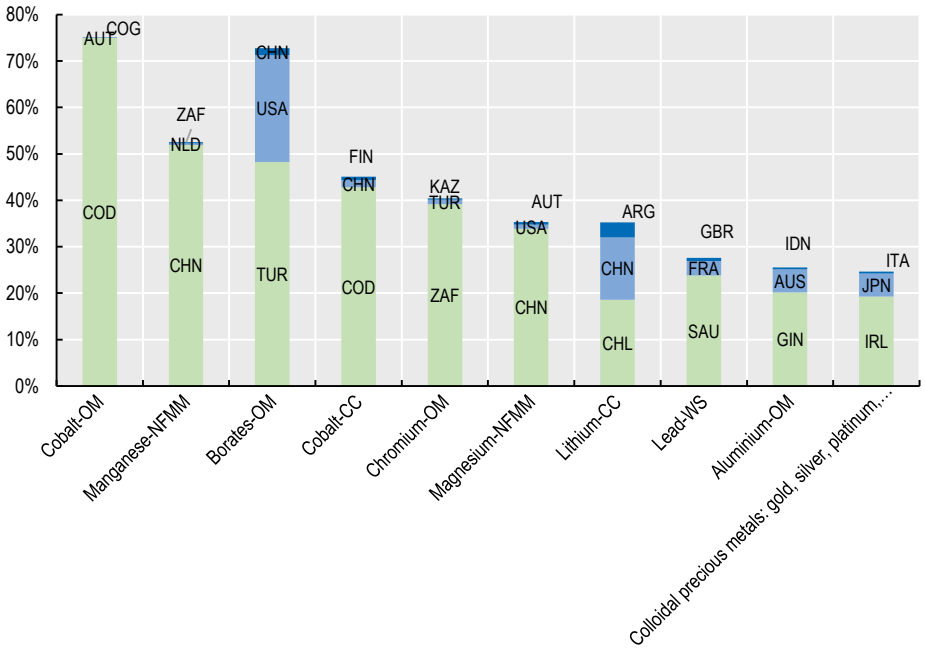
Global HHI index of export concentration across exporting countries and critical raw material 'products' and 'sectors'



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

Figure A C.5. Top 3 exporters of the top 10 most export-concentrated critical raw materials

Top 10 critical raw material 'products' and 'sectors'—export shares of top 3 exporters



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

Table A C.2. Ten exporters with highest shares of exports of critical raw material products

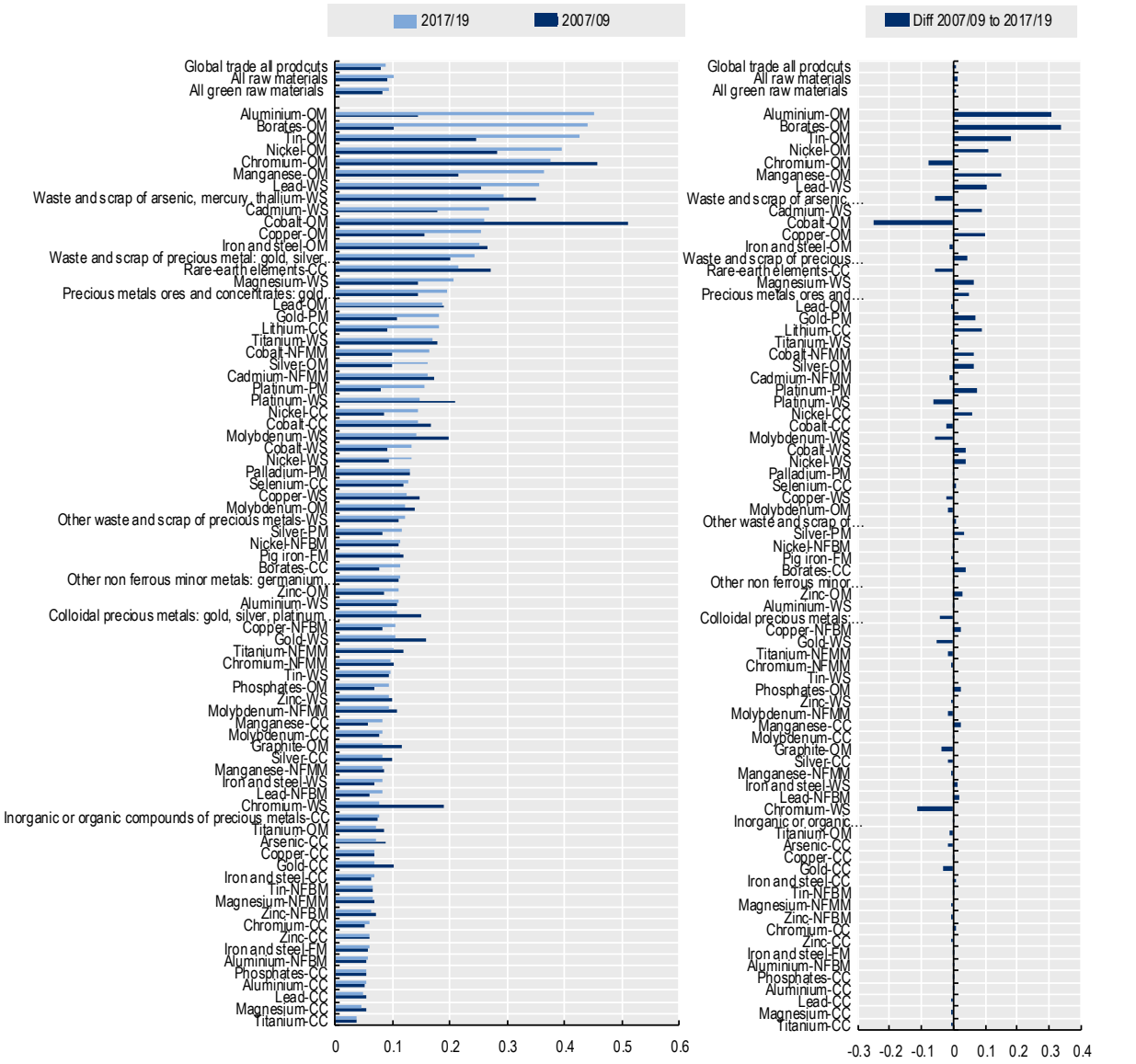
All critical raw material 'products' and 'sectors'—10 exporters with top average ranks of shares

	Average rank of trade share	St. dev. of rank of trade share	Average share	Median share
USA	7	6	1.5%	0.4%
DEU	10	11	1.0%	0.4%
CHN	14	17	2.8%	0.1%
NLD	16	12	0.2%	0.0%
GBR	16	12	0.5%	0.0%
FRA	17	13	0.3%	0.0%
BEL	18	13	0.1%	0.0%
CAN	19	13	0.2%	0.0%
JPN	19	20	0.6%	0.1%
ITA	21	14	0.1%	0.0%

Source: OECD calculations using the BACI data.

Figure A C.6. Concentration of global imports of critical raw materials across all importing countries in the period 2007-09 and 2017-19

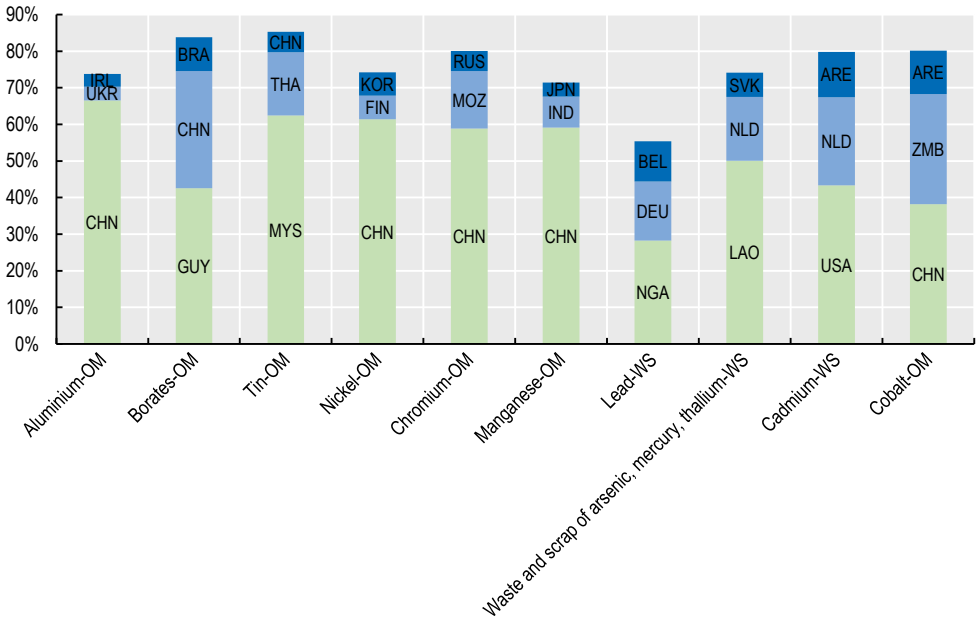
Global HHI index of import concentration across exporting countries and critical raw material 'products' and 'sectors'



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

Figure A C.7. Top 3 importers of the top 10 most export-concentrated critical raw materials

Top 10 critical raw material 'products' and 'sectors'—import shares of top 3 exporters



Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD calculations using the BACI data.

Table A C.3. Ten importers with highest shares of exports of critical raw material products

All critical raw material 'products' and 'sectors' — 10 importers with top average ranks of shares

	Average rank	standard deviation of rank	Average share	Median share
USA	7	8	9%	8%
DEU	7	7	7%	6%
CHN	9	10	12%	6%
JPN	10	9	6%	4%
KOR	11	9	5%	3%
IND	13	9	4%	2%
NLD	13	9	3%	2%
BEL	14	12	4%	2%
GBR	14	12	4%	2%
FRA	15	10	3%	2%

Source: OECD calculations using the BACI data.

Box A C.1. Simple working definition of bilateral trade dependencies

In order to provide a reasonably comprehensive and detailed starting point for discussion, trade dependencies of OECD countries have empirically been classified in the most simple terms as bilateral trade flows at the Harmonised System (HS) 6-digit level of product classification that meet five conditions:

- the importer is an OECD country
- the exporter is (2a) an OECD country or (2b) a non-OECD country
- the gross imports of the given product by the OECD country are overall highly concentrated
- the import from a specific non-OECD country accounts for a relatively high share (exceeding or equal to 10%) of the OECD's country's overall imports of the product, and
- the share of supplies from other OECD countries in the OECD country's imports is smaller than 20%.

Here, concentration is defined as where the Herfindahl-Hirschman Index (HHI) of imports of a given product calculated across all supplying countries exceeds or is equal to 0.2. The HHI is commonly used to measure market concentration. It is the sum of squared market shares and lies between 1/*n*, when all of the *n* suppliers have equal shares, and one, in a monopoly. The US Department of Justice and US Federal Reserve, for example consider markets with a HHI between 0.15 and 0.25 to be moderately concentrated and markets with HHI equal to or more than 0.25 to be highly concentrated. For the purpose of this paper, the level of concentration has been calculated using CEPII's BACI dataset and are averages of bilateral trade values in years 2017, 2018 and 2019 (i.e. the three years preceding the COVID-19 pandemic to assume away the pandemic-related abnormalities).

Applying these set criteria, only 0.4% of all bilateral trade flows involving OECD countries as importers are import dependencies (1.4% if criterion 5 is lifted, Table A C.4 below).

We see also that these criteria are relatively mild: bilateral imports of OECD countries which account for more than 10% a country's imports of a given product are relatively widespread (more than 8% of all bilateral import flows) and those where the overall concentration of imports is high (HHI >= 0.2) even more (58% of all bilateral imports) (Table A C.4). If these criteria were tightened, (e.g. shares of 20% or more and HHI of 0.5 of more were assumed) the counts and shares of trade dependencies would be fewer.

Table A C.4. Counts and shares of OECD countries' bilateral imports meeting different dependency criteria

Condition	Description	Number of concerned tariff lines	% of all tariff lines
2	All bilateral flows of OECD countries as importers	5 765 589	100.0%
	Of which meeting the following criteria:		
2&3	Imports of the given product by the OECD country are overall highly concentrated (HHI >= 0.2)	3 332 786	57.8%
2&4	Bilateral import from an OECD or non-OECD country accounts for a relatively high share bilateral share (share>=0.1)	474 697	8.2%
2&3&4	Flows with high HHI and bilateral share	295 538	5.1%
	Of which:		
2a&3&4	OECD exporters	214 454	3.7%
2b&3&4	Non-OECD exporters	81 084	1.4%
2b&3&4&5	Non-OECD exporters and share of other OECD exporters <0.2	24 486	0.4%

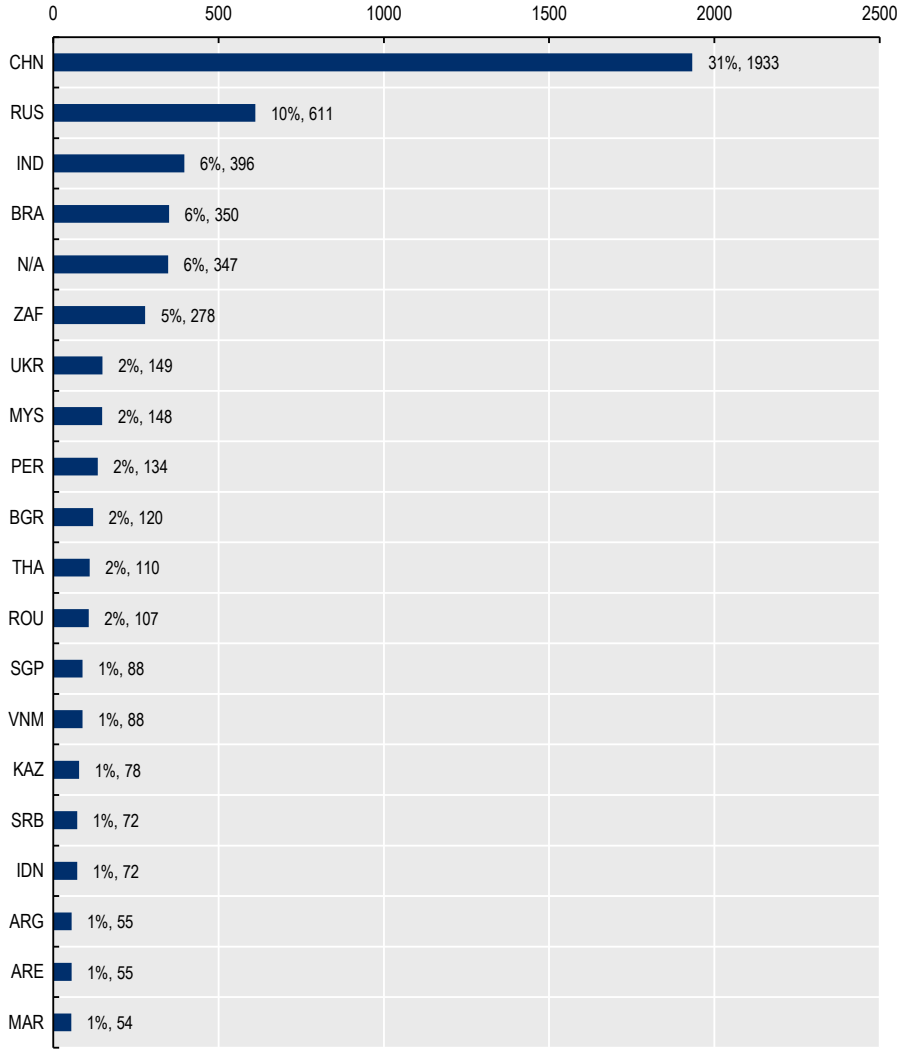
Source: OECD calculations using CEPII's BACI data.

Discussion and caveats

Looking at detailed gross import data, as is the approach here, allows a reasonably comprehensive coverage of countries and specific products at a good level of detail but suffers from many limitations. For example, it does not account for where the value added embodied in the imports actually originates, or for the extent to which imports are actually retained or used for exports or further processing in other countries. In a world of complex international supply chains, the weakest link can sometimes determine the vulnerability of the whole chain. The methodology applied also abstracts from how much is actually produced and consumed in the importing countries and whether trade links concern intra or extra-firm trade flows. This approach can therefore miss some dependencies while overstating others. Other methodological approaches, most notably the OECD's Inter-Country Input-output and Trade in Value Added (TiVA) data, or related sector specific work, such as OECD's recent work on semiconductors (DSTI/CIIE/WPIA(2022)4), can be explored further to arrive at a more comprehensive assessment.

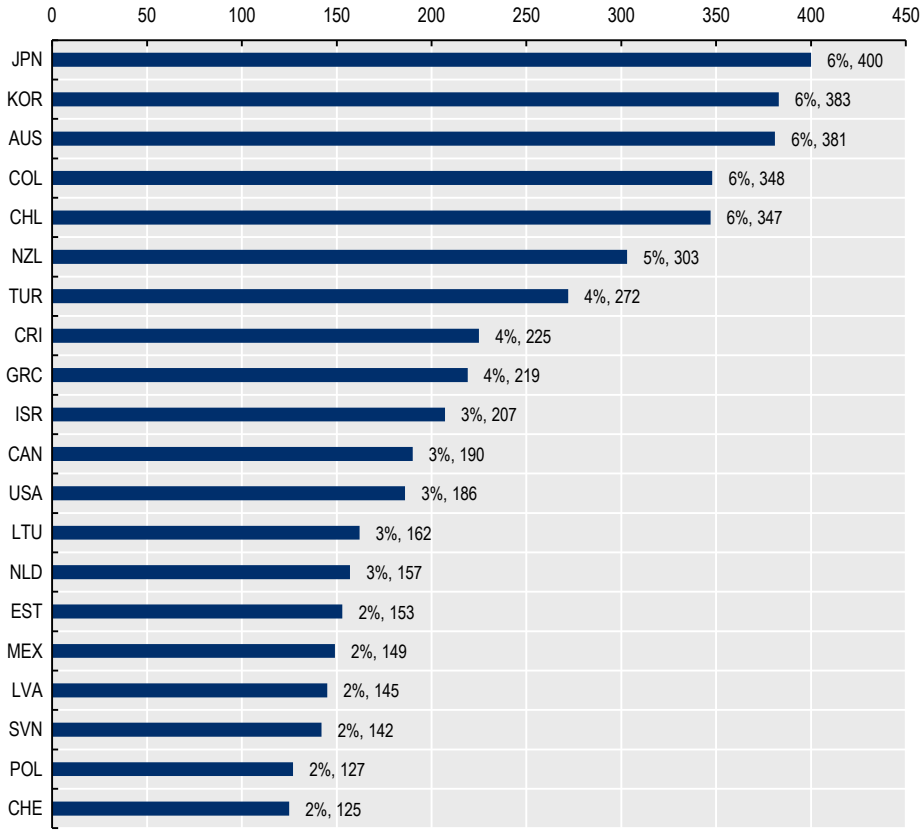
Source: Authors' own elaboration.

Figure A C.8. Count and share of dependencies in critical raw materials across supplying countries under alternative dependency criteria (top 20)



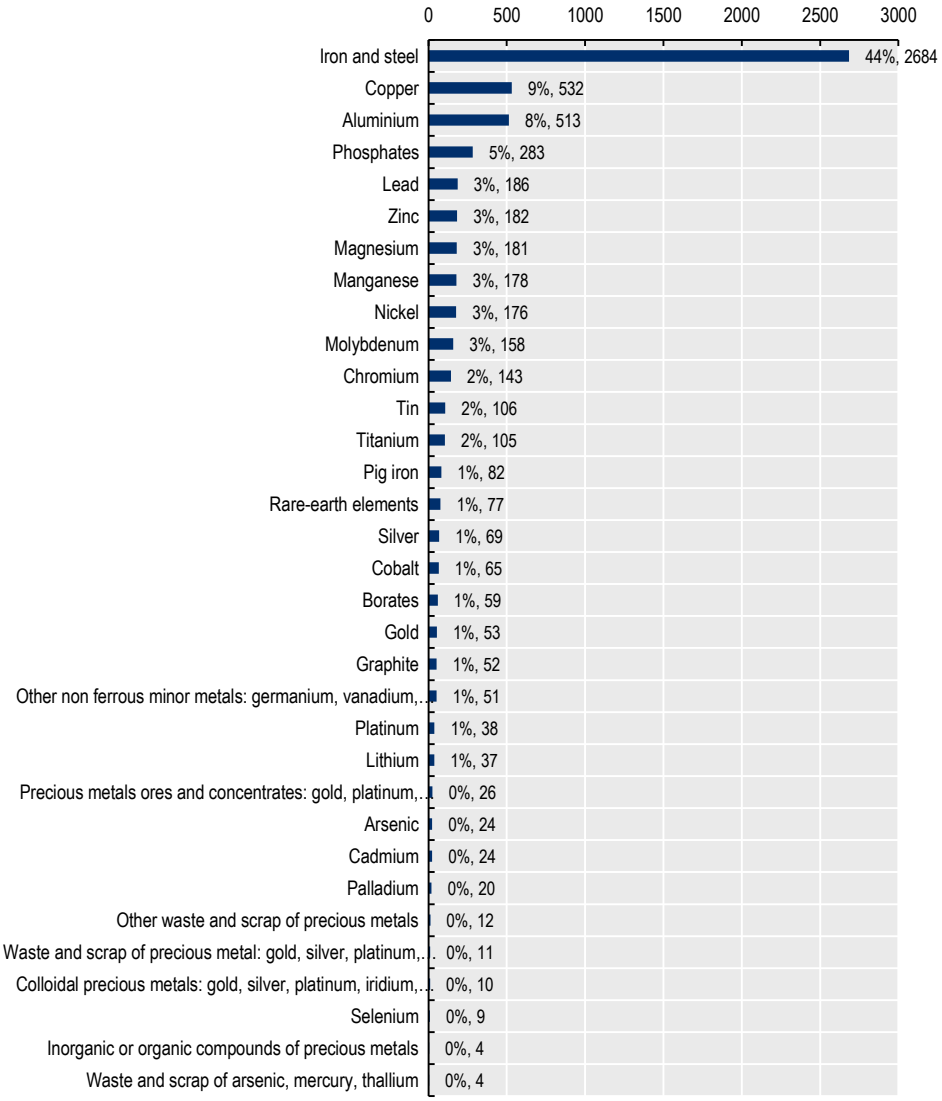
Source: OECD calculations using the BACI data.

Figure A C.9. Count and share of dependencies in critical raw materials across importing OECD countries under alternative dependency criteria (top 20)



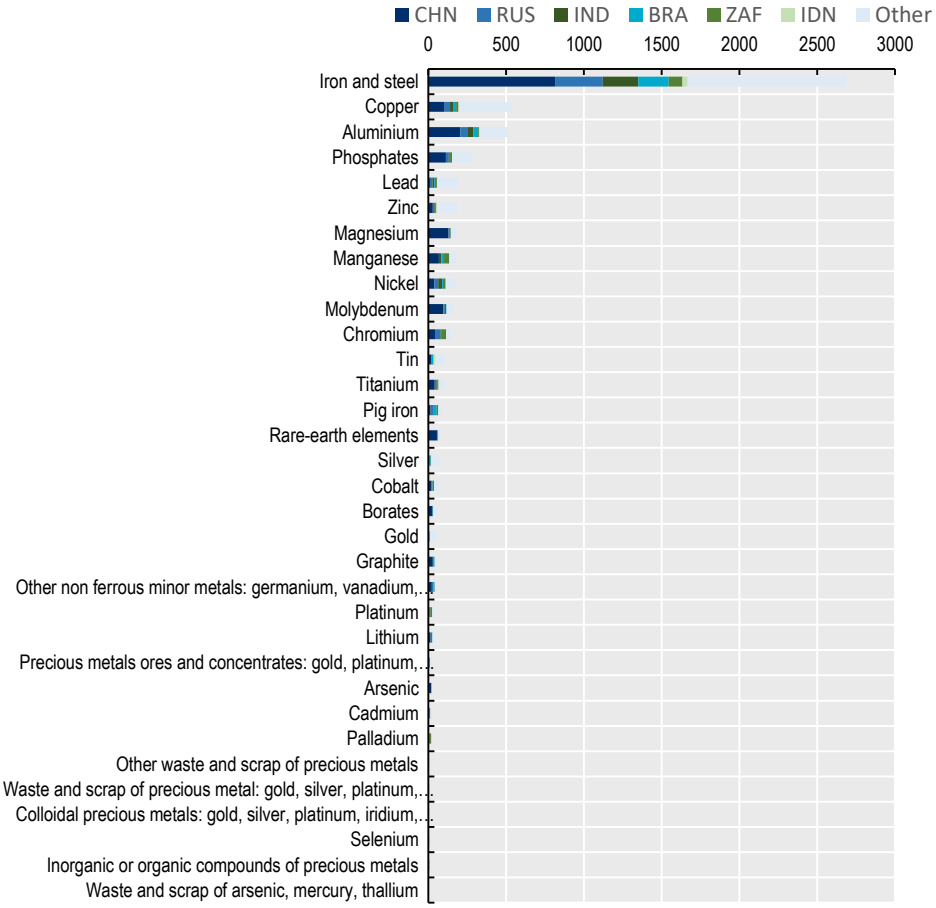
Source: OECD calculations using the BACI data.

Figure A C.10. Count and share of dependencies across imported critical raw materials under alternative dependency criteria



Source: OECD calculations using the BACI data.

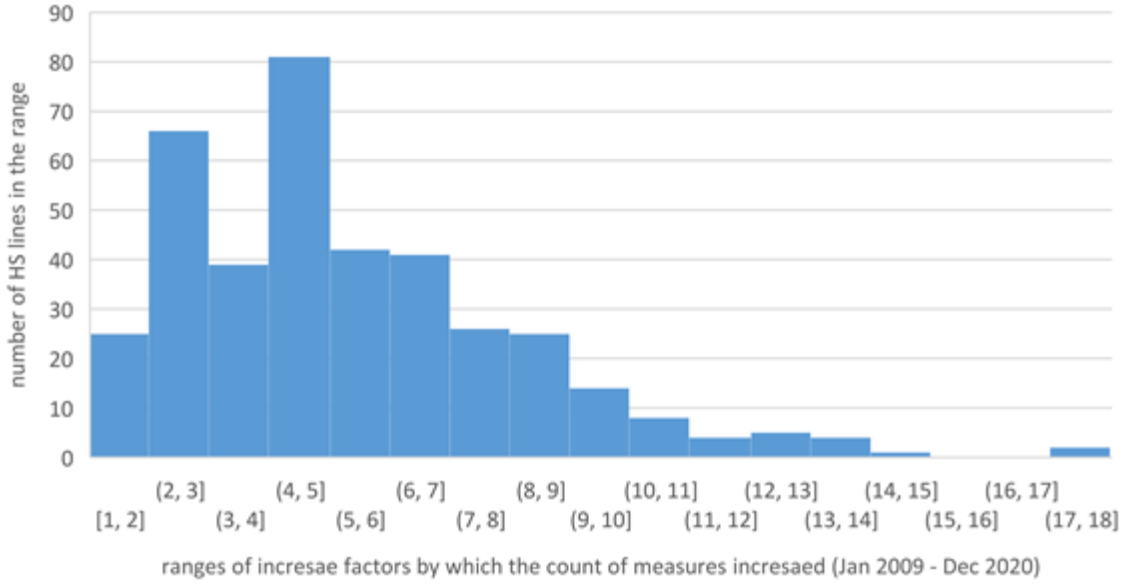
Figure A C.11. Count and share of dependencies across imported critical raw materials and supplying BRIICS countries under alternative dependency criteria



Source: OECD calculations using the BACI data.

Annex D. Tables and figures accompanying Section 4

Figure A D.1. Distribution of factors of increase between January 2009 and December 2020 of export restrictions across all critical raw material tariff lines



Note: These are the factor of increase of the count of all types of measures in place across all covered raw materials and all implementing countries, taking into account the stock of measures in place at the beginning of the period as well as new additions and eliminations.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure A D.2. Critical raw material tariff lines with largest increases in the number of export restrictions

product	sector	HS code	Official HS description (abbreviated)		initial stock	factor of increase Jan 2009 - Dec 2020
Iron and steel	OM	260112	Iron ores and concentrates: agglomerated (excluding roaste	(..)	3	17.7
Iron and steel	OM	260111	Iron ores and concentrates: non-agglomerated	(..)	3	17.3
Phosphates	OM	251020	Natural calcium phosphates, natural aluminium calcium phc	(..)	6	14.5
Lead	NFBM	780191	Lead: unwrought, unrefined, containing by weight antimony	(..)	1	14.0
Pig iron	FM	720110	Iron: non-alloy pig iron containing by weight 0.5% or less of	(..)	2	13.5
Pig iron	FM	720150	Iron: alloy pig iron, spiegeleisen, in pigs, blocks or other prir	(..)	2	13.5
Zinc	OM	260800	Zinc ores and concentrates	(..)	3	13.3
Molybdenum	OM	261310	Molybdenum ores and concentrates: roasted	(..)	4	12.8
Molybdenum	OM	261390	Molybdenum ores and concentrates: other than roasted	(..)	4	12.8
Iron and steel	FM	720293	Ferro-alloys: ferro-niobium	(..)	2	12.5
Aluminium	NFBM	760711	Aluminium: foil, (not backed), rolled (but not further worked),	(..)	2	12.5
Titanium	CC	282300	Titanium oxides	(..)	4	12.3
Aluminium	NFBM	760612	Aluminium: plates, sheets and strip, thickness exceeding 0	(..)	5	12.0
Aluminium	NFBM	760691	Aluminium: plates, sheets and strip, thickness exceeding 0	(..)	1	12.0
Aluminium	NFBM	760110	Aluminium: unwrought, (not alloyed)	(..)	2	11.5
Aluminium	NFBM	760429	Aluminium: alloys, bars, rods and profiles, other than hollow	(..)	3	11.3
Titanium	OM	261400	Titanium ores and concentrates	(..)	10	11.0
Iron and steel	FM	720299	Ferro-alloys: n.e.c. in heading no. 7202	(..)	4	11.0
Aluminium	NFBM	760120	Aluminium: unwrought, alloys	(..)	9	11.0
Zinc	NFBM	790400	Zinc: bars, rods, profiles and wire	(..)	1	11.0
Zinc	NFBM	790500	Zinc: plates, sheets, strip and foil	(..)	1	11.0
Zinc	NFBM	790700	Zinc: articles n.e.c. in chapter 79	(..)	1	11.0
Silver	OM	261610	Silver ores and concentrates	(..)	4	10.8
Pig iron	FM	720120	Iron: non-alloy pig iron containing by weight more than 0.5%	(..)	2	10.5
Lead	CC	282410	Lead: lead monoxide (litharge, massicot)	(..)	1	10.0
Lead	CC	282490	Lead oxides: n.e.c. in heading no. 2824	(..)	1	10.0
Aluminium	CC	282612	Fluorides: of aluminium	(..)	1	10.0
Aluminium	NFBM	760529	Aluminium: alloys, wire, maximum cross-sectional dimensic	(..)	1	10.0
Zinc	NFBM	790310	Zinc dust	(..)	1	10.0
Zinc	NFBM	790390	Zinc: powders and flakes	(..)	1	10.0
Molybdenum	NFMM	810299	Molybdenum: articles n.e.c. in heading no. 8102	(..)	2	10.0
Iron and steel	FM	720260	Ferro-alloys: ferro-nickel	(..)	3	9.7
Silver	CC	284321	Silver compounds: silver nitrates	(..)	2	9.5
Lead	NFBM	780600	Lead: articles n.e.c. in chapter 78	(..)	2	9.5
Silver	PM	710610	Metals: silver powder	(..)	7	9.4
Molybdenum	CC	282570	Molybdenum oxides and hydroxides	(..)	3	9.3
Molybdenum	CC	284170	Salts: molybdates	(..)	3	9.3
Silver	PM	710700	Base metals clad with silver: not further worked than semi-n	(..)	4	9.3
Borates	OM	252810	Sodium borates: natural, whether or not calcined	(..)	1	9.0
Borates	OM	252890	Borates: natural, and concentrates thereof, n.e.c. in heading	(..)	1	9.0
Selenium	CC	280490	Selenium	(..)	1	9.0
Zinc	CC	281700	Zinc: oxide and peroxide	(..)	1	9.0
Rare-earth eleme	CC	284610	Cerium compounds	(..)	3	9.0
Iron and steel	FM	720221	Ferro-alloys: ferro-silicon, containing by weight more than 5	(..)	3	9.0
Iron and steel	FM	720230	Ferro-alloys: ferro-silico-manganese	(..)	3	9.0
Iron and steel	FM	720241	Ferro-alloys: ferro-chromium, containing by weight more tha	(..)	3	9.0
Iron and steel	FM	720249	Ferro-alloys: ferro-chromium, containing by weight 4% or les	(..)	3	9.0
Lead	NFBM	780199	Lead: unwrought, unrefined, not containing by weight antimc	(..)	2	9.0
Zinc	NFBM	790111	Zinc: unwrought, (not alloyed), containing by weight 99.99%	(..)	3	9.0
Zinc	NFBM	790112	Zinc: unwrought, (not alloyed), containing by weight less tha	(..)	3	9.0
Molybdenum	NFMM	810294	Molybdenum: unwrought, including bars and rods obtained s	(..)	4	9.0
Cadmium	NFMM	810720	Cadmium: unwrought, powders	(..)	1	9.0
Cadmium	NFMM	810790	Cadmium: other than unwrought, n.e.c. in heading no. 8107	(..)	1	9.0
Titanium	NFMM	810890	Titanium: other than unwrought, n.e.c. in heading no. 8108	(..)	5	9.0
Phosphates	OM	251010	Natural calcium phosphates, natural aluminium calcium phc	(..)	8	8.9
Rare-earth eleme	CC	284690	Compounds, inorganic or organic (excluding cerium), of rare	(..)	4	8.8
Iron and steel	FM	720250	Ferro-alloys: ferro-silico-chromium	(..)	3	8.7
Iron and steel	FM	720292	Ferro-alloys: ferro-vanadium	(..)	3	8.7
Lead	NFBM	780110	Lead: unwrought, refined	(..)	3	8.7
Lead	NFBM	780419	Lead: plates, sheets, strip and foil, of a thickness (excludin	(..)	2	8.5
Titanium	NFMM	810820	Titanium: unwrought, powders	(..)	6	8.3
Other non ferrous	NFMM	811299	Gallium, germanium, hafnium, indium, niobium (columbium)	(..)	3	8.3

Note: all tariff lines with the factor of increase equal to or greater than the average plus one standard deviation (8.3).
Source: OECD calculations using CEPII's BACI data.

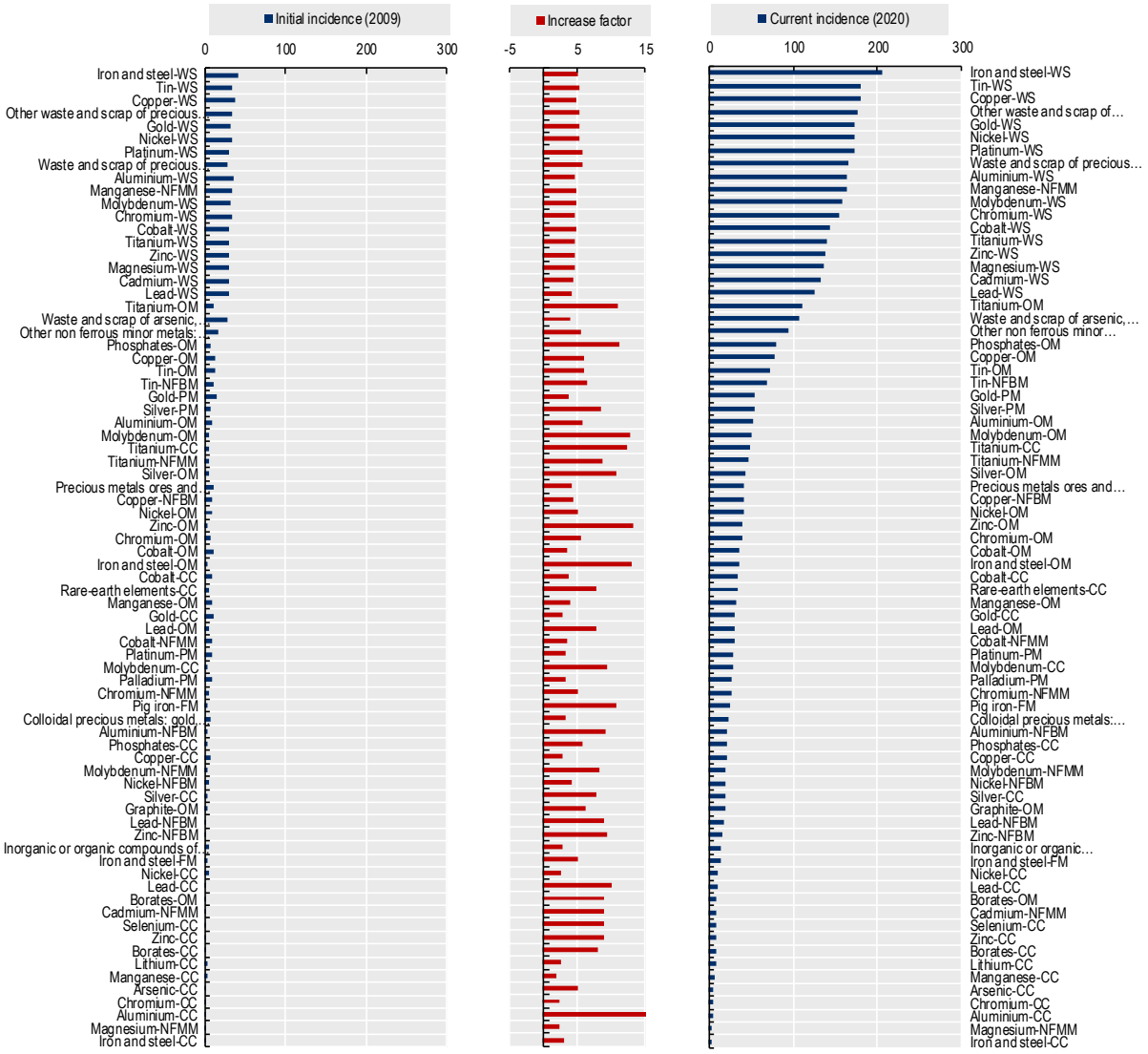
Figure A D.3. Critical raw material tariff lines with smallest increases in the number of export restrictions

product	sector	HS code	Official HS description (abbreviated)		initial stock	factor of increase Jan 2009 - Dec 2020
Lithium	CC	282520	Lithium oxide and hydroxide	(..)	3	2.7
Lithium	CC	283691	Carbonates: lithium carbonate	(..)	3	2.7
Chromium	CC	281910	Chromium trioxide	(..)	2	2.5
Chromium	CC	281990	Chromium oxides and hydroxides: excluding chromium trio	(..)	2	2.5
Iron and steel	FM	721113	Iron or non-alloy steel: flat-rolled, hot-rolled, rolled on four fa	(..)	2	2.5
Iron and steel	FM	721114	Iron or non-alloy steel: flat-rolled, hot-rolled, of a width less t	(..)	2	2.5
Iron and steel	FM	721119	Iron or non-alloy steel: flat-rolled, hot-rolled, of a width less t	(..)	2	2.5
Iron and steel	FM	721123	Iron or non-alloy steel: flat-rolled, cold-rolled, of a width less	(..)	2	2.5
Iron and steel	FM	721129	Iron or non-alloy steel: flat-rolled, cold-rolled, of a width less	(..)	2	2.5
Iron and steel	FM	721190	Iron or non-alloy steel: flat-rolled, n.e.c. in heading no. 7211	(..)	2	2.5
Iron and steel	FM	721210	Iron or non-alloy steel: flat-rolled, width less than 600mm, pl	(..)	2	2.5
Iron and steel	FM	721220	Iron or non-alloy steel: flat-rolled, of a width less than 600mr	(..)	2	2.5
Iron and steel	FM	721230	Iron or non-alloy steel: flat-rolled, width less than 600mm, pl	(..)	2	2.5
Iron and steel	FM	721240	Iron or non-alloy steel: flat-rolled, width less than 600mm, pa	(..)	2	2.5
Iron and steel	FM	721250	Iron or non-alloy steel: flat-rolled, width less than 600mm, pl	(..)	2	2.5
Iron and steel	FM	721260	Iron or non-alloy steel: flat-rolled, width less than 600mm, cl	(..)	2	2.5
Iron and steel	FM	722820	Steel, alloy: bars and rods, of silico-manganese steel	(..)	2	2.5
Nickel	NFBM	750400	Nickel: powders and flakes	(..)	4	2.3
Manganese	CC	282010	Manganese dioxide	(..)	3	2.0
Manganese	CC	282090	Manganese oxides: excluding manganese dioxide	(..)	3	2.0
Aluminium	CC	282732	Chlorides: of aluminium	(..)	0	2.0
Nickel	CC	282735	Chlorides: of nickel	(..)	4	2.0
Aluminium	CC	283322	Sulphates: of aluminium	(..)	0	2.0
Nickel	CC	283324	Sulphates: of nickel	(..)	4	2.0
Aluminium	CC	283330	Alums	(..)	0	2.0
Manganese	CC	284169	Salts: of oxometallic or peroxometallic acids, manganites, r	(..)	3	2.0
Iron and steel	FM	722591	Steel, alloy: flat-rolled, width 600mm or more, n.e.c. in heac	(..)	2	2.0
Iron and steel	FM	722592	Steel, alloy: flat-rolled, width 600mm or more, n.e.c. in heac	(..)	2	2.0
Iron and steel	FM	722599	Steel, alloy: flat-rolled, width 600mm or more, n.e.c. in heac	(..)	2	2.0
Iron and steel	FM	722692	Steel, alloy: flat-rolled, width less than 600mm, (excluding s	(..)	2	2.0
Iron and steel	FM	722699	Steel, alloy: flat-rolled, width less than 600mm, n.e.c. in iter	(..)	2	2.0
Iron and steel	FM	722720	Steel, alloy: bars and rods, hot-rolled, in irregularly wound c	(..)	2	2.0
Iron and steel	FM	722860	Steel, alloy: bars and rods n.e.c. in heading no. 7228	(..)	2	2.0
Aluminium	NFBM	760421	Aluminium: alloys, hollow profiles	(..)	1	2.0
Magnesium	NFMM	810490	Magnesium: articles n.e.c. in heading no. 8104	(..)	1	2.0
Manganese	CC	284161	Salts: of oxometallic or peroxometallic acids, manganites, r	(..)	5	1.8
Nickel	NFBM	750511	Nickel: bars, rods and profiles, not alloyed	(..)	3	1.0
Nickel	NFBM	750512	Nickel: bars, rods and profiles, of nickel alloys	(..)	3	1.0
Nickel	NFBM	750521	Nickel: wire, not alloyed	(..)	3	1.0
Nickel	NFBM	750522	Nickel: wire, of nickel alloys	(..)	3	1.0
Nickel	NFBM	750610	Nickel: plates, sheets, strip and foil, not alloyed	(..)	3	1.0
Nickel	NFBM	750620	Nickel: plates, sheets, strip and foil, of nickel alloys	(..)	3	1.0
Magnesium	NFMM	810430	Magnesium: raspings, turnings and granules, graded accorc	(..)	1	1.0

Note: All tariff lines with the factor of increase equal to or smaller than the average minus one standard deviation (2.7).
Source: OECD calculations using CEPII's BACI data.

Figure A D.4. Initial and current incidence of export restrictions across critical raw material product-sectors

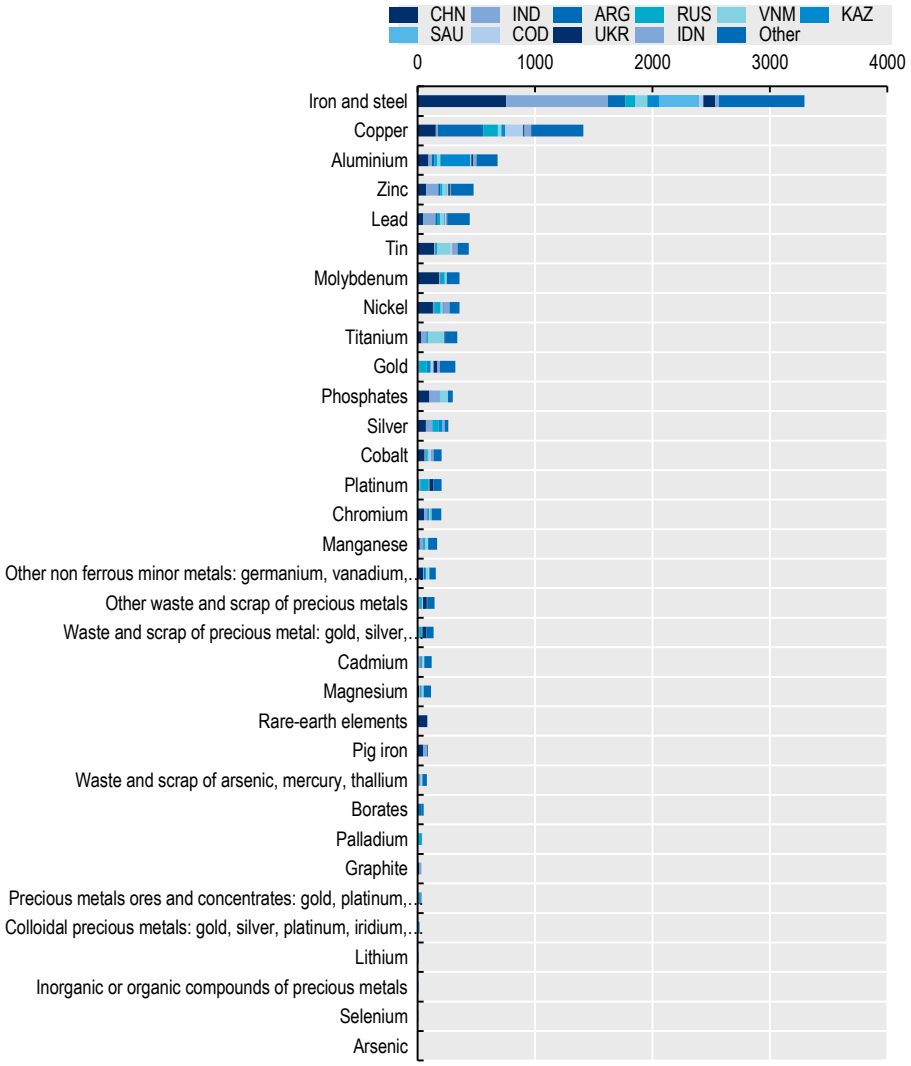
Initial scaled ('per tariff line') incidence of export restrictions by product-sector, increase factor and current scaled incidence



Note: Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC- chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals.
Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure A D.5. Breakdown of the global increase in the export restriction count in the period 2009-2020 by product and 'contributing' country

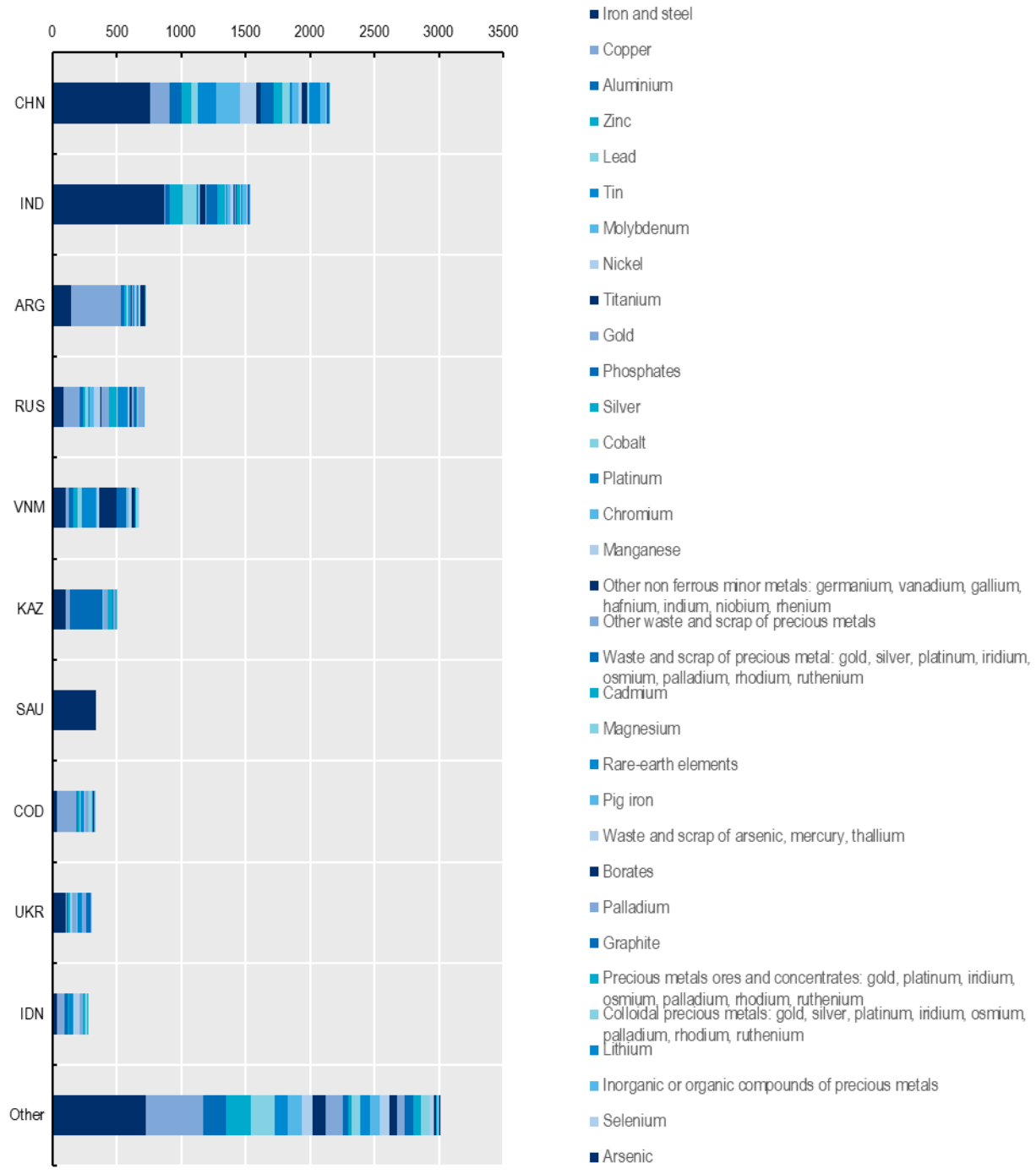
Country shares in the increase in the total number of export restriction measures between 2009 and 2020 for top 10 countries contributing the most to the total and other countries



Source: OECD Database on Export Restrictions on Industrial Raw Materials.

Figure A D.6. Breakdown of the global increase in the export restriction count between 2009 and 2020 by contributing country and product concerned

Products shares in the increase in the total number of export restriction measures between 2009 and 2020 for top 10 countries contributing the most to the total and other countries



Source: OECD Database on Export Restrictions on Industrial Raw Materials.

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