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Measuring distortions in international markets: the aluminium value chain

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MEASURING DISTORTIONS IN INTERNATIONAL MARKETS

THE ALUMINIUM VALUE CHAIN

This report builds on the OECD's longstanding work measuring government support in agriculture, fossil fuels, and fisheries in order to estimate support and related market distortions in the aluminium value chain. Results show that non-market forces, and government support in particular, appear to explain some of the recent increases in aluminium-smelting capacity. While government support is commonly found throughout the aluminium value chain, it is especially heavy in the People's Republic of China and countries of the Gulf Cooperation Council. Looking across the whole value chain also shows subsidies upstream to confer significant support to downstream activities, such as the production of semi-fabricated products of aluminium. Overall, market distortions appear to be a genuine concern in the aluminium industry, and one that has implications for global competition and the design of trade rules disciplining government support.

Key words: Trade, market distortions, government support, global value chains, subsidies

JEL Codes: F23; G38; H25; H81; L61

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Executive summary

In a challenging time for global trade, there is growing interest in updating the international trade rule-book to better address concerns about fair competition in the global economy. In response, the OECD has built on its longstanding work measuring government support in agriculture, fossil fuels and fisheries to estimate support and related market distortions in the aluminium value chain.

The aluminium sector has seen major changes over the last 15 years, notably the rise of the People's Republic of China (hereafter "China") as the leading producer by a wide margin in most segments of the value chain. This unprecedented increase in output has fuelled concerns about excess capacity in the sector that is depressing global aluminium prices and threatening the viability of producers worldwide.

To understand whether this increase in capacity has been driven by non-market forces, this report examines 17 of the largest firms operating along the aluminium value chain, which together make up more than half of global smelting capacity. Key findings are:

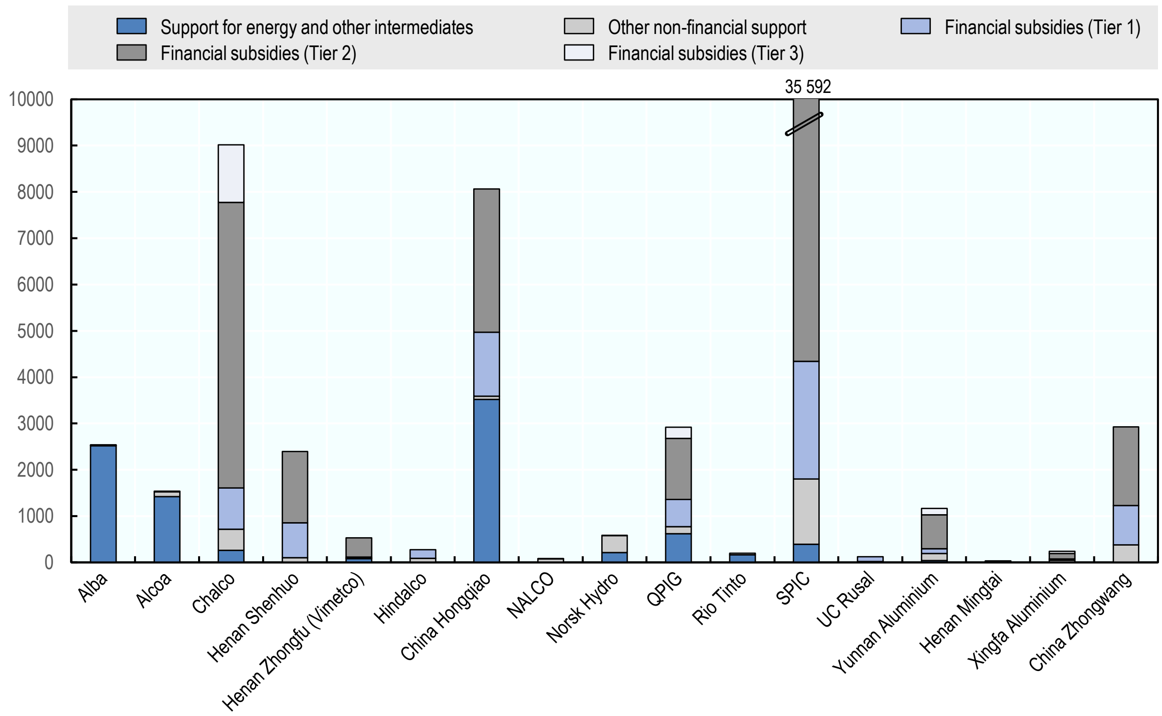
- Total government support for the 17 firms reached up to USD 70 billion over the 2013-17 period, depending on how financial support (i.e. concessional loans) is estimated. Although all 17 firms received some form of support, it is highly concentrated: the top 5 recipients receive 85% of all support, most of it at the smelting stage of the value chain.
- There are also important differences in the nature and scale of support received. Chinese firms obtained all of their support from Chinese authorities, notably financial subsidies, which overwhelmingly benefitted Chinese producers. Together with energy and input subsidies, these measures accounted for the vast majority of all support in China. By contrast, most other firms in the study tend to be multinationals that obtained support in the different places in which they operate (e.g. Australia, Brazil, Canada, and countries of the Gulf Cooperation Council - GCC), predominantly in the form of non-financial support (e.g. energy subsidies) and in lesser amounts. For all firms, support for R&D and labour is relatively minor.
- The vast majority of financial support was provided by China's state-owned banks to Chinese aluminium SOEs; however, two large private firms also benefitted from support from state-owned banks: China Hongqiao, the world's largest producer of primary aluminium, and China Zhongwang, China's largest producer of extrusion products.
- Looking at the value chain reveals that subsidies upstream confer significant support to downstream activities. Direct support at the smelting stage is important, but trade measures also matter. China's export taxes on primary aluminium, as well as its incomplete VAT rebates on exports of certain aluminium products, have served to discourage exports of primary aluminium and encourage production (and export) of semis and fabricated articles of aluminium. Access to cheap inputs has enabled Chinese producers of semis to expand production and compete in global markets at lower cost.
- While governments participate in the aluminium value chain via SOEs, state influence is at least as important as ownership, including because SOEs are both recipients and providers of support – especially in China, where SOEs provide SOEs and private

producers alike with below-market-cost inputs and loans. This fluid relationship between the government and companies generates opacity around the form and scale of government support.

- In sum, non-market forces, and government support in particular, appear to explain some of the increases in capacity in the aluminium sector in recent years. While government support is common all along the value chain, it is especially large in China and the GCC countries, even under the conservative assumptions used in this report. Excess capacity thus appears to be a genuine concern in aluminium, and one with implications for global competition and the design of trade rules disciplining government support.
- Two implications for the design of trade rules emerge from the analysis: (i) government support needs to be understood in the context of value chains, as upstream support has the effect of supporting downstream production; (ii) subsidy rules need to better account for the influence of the state, both as regards the dual role of SOEs as recipients and providers of support, and what this means for the transparency of support policies, including at the WTO.
- Finally, this study raises the question of whether similar patterns of government support can be seen in other value chains. Sector characteristics and data permitting, the approach pioneered in this study could help to build a broader understanding of government support in all its forms. The aim is to improve transparency of government support policies and thereby underpin international efforts to mitigate trade conflicts that otherwise will arise.

Government support for firms studied reached between USD 20-70 billion over the period 2013-17, depending on how financial support is estimated

Total government support by type, 2013-17 (USD millions, current)



Note: Tiers 1-3 reflect the different assumptions made to estimate financial subsidies. See Box 5.2 for more information. Data on non-financial support for QPIG and SPIC are for the years 2012-16. Total for SPIC includes USD 14 billion of Tier 3 financial subsidies not displayed on the graph.

1. Overview

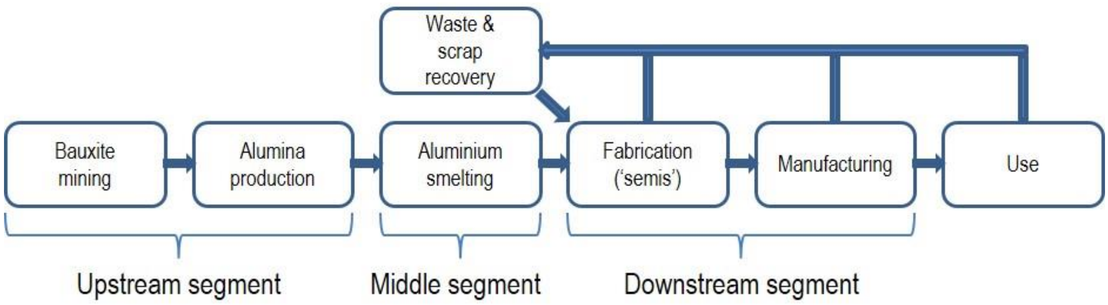
1.1. Measuring support

International trade policy discussions today reflect, in part, a growing interest in addressing apparent gaps in, and necessary updates to, the international trade rule-book. The OECD is responding to this interest by expanding its measurement of distortions in global markets. This ongoing work, based on a new taxonomy of support measures (Table 1.2), builds on longstanding OECD work measuring government support in agriculture, fossil fuels and fisheries.

This first report looks at trade distortions and government support in the aluminium industry. It examines a range of measures affecting the sector, including: export bans, export taxes, and incomplete VAT rebates on exports; import tariffs; energy subsidies; budgetary support and tax concessions; as well as loans provided on preferential terms and below-market returns on equity. This report follows earlier OECD practice in measuring support, but expands it by collecting data at the level of individual firms all along the aluminium value chain.

The aluminium global value chain spans a large number of sectors and products, which are subsumed under three broad segments (Figure 1.1): (i) the upstream segment, which comprises mining of bauxite and its refining into alumina; (ii) the middle segment, which covers smelting of primary aluminium and the production of secondary (recycled) aluminium; and (iii) the downstream segment, covering the production of semi-fabricated aluminium products (‘semis’) and their use in manufacturing processes further down the chain (e.g. in the motor-vehicle industry or the construction sector).

Figure 1.1. The aluminium production chain: stages of processing



Note: This diagram is for illustrative purposes only as the industry may define segments differently.
Source: simplified representation adapted from (Bertram et al., 2017[1]).

Support is measured at the level of 17 individual firms that operate at different stages of the aluminium value chain (Table 5.1). These firms were selected for their economic significance in the aluminium sector and with a view to ensure geographical balance. The focus on individual firms is necessitated by the fact that information on the support provided by governments to the aluminium industry is not readily or consistently available. While this lack of transparency implies a number of data gaps, and exclusion of

some significant firms for which sufficient information was not available, the firm-level approach taken has enabled a wide range of support measures to be identified at a more granular level across all levels of government, including municipal level. Taken together, the matrix of support measures and the data collected form a 'heat map' that helps identify where government support measures (and trade distortions more generally) are concentrated in the aluminium value chain.

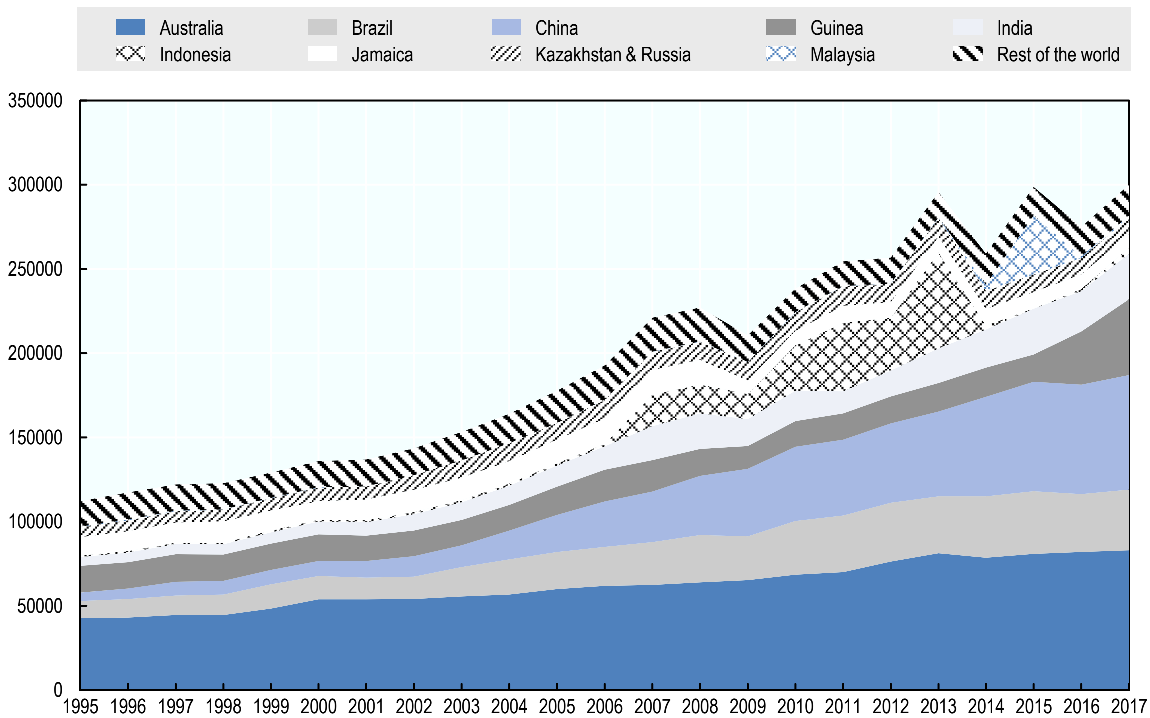
Where support takes the form of estimated price gaps (as in the case of input-price subsidies and concessional finance), this study has erred on the side of caution, opting for the most conservative estimate. Estimates may also be lower as they do not include additional factors (e.g. under-priced land and water) where there was not sufficient information available to estimate the related support. For these reasons, the figures in this report should be viewed as lower-bound estimates of the extent of support.

1.2. Production, capacity, and non-market forces in the aluminium value chain

The aluminium industry has undergone major changes over the last 15 years, notably the rise of China as the leading producer by a wide margin in all segments of the value chain, bar bauxite mining and aluminium recycling (Figure 1.2-Figure 1.5). This unprecedented increase in output has resulted from massive greenfield investments in new smelting capacity, but also from the development of new bauxite mines, alumina refineries, coal-fired power plants, and semis factories. There are mounting concerns among some WTO Members that excess capacity in the aluminium industry is depressing global aluminium prices and threatening the viability of producers worldwide (WTO, 2018[2]; WTO, 2017[3]).

Figure 1.2. Australia is the largest producer of bauxite, followed by Brazil and China

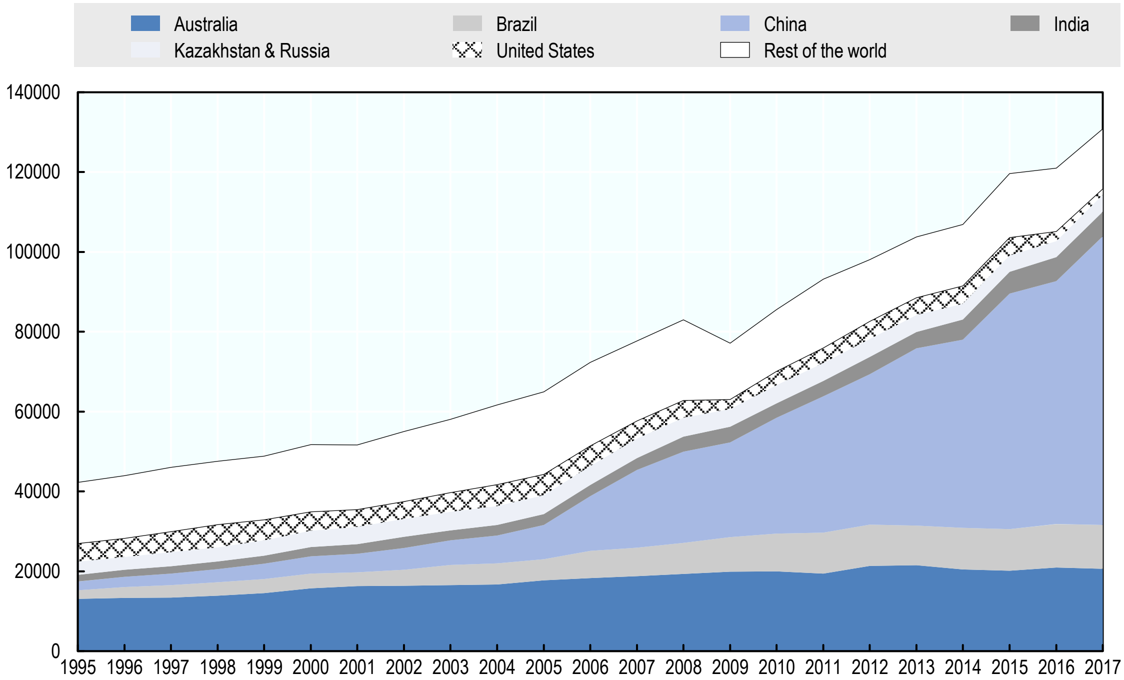
Global production of bauxite, 1995-2017 (in thousand metric tonnes)



Source: US Geological Survey and OECD research.

Figure 1.3. China's alumina production has surged over the past 15 years

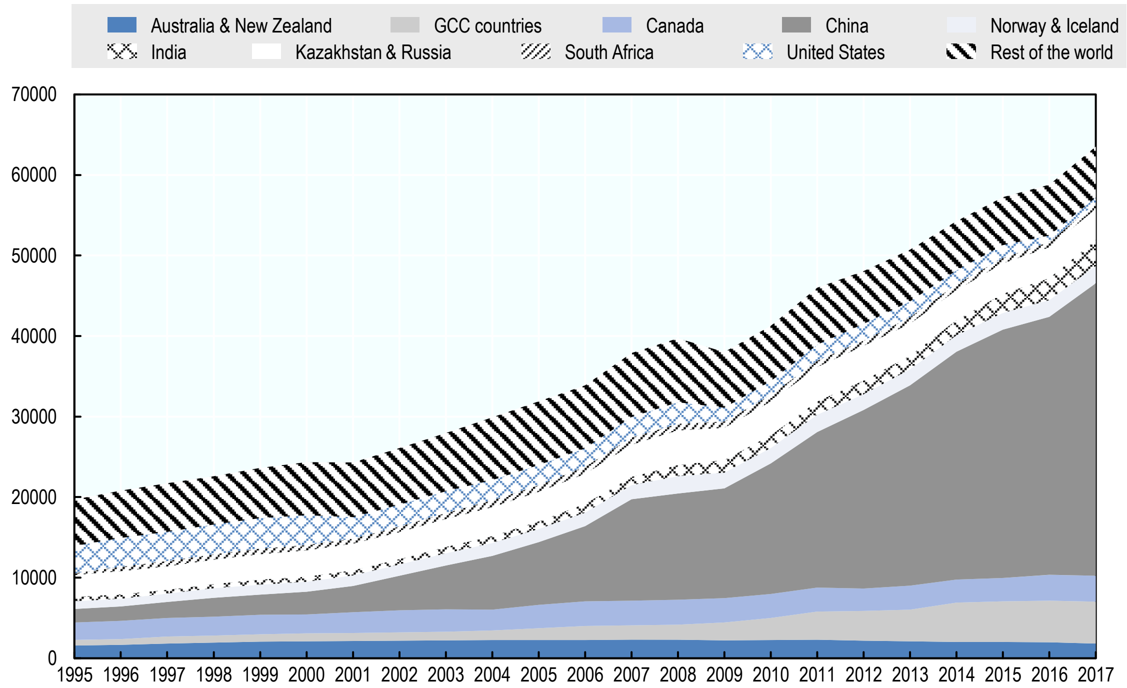
Global production of bauxite, 1995-2017 (in thousand metric tonnes)



Source: US Geological Survey and OECD research.

Figure 1.4. China has come to account for more than half of global output in primary aluminium

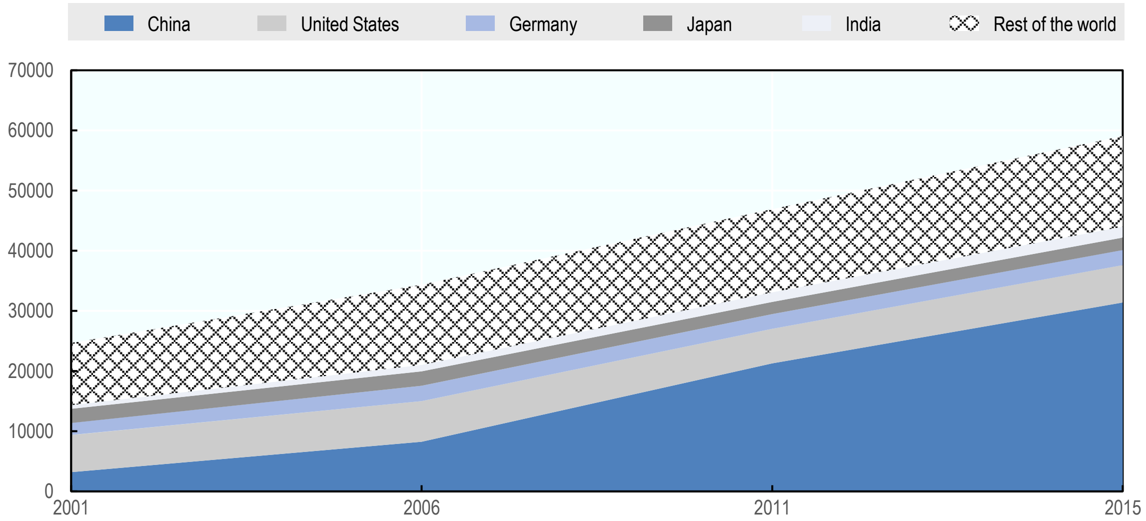
Global production of primary aluminium, 1995-2017 (in thousand metric tonnes)



Source: US Geological Survey and OECD research.

Figure 1.5. China has become in 15 years the world's largest producer of aluminium semis

Global production of semis, by producing country and product type, 2001-15 (in thousand metric tonnes)



Source: USITC (2017[4]).

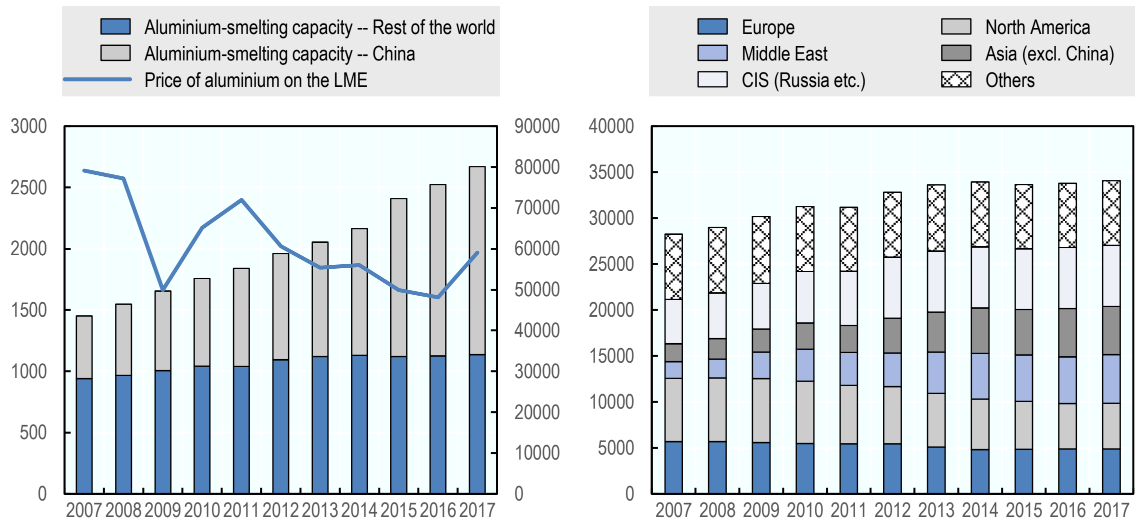
The price of aluminium on the London Metal Exchange (LME) does seem to have experienced a prolonged decline over the 2011-15 period (Figure 1.6). In several regions of the world, this price decline corresponded to a marked fall in the profitability of aluminium-producing firms, which pushed some companies to close down smelters in the European Union and North America. However, aluminium-producing firms in different regions of the world appear to have been affected differently by lower prices, with most producers in China and countries of the Gulf Cooperation Council (GCC) having sustained solid profit margins.

These contrasts in performance raise the question of what enabled some companies to weather better the global price decline. Generally speaking, access to low-cost sources of electricity has tended to make certain producers more resilient (USITC, 2017[4]). However, the 2011-15 period was also one of relatively high prices for the coal[1] on which Chinese firms rely to generate electricity for their aluminium smelters. With producers in China squeezed between lower aluminium prices and higher input costs, one would also expect their profit margins to have been affected negatively; they were instead higher than average, exceeding 10% in 2011, the year in which Chinese coal prices peaked.

1 Alumina prices were also relatively high around 2011, though they have since decreased and rebounded slightly.

Figure 1.6. Increased capacity has seen depressed prices

Left: LME price (USD per metric tonne; left scale) and smelting capacity (thousand metric tonnes per year; right scale)
Right: smelting capacity outside of China (thousand metric tonnes per year)



Source: French INSEE for aluminium prices on the London Metal Exchange (LME); European Aluminium association for estimated global capacity.

This suggests that other, non-market factors may have played a role in fuelling capacity additions and shoring up profits at certain companies. Non-market forces encompass a wide range of government interventions that might help explain the persistence of excess capacity in the aluminium industry. At a broad level, this includes all policies that directly or indirectly favour increases in capacity that are not market-driven, either by encouraging the construction of new smelters or preventing the retirement of older ones. Subsidies, and subsidised bank loans in particular, have been shown, for example, to prevent the exit of less productive firms hit by unfavourable shocks, turning them into "zombies" that distort competition throughout the rest of the economy (Adalet McGowan, Andrews and Millot, 2017[5]).

To help disentangle the respective influence of market and non-market forces on smelting capacity, this work assesses the direct support that aluminium-producing firms have received from governments in recent years, along with other market-distorting measures tied to state involvement in the economy.

1.3. Main findings

Government interventions appear widespread all along the aluminium value chain, with total government support for firms studied having reached between USD 20 billion and USD 70 billion over the 2013-17 period[2], depending on how financial support is estimated (Figure 1.7). Support is relatively large in aluminium smelting and primarily takes the form of energy subsidies and concessional finance. Although all 17 firms examined in the study received support in one form or another, its significance varies enormously across

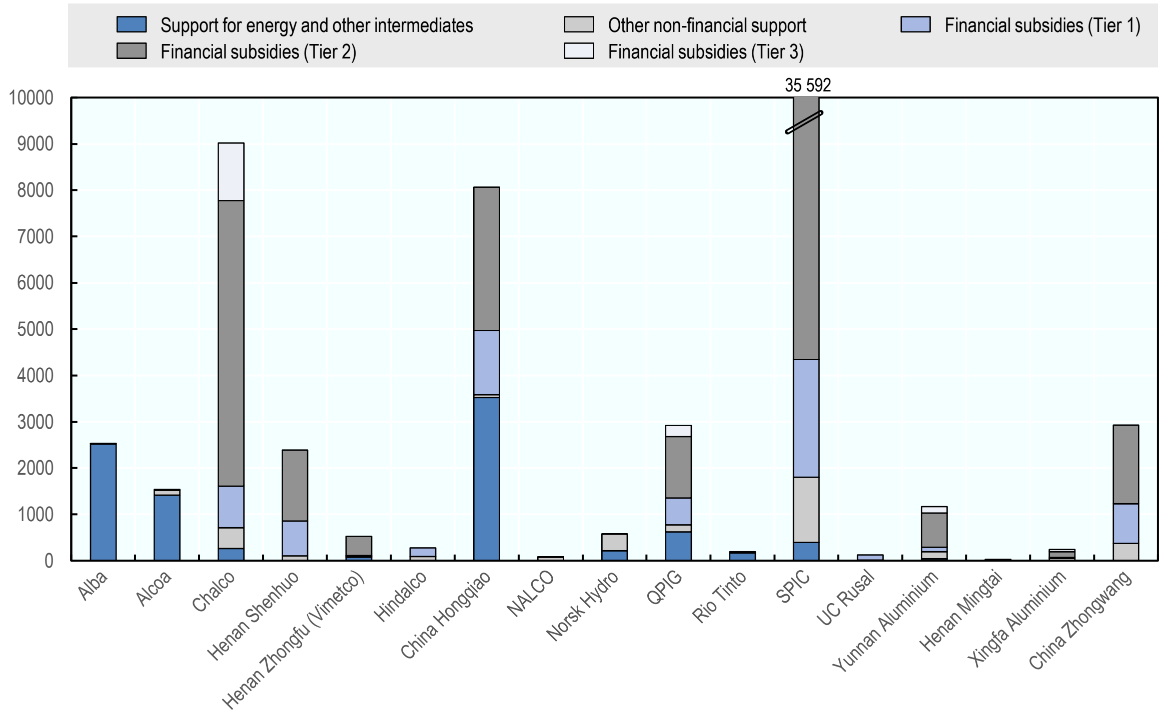
[2] In what follows, support estimates are expressed over a five-year interval given considerable year-to-year variability in the numbers for individual firms (e.g. due to one-off measures).

individual companies, countries, and types of measures. While non-financial support is granted to varying degrees to many firms, financial subsidies are more heavily concentrated in Chinese firms.

Given this heterogeneity, three separate types of support measures are discussed below in more detail: non-financial government support, financial subsidies, and trade measures. It is important to note that, as these measures can affect production and investment differently, the relative amounts of support they confer may not necessarily reflect their criticality for firms.

Figure 1.7. Government support for firms studied reached between USD 20-70 billion over the period 2013-17, depending on how financial support is estimated

Total government support by type, 2013-17 (USD millions, current)



Note: Tiers 1-3 reflect the different assumptions made to estimate financial subsidies. See Box 5.2 for more information. Data on non-financial support for QPIG and SPIC are for the years 2012-16. Total for SPIC includes USD 14 billion of Tier 3 financial subsidies not displayed on the graph.
Source: OECD research.

Non-financial government support

Aggregate results for the 17 firms studied show non-financial support to have totalled USD 12.7 billion over the 2013-2017 period, i.e. an annual average of USD 2.5 billion. This support was heavily concentrated, with the top five recipients attracting more than 80% of all support. The largest, China Hongqiao, accounted for roughly 30% of all support, followed by Aluminium Bahrain [Alba] (21%) and China's State Power Investment Corporation [SPIC] (15%). Alcoa and the Qinghai Provincial Investment Group [QPIG] come next, with 12% and 6% respectively. While firm size helps explain why Hongqiao, SPIC, and Alcoa are in the top five, the ranks occupied by Alba and QPIG (two local SOEs) are more surprising given the relatively smaller scale of their operations. Alba stands out in particular given its large support relative to smelting capacity of 970 kt.

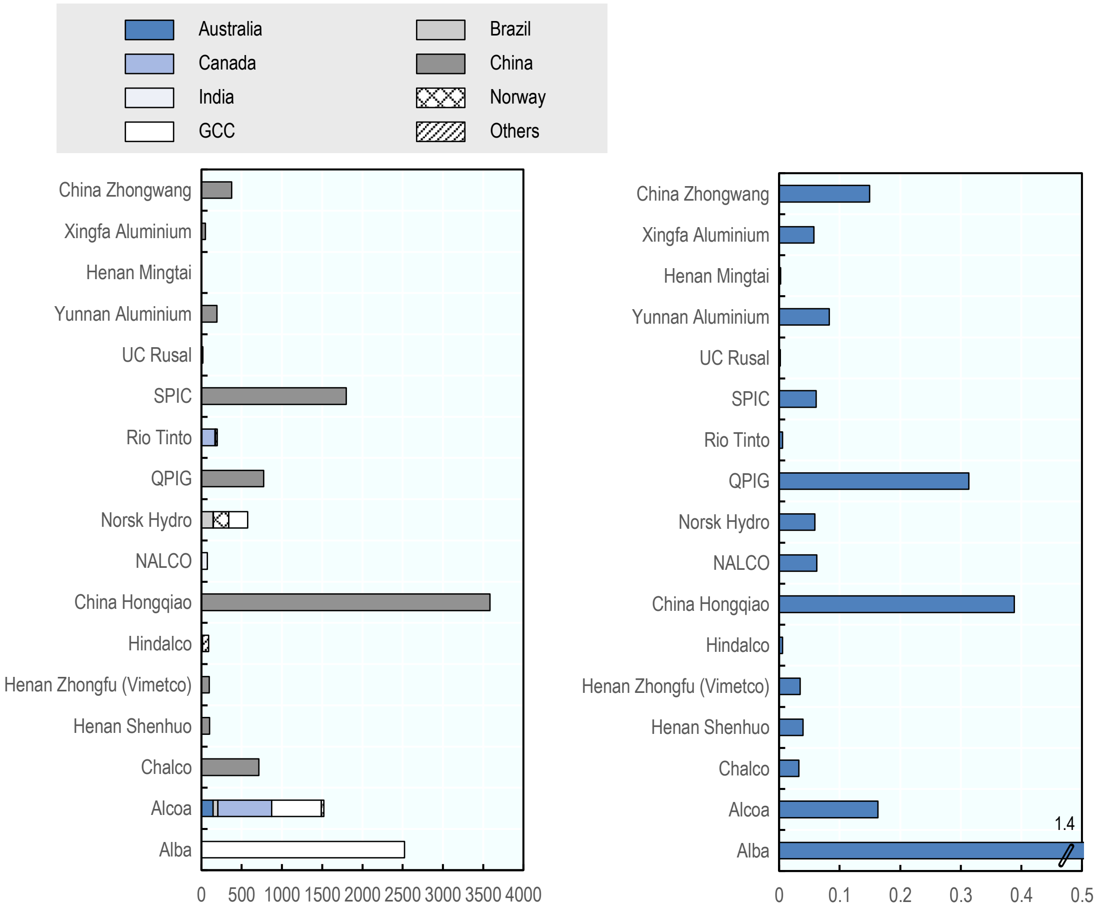
Scaling support amounts using annual revenue shows size to be only one part of the story (Figure 1.8). Even controlling for size, the support received by Hongqiao remains, for example, very large.

Alcoa, Norsk Hydro, and Rio Tinto obtained relatively little support from their home countries of the United States, Norway, and Australia[3] respectively, but were, however, able to attract more generous support from the other countries in which they operate, in particular Brazil, Canada, and GCC countries. In contrast, Chinese firms received all of their support from the Chinese authorities (Figure 1.8). Aggregating results at the level of individual countries shows China and Bahrain with the highest levels of non-financial support provided, followed by Canada, Saudi Arabia, and Qatar (Figure 1.9).

Figure 1.8. Non-financial government support by country (left) and scaled by revenue (right)

Left: 2013-17, USD millions

Right: 2013-17, scaled by revenue in 2016



Note: Data for QPIG and SPIC are for the years 2012-16. “Others” are New Zealand, Russian Federation, Spain, and the United States.
Source: OECD research.

3 Or the United Kingdom, Rio Tinto having two headquarters in two different countries.

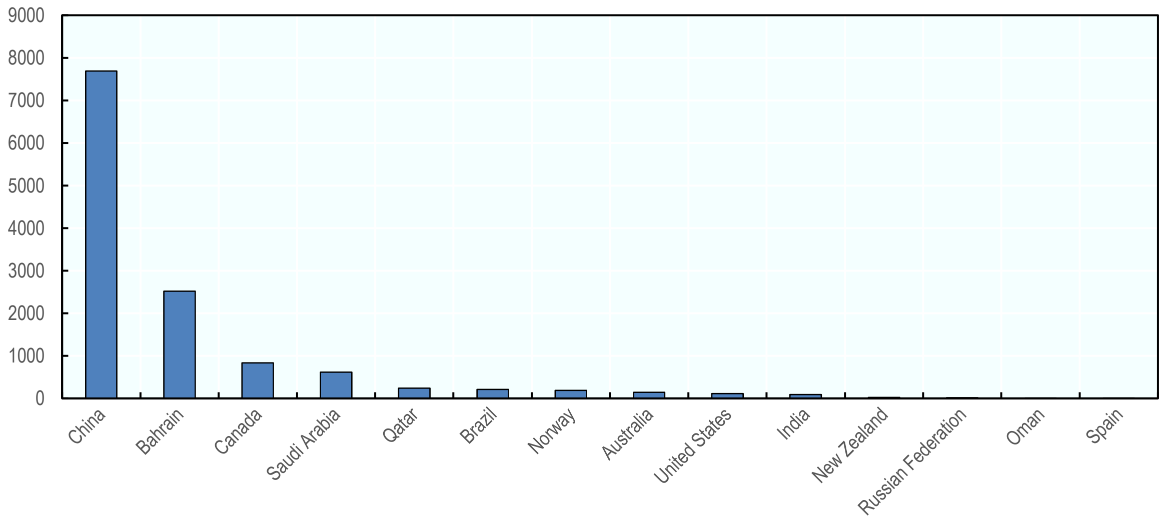
Overall, specialised producers of aluminium semis do not seem to receive as much support as smelters. The three Chinese companies in the sample specialised in the production of semis[4] did not receive large non-financial subsidies from Chinese authorities (less than USD 100 million a year on average). Similarly, for Hindalco and Norsk Hydro support related to the production of semis seems modest (e.g. small subsidies to Hindalco from the states of Kentucky and New York) or non-existent (Norsk Hydro). However, estimates of support for semis do not consider any implicit support that subsidies for, and export restrictions on, primary aluminium may confer on producers downstream.

Primary aluminium accounts for about 75-86% of total production costs for semis, which makes competitiveness in the semis segment largely dependent on the cost of procuring raw aluminium. While such support is identified later in this report, in the absence of a robust modelling framework no attempt is made to quantify the implicit subsidy.

Non-financial government support has generally helped companies in the sample increase their profitability, and even turned losses into profits in certain cases (Figure 1.10). This suggests that the higher profit margins that some aluminium producers in China and GCC countries obtained in recent years resulted in part from generous government support. This was especially so for Alba, Hongqiao, and the Qinghai Provincial Investment Group (QPIG).

Figure 1.9. Aggregate results for firms studied show China and Bahrain provide most of the support

Total non-financial government support over the period 2013-17, by country

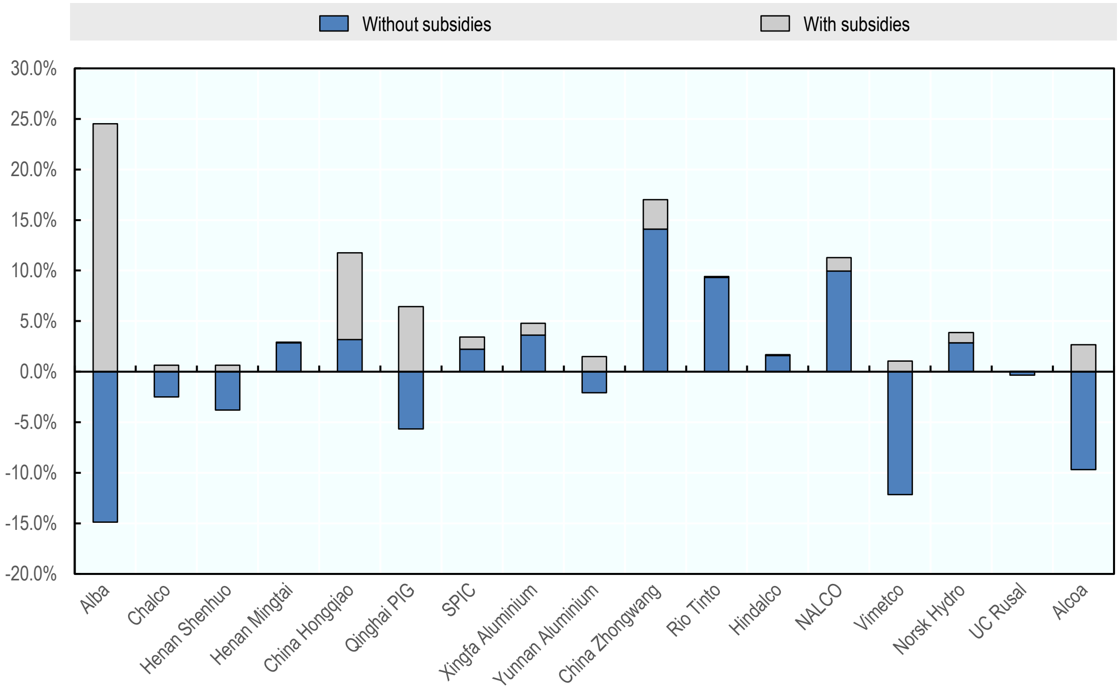


Note: The data above are based on a sample of firms and so should not be considered country totals.
Source: OECD research.

4 China Zhongwang, Xingfa Aluminium, and Henan Mingtai.

Figure 1.10. Government support has helped companies increase their profitability

Average profit margins over the 2013-17 period, with and without non-financial government support (%)



Note: Data for QPIG and SPIC are for the years 2012-16, and 2013-16 for Vimetco.
Source: OECD research.

The subsidies that helped make Hongqiao and QPIG appear more profitable had much to do with the actions of local authorities in China. In Hongqiao's case, the company benefitted enormously from support provided by the municipality of Binzhou, Shandong, which "positively guides and supports the development and growth of the aluminium industry cluster by various policies and arrangements" (China Hongqiao Group Limited, 2017[6]). This support has mostly taken the form of inputs sold at below-market prices to Hongqiao by Binzhou Gaoxin, a local SOE owned by the Zouping Economic and Technological Development Zone State-owned Assets Operation and Management Center, and which "is responsible for the supply of electricity and alumina as well as promoting the implementation of the development plan of the aluminium industry set by the local government, to ensure the stable supply of energy and raw materials for the aluminium industry cluster" (*ibid*).

In the case of the Qinghai Provincial Investment Group (QPIG), the company is 70% owned and managed by the State-owned Assets Supervision and Administration Commission (SASAC) of Qinghai and attracts "strong support from governmental policies" at the province level (Qinghai Provincial Investment Group Co. Ltd., 2017[7]). The firm thus acknowledges receiving (*ibid*):

> *"financial support from the government in the form of capital injections, priority possession rights to mineral resources, governmental grants and subsidies. The Group has also benefited from preferential tax treatment from the Qinghai provincial government in the form of various tax exemptions and concessions. […] In order for the Group to benefit from the subsidies, the aluminium prices needs to be below a certain pricing threshold."*

Industrial zones in China and elsewhere often serve as 'subsidy hotspots', wherein local governments offer support in numerous forms to investors and established companies. GCC countries also have a number of such zones and parks, where energy-intensive industries (e.g. petrochemicals, aluminium, and fertilisers) concentrate and are able to benefit from tax concessions, facilities, and cheaper inputs. This is, for example, the case in Qatar's Mesaieed Industrial City, where Qatalum, a 50/50 joint venture between Norsk Hydro and Qatar Petroleum, has obtained a 10-year tax holiday coupled with advantageous natural-gas prices that were set for many years at around USD 1 per million BTU (Krane and Wright, 2014[8]).[5] Alcoa, through its 25.1% participation in Ma'aden Aluminium, has also benefitted from the low electricity tariffs offered in the Ras Al-Khair Industrial City in Saudi Arabia. In the Russian Federation, the USITC (2017[4]) has noted that plans are in place for developing the "Aluminium Valley", a Rusal-led special economic zone in the region of Krasnoyarsk that would offer an array of tax concessions for encouraging foreign investment in the production of semis.

Overall, input subsidies, and energy subsidies in particular, constitute the bulk of all non-financial support benefitting aluminium producers worldwide. The section next takes a closer look at those measures.

A closer look at input subsidies, and energy in particular

Energy subsidies take on particular importance in the context of the aluminium value chain given that electricity accounts for up to 40% of the costs of smelting. Energy subsidies are relatively easy to estimate where they take the form of direct budgetary transfers or tax concessions (OECD, 2018[9]). Quantifying the value of energy subsidies conferred through other government revenue foregone or through induced transfers can prove much more challenging. In line with international practice (Kojima and Koplow, 2015[10]), price gaps were used to estimate the benefits that below-market prices for electricity and fossil fuels confer to aluminium producers. A similar approach was used to estimate support provided in the form of below-market prices for alumina.

In Québec, energy subsidies take the form of published government decrees specifying the conditions under which individual aluminium smelters get to purchase electricity from the provincial state-owned power company, Hydro Québec. For certain smelters (but not all), the prices derived from those decrees can be USD 0.01-0.02 per kWh below those paid by other large industrial users of electricity in the province. The lower prices are generally awarded to aluminium producers as *quid pro quo* for additional investments in Québec.[6] In China, QPIG was able to obtain electricity from the province at cheaper rates; for 2016 that rate was lowered to CNY 0.28 per kWh instead of the prevailing CNY 0.33 per kWh (a gap of about USD 0.01 per kWh). Yunnan Aluminium, another provincial SOE, likewise obtained cheaper hydro-electricity back in 2012-13.

Qualitative information suggests the existence of possible land-related support in, at least, Bahrain and China. The Binzhou municipality in Shandong, where Hongqiao's operations are located, offers, for example, rebates for 50% of land-transfer fees paid by companies

5 British thermal units. This compares with natural-gas prices in the United States that are between USD 2-4.5 per million BTU, which is already considered a low level in the industry as Asian companies pay between USD 7-20 per million BTU for their gas in liquefied form.

6 See for instance http://news.alcoa.com/press-release/alcoa-reaches-power-agreement-improve-competitiveness-quebec-smelters-secure-3000 (accessed on 31 August 2018).

establishing a presence there. Likewise, Alba's 2017 annual report notes that: "the Group is using land leased from the Government of Bahrain […] and land leased from The Bahrain Petroleum Company B.S.C. […]. These leases are free of rent." Whether similar arrangements exist elsewhere is unknown. Given this lack of information no attempt is made to quantify possible benefits that might accrue to individual firms.

The selection of benchmark prices for estimating input subsidies inevitably involves a number of choices and assumptions, and this study has erred on the side of caution as much as possible, opting for conservative benchmarks at different stages. Coupled with the number of data points that are not covered (e.g. land and water subsidies), this implies that the results presented above for input subsidies should be considered lower-bound estimates.

A closer look at tax incentives and concessions

Besides input subsidies, tax concessions are another important form of support that is found throughout the whole value chain. These measures are especially widespread in Brazil, China, and GCC countries. Brazil's SUDAM tax incentives encourage, for example, investment in the country's Amazon region, where they have benefitted the operators of bauxite mine and alumina refineries such as Mineração Rio do Norte and Alunorte.[7] China similarly encourages economic activity in Western provinces (e.g. Gansu, Qinghai, and Xinjiang) through lower rates of income tax under the country's Western Development Strategy. Those are generally the same provinces that have seen new smelting capacity, and which are singled out in the *2016-20 Non-ferrous Metal Industry Development Plan*. China also offers lower rates of income tax (or tax holidays altogether) to companies producing specific goods that the government wants to encourage. This includes certain aluminium semis, such as those produced by China Zhongwang, China's largest extrusion company, which has obtained the 'High and New Technology Enterprise' status from Liaoning Province and the lower taxes attached to that status.

The bulk of all tax concessions found in this study benefit enterprise income and capital (per the matrix of support, Table 1.2). Support for physical capital is especially important for its effects on investment: by encouraging a faster replacement of machines or an increase in the stock of physical assets, such measures may give beneficiaries a competitive edge through access to more recent technologies. A consequence for competition may thus be that countries that have subsidised capital the most end up having the most competitive firms, e.g. the most energy-efficient smelters. In turn, those firms that have acquired newer equipment may subsequently be able to compete effectively without subsidies.

Other forms of support

The remainder of measures are generally smaller and concern support for labour and R&D (i.e. knowledge), which represented 0.1% and 2.2% of all support, respectively. A few one-off 'bail-outs' were also identified, whereby governments seek to prevent a plant from closing and shedding jobs, generally in the form of direct budgetary transfers from central or local authorities. In Australia for example, the Federal Government and the

7 Both are joint ventures involving companies from OECD countries (e.g. Alcoa, Norsk Hydro, and Rio Tinto).

State of Victoria committed jointly AUD 240 million (about USD 173 million) in funding to prevent the closure of Alcoa's Portland smelter.

Some of these measures are of greater concern than others from a competitive standpoint, particularly those that prevent the exit of older, inefficient plants. Others can be less problematic where they seek to improve working conditions or encourage basic research as opposed to those research activities closer to commercial applications. The Government of Norway, for example, provided a total NOK 1.5 billion (about USD 180 million) over several years to Norsk Hydro for supporting R&D at the Karmøy demonstration plant.[8] The United States Government, through the Department of Energy, likewise supported Alcoa's research efforts into aluminium recycling, high-strength automotive sheet, and CO_2 sequestration. Examples of labour-related support measures would include the subsidies that certain Chinese smelters received in relation to training and social security (e.g. SPIC and Yunnan Aluminium), or the workforce-training grants Alcoa obtained from the States of Indiana and Washington.

Support provided through the financial system

A bird's-eye view of financial health for firms in the sample

A snapshot of the sampled firms' financial wellbeing can be derived from information contained in their financial statements. Firms' investment decisions are dependent on their ability to generate funds, either through their own internal activities or through external financing. In turn, their performance and financing structure are crucial in determining their ability to raise funding. The indicators below help shed light on firms' profitability, their funding structure, and the extent to which they are exposed to financial difficulties. Together, they can also be used to detect financially constrained firms and inconsistencies among the indicators, which could hint at the presence of other factors that are not accounted for by financials and warrant further investigation.

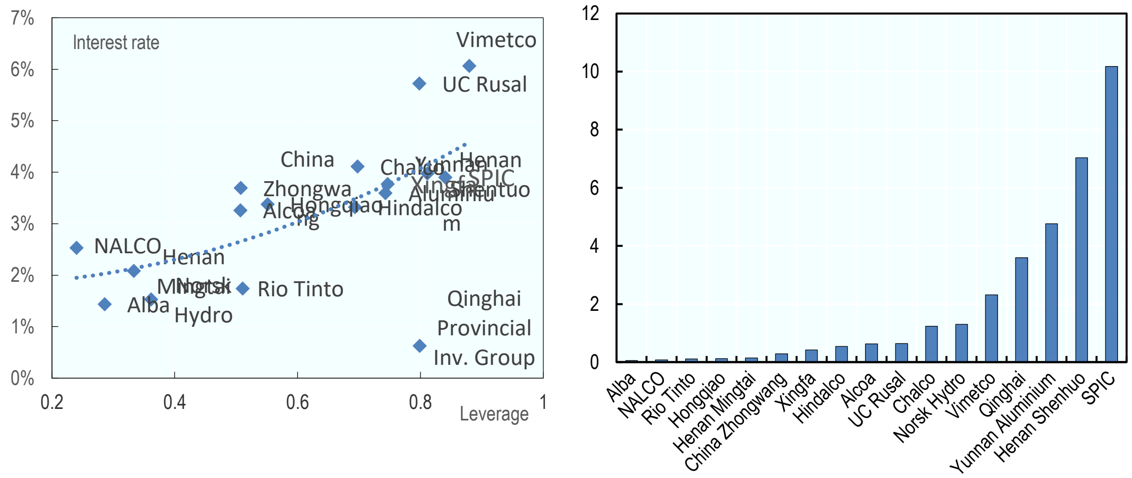
Firms studied appear to have resorted to debt financing as their main source of external funding and to have maintained high levels of leverage over the 2010-16 period. Debt-to-equity ratios are above one for most of them, with debt representing four to nine times the equity level for many companies. High debt levels are problematic when the debt burden becomes excessive, crowding out productive investment and increasing vulnerability to economic downturns. However, if the firm is indebted at a low cost, or is generating enough cash flow to pay off its debt and invest in future growth, then high leverage ratios can be acceptable. For a number of firms, interest payments exceeded their profits by a multiple of five to seven over the period studied (Figure 1.11).

The interest rate represents the return investors demand for incurring the opportunity cost of foregone alternative projects, as well as the risk of default associated with high levels of leverage. A firm's excessive indebtedness should therefore translate into a higher interest rate: there is generally a positive relationship between the leverage ratio and the implicit interest rate on firms' debt holdings (Figure 1.11). This positive relationship is, however, not satisfied by some firms (e.g. QPIG), indicating a decoupling between the price of capital and the level of debt.

8 Those grants were notified and approved in 2015 as authorised state aid by the EFTA surveillance authority.

Figure 1.11. The more leveraged firms face higher interest rates, though there are exceptions

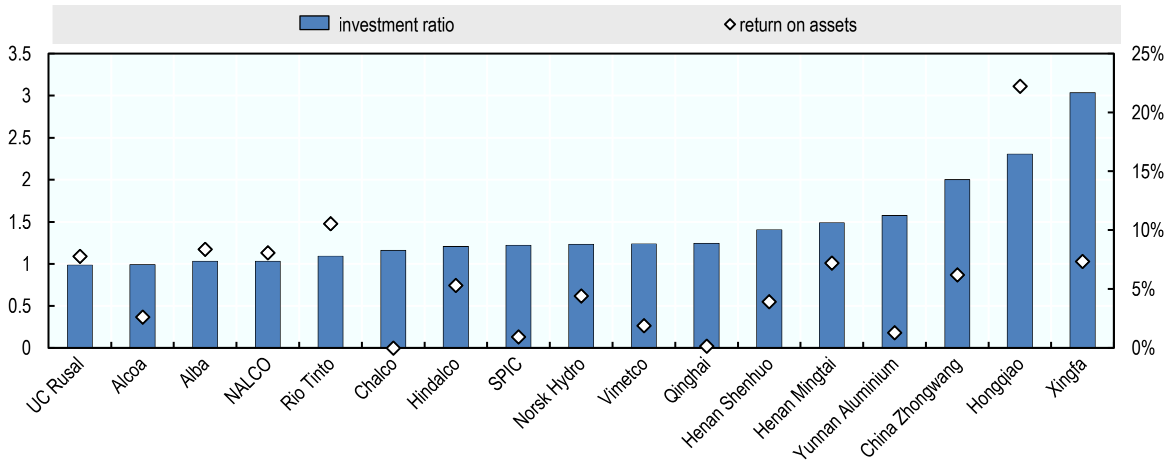
Average interest rate and leverage (left) and inverse interest coverage ratio (right) (2010-17)



Note: The implicit interest rate is a proxy for the cost of financing for firms. It is calculated as the interest payment divided by the average debt level in the same and previous period. The implicit rate is not qualified by the risk profile of countries where firms operate. Therefore information from the graph is partial. The inverse interest-coverage ratio is calculated by dividing interest expenses by operating profits before taxes and interest payments (EBIT).

Figure 1.12. Investment remains high despite low returns on asset for several firms

Average investment ratio (left scale) and return on assets (right scale), 2010-16



Note: The investment ratio is measured as the increase in the capital stock; the return on assets is measured as profits (EBIT) divided by the average total assets over two consecutive periods.

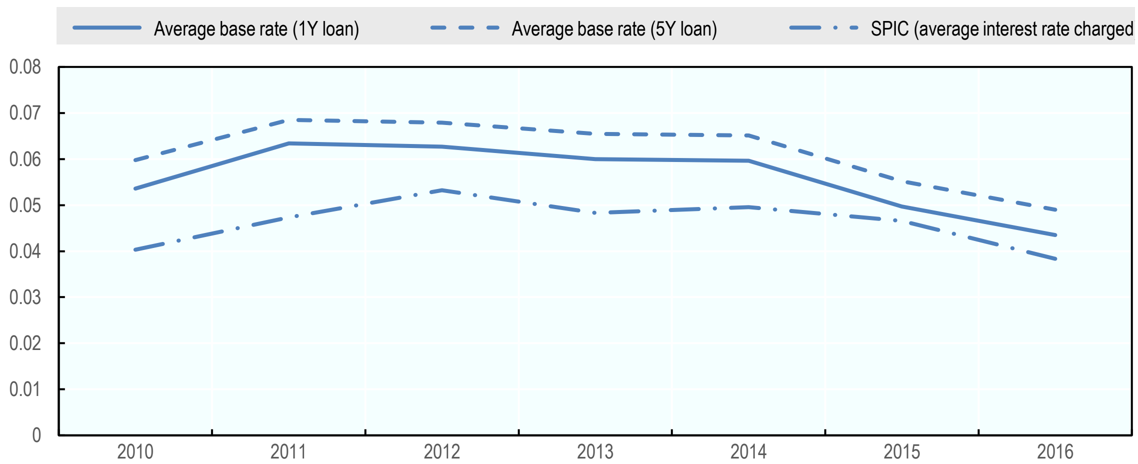
The low interest rates calculated for some firms, coupled with their high inverse interest-coverage ratios, already hint at the presence of support programmes that mute the role of debt levels in the setting of the price of capital. Yet despite below-average returns on assets, firms have kept investing, as evidenced by positive growth rates in capital accumulation (Figure 1.12). These indicators suggest an inconsistency between the rising debt level on firms' balance sheets and their declining profitability, which would normally suggest a decreased ability to borrow at lower rates.

In what follows this top-down approach is complemented by information on concessional borrowing, with a view to determining the extent to which governments have used credit to support aluminium firms.

Estimating concessional borrowing at the firm level

There is anecdotal evidence that certain firms in China have obtained financing on concessional terms.[9] First among these is state-owned SPIC, which in a 2016 bond prospectus explicitly stated that it attracts considerable financial support from Chinese policy banks bearing "interest rate below benchmark" (State Power Investment Corporation, 2016[11]). From 2010 to 2016, the yearly average interest rates that SPIC paid on its borrowings[10] were lower than the average lending base rate published by the People's Bank of China (PBOC) (Figure 1.13). QPIG likewise mentions in a 2017 bond prospectus that it maintains strong ties with Chinese banks, including policy banks that have provided QPIG with low-cost financing sources (Qinghai Provincial Investment Group Co. Ltd., 2017[7]). Yet the discussion above indicated that QPIG has low profitability and high debt levels. There can be many reasons why interest rates are low for these firms; however, the contrast between poor financial indicators and low interest rates may suggest some potential under-pricing of the risk associated with those borrowers.

Figure 1.13. Average interest rates charged to SPIC have been below Chinese base rates



In order to estimate a subsidy equivalent of concessional borrowing for all firms in the sample, a comparison is made between the actual interest rate that firms bear and a hypothetical benchmark rate that could have been charged in private markets. Given the sensitivity of results to assumptions, the analysis is undertaken incrementally in three tiers, with each tier adding different spreads on top of a base rate:

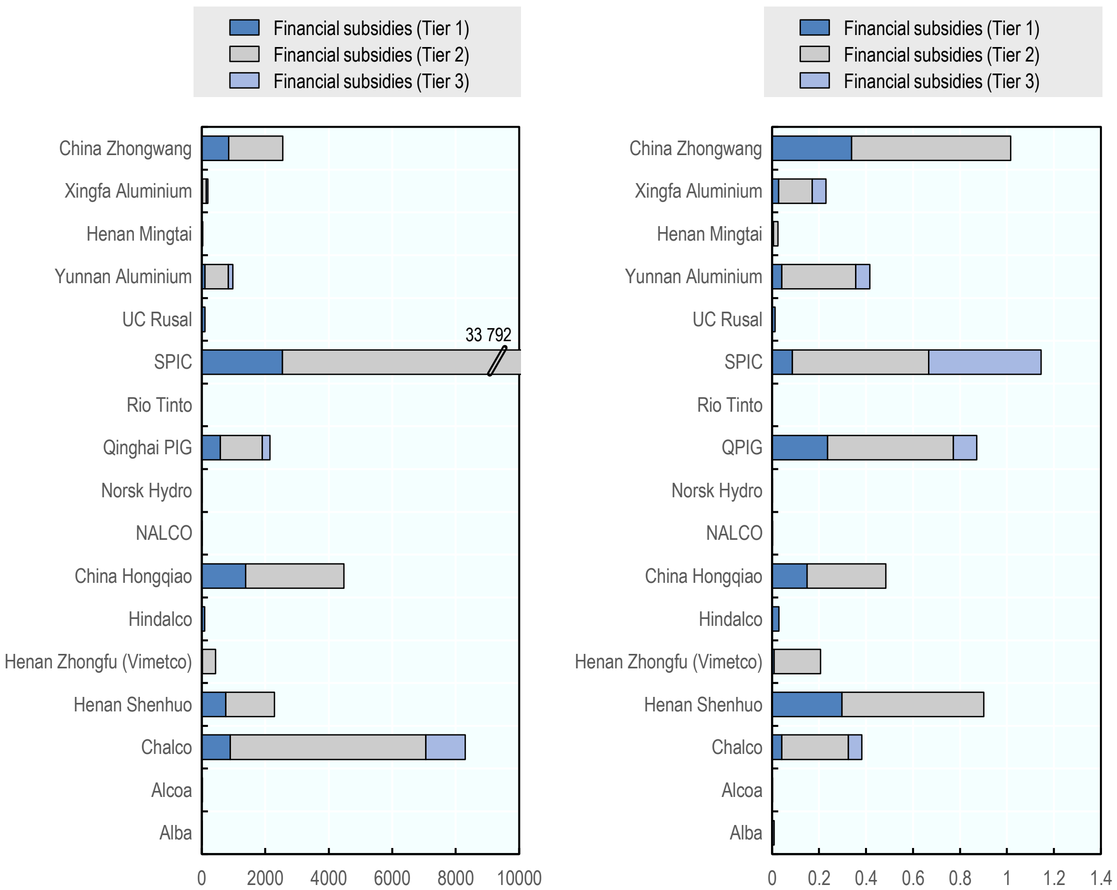
9 Recent years have also seen an increase in the number of debt-equity swaps in China, whereby an SOE acting on behalf of the government converts the debt of highly leveraged firms into shares. This was the case for Hongqiao in 2017.

10 Calculated as interest payments over the average of total borrowings in year t and t-1.

- *Tier 1* adds to the base rate spreads that reflect the risk profile of USD-denominated debts, taking into account individual company credit ratings.
- *Tier 2* is similar to Tier 1 but considers the risk profile of debts denominated in the local currency.
- *Tier 3* considers the additional interest that would have been charged absent the implicit government guarantee enjoyed by some firms.

Figure 1.14. Adding financial subsidies increases total government support for firms in the sample between USD 8 billion (Tier 1) and USD 56 billion (Tier 3)

Financial government support (Tier 1, Tier 2, and Tier 3) over the period 2013-17;
Left: USD millions, current; Right: scaled by revenue in 2016



Tier 1 analysis finds the total subsidy equivalent during 2013-17 to have reached a total of at least USD 7.5 billion for all companies studied. Of these companies, SPIC (USD 2.5 billion, 33% of the total), Hongqiao (USD 1.4 billion, 18%), and Chalco (USD 0.9 billion, 12%) accounted for the largest portion (Figure 1.14). Furthermore, because both SPIC and Hongqiao only disclose a range for their interest rates rather than weighted averages, actual subsidy equivalents may in fact have exceeded these amounts had the upper bound of the range[11] applied, i.e. USD 5.5 billion and USD 1.8 billion for

[11] That is, the lowest interest rate in the range.

SPIC and Hongqiao respectively. Controlling for firm size changes the picture somewhat, and shows in particular Henan Shenhuo, QPIG, and China Zhongwang (a semis producer) to have obtained disproportionately large financial support (see the longer version of the report).

By considering the risk profile of debts denominated in the local currency (e.g. the Chinese yuan), Tier 2 estimates add another USD 32 billion subsidy equivalent over the period 2013-17 (Figure 1.14). This estimate using Tier 2 spreads, which is additional to Tier 1 estimates, accounts for the interest rates that would have been charged had local market risks been priced in. The resulting estimates show SPIC to be a clear outlier: Tier 2 numbers add a staggering USD 17 billion to the company's subsidy equivalents, which are not explained entirely by size. As shown in Figure 1.13, the company has obtained loans at interest rates that are below the PBOC benchmark, likely due to SPIC's status as one of the 'big five' power companies in China that are owned and managed by the Central Government. Those five power companies have reportedly attracted significant support in the form of preferential loans from state-owned banks, equity injections, and VAT concessions (Hervé-Mignucci et al., 2015[12]).

Last, Tier 3 analysis considers the impact that implicit or explicit government guarantees may have had on the interest rates charged to certain state-owned companies. The resulting estimates add another USD 16 billion to Tier 2 numbers, with SPIC alone obtaining USD 14 billion and Chalco USD 1.2 billion (Figure 1.14). This reflects the credit-rating uplifts of several notches that these companies obtained due to the high probability, as perceived by credit-rating agencies, of the government stepping in should these companies experience financial distress. The only exception among SOEs is Norsk Hydro: although it is 34% owned by the Government of Norway, credit-rating agencies (e.g. Moody's)[12] have judged support from Norwegian authorities unlikely and Tier 3 spreads are thus estimated to be zero.

Adding to the estimates discussed above, Alcoa and Rio Tinto both received 30-year loans at zero interest rate from Investissement Québec, a state-owned investment company established by the Province of Québec in Canada. The loans were conditioned on the beneficiary companies undertaking additional investment at existing facilities. With the planned investments failing to materialise, only part of the loans have been used to date. Although detailed information on repayment schedules could not be located, these loans have likely saved the two companies less than USD 100 million in interest payments combined over the period 2013-17.

The estimates presented above paint a picture of financial support that is by and large concentrated in China, with few exceptions. Although all companies in the sample have obtained some form of non-financial support (e.g. R&D or energy subsidies) from one or several countries, the provision of financial support appears to be mostly a Chinese trait. One explanation that has been put forward is that "China's banking system was designed not to serve the interests of the private sector but to provide credit – cheaply and in large amounts – to state-owned companies" (McMahon, 2018[13]). The results above appear to give credence to this assertion in that Chinese aluminium SOEs have attracted the vast majority of all financial support. While not an SOE, Hongqiao nonetheless also benefitted

12 See for instance Moody's rating report dated 28 March 2017, "Rating Action: Moody's affirms Baa2 issuer rating of Norsk Hydro ASA, upgrades the baseline credit assessment to baa2 from baa3, stable outlook".

from significant concessional finance. Moreover, this support (including for Hongqiao) was itself largely provided by another group of SOEs, namely state-owned banks (e.g. Agricultural Bank of China, China Construction Bank, and Industrial and Commercial Bank of China) and policy banks (e.g. China Development Bank).

The numbers presented above are nevertheless subject to important caveats and possibly under-estimate the true amount of financial support. For example, the base rates used for loans denominated in the Chinese yuan (i.e. the PBOC benchmark rates) may themselves be suppressed to some extent. To the extent this is true, it would have the effect of increasing further benchmark interest rates and therefore the estimated financial support. Further, there is little readily available information in any country on financial support that may – or may not – be provided to specific firms.

Another caveat relates to the consideration of what investors in a private market would view as a reasonable rate of return on equity. Because the true cost of capital represents a weighted average of the cost of debt and equity, a “fair-value” approach to estimating the cost of financing for SOEs should not only consider SOEs’ borrowing costs, but also the returns they generate for their shareholders (i.e. the state). To estimate the extent to which SOEs in the sample have generated adequate returns for their shareholders, these companies’ return on equity is compared with a notional expected return on equity (Lucas, 2014[14]). While the numbers in Table 1.1 do not necessarily imply the existence of a ‘subsidy’ as such, they are nonetheless indicative of a tendency for certain SOEs to not be subject to the same market discipline as other firms in the industry. This is especially so for Chalco, NALCO, QPIG, and Yunnan Aluminium, which have obtained average returns on equity that are far lower than the industry benchmark.

Table 1.1. Certain SOEs are not subject to the same market discipline as other firms in the industry

Company name	Actual average return on equity	ROE benchmark	Difference
Alba	8.13%	6.26%	1.87%
Chalco	**1.50%**	**8.84%**	**-7.34%**
NALCO	**6.72%**	**13.40%**	**-6.68%**
Norsk Hydro	4.15%	6.54%	-2.39%
QPIG	**0.70%**	**8.84%**	**-8.15%**
SPIC	6.83%	8.84%	-2.02%
Xingfa	18.66%	8.84%	9.81%
Yunnan Aluminium	**2.47%**	**8.84%**	**-6.38%**

Note: Actual returns on equity are averaged over the period 2013-16; the benchmark over the period 2013-17. Data for Henan Shenhuo were not available at the time of writing.
Source: OECD calculations on the basis of Lucas (2014[14]).

Finally, one last caveat that applies to the financial estimates discussed above concerns the prevalence of shadow banking in China, and the role it could have played in enabling certain companies to borrow more than what was on offer from state-owned banks. Shadow banking takes many forms in China, including unregulated lending and entrusted loans. However, due to the lack of transparency surrounding such loans, this study has not attempted to identify them systematically, much less estimate a subsidy equivalent.

Trade measures

The use of trade-policy instruments to promote downstream industries

A number of aluminium-producing countries have imposed trade barriers as part of national strategies to promote the development of downstream industries. Export restrictions are the most notable barriers, with a few countries having used them to make targeted products cheaper domestically, thus favouring domestic industries downstream that rely on these products as inputs or intermediates.

Export bans on bauxite by Indonesia and Malaysia had a significant effect on world markets, given their relatively large bauxite resources. Indonesia introduced its export ban in 2014 in a bid to induce bauxite-mining firms to build domestic refining and smelting facilities. As exports from Indonesia were brought to a halt in 2014, much of the activities of bauxite producers crossed the border into neighbouring Malaysia, which experienced a sudden mining boom that led to widespread environmental degradation and illegal extraction. The Government of Malaysia responded by introducing an export ban of its own in January 2016, which remains in place at the time of writing (U.S. Geological Survey, 2018[15]).

China's export taxes are another measure that has had important effects on world aluminium markets. Their impact has come on top of the impact of China's incomplete rebates of value-added tax (VAT) for exporters, which also serve to discourage exports of primary aluminium while encouraging exports of certain semis and fabricated articles of aluminium (Box 1.1). The combination of incomplete VAT rebates and export taxes implies a *de facto* export tax on primary aluminium well in excess of 15% (around 30%). This is in contrast with more processed aluminium products (e.g. semis), for which VAT costs and export taxes are generally both lower.

Similarly to export restrictions, the structure of certain countries' import tariffs may also favour downstream activities in the aluminium value chain. By charging higher import tariffs on semis and fabricated articles of aluminium, governments such as the Russian Federation or Korea have indirectly sought to support domestic processing down the value chain.

Box 1.1. China's policy of incomplete VAT rebates

Incomplete rebates of VAT for exporters are a specific tool used by China to favour exports of certain products. China's VAT policy differs from the standard destination-based VAT system of many countries in that it does not fully refund the VAT on exports. Instead, China-based exporters may be eligible for VAT rebates that range from zero to a full refund of the typical 17% VAT rate, depending on the product they export. China's system of VAT rebates can be considered a trade-policy tool since the Government often modifies rebate rates selectively, restricting exports of certain products while encouraging others.

Estimated VAT costs for different aluminium products in China show exports of bauxite, alumina, and primary aluminium to have all borne the full extent of the VAT – and thus to have been penalised – over the past 8 to 15 years. In other words, they had zero or near-zero rebates in the period. On the contrary, exports of semis and articles of aluminium had higher VAT rebates over the same years, and were thus promoted *relative to upstream products*.

Source: (Gourdon, Monjon and Poncet, 2017[16]).

Trade policy has had visible effects in the aluminium value chain

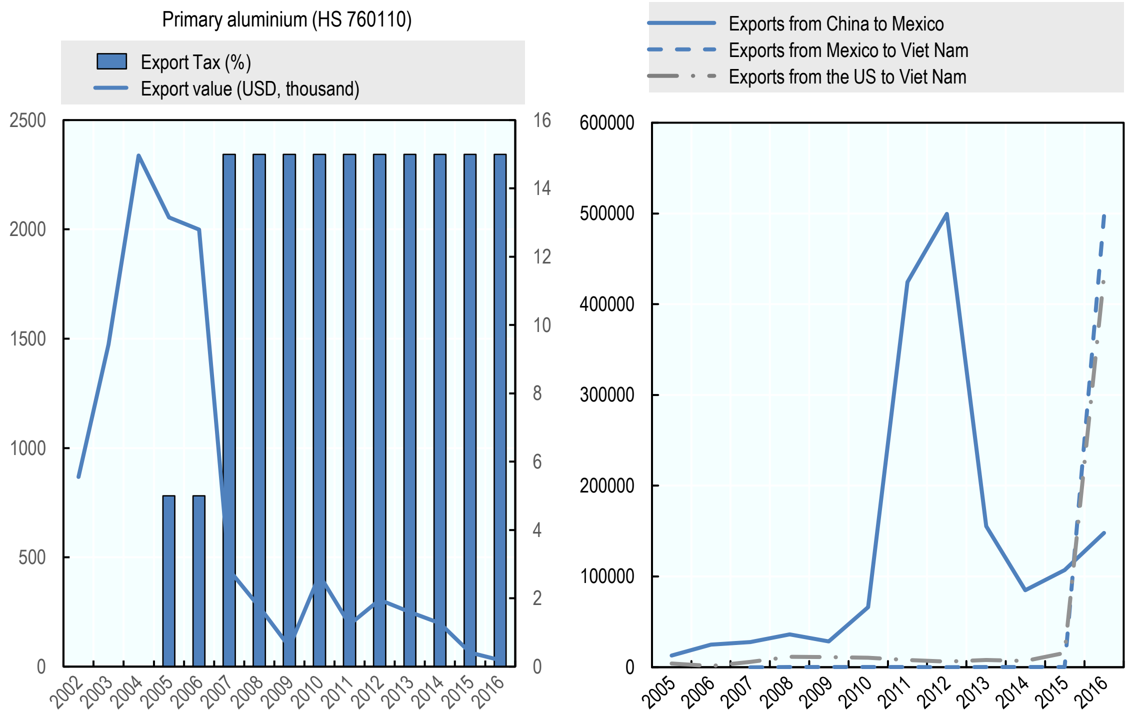
The export bans introduced by Indonesia and Malaysia between 2014 and 2016 affected China much more than other alumina producers. The year before Indonesia introduced its 2014 export ban, it accounted for 38% of China's imported bauxite, which represented 99% of Indonesia's exports of bauxite. Bans by Indonesia and Malaysia thus pushed China to revamp its sourcing strategy, and helped cement the growing importance of Guinea in world bauxite exports.

There is evidence that Indonesia's export ban had some success in increasing domestic alumina refining. While Indonesia did not produce any alumina prior to the introduction of the bauxite export ban in 2014, production has since started and grown every year, reaching 1.5 million tonnes in 2017. There has not been any discernible impact on the country's production of primary aluminium, however. It is, meanwhile, too early to tell if Malaysia's 2016 export ban has had comparable effects.

In the middle segment of the value chain, China's export restrictions have proven effective in curbing its exports of primary aluminium (Figure 1.15): China does not export a significant amount of primary aluminium, despite being the world's largest producer and having what it acknowledges to be excessive smelting capacity. The main net exporters of primary aluminium are currently Australia, Canada, Iceland, India, Norway, the Russian Federation, and the United Arab Emirates, which together accounted for more than half of global exports of primary aluminium in 2016. By contrast, China accounted for a mere 2% of global exports.

Figure 1.15. China's export restrictions have curbed its exports of primary aluminium but encouraged some trans-shipments

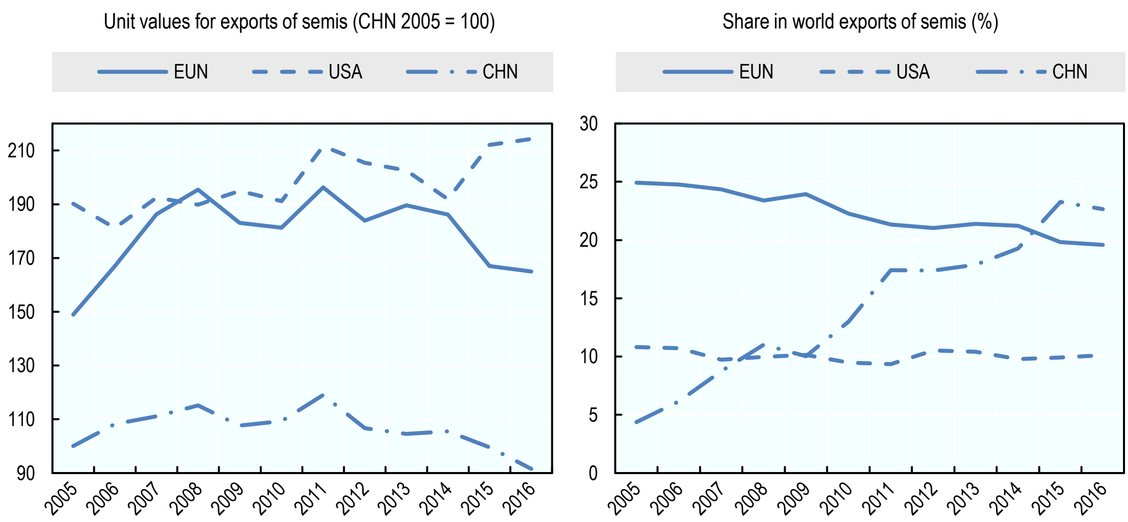
Left: Export taxes (*ad valorem*) and Chinese exports in value (USD thousand)
Right: Bilateral export flows (in metric tonnes)



China's export barriers, coupled with smelting output that exceeds domestic demand, have led some exporters in the country to circumvent border restrictions by exporting primary aluminium disguised as semis (Figure 1.15). The process usually involves trans-shipments through third countries, wherein 'fake semis' are re-melted into primary-aluminium ingots before they are re-exported as such to their final destination (Taube, 2017[17]; USITC, 2017[4]). This enables Chinese exporters to evade the 15% export tax on primary aluminium while at the same time obtaining a partial refund of VAT, which together, and depending on the prevailing price of aluminium on the LME, can make the operation worthwhile.

All this means that China's excess supply of primary aluminium has mainly stayed within China, where it has benefitted Chinese producers of semis through lower input costs. Although there are many other factors affecting semis production costs – including cost of labour, domestic regulations, and subsidies – there is little doubt that export restrictions and tariffs have played a role in keeping the cost of primary aluminium as a key input down. Lower production costs for semis have in turn translated into lower export prices that have made China more competitive in most segments of the semis market (Figure 1.16). China's cost competitiveness and trade policies have turned the country into a large net exporter of semis. Although China currently dominates exports of aluminium semis worldwide, this is a relatively new development (Figure 1.17). The picture is strikingly similar for more processed articles of aluminium, where again lower unit values on exports have made China the largest net exporter by a wide margin, with rapid export growth leading to the country now holding around 20% of global market share.

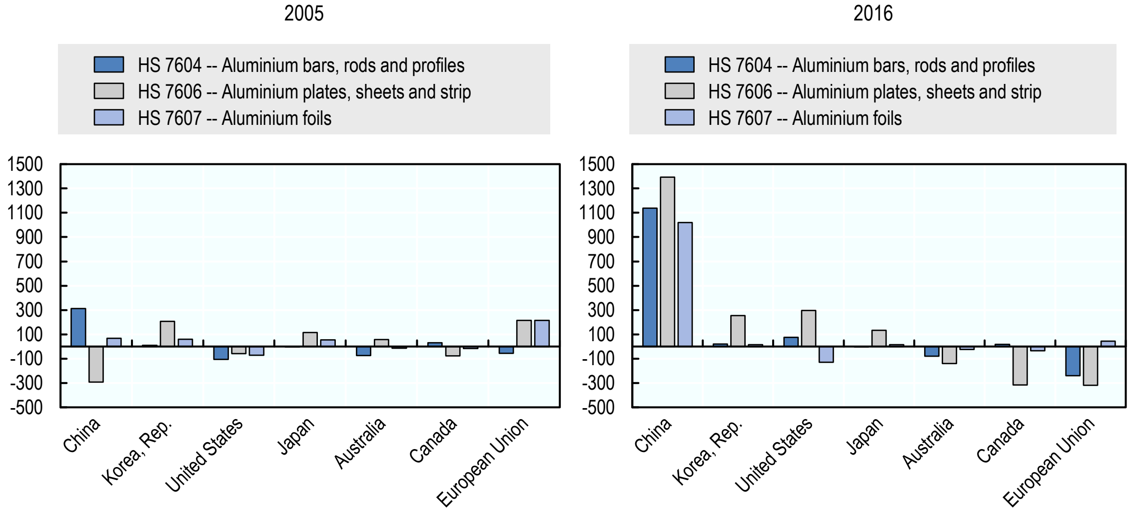
Figure 1.16. There is a persistent gap between the prices on semis offered by China and those offered by the European Union and the United States



Note: Unit values of exports do not account for possible quality differences between goods under the same HS heading. They should therefore be taken with caution, and are only meant to serve as a proxy for unit export prices. Aluminium semis here comprise: HS 760429, 760611, 760612, 760711, 760719, and 760720.

Figure 1.17. China has come to dominate semis' exports over the past decade

Net exports by country (thousand metric tonnes)



China's rapid ascent as the world's largest exporter of aluminium semis, and the policies that appear to have made this ascent possible, have met growing resistance from other aluminium-exporting countries. There has been in particular a series of trade disputes and trade remedies targeting China's policies in the aluminium sector. The year 2018 also saw the United States impose a 10% tariff on certain aluminium imports pursuant to Section 232 of the Trade Expansion Act of 1962. This tariff was soon followed by the introduction of commensurate tariffs by other countries, which these governments imposed to guard against import surges resulting from the diversion of aluminium originally bound for the United States. It is, however, too early at this stage to assess what impacts, if any, the above measures will have on trade in aluminium products.

State involvement along the aluminium value chain

Governments are involved at different stages of the aluminium value chain through SOEs and direct participation in mining joint ventures. State ownership globally is estimated to account for at least 27%, 34%, and 41% of total capacity in bauxite mining, alumina refining, and smelting respectively. States have traditionally retained important stakes in their mining sectors and it is therefore not surprising that about a quarter of all bauxite-mining capacity is currently in the hands of governments. Growing ownership of capacity by the state moving up the value chain is more surprising and largely accounted for by China, Norway, and the GCC countries. China alone makes up more than two-thirds of all state-owned capacity in both alumina refining and aluminium smelting.

China, Norway, and the GCC countries all have a strong tradition of state ownership in multiple sectors of the economy, including oil and gas extraction (e.g. PetroChina, Equinor, and Saudi Aramco) and airlines (e.g. Air China and Qatar Airways).[13] In China's case, it has been estimated that the country "has more than 150 000 companies that are owned by various strata of government, accounting for about 25% of economic

13 The Norwegian Government sold its remaining shares in Scandinavian airline SAS in June 2018.

output and one in five urban jobs" (McMahon, 2018[13]). It is therefore not surprising to find governments in these countries owning some or all of the aluminium-smelting capacity, as well as the power plants that generate the electricity for the smelters.

The ways in which SOEs are managed in different countries, and the extent to which governments exert influence over SOEs' decisions and operations have important implications for global competition. For example, China's SPIC mentions explicitly in a 2016 bond prospectus that "[it] is one of 52 backbone state-owned enterprises supervised by SASAC"[14] and that "[it] plays a key role in the formulation and implementation of policies in the power sector", for which it "receives comprehensive and sustainable support from the PRC Government" (State Power Investment Corporation, 2016[11]). QPIG notes in a 2017 bond prospectus that "the Qinghai provincial government can exert significant influence on the Group" (Qinghai Provincial Investment Group Co. Ltd., 2017[7]).

Yet ownership forms but one of different ways in which governments can exert influence over companies in the aluminium value chain. Earlier OECD work has emphasised the broader concept of "state enterprise" since "*ownership* is neither necessary for governments to influence enterprises' operations, nor does it inevitably entail such influence" (Kowalski and Rabaioli, 2017[18]). State influence is evident through the support that private companies such as China Hongqiao, China Zhongwang, and Henan Zhongfu (Vimetco) have obtained from central and local authorities in China, and, to a much lesser extent, Alcoa from Saudi Arabia. The results discussed above indeed show that SOEs are not always the largest or the only recipients of support, echoing others' findings that "state subsidies [in China] flow into [SOEs], although some well-connected private firms also benefit from indirect subsidies" (Haley and Haley, 2013[19]), and that "many so-called private companies maintain close connections to government organizations through political, business or personal ties" (Taube, 2017[17]).

This suggests state influence in the aluminium value chain to be a matter of degree, ranging from benign regulatory oversight to stronger forms of government involvement. To be sure, governments have an important role to play in the economy, be it to redistribute income and wealth, to correct market failures, or to ensure the provision of public goods, among other goals. This role becomes, however, problematic where government involvement in an industry serves to favour domestic companies at the expense of foreign companies. The countries covered in this study seem to be located at different points along this spectrum. Some have no state ownership of production facilities and provide relatively little support, if any at all (e.g. Iceland, New Zealand, Spain, and the United States). Other governments own a significant portion of local capacity but provide small support in relative terms (e.g. Norway and Oman). Then there are some countries that do not own much capacity but that provide significant support relative to the former two groups (e.g. Brazil and Canada). Finally, there are countries that both own a sizable portion of local capacity and provide much larger support to local firms (e.g. Bahrain, China, Qatar, and Saudi Arabia).

This last set of countries are usually characterised by administered input prices (e.g. energy) and a strong role of the state in allocating capital across industries and firms. Saudi Arabia's Public Investment Fund, for example, channels the country's wealth into hundreds of companies to diversify the economy away from oil in line with Saudi

[14] State-owned Assets Supervision and Administration Commission.

Vision 2030. What makes China different in this case is the porous and fluid relationship that the government maintains with companies, including through the appointment of key personnel and the day-to-day operation of firms. SPIC, the key personnel of which are directly appointed by the SASAC and the State Council, states in its 2016 bond prospectus that “the PRC government continues to play a significant role in regulating industrial development, the allocation of resources, production, pricing and management”.

Critically, the relationship in China between the government and companies generates opacity around the form and scale of government support. One example is the provision of inputs such as coal, alumina, or electricity by Chinese SOEs to other companies – public or private – for prices that are below market, and for which it can be very difficult to identify the specific policies that underlie support (where they even exist). This example illustrates a broader tendency for “provincial and municipal governments [in China to] subsidize purchases of raw materials by requiring other SOEs or pressuring their own suppliers to provide these inputs at below-market or even below-cost prices” (Haley and Haley, 2013[19]). Such practices blur the line between public and private and contribute to making Chinese policy opaque to outsiders, rendering it difficult to “ascertain the true policies that underlie the subsidies” (McMahon, 2018[13]; Haley and Haley, 2013[19]).

State influence in China is especially evident in the area of financing, with companies able to borrow from policy banks and other state-owned financial institutions on terms that are much more favourable than those available in private markets. SOEs alone account reportedly for as much as 60% of all corporate debt in China (McMahon, 2018[13]). State enterprises thus play a complex role as both recipients and providers of support in China.

1.4. Conclusions and policy implications

The above evidence on government support shows that at least some of the increases in smelting capacity in recent years have been driven by non-market forces and subsidies in particular. While government support is common along the aluminium value chain, it is especially heavy in China and the GCC countries. Excess capacity appears in that sense to be a genuine concern in the aluminium industry, and one that has implications for global competition as production moves where governments have offered the most support. To the extent this does not coincide with a natural comparative advantage in energy-intensive industries, government support has wider implications in terms of economic efficiency, and potentially even environmental outcomes.

This evidence also has implications for the design of trade rules designed to discipline government support, notably in terms of the need to take account of the impact of actions along the value chain, and the need to take account of the role of the state, including in terms of the priority of increasing transparency. Additionally, the nature of the measures identified in this sector suggest that government support may not only be confined to aluminium, but may represent broader economic trends warranting further analysis.

Government support needs to be understood in the context of value chains

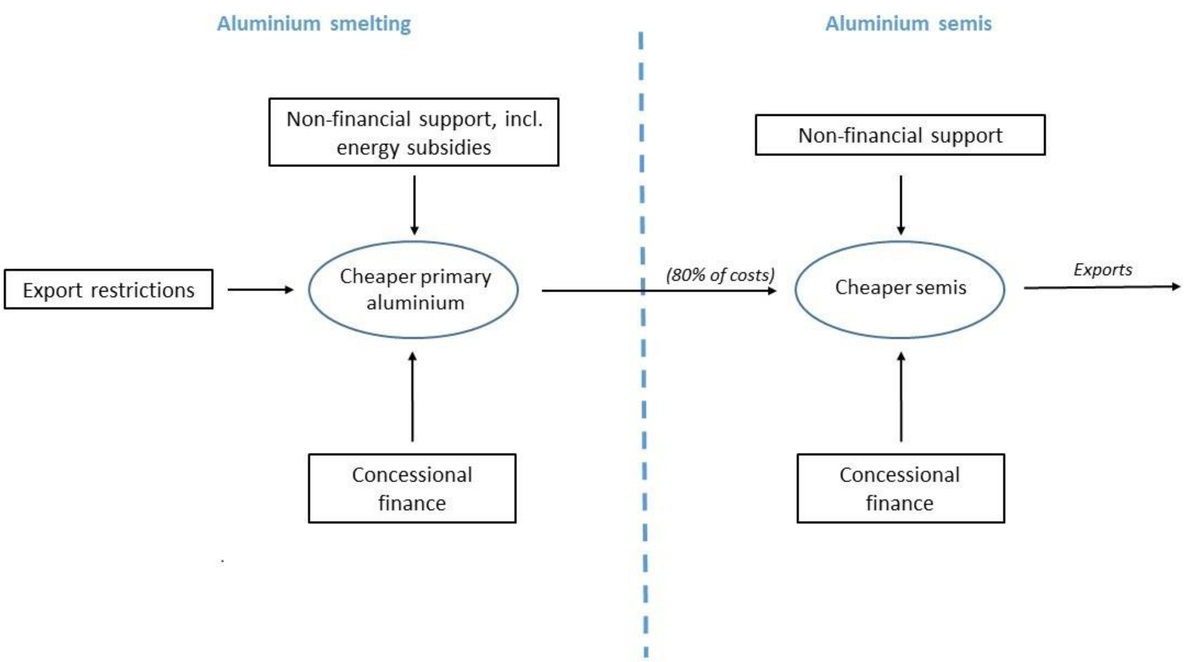
Government interventions appear widespread all along the aluminium value chain, though some stages in the chain seem to attract more support than others. This is especially the case with aluminium smelting, for which support is relatively large and primarily takes

the form of energy subsidies and concessional finance. The effects of support provided at the smelting stage have repercussions at various points in the aluminium value chain, and in particular downstream in the manufacturing of semi-fabricated products of aluminium ("semis").

The effect of support for smelting has been most pronounced in China, due to both its export restrictions (in particular as Chinese firms account for almost 60% of world output in volume terms) and much larger domestic support. The combined effect of these measures has been to make aluminium cheaper in China than it would otherwise have been, conferring a cost advantage to Chinese producers of semis, whose exports have grown very rapidly (Figure 1.18).

The effects that government support and other policies (e.g. export restrictions) have all along the aluminium value chain suggest that trade rules may need to be revisited to better account for the greater complexity of international production. The WTO's Agreement on Subsidies and Countervailing Measures is, for example, "premised on trade involving goods that are produced in one country and sold to another" (Hoekman, 2016[20]). Despite aluminium being a relatively simple value chain (compared with, say, smartphones and aircrafts), policy spill-overs between segments of the chain are already apparent, e.g. whereby coal sold at below-market prices finds its way into cheaper electricity, cheaper primary aluminium, and eventually cheaper aluminium semis that are exported in world markets. Likewise, support for smelting increases demand for alumina and bauxite, with implications for the companies that compete in those segments.

Figure 1.18. Government policies in key parts of the aluminium value chain in China



Subsidy rules need to better account for the influence of the state

Government ownership is also prevalent all along the aluminium value chain in several countries, especially downstream towards aluminium smelting. However, aside from ownership, the evidence points to the role of state *influence* in orienting production and

investment decisions, in particular through government management of input prices and the flow of credit to aluminium producers. State influence is most prevalent in China and the GCC countries, with SOEs being not only recipients, but also providers, of support.

While there is a need for greater transparency and data on subsidy policies, the fluid relationship observed in China between the state and companies creates issues for transparency in relation to government support policies. The definition of government support itself becomes blurry where the government is heavily involved in the day-to-day financing and management of companies, making it difficult to identify the precise policy actions and documents that underlie the support provided, where they exist at all. This has implications for the notification of subsidies in the WTO, which are usually couched in terms of individual policies, and more generally for understanding the impacts, positive and negative, that support has on global competition and trade.

With heavy state management of the economy making it more difficult to connect government support to individual policies, improving information on subsidies and other forms of support may need to also draw upon the estimation of price gaps. By focussing on economic outcomes rather than policy inputs, price-gap estimates can provide a more accurate and all-encompassing picture of government support in important areas such as energy inputs and concessional finance. There are, however, many limitations in price-gap analysis, and greater efforts will need to be devoted to refining the approach and defining best practices for appropriate guidelines and disciplines, including for use in the WTO context.

More generally, transparency remains fundamental in enabling information on support to be collected and compared across firms, countries, and stages of the value chain. The above results were obtained through extensive research at the level of individual firms and countries, yet the remaining data gaps underscore the need for governments to improve disclosure of information on support, including support provided to and through state enterprises, at a sufficient level of detail to allow for meaningful analysis.

State influence and government support beyond the aluminium value chain

This study of the aluminium value chain has highlighted the importance of energy subsidies and concessional finance in government support for aluminium producers, as well as the role of state enterprises as both recipients and providers of that support. This raises the question of whether similar patterns can be observed in other sectors and value chains, particularly as one moves into more technology-oriented markets with different cost structures and demand patterns.

Sector characteristics and data permitting, the approach pioneered in this study could usefully be applied to other industries and value chains in order to provide a more representative and systematic view of government support, and industrial policy more broadly. The matrix of support measures (Table 1.2) could serve as a kind of 'heat map' with different areas of support varying in importance across sectors and value chains. In this way, it could provide the foundation for building a broader understanding of government support in all its forms.

Table 1.2. Indicative matrix of support measures, with illustrative examples

			Statutory or formal incidence (to whom and what a transfer is first given)							
			Production							Consumption
						Costs of value-adding factors				
			A: Output returns	B: Enterprise income	C: Cost of intermediate inputs	D: Labour	E: Land and natural resources	F: Capital	G: Knowledge	H: Direct support to consumers
Transfer Mechanism (how a transfer is created)	1: Direct transfer of funds		Output bounty or deficiency payment	Operating grant	Input-price subsidy	Wage subsidy	Capital grant linked to acquisition of land	Grant tied to the acquisition of assets, including foreign ones	Government R&D	Unit subsidy
	2: Tax revenue foregone		Production tax credit	Reduced rate of income tax	Reduction in excise tax on input	Reduction in social charges (payroll taxes)	Property-tax reduction or exemption	Investment tax credit	Tax credit for private R&D	VAT or excise-tax concession
	3: Other government revenue foregone			Waiving of administrative fees or charges	Under-pricing of a government good or service		Under-pricing of access to government land or natural resources	Debt forgiveness or restructuring	Government transfer of intellectual property rights	Under-pricing of access to a natural resource harvested by final consumer
	4: Transfer of risk to government		Government buffer stock	Third-party liability limit for producers		Assumption of occupational health and accident liabilities	Credit guarantee linked to acquisition of land	Loan guarantee; non-market-based debt-equity conversion		Price-triggered subsidy
	5: Induced transfers		Import tariff or export subsidy; local-content requirements; discriminatory GP	Monopoly concession	Monopsony concession; export restriction dual pricing	Wage control	Land-use control	Credit control (sector-specific); non-market mergers and acquisitions	Deviations from standard IPR rules	Regulated price; cross subsidy
		-- Including advantages conferred through state enterprises						Below-market loan, including by state-owned bank		

Note: This matrix is a work in progress and may be refined in the future. Some measures may fall under a number of categories (e.g. debt-equity conversions may involve elements of both risk transfers and revenue foregone). GP = Government procurement. Adapted from OECD (2018[9]).

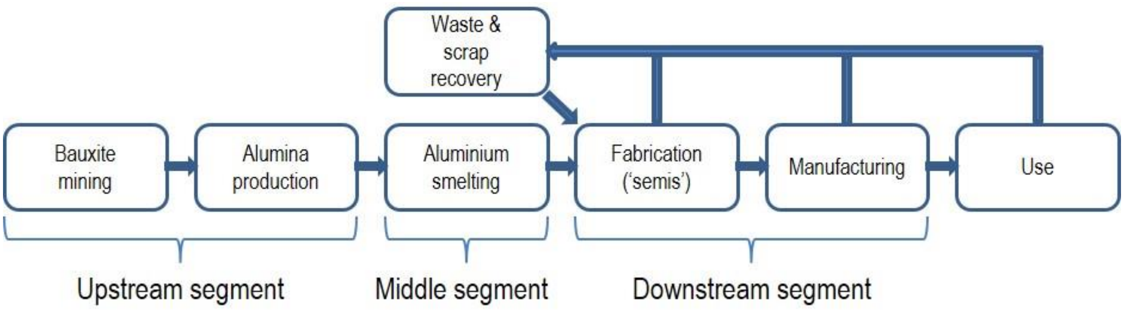
2. The global context: Key developments along the aluminium value chain

The aluminium value chain spans a large number of sectors and products, underscoring the importance of seeing trade and international competition through the lens of global value chains (GVCs). Aluminium is a widely used material that finds its way in numerous industrial and consumer applications downstream, ranging from building structures and window frames to motor vehicles, airplanes, space shuttles, electric transmission lines, and beverage and food packaging. The production of raw aluminium itself hinges upstream on the mining and transformation of bauxite ore for later use in an energy-intensive process known as electrolysis.

For the purpose of this report, the aluminium value chain is here subsumed under three broad segments, namely: (i) the upstream segment, which comprises mining of bauxite and its refining into alumina; (ii) the middle segment, which covers smelting of primary aluminium and the production of secondary (recycled) aluminium; and (iii) the downstream segment, covering the production of semi-fabricated aluminium products ("semis") and their use in manufacturing processes further down the chain (e.g. in the motor-vehicle industry or the construction sector).

The analysis that follows centres on the upstream and middle segments of the chain, as well as on the production of aluminium semis to a lesser extent. In terms of Figure 2.1, this includes all production stages to the left of 'manufacturing':

Figure 2.1. The aluminium production chain: stages of processing



Note: This diagram is for illustrative purposes only as the industry may define segments differently.
Source: simplified representation adapted from (Bertram et al., 2017[1]).

2.1. The upstream segment: The mining of bauxite and its refining into alumina

World trade in bauxite is growing, with China the largest importer

The basic ingredient in the production of aluminium is bauxite, large deposits of which are found in Australia, Brazil, China, Indonesia, Malaysia, Viet Nam, and West Africa (mostly Guinea). Smaller deposits are also found in parts of Europe (e.g. Greece), India, Russian Federation, and Central America and the Caribbean (e.g. Jamaica and Guyana) (U.S. Geological Survey, 2018[15]). Bauxite is generally found near the surface, where it is extracted using open-cast mining techniques before it is crushed and washed for further processing.

Although Australia remains the largest producer (Figure 2.2), countries in Southeast Asia and West Africa are growing sources of bauxite. Chinese production saw a significant increase but has levelled off in recent years. The most dramatic increase took place in Indonesia, which became the world’s second largest producer in 2013 before the government banned exports of bauxite in January 2014, causing production to collapse and mining operations to move to neighbouring Malaysia, where bauxite mining increased 160-fold between 2013 and 2015. An increase in illegal mining and large-scale environmental degradation in turn led Malaysia to ban bauxite mining in January 2016 (U.S. Geological Survey, 2018[15]). The resulting shortfall in supply has been met partly through additional exports from Guinea, Ghana, and Sierra Leone, where large aluminium multinationals are investing increasingly to secure a steady supply.

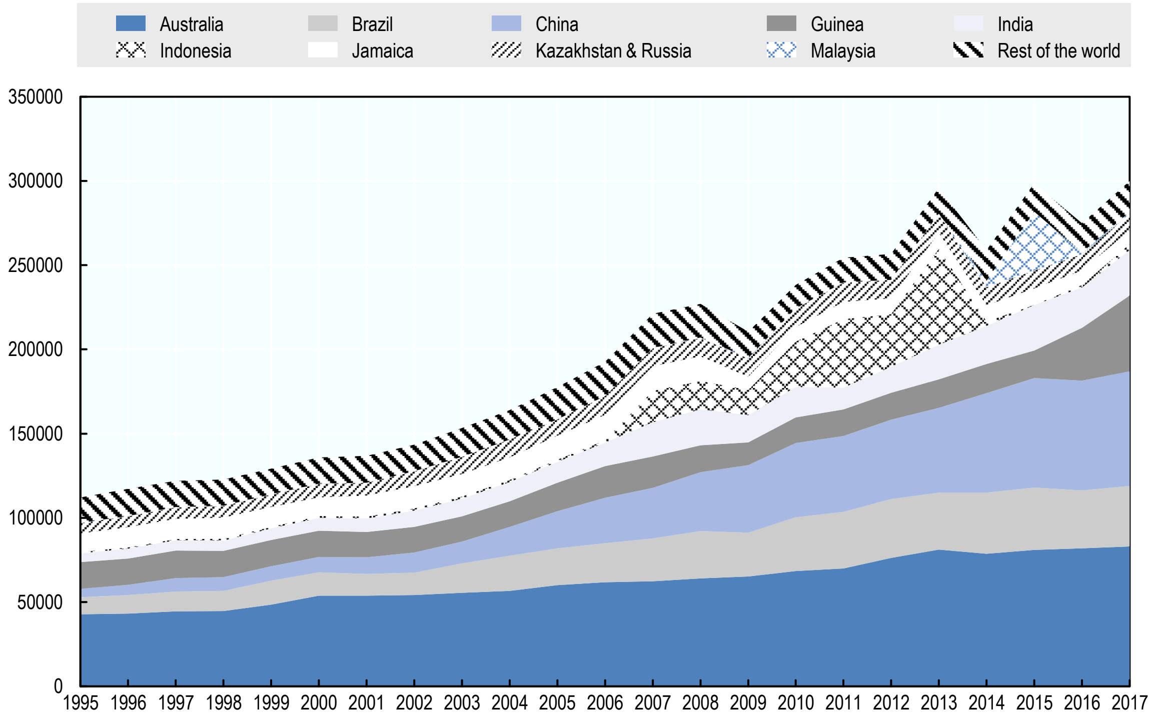
Bauxite-mining operations are usually conducted by large international corporations either through full ownership or through joint ventures with local state enterprises. The vast Sangaredi mine in Guinea is, for example, operated by the Compagnie des Bauxites de Guinée, which is ultimately owned by US firm Alcoa, mining giant Rio Tinto, the Guernsey-based Dadco Group, and the Government of Guinea, which retains a 49% stake. Large aluminium-producing firms from China and the Middle East have also entered the market, with the Chongqing-based Bosai Group acquiring majority stakes in mines in Ghana and Guyana. The state-owned Emirates Global Aluminium (EGA) Corporation has sole ownership of a large concession in the Boké region of Guinea operated by its local subsidiary, the Guinea Alumina Corporation. Other significant producers of bauxite include: Australian firms Alumina Limited and South32; the Aluminium Corporation of China (Chalco) and SMB-WAP, a Guinea-based consortium involving the China Hongqiao Group[15], shipping and logistics firms, and the Government of Guinea; India-based Hindalco Industries; Norway’s Norsk Hydro (through equity stakes in Brazil); and the Russian Federation’s UC Rusal.

Global trade in bauxite has grown fast over the past decade, mirroring the increase in mining output. This reflects a steep increase in demand from Chinese aluminium producers, with China now accounting for about two-thirds of global imports (Figure 2.3), much of it from Australia and Guinea. Brazil is currently the only large exporter for whom China is not the largest market, notwithstanding a significant increase in Brazilian exports to China in 2016.

15 Through its wholly-owned subsidiary Shandong Weiqiao Aluminium & Power Co. Ltd.

Figure 2.2. Australia remains the largest producer of bauxite, alongside Brazil and China

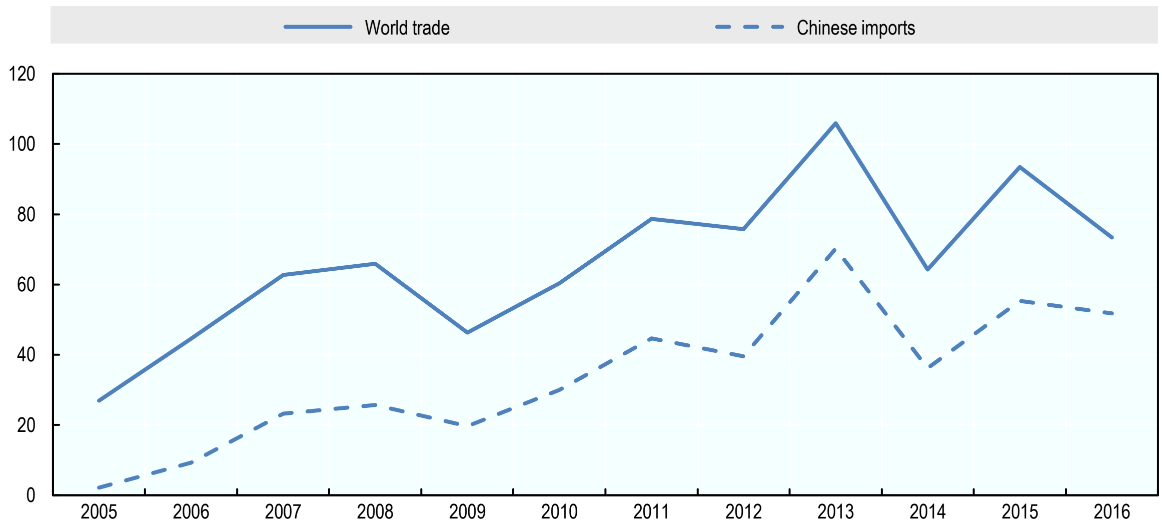
Global production of bauxite, 1995-2017 (in thousand metric tonnes)



Note: Data for 2017 are provisional estimates.
Source: US Geological Survey and OECD research.

Figure 2.3. China now accounts for about two-thirds of global bauxite imports

World trade in bauxite, 2005-16 (in million metric tonnes)



Source: OECD on the basis of data from the BACI database.

Production of alumina worldwide has more than doubled since 2000

The next stage in the chain involves the refining of bauxite into alumina, a white powder that, alongside electricity, is the main intermediate input into the smelting of primary aluminium. About two to four tonnes of bauxite are necessary to produce one tonne of alumina, which in turn yields roughly half a tonne of aluminium (Norsk Hydro, 2012[21]). Most (90%) alumina is used in aluminium production[16], with the remainder used in other industrial applications (e.g. for the production of ceramics or cosmetics). Bauxite refining often takes place near mining sites or ports, before the alumina is then shipped to smelting facilities for transformation into primary aluminium.

Chinese alumina production has surged over the past 15 years, doubling global supply and reducing China's reliance on imports of alumina (Figure 2.4). By contrast, China currently imports almost half of its bauxite needs (Figure 2.5) and this dependency is expected to increase further as its domestic resources are generally of low quality.[17] Chinese alumina refiners are thus increasingly exposed to fluctuations in international bauxite prices – as seen in the months that followed Indonesia's 2014 ban on bauxite exports (Shanghai Metals Market, 2016[22]) – as opposed to being able to negotiate prices for their own domestic supply.

Outside China, most alumina-producing regions are also important producers of bauxite, with the exception of the United States. This includes long-time incumbents such as Australia, Brazil, Kazakhstan, and the Russian Federation, but also new entrants such as Indonesia and Saudi Arabia. Construction of a large alumina refinery in Al Taweelah (Abu Dhabi) is also underway. By contrast, Jamaica, Suriname, and the United States – among others – have curtailed some or all of their capacity, including Alcoa's Point Comfort refinery in Texas and Sherwin Alumina's Corpus Christi plant (also in Texas).

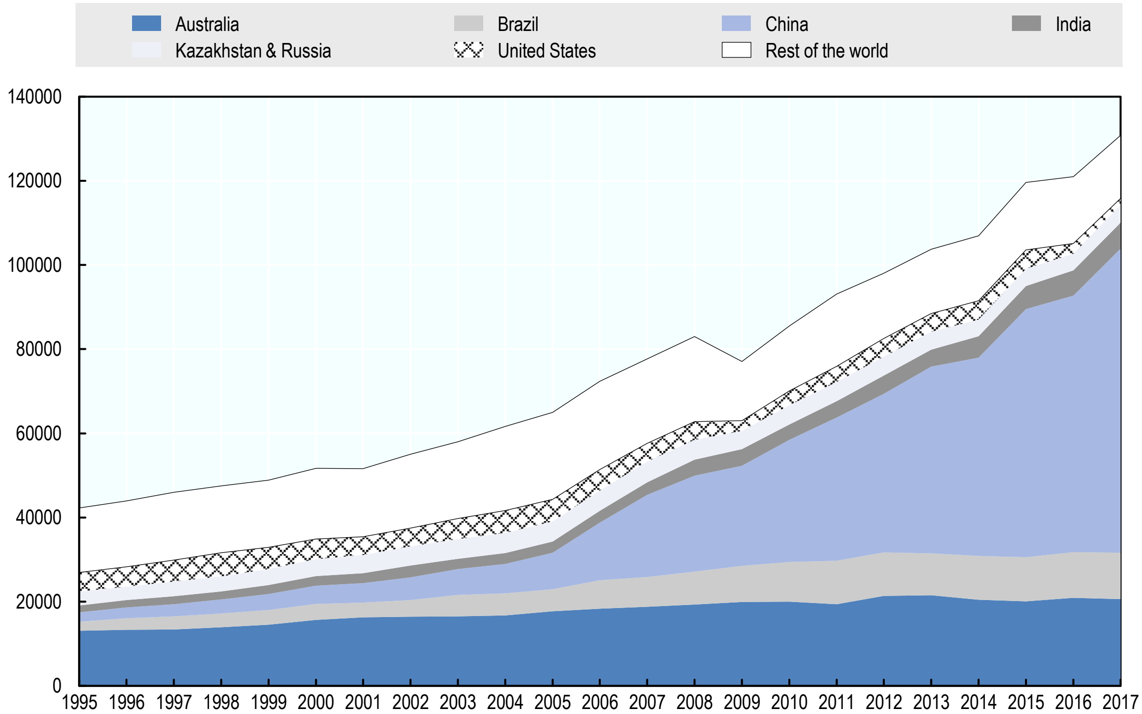
The same vertically-integrated firms generally operate bauxite mines in conjunction with their alumina refineries for cost-efficiency reasons (USITC, 2017[4]). For example, Alcoa (United States) and Norsk Hydro (Norway) both have stakes in mines and refineries in Australia and Brazil, and UC Rusal's (Russian Federation) operations in Guinea also cover both activities. Several of China's largest firms display a similar degree of vertical integration, although most refine their bauxite domestically, which explains in part the country's unprecedented surge in alumina production.

16 International Aluminium Institute (IAI), see http://bauxite.world-aluminium.org/refining/process/ (accessed on 12 July 2018).

17 The 2016 annual report of the Aluminium Corporation of China ('Chalco') notes, for instance, that "[m]ost of the bauxite reserves in China [… display] low alumina-to-silica ratio."

Figure 2.4. China's alumina production has surged over the past 15 years

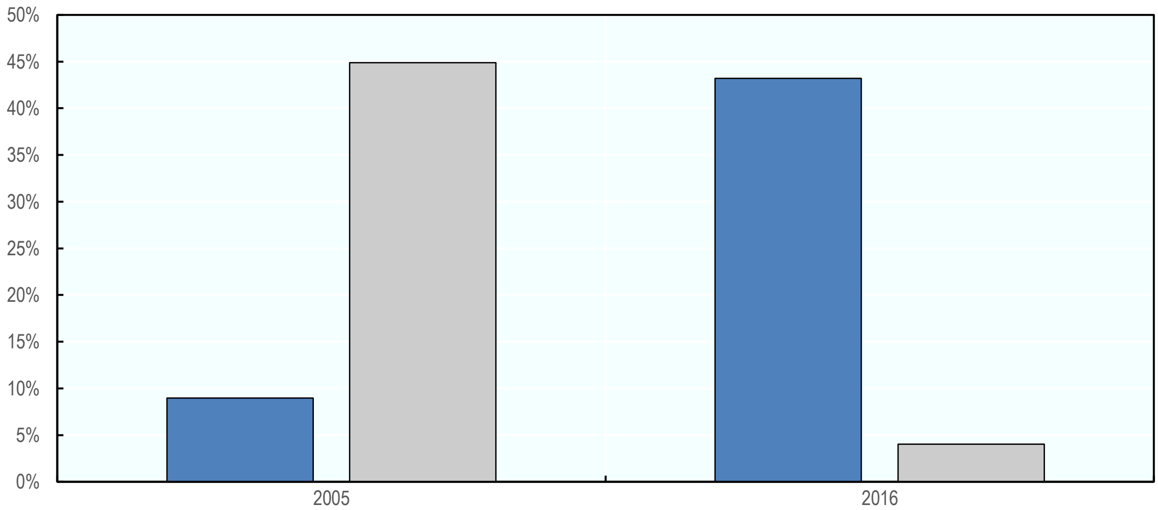
Global production of alumina, 1995-2017 (in thousand metric tonnes)



Note: Data for 2017 are provisional estimates.
Source: US Geological Survey and OECD research.

Figure 2.5. China's production surge has ended its reliance on alumina imports while exposing it to fluctuations in international bauxite prices

Import dependency ratios for China, 2005 and 2016 (%)



Note: Import dependency is here defined as imports over the sum of imports and domestic production.
Source: US Geological Survey and OECD research for domestic production; BACI database for imports.

The list of top alumina producers by capacity confirms the heavy presence of Chinese firms at the refining stage (Table 2.1), including one large state-owned enterprise in the form of Chalco. The second largest Chinese firm by capacity, the China Hongqiao Group, is a relatively recent addition to the global top 10 of producers, having invested heavily in new refining capacity in its home province of Shandong. The Group is also planning the construction of a refinery in Guinea through its participation in the SMB-WAP consortium.[18]

Table 2.1. Top 10 producers of alumina, by capacity

Rank	Firm name	Annual capacity (kt)	Parent country
1	Aluminium Corporation of China (Chalco)	15 944	CHN
2	Alcoa	14 370	USA
3	China Hongqiao Group [1]	12 500	CHN
4	Rio Tinto	10 930	GBR
5	UC Rusal	9 733	RUS
6	Norsk Hydro	5 712	NOR
7	South32	5 216	AUS
8	East Hope Group [1]	5 200	CHN
9	Hangzhou Jinjiang Group [1]	3 840	CHN
10	Hindalco	3 145	IND

Note: [1] Numbers for these companies may under-estimate their actual capacity.
Source: OECD estimates on the basis of latest information from the US Geological Survey and of company-level information (e.g. industry and company websites and annual reports).

2.2. The middle segment: Aluminium smelting and recycling

China smelts almost 60% of all primary aluminium

The transformation of alumina into primary aluminium through electrolysis is a highly energy-intensive operation, whereby a high electric current is passed through an electrolyte in which alumina has been dissolved. Competitive and reliable electricity is therefore critical to aluminium smelting: energy can represent up to 40% of the costs of production for primary aluminium, depending on local power prices (Norsk Hydro, 2012[21]).[19]

Energy costs are the most significant source of variation in the total cost of aluminium production across countries and regions, and by some estimates account for about 70% of that variability (Nappi, 2013[23]). Energy costs can vary greatly depending on the energy source, its availability, and countries' energy and environmental policies so that geography and resource endowments play an important role. Producers in the Americas (e.g. Brazil, Canada, and the United States) and in Europe (e.g. Iceland and Norway) tend to rely on hydropower[20], and are located close to or in mountainous regions to minimise

18 See www.cnbcafrica.com/apo/2017/12/04/guinea-smbwinning-announces-a-us-3-billion-investment/ (accessed on 13 July 2018).

19 Alumina contributes another 40%, which means that electricity and alumina alone both make up roughly 80% of all smelting costs.

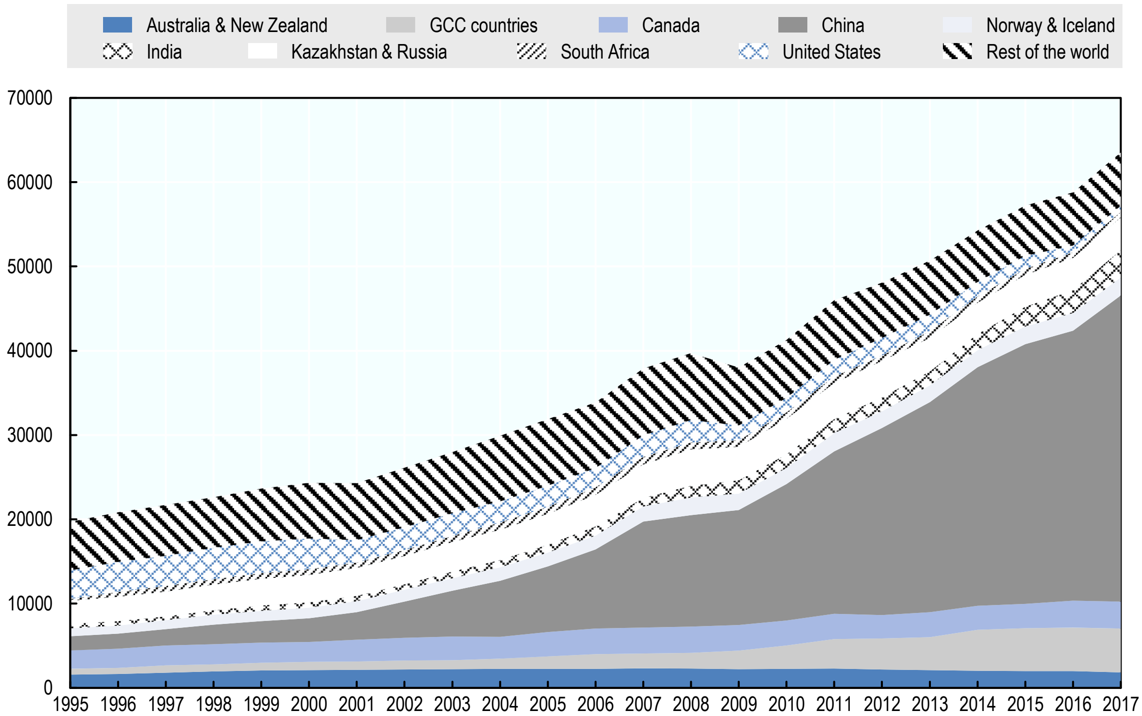
20 Iceland relies on large-scale geothermal energy as well.

transmission losses. In the Middle East, smelting uses predominantly power sourced from the region's vast reserves of natural gas (e.g. in Qatar and Saudi Arabia). By contrast, producers in Australia, China, and India have a much heavier reliance on coal-fired power plants.

Aluminium smelting also needs petroleum coke to prepare the carbon anodes that enable the process of electrolysis, with the combustion of these anodes emitting significant quantities of carbon dioxide (CO_2).[21] This and other greenhouse gases emitted during smelting (e.g. perfluorocarbons, or PFCs) have led the European Union, New Zealand, and other countries to include aluminium smelters in their emission trading schemes. The stringency and enforcement of environmental policies can thus constitute another important factor affecting competitive conditions in the aluminium industry.

Figure 2.6. China has come to account for more than half of global output in primary aluminium

Global production of primary aluminium, 1995-2017 (in thousand metric tonnes)



Source: US Geological Survey, industry sources, and OECD research.

21 This is the case irrespective of whether the electricity used in smelting is carbon-free. Depending on how the electricity is generated, the CO_2 emissions factor of smelting can range from 2 275 kg CO_2 per tonne of aluminium produced in Norway (using hydro-powered electricity) to 16 650 kg CO_2 per tonne in Australia (using coal-fired electricity) (ADEME, 2014[68]).

As with alumina, the past 15 years have witnessed a rapid, unparalleled increase in primary aluminium production in China, which now accounts for almost 60% of global output (Figure 2.6). This dwarfs any other development in the sector, including the growing prominence of Gulf Co-operation Council (GCC) countries[22], which have become collectively the world's (distant) second largest producer of primary aluminium. Production is declining in Australia, the European Union, and the United States, and OECD-based aluminium companies have invested in the Middle East to benefit from the region's comparatively low energy prices. In addition to Alcoa's partnership with the Saudi Arabian Mining Company (Ma'aden) in Ras Al Khair[23], Norsk Hydro has recently partnered with Qatar Petroleum in establishing the Qatalum smelter in Mesaieed. Rio Tinto is likewise involved in the Sohar smelter in Oman, in partnership with the Oman Oil Company and the Abu Dhabi National Energy Company.

While China was increasing its smelting output by a factor of twenty, capacity declined in a number of OECD countries, a trend that has accelerated markedly in recent years. Examples include: the decommissioning of the Point Henry smelter in Victoria (Australia) in 2014; the closing by Alcoa of Italy's last remaining smelters in Sardinia and the Veneto in 2013-14; the curtailment in 2014 of Alcoa's Massena East smelter in the state of New York (United States); and the closing in 2012 of Rio Tinto's Lynemouth smelter in Northumberland (United Kingdom). Other plants have, meanwhile, been running at reduced capacity for the past few years, such as Century Aluminium's smelters in Kentucky and South Carolina (United States). Outside of the OECD area, South Africa also saw the closing of its Bayside smelter in 2014, previously owned by Australia-based South32. In several cases, parent companies cited rising energy costs or environmental regulations as a primary reason for curtailing capacity at the smelters.

These changes have in turn profoundly modified the list of key players in the sector. UC Rusal (Russian Federation) has lost its place as the world's largest producer of primary aluminium to the China Hongqiao Group, a Shandong-based company that used to manufacture and distribute jeans and denim in the 1990s, before moving into power generation in 2002 and aluminium smelting in 2006 (Table 2.2). China Hongqiao now dominates aluminium smelting worldwide, with an annual installed capacity exceeding seven million tonnes, representing more than 15% of China's total smelting capacity in 2017 (it is also a large producer of upstream alumina).

State-owned Chalco (also known as the Aluminium Corporation of China) is another major vertically integrated producer, especially in view of its domestic capacity in bauxite mining and alumina refining (it is the largest global producer of alumina; see Table 2.1). Other major Chinese producers include: the Xinfa Group (private); the State Power Investment Corporation (SPIC)[24]; Henan Shenhuo (a local SOE); and Yunnan Aluminium, a provincial SOE. The growing prominence of Middle-East producers is, meanwhile, evident in the rise of Emirates Global Aluminium (EGA) as well as other

22 Member countries of the Gulf Co-operation Council (GCC) are: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE). Of these, only Kuwait does not engage in aluminium smelting.

23 The Ras Al Khair aluminium complex (25.1% owned by Alcoa) combines a power plant, an alumina refinery, 720 smelting pots, a cast-house, and rolling mills.

24 Formerly known as China Investment Power Corporation, one of the "big five" state-owned power-generation companies in China.

smaller producers in the region (e.g. Aluminium Bahrain [Alba], Ma'aden Aluminium, Qatalum, and Sohar). While the increasing importance of Chinese and Middle-Eastern firms is undeniable, a number of older companies from OECD countries remain in the top 20, namely Alcoa (5th largest producer), Rio Tinto (6th largest), and Norsk Hydro (12th largest). The presence of two Indian firms is also notable, namely Vedanta Resources (14th) and Hindalco (18th).

Table 2.2. Top 20 producers of primary aluminium, by capacity

Rank	Firm name	Annual capacity (kt)	Parent country
1	China Hongqiao Group	7 802	CHN
2	UC Rusal	4 402	RUS
3	Xinfa Group	4 322	CHN
4	Aluminium Corporation of China (Chalco)	3 987	CHN
5	Alcoa	3 402	USA
6	Rio Tinto	3 389	GBR
7	State Power Investment Corporation (SPIC)	3 103	CHN
8	Emirates Global Aluminium	2 600	ARE
9	Henan Shenhuo Group	2 402	CHN
10	Yunnan Aluminium Co. Ltd.	2 216	CHN
11	East Hope Group	2 079	CHN
12	Norsk Hydro	2 060	NOR
13	Hangzhou Jinjiang Group	2 037	CHN
14	Vedanta Resources	1 570	IND
15	Jiuquan Iron and Steel Co. Ltd. (JISCO)	1 555	CHN
16	Hunan Zengshi Group	1 506	CHN
17	Qinghai Provincial Investment Group Co. Ltd.	1 374	CHN
18	Hindalco	1 343	IND
19	Shaanxi Youser Group	1 220	CHN
20	Vimetco N.V.	1 178	NLD

Note: Capacity estimates for Chinese companies may differ from the numbers reported by the companies themselves for reasons explained in Box 3.1.
Source: OECD estimates on the basis of latest information from the US Geological Survey, industry sources, satellite imagery, and company-level information (e.g. company websites and annual reports).

OECD countries continue to undertake most aluminium recycling

Aluminium can in theory be recycled indefinitely without losing its properties (which include light weight, resistance to corrosion, and conductivity) (Norsk Hydro, 2012[21]). Recycling (secondary) aluminium from scrap and waste is increasingly viewed as a viable alternative to smelting primary aluminium, in particular given recycling's lower energy intensity and better environmental profile.[25]

Metallic waste and scrap are generated either as a by-product of manufacturing or from recycled goods (e.g. beverage cans, automobiles, wires, and cables). In Figure 2.1, flows of secondary aluminium are represented by loops marked "waste & scrap recovery", which represent recycled material from industrial waste and final consumption that feeds back into the production process.

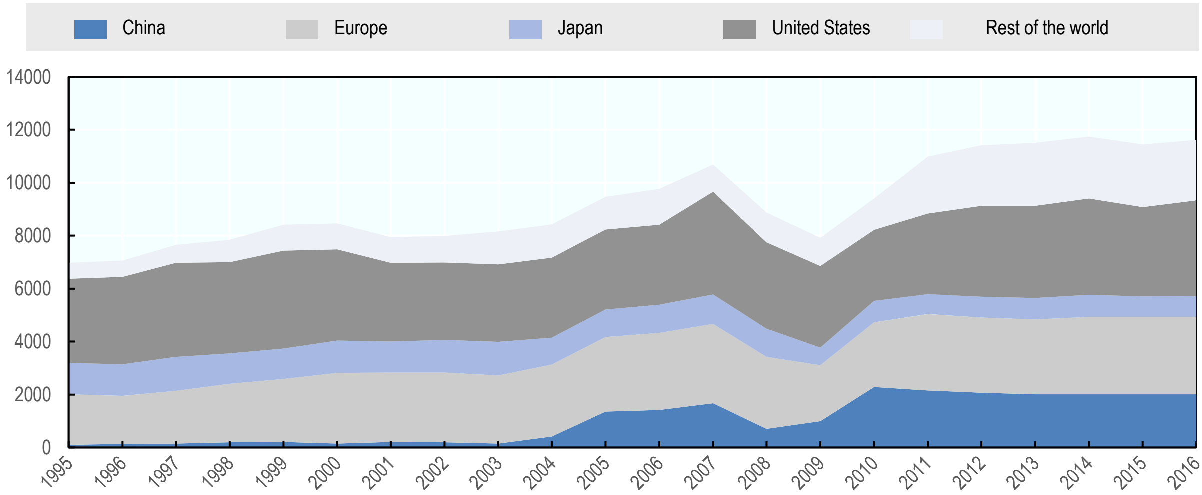
25 The industry estimates that recycling saves as much as 95% of the energy used in smelting aluminium (European Aluminium, 2016[69]).

The "circular economy"[26] is well established in the aluminium sector. Bertram et al. (2017[1]) estimate globally that over 26 million tonnes of new and old scrap are supplied every year to cast houses, where they are re-melted into raw aluminium ingots. This is equivalent to as much as 45% of all primary aluminium produced in the world in 2016, or alternatively 30% of all aluminium, both primary and secondary, produced that year. Scrap predominantly takes the form of mixed and casting scrap, followed by used beverage cans, and other rolled and extruded scrap.

The recycling of aluminium is more advanced and is centred in OECD countries, due to their higher propensity to collect and sort waste (Figure 2.7). The US-based Aluminium Association (2016[24]) estimates that about 37% of the aluminium used in the United States in 2016 was derived from recycled materials; the proportion in the European Union was about 36%.[27] Japan no longer produces primary aluminium and concentrates entirely on the recovery of secondary materials through companies such as Daiki Aluminium Industry, Nikkei MC Aluminium Co. Ltd., and Asahi Seiren Co. Ltd.

Figure 2.7. OECD countries concentrate most of the secondary-aluminium industry

Global production of secondary (recycled) aluminium, 1995-2016 (in thousand metric tonnes)



Source: Japan Aluminium Association.

Although the structure of the recycling industry is less concentrated than the more upstream segments in the aluminium value chain (USITC, 2017[4]), some large firms stand out for the scale of their recycling and re-melting activities. Those are generally "captive producers" of secondary aluminium, for which recycling is but one of the segments in which they operate in the aluminium value chain (*ibid*). In-house recycling thus allows them to obtain the raw materials they need downstream for the production of semi-fabricated aluminium products. Notable examples include: Norsk Hydro (Norway), which operates various secondary-aluminium plants throughout Europe and the United

26 The circular economy seeks to decouple industrial production from resource use as per Goal 12 of the UN 2030 Agenda for Sustainable Development on "ensuring sustainable consumption and production patterns."

27 See the European Aluminium association's online database, which is available at: www.european-aluminium.eu/data/ (accessed 20 July 2018).

States; Aleris, Arconic, and Kaiser Aluminium, which are all US-based producers of semis with captive recycling facilities; Hindalco (India), which operates large secondary plants in Germany and in the United States through its subsidiary Novelis; AMAG Austria Metall's domestic facilities in Ranshofen, Upper Austria; and TRIMET Aluminium's (Germany) secondary smelters in Gelsenkirchen and Harzgerode.

2.3. The downstream segment: Semi-fabricated aluminium products and their use in manufacturing

China has also come to dominate the transformation of aluminium downstream

Once primary aluminium has been smelted (or recycled), it is transformed into semi-fabricated aluminium products ("semis") for further use in manufacturing and construction. This transformation is performed in a variety of ways, depending on how semis are to be used downstream:

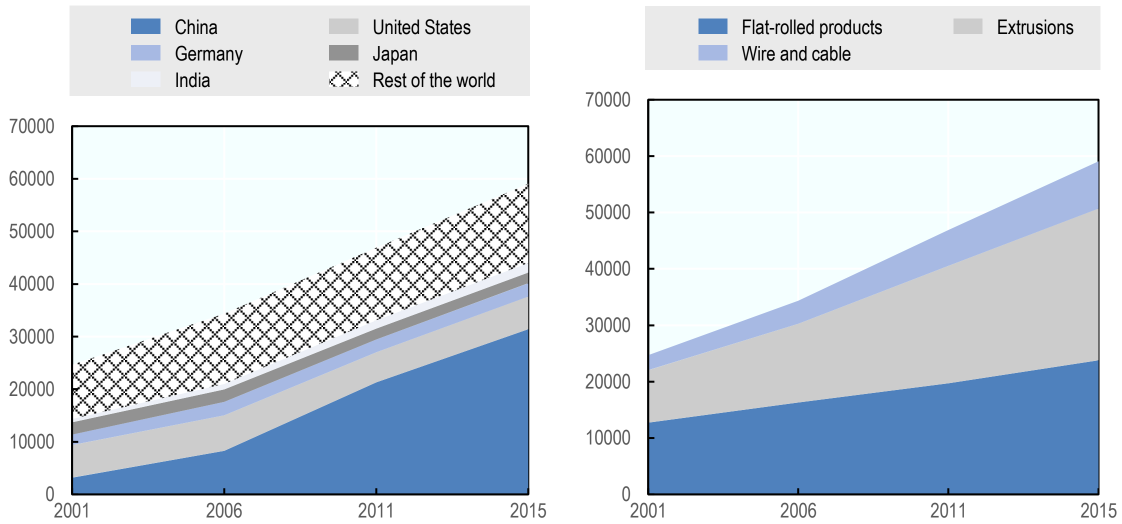
- *Extrusion* allows a solid cylinder of aluminium (a billet) to be forced by compression into profiles for use mainly as building materials (e.g. window and door frames) or as vehicle components (e.g. car chassis and cylinder heads), or drawn into wire for the power sector (e.g. as wires and transmission cables, in replacement of copper).
- *Rolling* transforms aluminium into sheets, plates, and foils that are then used in the vehicle industry (e.g. car frames and boat hulls), in the aeronautics industry (e.g. aircraft fuselages), in construction (e.g. roofing), and in the packaging of beverages and food (e.g. flexible containers and cans).
- *Forging* is a manufacturing process whereby aluminium is pressed or squeezed under great pressure to produce high-strength parts;
- Finally, the *casting* of foundry alloys (e.g. adding copper or silicon) can also be employed to give aluminium products a number of properties and intricate shapes, e.g., for use as wheel rims or as components in small household appliances like lawnmowers and coffee makers.

As in most other segments of the aluminium value chain, the past 15 years have seen China increase its production dramatically to become the world's largest producer of semis (Figure 2.8). Over the same period, only India, Mexico, and the Russian Federation saw significant increases in their output, though far below that of China.

The majority of the increase in China's semis production took the form of extrusion products, fuelled by the country's infrastructure and housing boom. The USITC (2017[4]) thus remarked that "extrusion production [is] highly concentrated in China, which accounted [over the period 2001-15] for 64% of the global total." To a lesser extent, infrastructure development also helps explain India's production increase from about 600 kt in 2001 to nearly 1 800 kt in 2015. Although the increase is less pronounced than in the case of extrusions, China has similarly come to dominate global production of flat-rolled products, overtaking the United States in less than ten years.

Figure 2.8. China has become in 15 years the world's largest producer of semis

Global production of semis, by producing country and type of product (2001-15, in thousand metric tonnes)



Source: USITC (2017[4]).

The cost of producing aluminium semis is largely determined by the cost of procuring raw materials in the form of primary aluminium. The USITC (2017[4]) noted, for example, that "among rolled products, unwrought aluminium accounted for between 75 and 86% of average business costs […] in 2015." Though less decisive than at the smelting stage, the energy used in re-melting aluminium represent a significant part of the costs of transforming primary aluminium into semis. This explains in part why certain producers of semis (mostly in China, but also in Oman) have opted to locate their facilities near smelters in order to obtain the raw aluminium they need in liquid, molten form, thereby allowing them to save on energy costs. By contrast, other firms in Europe and the United States have chosen to locate their plants close to their customer base to save on shipping costs. A number of semis producers in the United States have, for instance, set up factories in Kentucky and Michigan to favour proximity to automotive producers.

The semis industry is a lot less concentrated than other segments of the aluminium value chain: producers can range from local, specialised SMEs serving a unique customer (e.g. a car manufacturer) to large, vertically integrated multinationals. Together with the wide variety of aluminium semis that are produced (extrusions, wires, cables, sheet, foil, plates, etc.), this makes it difficult to establish a global ranking of semis producers by capacity. In what follows, this section therefore only describes a subset of large producers but does not attempt to inventory and rank companies in a systematic and comprehensive fashion.

Among the large firms that produce semis, one can distinguish between those that specialise in semis and those that also have sizable operations upstream. The former include a number of companies in China, where there seems to be a separation between businesses in the upstream and midstream segments (i.e. bauxite-alumina-smelting) and those that concentrate on semis. China Zhongwang and Guangdong Xingfa Aluminium

Co. Ltd. ("Xingfa Aluminium")[28], two of China's largest extrusion firms, do not, for example, engage in the production of primary aluminium on any significant scale. The same is true of flat-rolled producer Henan Mingtai Aluminium. In the United States, Alcoa Inc.'s separation in 2016 into Alcoa Corp. – which focusses on smelting and upstream activities – and Arconic – which produces semis – follows a similar pattern. Other large firms that are specialised in semis include: the Gulf Aluminium Rolling Mill Company (Bahrain); Nemak (Mexico); Constellium (the Netherlands); Oman Aluminium Rolling Company LLC (Oman); Gränges AB (Sweden); Aleris, Kaiser Aluminium, Bonnell Aluminium, and Jordan Aluminium (United States).

Alongside companies that are specialised in the production of semis are large aluminium multinationals that are top producers of both primary aluminium (Table 2.2) and semis.[29] Examples would be: Chinalco (Chalco's parent), which produces flat-rolled semis through subsidiaries such as the Chongqing-based Southwest Aluminium Group; the China Hongqiao Group; Hindalco (India), which owns US-based producer Novelis; Vimetco N.V. (the Netherlands), and its Chinese subsidiary Henan Zhongfu Industry Co. Ltd.; Norsk Hydro (Norway), in particular owing to its recent acquisition of Sapa Extrusions; and Ma'aden (Saudi Arabia), which boasts the largest capacity for semis production in the GCC region.

Current and future demand for aluminium semis

Given their many uses, demand for aluminium semis is generally more diversified and less volatile than that for other base metals[30], and the industry expects demand to increase further in the future. Much of the growth in demand comes increasingly from the transportation sector (Figure 2.9) since aluminium is about three times lighter than steel, although it is also more expensive. "Light-weighting" of vehicles takes on particular importance in the context of increasingly stringent emissions standards and the addition of new features and equipment in cars. This induces car manufacturers to favour lighter frames to limit weight increases, especially for electric vehicles given the considerable weight of their batteries.[31] Accordingly, there has been a trend towards incorporating more aluminium in road vehicles (Figure A A.1).

In the case of China, demand for aluminium semis has traditionally come from the building and construction sector (Figure 2.9), which – as noted above –explains in part the country's relative specialisation in extrusions. Much of the impetus for the rapid increase in the production of extrusions worldwide (Figure 2.8) originated in China's unprecedented housing boom, which "has been the engine of [the country's] growth in

28 Xingfa Aluminium (Guangdong Xingfa Aluminium Co. Ltd.), a producer of semis, should not be confused with the Xinfa Group, a large smelting corporation. See Table 2.2.

29 These companies also sometimes produce their own bauxite and alumina.

30 This can be seen by looking at the evolution over long periods of time of spot prices for aluminium and other base metals (e.g. tin, zinc, and copper) on the London Metal Exchange (LME), with the former having tended to vary less in magnitude.

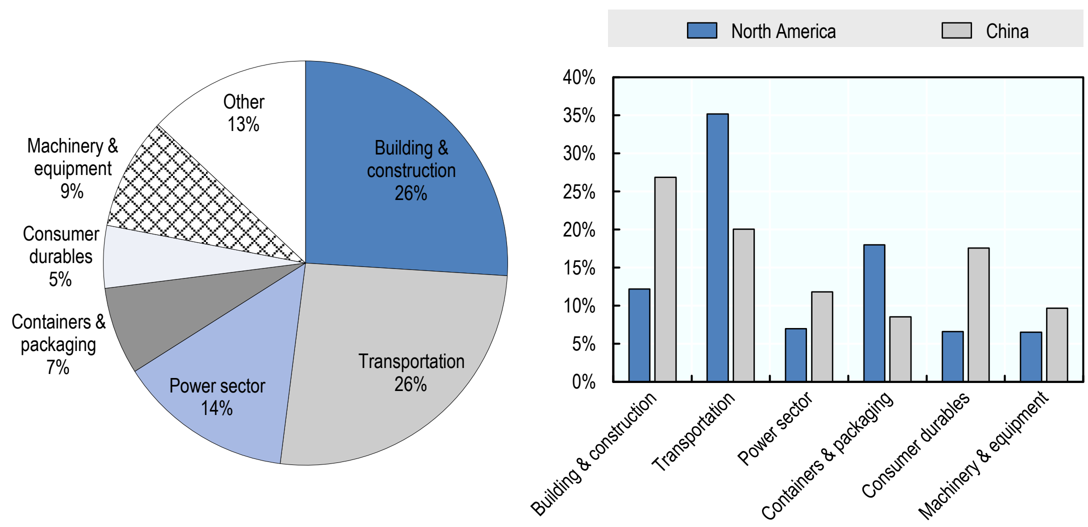
31 As an example, a full-electric Tesla Model S weighs about 2 100 kg, compared with about 1 475 kg for a BMW 318i Sedan.

the past two decades", pushing real estate above 20% of Chinese GDP in 2013 (McMahon, 2018[13]).[32]

Recent years have, however, witnessed an increasing emphasis in China on the production of flat-rolled aluminium products, with a view to serving both the domestic transport industry and export markets. Market participants expect that trend to continue over the coming decade (Fog, 2016[25]) on the back of greater demand for lighter vehicles and government support for the production of electric vehicles and other transport equipment. One stated goal of China's 2013 *Guiding Opinions of the State Council on Resolving Serious Production Overcapacity Conflicts* was thus to "promote the development and use of aluminium components as part of overall vehicle mass-reduction efforts" and of broader initiatives to mitigate local air pollution. Yunnan Aluminium, a provincial SOE, likewise mentions in its 2016 annual report that "as a high-quality, lightweight 'green metal', uses of aluminium will become more and more extensive, and its characteristics will be more and more favoured by the whole society, thus promoting continuous improvement in the relationship between [aluminium] supply and demand."

Figure 2.9. Demand for aluminium semis is coming largely from the transportation sector

Aluminium consumption in 2016 by end-use, globally (left) and in selected economies (right)



Note: Data for China are for the year 2015.
Source: OECD on the basis of data from the Aluminium Association, CICC (2016[26]), and Norsk Hydro.

The Chinese Government's *Made in China 2025* strategy is explicit about China's ambitions in a number of key sectors that depend on aluminium to varying degrees. Although the document only mentions non-ferrous metals once in relation to "green manufacturing", Section 6 lists ten priority industries, of which several rely on aluminium semis as inputs, and which are to be encouraged by means of dedicated funding and state direction. These include in particular: 'new energy' and energy-saving vehicles; aviation and aerospace; advanced rail-transportation equipment; and electrical equipment.

32 Quoting a statistic from the US Geological Survey, McMahon (2018[12]) adds that "between 2011 and 2013, China laid more cement than the United States did during the entire twentieth century."

Further downstream, many governments in the OECD and elsewhere have also taken steps to encourage production and sales of electric vehicles by way of tax concessions, direct subsidies, and other non-fiscal instruments (IEA, 2018[27]). France, Japan, Norway, the United Kingdom, and the United States, among others, have already adopted policies encouraging the uptake of electric cars (e.g. VAT exemptions, free parking, or direct financial incentives). In China, the Government similarly uses price subsidies to support sales of electric vehicles as prescribed in the *Circular on the Promotion of New Energy Vehicle in 2016-2020 (Cai Jian [2015] No. 134)*. These and any future measures will likely increase derived demand for aluminium semis in coming decades.

3. Production capacity, profits, and the role of non-market forces

3.1. There are mounting concerns about excess capacity in the aluminium industry…

China's growing dominance of the aluminium industry has not come without disruption for other countries and global trade patterns. The previous section showed that China has become in 15 years the leading producer by a wide margin in all segments of the aluminium value chain, bar bauxite mining and aluminium recycling. This unprecedented increase in output has hinged on massive greenfield investments in new smelting capacity, but also on the development of new bauxite mines, alumina refineries, coal-fired power plants, and semis factories.

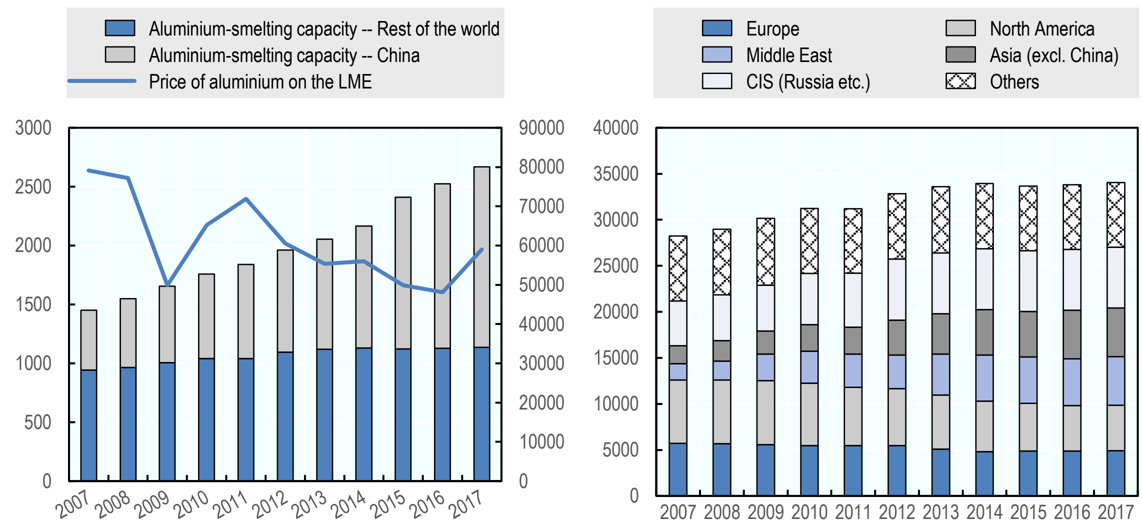
There are mounting concerns among some WTO Members that large capacity additions in China and elsewhere may have led to excess capacity in the aluminium industry, depressing global aluminium prices and threatening the viability of producers worldwide (Figure 3.1) (WTO, 2018[2]; WTO, 2017[3]). Although current concerns about industrial excess capacity are wide-ranging and pertain to several sectors (e.g. steel, cement, and shipbuilding) (OECD, 2017[28]), aluminium features prominently in relevant submissions to the WTO (*ibid*) and recent statements by the G7 and other intergovernmental fora. Both the Taormina Communiqué (2017) and the Charlevoix Communiqué (2018) mention explicitly the desire of G7 countries to address global excess capacity in aluminium. The Statement of the French Chair of the 2018 OECD Ministerial Council Meeting (OECD, 2018[29]) likewise noted that members of the OECD "share the view that severe excess capacity in key sectors such as steel and *aluminium* are serious concerns for the proper functioning of international trade" (emphasis added).

This view is echoed by representatives of the aluminium industry, who met on 4 June 2018 at the Montreal Aluminium Summit, and during which they called on G7 and G20 Leaders to address overcapacity in the aluminium value chain at the multilateral level (The Aluminum Association et al., 2018[30]). A year earlier, a report commissioned by Germany's Association of Non-Ferrous Metals Producers (WVMetalle) described China's overcapacity in non-ferrous metals as "persistent" despite Chinese firms being "less innovative, less productive and – measured in fair market competition terms – less competitive" (Taube, 2017[17]). The report went on to note that "the formation of excess capacities has caused a supply glut in China which has depressed prices and pushed surplus materials into export markets" (*ibid*).[33]

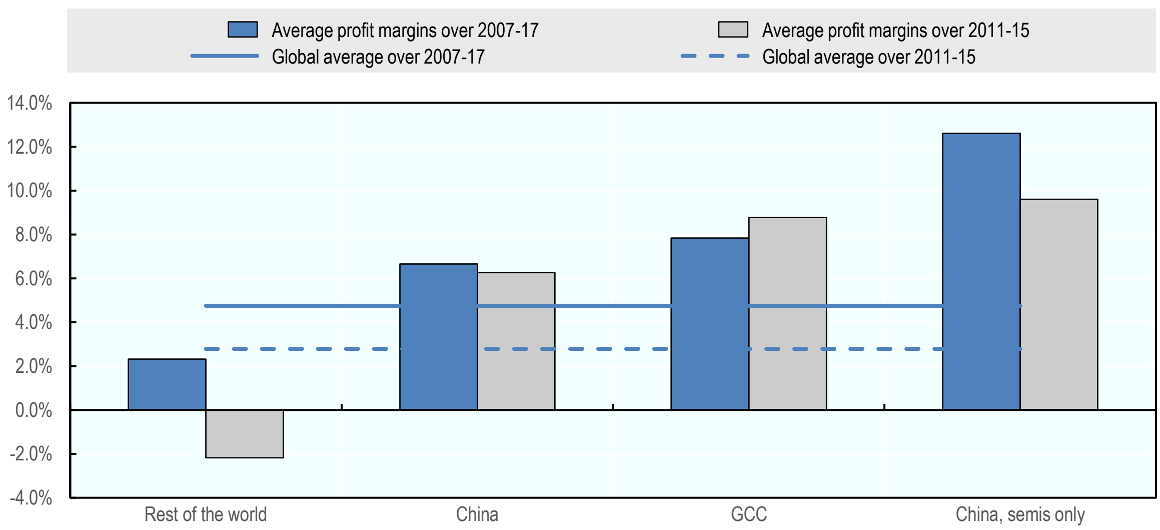
33 Another report commissioned by the Aluwatch association makes the same point (Jégourel and Chalmin, 2015[31]).

Figure 3.1. There are concerns that capacity additions in China may have depressed prices and profits elsewhere

Left: LME price (USD per metric tonne; left scale) and smelting capacity (thousand metric tonnes; right scale);
Right: smelting capacity outside China (thousand metric tonnes)



Weighted averages of profit margins for a sample of firms (%)



Note: Average profit margins were weighted by firms' smelting capacity (or revenue for companies producing only semis). The sample considered here comprises: UC Rusal, Alcoa, Rio Tinto, Norsk Hydro, Vimetco, Century Aluminium, Vedanta Resources, Hindalco, and South32 ('Rest of the world'); Chalco, China Hongqiao, Henan Shenhuo, Qinghai Provincial Investment Group, Shandong Nanshan, SPIC, and Yunnan Aluminium ('China'); EGA and Aluminium Bahrain ('GCC'); China Zhongwang, Xingfa Aluminium, and Henan Mingtai ('China, semis only').
Source: French INSEE for aluminium prices on the London Metal Exchange (LME); European Aluminium association for estimated global capacity; and OECD research and calculations for average profit margins.

China itself acknowledges that its aluminium sector suffers from excessive capacity in high-level policy statements and official documents. During his keynote speech at Davos in January 2017, and again in the context of the 19th Congress of the Chinese Communist Party, President Xi (2017[31]) declared, for example, that "[China] will continue efforts to cut overcapacity, reduce excess inventory, deleverage, […] and work to achieve a dynamic balance between supply and demand". A few years earlier, the 2013 *Guiding Opinions of the State Council on Resolving Serious Production Overcapacity Conflicts* had already directed Chinese companies to close down older aluminium smelting capacity by 2015 in an attempt to favour more energy-efficient plants. The *Central Economic Work Conference* of December 2015 reiterated subsequently the importance for China of reducing excess capacity, to little effect (OECD, 2017[28]). More recently, the *2016-20 Non-ferrous Metal Industry Development Plan*[34] emphasises explicitly the need for "controlling capacity expansion, encouraging upgrading or closure of low-efficiency plants, promoting industry concentration, strengthening company management."

The price of aluminium on the London Metal Exchange (LME) does seem to have experienced a prolonged decline over the 2011-15 period (Figure 3.1), which the USITC (2017[4]) has attributed to oversupply and falling production costs. In several regions of the world, this price decline corresponded to a marked fall in the profitability of aluminium-producing firms, which pushed some companies to close down smelters in the European Union and North America.

Aluminium-producing firms in different regions of the world appear to have been affected differently by the lower prices, with most producers in China and the Gulf countries having sustained solid profit margins in the face of lower revenues. China Hongqiao and the Qinghai Provincial Investment Group (a local SOE) managed in particular to increase their revenue considerably over the 2011-15 period, even as their competitors in China and elsewhere were generating less income. Companies specialised in the production of semis in China (e.g. China Zhongwang and Xingfa Aluminium) seem, meanwhile, to have benefitted from the lower prices on primary aluminium, which enabled them to attain relatively high profit margins all throughout the period.

These contrasts in performance raise the question of what enabled some companies to weather better the global price decline, be it abundant energy resources or government intervention.[35] While experiencing a decline in revenue and profits, a company like Norsk Hydro was nevertheless able to record higher profit margins than many of its peers, possibly thanks to Norway's abundant and competitive hydro-based electricity. More generally, "access to low-cost sources of electricity" has tended to make certain producers more resilient (USITC, 2017[4]). The case of China is more ambiguous as the 2011-15 period was also one of relatively high prices for coal[36], on which the country relies for generating the electricity that feeds its smelters. China's Qinhuangdao spot price for coal

34 Attached to China's *13th Five-year Plan*.

35 Although business diversification may in principle enable some companies to make up for losses in their aluminium segment through higher profits in other segments (e.g. in semis or non-aluminium-related activities), Chinese firms are on average more specialised in aluminium smelting than their non-Chinese peers (e.g. Rio Tinto, South32, or Vedanta Resources).

36 Alumina prices were also relatively high around 2011, though they have since decreased.

peaked in 2011, averaging about USD 84 a tonne over the period 2006-10 and USD 97 a tonne over 2011-15, from a low of about USD 36 a tonne over 2000-05.[37]

This suggests that other, non-market factors may have played a role in fuelling capacity additions and shoring up profits at certain companies. With producers in China squeezed between lower aluminium prices and higher input costs, one would expect their profit margins to be affected negatively; they were instead higher than average, exceeding 10% in 2011, the year in which Chinese coal prices peaked. Moreover, monthly aluminium production in China has been less responsive to price changes than production in Western Europe and North America (Jégourel and Chalmin, 2015[32]). One likely explanation is that policies in China have acted in a counter-cyclical fashion, partly insulating domestic producers from international competitive pressures.

3.2. …but excess capacity is hard to measure

The view that government intervention may have been a primary driver of overcapacity underlies many recent discussions of the level playing field for global trade at the WTO and in other intergovernmental fora.[38] Yet, other factors may also be relevant: some companies may simply prefer to retain spare capacity; for example, to be able to meet unexpected surges in demand and avoid price spikes or shortages, such as in energy markets. In addition, recessions and the business cycle more generally can generate ‘slack’ in the economy in the form of unemployed productive resources. Quarterly data for the United States’ manufacturing sector shows, for example, that capacity utilisation tends to vary across industries and years, with a notable dip observed during the Great Recession of 2008-09 (Figure 3.2).

The economics literature draws a conceptual distinction between *cyclical* excess capacity and *structural* excess capacity (Blonigen and Wilson, 2010[33]). *Structural* excess capacity is meant as excess capacity that is persistent in time and driven by subsidies (and non-market forces more generally). Importantly, this implies that cyclical excess capacity does not require the existence of government intervention whereas structural excess capacity does.

While data on actual output by country and year are relatively easy to obtain,[39] the same cannot be said of data on production capacity, for which most industry participants appear to rely on third-party estimates provided commercially by private consulting firms. The annual reports of aluminium-producing companies are one primary source of information on capacity at the plant or company level, although this limits data collection to those

37 Data on coal prices were taken from the June 2018 edition of the *BP Statistical Review of World Energy*. Prices are inclusive of Chinese value-added tax at the standard 17% rate.

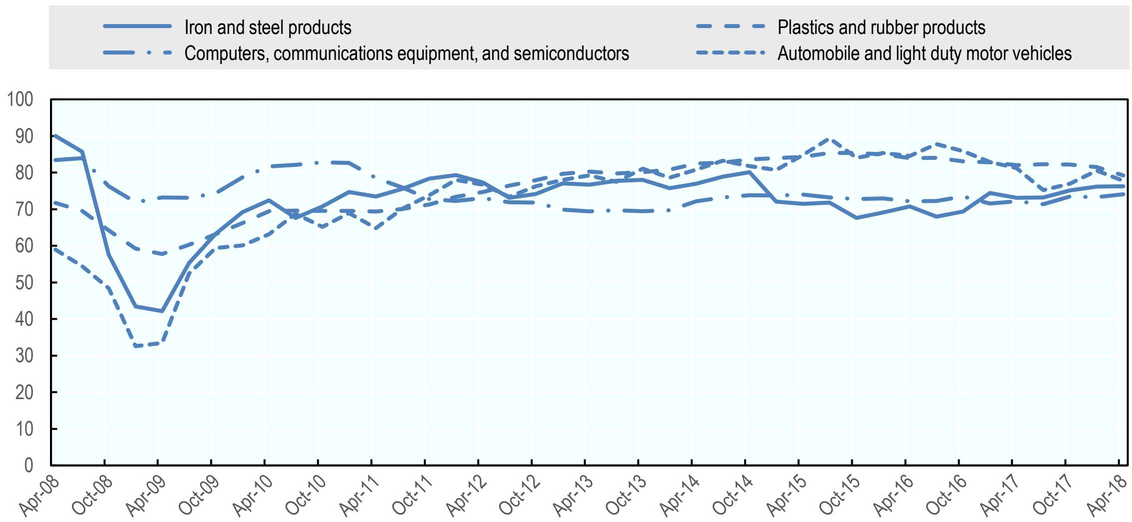
38 In April 2017, Canada, the European Union, Japan, and the United States circulated, for example, a WTO communication on “the role of subsidies in creating overcapacity”, and which called on Members to “strive to find ways to tackle more effectively harmful subsidies and other types of support from governments […] that contribute to severe overcapacity” (WTO, 2017[3]). A more recent WTO communication from the United States likewise argued that “excess capacity is driven to a large degree by actions of the Chinese government, including massive, market-distorting subsidies and a variety of other policies and practices” (WTO, 2018[2]).

39 See for example Figure 2.6.

firms that are publicly listed on stock exchanges, or to those that issue corporate bonds on international markets and publish bond offerings or prospectuses. There are also concerns relating to data comparability and reliability in certain cases.[40]

Figure 3.2. Capacity utilisation in the US varies across industries and years

Percentage of capacity in the United States' manufacturing sector, quarterly, seasonally adjusted



Source: FRED database, US Federal Reserve Bank of St. Louis.

Getting reliable capacity data is especially difficult for China, where many large companies are either private, unlisted firms (e.g. groups such as Xinfa and East Hope) or SOEs with limited reporting obligations (e.g. SPIC). In these cases, relying solely on annual reports and financial statements does not usually suffice, and other methods are sometimes necessary to measure capacity at the plant or firm level. This report relies on satellite images obtained from Google and the European Space Agency (ESA) to estimate the capacity of individual aluminium smelters in China as of early 2018, cross-checked with company reports and secondary sources (Box 3.1).

Using satellite images, we estimate that Chinese smelting capacity stood at about 48.7 million tonnes per year at the beginning of 2018. Although this estimate is likely an upper-bound number subject to caveats and approximations, it is nonetheless indicative of the size of China's primary-aluminium segment and aligns well with other, secondary sources.[41] The information thus collected for each individual plant suggests that most

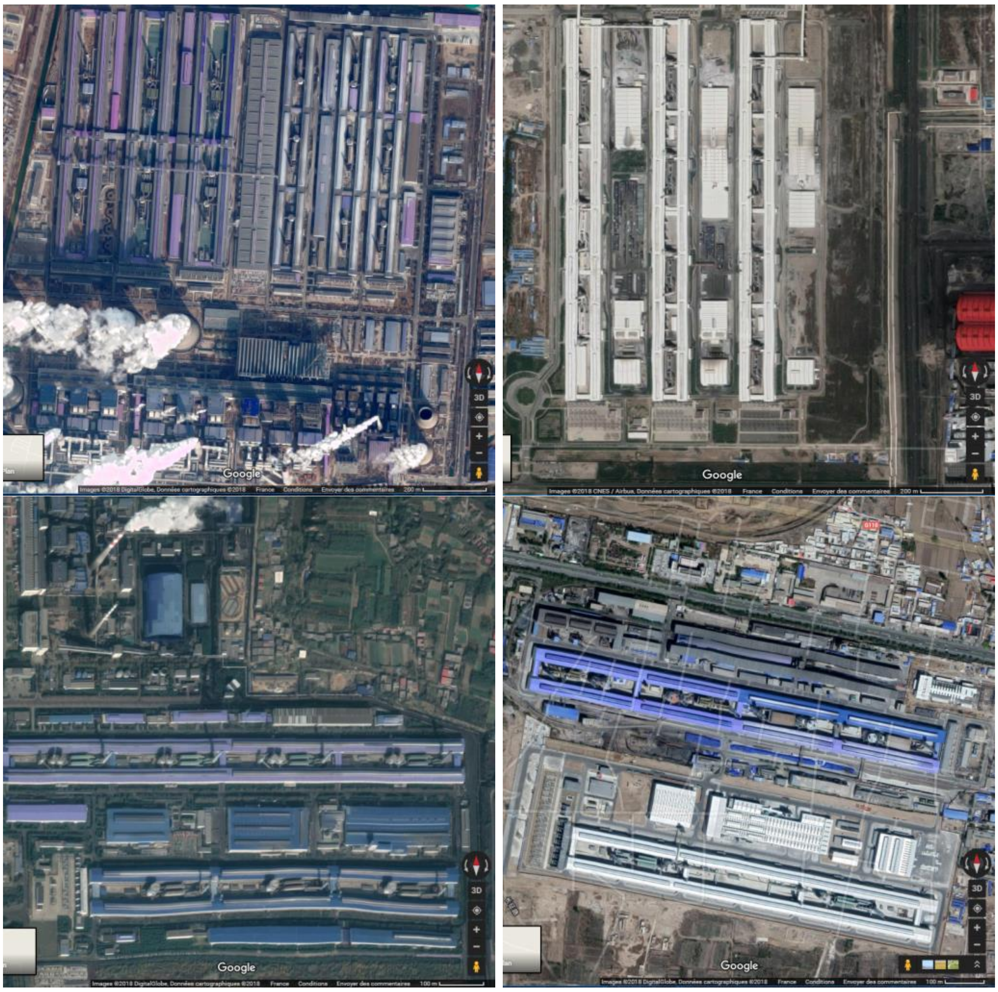
40 Page 8 of China Hongqiao's 2017 annual report states, for instance, that "as of 31 December 2017, the Group's annual operating production capacity of aluminium products reached 6 460 000 tons", while mentioning on the following page that "the Group's aggregate production volume of aluminium products in 2017 amounted to approximately 7 544 000 tons." This makes for a gap of more than one million tonnes that cannot readily be explained by differences in the definition of products or in the measurement of capacity (e.g. installed versus operating).

41 The European Aluminium association estimated, for example, China's smelting capacity to stand at about 45.4 million tonnes annually in 2017, and further noted that China was

smelting in China occurs in four provinces, which collectively account for roughly 60% of all Chinese smelting capacity: Henan, in the centre-east (11%); Inner Mongolia, in the centre-north (11%); Shandong, China's powerhouse in the east (24%); and Xinjiang, in the far west (15%) (Figure 3.3). Other Western provinces with large smelting capacities are Gansu (6%) and Qinghai (8%).

Figure 3.3. Four provinces collectively account for roughly 60% of all Chinese smelting capacity, with examples

Top-left: Smelters in Chiping, Shandong [Xinfa Group]
Top-right: The Tianshan smelter in Shihezi, Xinjiang [Hunan Zengshi Group]
Bottom-left: Henan Zhongfu's smelter in Gongyi, Henan [Vimetco]
Bottom-right: Smelters in Baotou, Inner Mongolia [Chalco]



Source: Satellite images from Google Maps.

expected to add another 3.3 million tonnes in 2018, for a total 48.7 million tonnes in 2018 (The Aluminum Association et al., 2018[29]).

Box 3.1. Estimating smelting capacity using satellite images

Aluminium smelters possess a characteristic shape that distinguishes them from other industrial facilities, and which makes them relatively easy to identify using satellite-based observation. Besides airports, bridges, and open-cast mines, few man-made structures are as easily recognisable from the sky as aluminium smelters.

Another trait of aluminium smelters is the relatively constant ratio that can be observed between their size and their capacity, regardless of their location. To highlight but a few examples:

- Canada's Alouette smelter has a 606 kt annual capacity and four potlines of about 1 km each (606/4000 = 0.15);
- Saudi Arabia's Ras Al Khair smelter has a 740 kt annual capacity and four potlines of about 1.14 km each (740/4560 = 0.16);
- Iceland's Reyðarfjörður smelter has a 344 kt annual capacity and two potlines of about 1.08 km each (344/2160 = 0.16);
- Malaysia's Samalaju smelter has a 640 kt annual capacity and four potlines of about 1.05 km each (640/4200 = 0.15).

Using this ratio ($\approx$ 0.15) – and after having measured through satellite images the approximate length of potlines for all smelters that we identified in China –, we were able to estimate capacity at the plant level in China in a systematic fashion. Individual smelters were identified by looking at all regions of China reported to be the location of smelting capacity on companies' own websites, in their annual reports, or in industry publications (e.g. Antaike and the US Geological Survey). Although the estimates thus obtained are not reproduced over time, they do provide nonetheless a useful snapshot of Chinese smelting capacity at the time of measurement (Q1 2018).

There are, however, a number of limitations inherent in this approach. One is that it works only for aluminium smelters; any satellite-based estimate of capacity for alumina refineries, semis production plants, or bauxite mines would likely be erroneous. Another is that the estimates thus obtained are likely upper-bound numbers, in that satellite observations are not able to distinguish between operational capacity and installed capacity that could take months to restart, nor do they permit verification of whether buildings are effectively empty or not (unless this is stated explicitly in company reports).

The source for most satellite images was Google, though we also used at times more recent images from the ESA's Sentinel satellites. This was especially important in the case of frontier provinces of China (e.g. Inner Mongolia and Xinjiang), where Google images often seemed to be outdated or low-resolution, thereby providing an inaccurate view of current smelting capacity (Figure A A.2).

With the exception of Henan, capacity in the large-smelting provinces of China is relatively new. This reflects in part a gradual movement of smelting activities towards the west and the centre-north of the country, where coal is available locally and pollution is emitted far from major urban centres on the eastern coast. In the case of Shandong, the province's significant capacity owes more to its historical economic importance and to its hosting of relatively large groups such as China Hongqiao and Xinfa. Overall, aluminium smelting appears rather geographically concentrated in China. It differs in that regard from steelmaking, which is reportedly more fragmented both across firms and provinces (Haley and Haley, 2013[19]).

Bearing in mind the applicable caveats (Box 3.1), the above estimates imply that China's capacity utilisation in primary aluminium stood at about 75% in 2017-18, which is considerably lower than the proportion of capacity utilised by firms elsewhere, bar India and the United States. Rio Tinto's 2017 annual report shows, for example, a 96% capacity utilisation rate; UC Rusal's was 95% that same year, while Norsk Hydro and smelters in the GCC seem to have been operating at near full capacity. Even allowing for errors in the measurement of Chinese capacity, the difference in capacity utilisation remains large. That said, US-based companies (Alcoa and Century Aluminium) had capacity utilisation rates comparable to China's that year, at about 75%.

Industry sources[42] indicated that capacity-utilisation rates around 70-75% and below were not sustainable in the case of market-driven firms competing in the smelting segment. Yet the average profit margins of Chinese firms exceeded their competitors' (see previous sub-section). This again suggests that non-market forces may have been involved in sustaining the profitability of aluminium-producing companies in China. It is also possible that this headline average conceals considerable disparity within China at the level of individual provinces and firms, with some smelters operating at much higher capacity while others have temporary idled their facilities for environmental or administrative reasons. In the absence of transparent information on the capacity of individual smelters in China, it is difficult to determine what has caused such low capacity utilisation.

3.3. The role of the broader policy environment

Against this background, the analysis now turns to the role of non-market forces in the aluminium industry. Non-market forces encompass a wide range of government interventions that might help explain the persistence of excess capacity in the aluminium industry. At a broad level, this includes all policies that directly or indirectly favour increases in capacity that are not market-driven, either by encouraging the construction of new smelters or preventing the retirement of older ones. Subsidies, and subsidised bank loans in particular, have been shown, for example, to prevent the exit of less productive firms hit by unfavourable shocks, turning them into 'zombies' that distort competition throughout the rest of the economy (Adalet McGowan, Andrews and Millot, 2017$_{[5]}$).

A useful starting point is to take stock of the broader policy environment within which aluminium-producing firms operate, and in particular of the domestic rules and incentives that govern competition and sectoral development. Some countries have, for instance, issued medium-term national plans or strategies for the development of their own aluminium industry. In Canada, the Provincial Government of Québec has adopted the *Québec Aluminium Development Strategy* for the period 2015-25, which aims, among other things, to double aluminium processing (i.e. semis production) in Québec, encourage the growth of smelter projects in the province, and use government procurement as a lever for generating demand for aluminium (Government of Québec, 2015$_{[34]}$). Initial public funding of CAD 32.5 million has been allocated over the first three-year phase in support of investment, export promotion, and demonstration projects.

Another example can be found in Saudi Arabia's Vision 2030, which mentions the Kingdom's aim to increase the use of the country's aluminium resources in keeping with its broader objective of national economic diversification. The Ministry of Industry and Trade of the Russian Federation has likewise adopted a development strategy for non-ferrous metals for the period 2014–20 and to 2030, which sets forth policies to encourage the use of aluminium in downstream applications (e.g. rail transport and power transmission) (USITC, 2017$_{[4]}$).

None of these strategies are as specific and ambitious as China's *2016-20 Non-ferrous Metal Industry Development Plan*, an offshoot of the country's broader 13th Five-Year Plan. Alongside general calls for improving product quality and upgrading technologies,

42 Source: Interview that the OECD conducted in July 2018 with representatives from the European Aluminium Association.

the Plan also sets forth targets for increasing smelter capacity utilisation and energy efficiency, increasing aluminium production to 40 million tonnes per annum (CM, 2017[35]; Taube, 2017[17]), and promoting the vertical and horizontal integration of aluminium firms, with a view to creating domestic champions that exercise control over coal mines, adjacent power plants, and alumina refineries.

Crucially, the Plan envisages a quota system to address the issue of excessive smelting capacity, whereby the construction of new smelters in China is to be matched by the closing of older, less efficient plants. It is, however, unclear how this quota system is to achieve capacity cuts since the net effect of the policy would presumably be to increase capacity overall by favouring newer, more productive facilities. Back in 2013, the *Guiding Opinions of the State Council on Resolving Serious Production Overcapacity Conflicts* had already instituted a similar quota system that proved ineffective as “newly released plants have overcompensated capacity reductions accomplished through the elimination of small, old or inefficient smelters” (Taube, 2017[17]). The same result appears to have been observed in the case of China’s coal-fired power sector over the period 2006-10, whereby the closure of smaller, inefficient plants was more than offset by newer, larger plants (Hervé-Mignucci et al., 2015[12]).

The *Notice of Specific Action Working Plans Regarding Regulating Unlawful Electrolytic Aluminium Projects*, jointly issued in April 2017 by the NDRC, the Ministry of Industry and Information Technology (MIIT), the Ministry of Land and Resources, and the Ministry of Environmental Protection, recently called for the elimination of “unlawful” projects or capacity within six months. Expectations of future aluminium demand coming from China’s transportation sector and a recent rebound in aluminium prices risk undermining these actions, however.

One key instrument China has been using to curb capacity growth is to set energy and environmental standards that are more stringent for new smelters – measures which also reflect the country’s broader push to address worsening air quality. The *Standards for the Aluminium Industry* issued in July 2013 specify, for instance, that in the case of existing smelters the amperage of electrolytic cells ought to exceed 160 kA and power consumption to remain below 13.8 kWh per kg of aluminium; those parameters are 400 kA and 13.2 kWh respectively for new smelters and for capacity expansions at existing smelters. New capacity in China has therefore tended to be on average more energy-efficient and productive than older smelters in the country and abroad (USITC, 2017[4]; CM, 2017[35]). To help enforce the new standards, Chinese authorities have also adjusted power prices so that less efficient smelters pay more for their electricity through so-called “tiered electricity pricing”. The growing reliance of Chinese aluminium firms on their own captive power plants complicates, however, the enforcement of this pricing scheme, as do preferential power prices provided at the provincial level.[43]

The fight against local air pollution has been an important driver of China’s attempts to curb excessive smelting capacity. Recurring pollution peaks in the winter led the Ministry of the Environment to issue last year the *2017 Working Plan for Air Pollution Control in the Beijing-Tianjin-Hebei Area*. The plan imposed seasonal cuts in industrial capacity for

[43] The 2013 *Guiding Opinions of the State Council on Resolving Serious Production Overcapacity Conflicts* prohibit the introduction of preferential power prices on provinces’ own initiative. Yet there are a number of examples of preferential power prices at the province level (e.g. in Qinghai and Yunnan). See Section 5.2.

the period September 2017 to March 2018, including for aluminium smelters and alumina refineries located around Beijing, Tianjin, and 26 other cities in Hebei, Henan, and Shandong (China's largest smelting province). The cuts were notably due to affect as much as 30% of the smelting capacity of top producers like China Hongqiao and the Xinfa Group. Shandong Weiqiao, a wholly-owned subsidiary of Hongqiao, was reportedly expected to idle 2.53 million tonnes out of a total of 7.27 million tonnes of capacity, though there can be doubts as to whether the cuts were actually implemented.[44]

By favouring industry concentration and larger smelting operations, the emphasis placed by China on energy efficiency and productivity may run counter to the objective of reducing capacity. There has certainly been a trend towards the construction of larger smelters in China at both existing sites and new locations (USITC, 2017[4]). The 2013 *Standards for the Aluminium Industry* themselves prescribe explicitly that new aluminium projects relying on imported bauxite must have an annual capacity of no less than 800 kt, presumably to exploit economies of scale. Again, this may cause producers to increase capacity on a net basis, despite there being a quota system in place.

Taken together, the different measures adopted by Chinese authorities seem to have had conflicting effects on firms' investment decisions, especially as they favour equally new plants and expansions at existing ones. Taube (2017[17]) argues that while "capacity additions and upgrades [help] lower production costs", "they [also] serve as credible commitments to one's market position, thereby […] fuelling a too-big-to-fail[45] situation, i.e. discouraging government authorities from allowing plants to go under." Recent OECD research has indeed shown the share of zombie firms to be higher among larger companies, possibly because "large firms are more likely to receive government subsidies since there is a preference to limit the employment loss due to the exit of large firms" (Adalet McGowan, Andrews and Millot, 2017[5]). Subsidies are certainly part of the aluminium landscape in China, with the *2016-20 Non-ferrous Metal Industry Development Plan* calling for "safeguard measures" via the extension of financial and tax support, including company bail-outs or help with non-performing loans.[46]

In spite of the efforts deployed by the Central Government, smelting capacity in China has kept growing on a net basis every year (Figure 3.1). There are several possible reasons for this, none of which are mutually exclusive. One is that policy action on curbing capacity in the aluminium industry may have been less resolute than for steel and coal mining (Wang, 2017[36]). Another has to do with China's debt-fuelled construction boom, which has been "essential to buoying dozens of industries that are already mired in overcapacity, like steel, cement, and glass" (McMahon, 2018[13]). Besides housing, the country's thirst for infrastructure has also served to sustain demand for aluminium, with non-ferrous metals constituting a vital "modular component of the national industrial

44 As already mentioned above, China Hongqiao's 2017 annual report mentions that the group produced about 7.5 million tonnes in 2017 out of an operating capacity of 6.5 million tonnes (sic). Neither of these figures is consistent with the announced winter cuts for 2017-18. Moreover, there have been some press reports of proposals in China to give provinces more responsibility in deciding on and enforcing winter cuts, which, if approved, would make cuts less binding in certain regions (Xu and Mason, 2018[70]).

45 Or "too politicized to fail" (*ibid*).

46 The issue is addressed further in Section 5 of this report.

economy" (Taube, 2017[17]). Recent mega-projects such as the One Belt, One Road initiative and Made in China 2025 will likely reinforce that trend in coming years.

Still another reason for the continued addition of smelters in the face of excess capacity might have to do with local authorities and their competition for resources. Haley and Haley (2013[19]) note, for example, how "the Chinese state consists of decentralized organizational sets that often pursue their own interests." Local officials at the province and city level usually have a number of targets they are expected to achieve, which induces them to maximise economic growth and tax revenue in their jurisdiction by attracting investment. Because they are capital-intensive, mining and heavy industries are usually favoured over lighter industries (McMahon, 2018[13]; Taube, 2017[17]). To attract those heavy industries, local governments deploy a wide array of incentives, including the provision of land, financing, and cheap inputs to willing investors, often in the context of "industrial parks" located on the outskirts of cities. Subsidies are, in that sense, "the tools of local governments competing with each other" (McMahon, 2018[13]).

The same incentive structure can lead local authorities to keep alive unprofitable firms operating in their jurisdictions, thus turning them into zombie firms. This creates a sort of "mutual dependence" between the authorities and companies, whereby governments need firms to sustain employment, growth, and revenue, while firms need governments to subsidise them and bail them out (Haley and Haley, 2013[19]). Because local governments retain 25% of the proceeds from value-added tax (VAT), they are often willing to keep large loss-making companies afloat so they can continue generating revenue, despite the absence of any tax revenue on company profits (McMahon, 2018[13]).[47]

This competition for investment among provinces finds an equivalent in trade, as local authorities sometimes seek to protect their own industries by imposing administrative barriers on trade with other provinces (*ibid*). By preventing a more rational allocation of productive resources across the country, provincial protectionism can also contribute to excess capacity by encouraging more physical investment locally than the market would otherwise demand.

In sum, the broader policy framework within which aluminium production takes place in China appears complex, opaque, and sometimes contradictory. This can generate inconsistencies between central and local policies, which fuel capacity expansion locally even though central authorities express publicly their desire to curb capacity growth (CM, 2017[35]). It remains to be seen whether new actions by the Central Government, such as the *Working Plans* issued in April 2017, will prove effective in disciplining capacity additions.

47 The proceeds from China's VAT were recently shared "in a 50:50 proportion temporarily as the business-tax to VAT conversion deprived sub-national governments of a major revenue source" (OECD, 2017[27]).

4. Trade in aluminium products and the influence of trade policy

This section focusses on one particular type of government intervention along the aluminium value chain, namely trade restrictions imposed at the border, and their impacts on trade in aluminium-related products.

Trade occurs at all stages of the aluminium supply chain, enabling companies to procure the inputs and intermediates they need, and to sell their products to markets further downstream. The dramatic changes that have taken place in the aluminium value chain – documented in Section 2 – have had a notable influence on trade patterns. This influence continues, however, to be mediated by the trade-policy instruments maintained by a number of countries.

4.1. The use of trade-policy instruments to promote downstream industries

A number of aluminium-producing countries have imposed trade barriers as part of national strategies to promote the development of downstream industries. In many cases, this is portrayed by countries as moving up the value chain, or climbing the product-sophistication ladder, on the underlying assumption that they would be better off processing products further downstream. China, for example, has employed "a variety of instruments to direct trade flows in line with the national industrial policy agenda" (Taube, 2017[17]). Indonesia and Malaysia are also notable for their use of export restrictions upstream in the value chain, while other countries like the Russian Federation use import-tariff escalation. This section discusses the range of trade-policy tools that governments apply to aluminium-related products.

Export restrictions

Export restrictions introduce a range of distortions in supply chains, affecting both exporting and importing countries. These can take the form of outright prohibitions (i.e. bans), taxes (*ad valorem* or specific), quotas, or non-automatic licensing[48] and permits. Regardless of their precise nature or justification, these measures generally have the effect of making the targeted product cheaper domestically, thus favouring domestic industries downstream that rely on this product as an input. Where the country is initially a large exporter of the product in question, export restrictions can also increase its price on world markets, as lower quantities compel downstream industries abroad to pay more for their inputs or intermediates, which can in turn affect production volumes.

Only a handful of countries maintain export restrictions in the upstream and middle segments of the aluminium value chain, with the exception of more common restrictions

48 "Although non-automatic export licensing is not a restriction in itself, if the licenses are granted in a stringent or non-transparent fashion, export volumes may be affected" (Korinek and Kim, 2010[71]).

on aluminium waste and scrap. The OECD's *Inventory of Export Restrictions on Industrial Raw Materials*[49] shows China, Guinea, India, and Indonesia are significant producing countries that have imposed some form of restrictions on their exports of bauxite or alumina.[50] They were joined in 2016 by Malaysia, which introduced a ban on its exports of bauxite that followed that by Indonesia. In the case of primary aluminium, export restrictions have been imposed in particular by China, Indonesia, and Oman. Other measures reported for the Russian Federation and Kazakhstan concern only unwrought aluminium alloys. In the downstream segment, only Brazil, China, Egypt, Oman, and Tajikistan restrict to varying degrees their exports of some of the most important semis (e.g. bars, rods, profiles, plates, and sheets).

Bans introduced by Indonesia and Malaysia on exports of bauxite count among the most significant measures. This is because the two countries possess relatively large bauxite resources, so any supply disruption on their part has the potential to affect world markets. Indonesia introduced its export ban in 2014 in a bid to induce bauxite-mining firms to build domestic refining and smelting facilities. The ban was combined with a requirement that foreign companies reduce their interests in mining ventures to 49% by the tenth year of operation. Firms which could export ore, either because they had already invested in refining facilities or were in the process of doing so, were also subject to high export taxes. The Government of Indonesia eased the ban in 2017 in the face of fiscal pressures, allowing bauxite with an aluminium oxide content of at least 42% to be exported "in certain amounts" (Reuters, 2017[37]; U.S. Geological Survey, 2018[15]).

As exports from Indonesia were brought to a halt in 2014, much of the activities of bauxite producers crossed the border into neighbouring Malaysia, which experienced a sudden mining boom that led to widespread environmental degradation and illegal extraction. The Government of Malaysia responded by introducing an export ban of its own in January 2016, which remains in place at the time of writing (U.S. Geological Survey, 2018[15]).

China's regime of export taxes is another significant measure that has had important effects on world aluminium markets.[51] Export taxes in China are product-specific tools, with the Government fine-tuning rates at the 8- or 10-digit level in the Harmonized System (HS). Official Chinese statements announcing specific adjustments to export taxes often contain justifications for the policy change. These are often couched in terms of promoting products with "higher value" or reducing exports of "undesirable industries", i.e. industries producing polluting goods or consuming large amounts of energy and natural resources.

Export restrictions are also sometimes motivated by other considerations, such as the subsidisation of downstream industries or the manipulation of terms-of-trade[52] (Gourdon, Monjon and Poncet, 2016[38]). China applies most of its export taxes on industrial raw materials, primary products, and natural resources for which domestic demand is high, with the intent of safeguarding the needs of domestic production. In the case of

49 See https://oe.cd/export-restrictions-data (accessed on 9 August 2018).

50 Egypt and Oman also have restrictions but are not significant exporters or producers.

51 Sub-section 4.2 discusses those impacts in more detail.

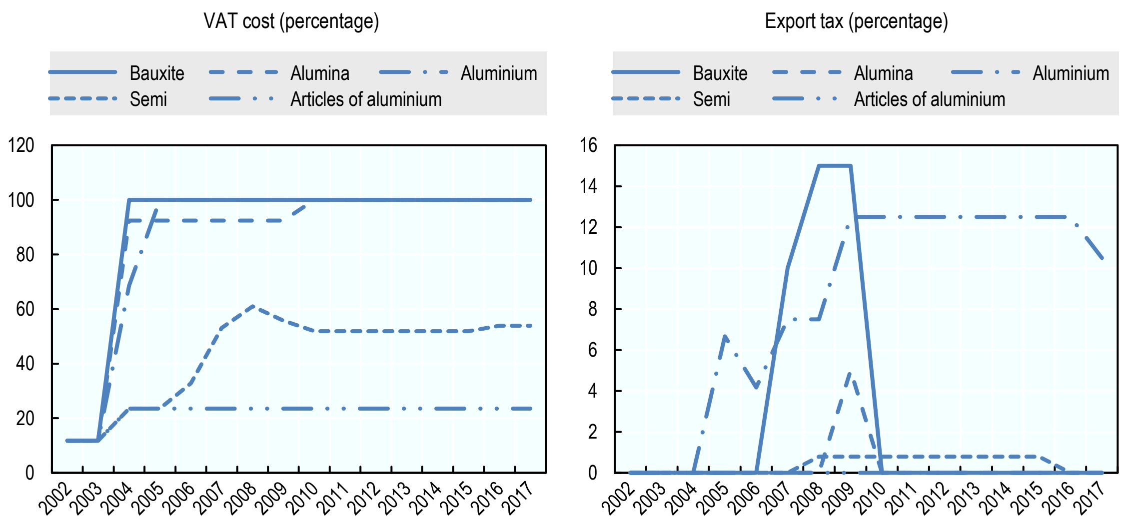
52 Terms-of-trade designates the ratio between a country's export and import prices.

aluminium, taxes range from a low of 0-1% on semis and articles of aluminium to a 15% rate on primary aluminium (Figure 4.1). This confers strong incentives for smelters to sell their production to domestic semis producers, who benefit through lower prices on their intermediates.

China's policy of incomplete VAT rebates

Incomplete rebates of VAT for exporters are a specific tool used by China to favour exports of certain products. China's VAT policy differs from the standard destination-based VAT system of many countries in that it does not fully refund the VAT on exports.[53] Instead, China-based exporters may be eligible for VAT rebates that range from zero to a full refund of the typical 17% VAT rate, depending on the product they export. China's system of VAT rebates can be considered a trade-policy tool since the Government often modifies rebate rates selectively, restricting exports of certain products while encouraging others.

Figure 4.1. China has been using VAT rebates and export taxes selectively to hinder exports of primary aluminium



Source: OECD calculations.

China has used VAT rebates selectively to discourage exports of primary aluminium while encouraging exports of certain semis and fabricated articles of aluminium. Estimated VAT costs[54] for different aluminium products in China show exports of bauxite, alumina, and primary aluminium to have all borne the full extent of the VAT – and thus to have been penalised – over the past 8 to 15 years. In other words, they had zero or near-zero rebates in the period (Figure 4.1). On the contrary, exports of semis and

53 China started off with a complete VAT rebate in 1994, but the strong rise in exports during the 1990s generated a heavy fiscal burden for the Government, which quickly lowered the VAT export rebates and fixed different rates across sectors and products (Chandra and Long, 2013[38]).

54 Higher VAT costs come from lower VAT rebates, and vice versa. See Box A A.1 in the Annex for more detail on the calculation of VAT costs.

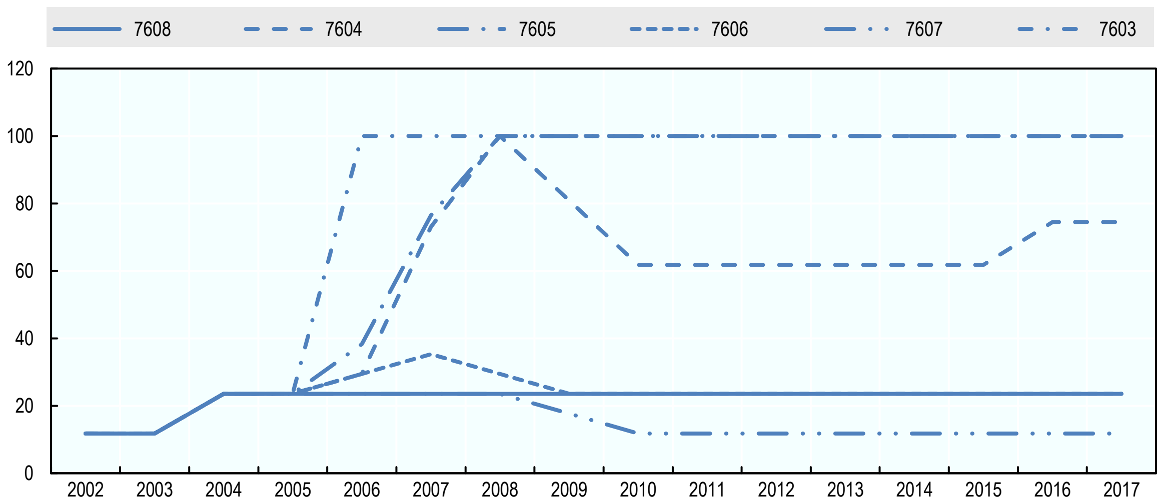
articles of aluminium[55] had higher VAT rebates over the same years, and were thus promoted *relative to upstream products*. Although VAT costs for semis exports increased significantly over 2004 to 2008 – from 25% of the full VAT rate to around 60% – they have remained stable at around 50% ever since. This also hides considerable disparity among semis (Figure 4.2): the Government stopped reimbursing the VAT on exports of aluminium powders and flakes (HS 7603) and aluminium wire (HS 7605) several years ago, but has continued to reimburse part (bars, rods, and profiles; HS 7604) or all of the tax (plates, sheets, and foil; HS 7606-07) on other semi-fabricated products.

The impacts of China's selective VAT rebates are additive to those generated by its export taxes. This is because a "destination-based VAT system without a complete export tax rebate is detrimental to a country's exports", and so is akin to an export tax (Chandra and Long, 2013[39]). The combination of incomplete VAT rebates and export taxes implies a *de facto* export tax on primary aluminium well in excess of 15% (around 30%). This is in contrast with more processed aluminium products, for which VAT costs and export taxes are generally both lower (Figure 4.1). One exception is aluminium waste and scrap, an input into production, which faces the highest taxes.

VAT rebates and export taxes do not always provide consistent signals to Chinese exporters, however. The Government has, for example, set tax rates on exports of bauxite and alumina at zero since 2010, even though both products have remained subject to the full VAT cost (Figure 4.1). In the case of primary aluminium, small reductions in the export tax were observed in 2017 for high-purity aluminium and light, alloyed aluminium. Lastly, export taxes on semis seem to have affected primarily bars, rods, and profiles (HS 7604) since 2008, during which time VAT costs for these products were, however, decreasing.

Figure 4.2. There is considerable disparity in how China applies VAT rebates on its exports of semis

VAT cost (percentage) on aluminium products



Source: OECD calculations.

55 For the purpose of this report, fabricated articles of aluminium correspond to products listed under HS 7610-7616 while semis are found under HS 7603-7609.

Import tariff escalation

Similarly to export restrictions, the structure of countries' import tariffs may also favour downstream activities in the aluminium value chain. By introducing a wedge between domestic and international prices, import tariffs confer support to domestic producers while hurting industrial users and final consumers. Tariff escalation refers to a situation where this support from import tariffs[56] benefits primarily the domestic processing of products downstream, as opposed to the production of raw materials upstream. By charging higher import tariffs on more processed products, governments seek to encourage downstream activities that they believe generate more value added. Tariff escalation is thus another trade policy tool that countries can use to promote downstream industries.

In the case of aluminium, tariff escalation often takes the form of countries imposing import duties on semis and fabricated articles of aluminium that are higher than those for primary aluminium. In other cases, governments support the refining stage through higher tariffs on alumina than on raw bauxite. A consequence of these policies is that they limit the scope for other countries exporting raw materials such as bauxite to move up the value chain into the refining and smelting stages. As opportunities for diversifying exports are more limited, tariff escalation may also expose these countries to heightened price volatility.[57]

The structure of countries' import tariffs parallels to a large extent their position in the aluminium value chain (Figure 4.2). Tariff escalation seems to have become more pronounced since 2005 in Korea, the Russian Federation, and the European Union (to a lesser extent), as evidenced by an increase in the gap between import duties on semis and those on primary aluminium. By contrast, Canada seems to have eliminated fully that gap, possibly reflecting its focus on hydro-based smelting and its reliance on semis imported from the United States (USITC, 2017$_{[4]}$). At the upstream end of the chain, India appears to have increased the wedge between import tariffs on alumina and bauxite, while the Russian Federation did the opposite, conferring "negative protection" on (i.e. effectively taxing) its alumina refineries. This may be a reflection of UC Rusal's growing involvement in the production of alumina overseas (e.g. in Guinea, Italy, Ireland, and Jamaica). Overall, the Russian Federation's tariff structure provides the clearest instance of tariff escalation, starting from a negative tariff wedge on alumina that becomes positive and larger as one moves up the value chain.

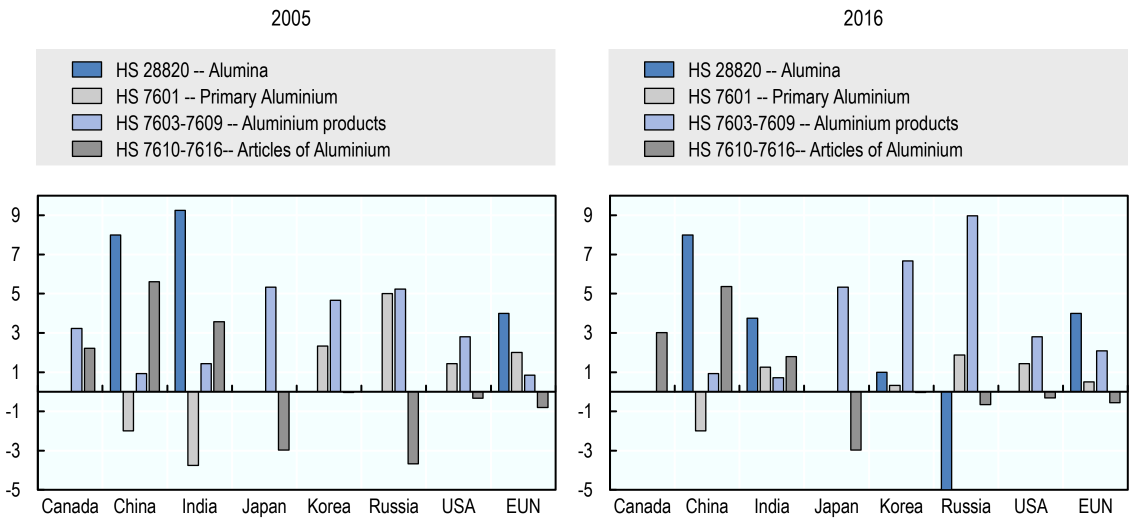
While the structure of its import tariffs did not change noticeably between 2005 and 2016, China continues to apply duties that discourage imports of alumina and articles of aluminium into the country. This is consistent with China ending its reliance on alumina imports by sourcing more bauxite from overseas to feed the country's growing number of refineries (Figure 2.5). China appears, however, to apply lower tariffs on imports of primary aluminium and semis, though the impact of these lower tariffs cannot be

56 As explained later in Section 4, import tariffs are one type of 'induced transfers' that governments use to favour domestic producers.

57 Notable examples of tariff escalation can be found in the agro-food sector of many OECD countries, which often maintain import tariffs on raw products like cocoa beans that are lower than for more processed products like chocolate.

considered independently of the export restrictions described above (e.g. a 15% export tax on primary aluminium).

Figure 4.3. Tariff wedges as a measure of tariff escalation



Note: See Box A A.2 in the Annex for more detail on the calculation of tariff wedges.
Source: OECD calculations.

4.2. Trade policy has had visible effects in the aluminium value chain

The various trade policy tools that governments have been using to promote downstream aluminium industries have had noticeable impacts on trade in aluminium products. This sub-section discusses three particular trade effects that were likely caused – in part at least – by the measures described above. Although this sub-section does not cover all possible impacts that trade policy tools might have had on global trade in aluminium products, the three cases below are nonetheless particularly salient in terms of their scale and significance for aluminium supply chains.

Export restrictions imposed by Indonesia and Malaysia on bauxite have disrupted supply chains

China's increasing reliance on imported bauxite has made it more vulnerable to export restrictions applied by bauxite-rich countries. China's growing demand for higher-quality bauxite from overseas (Figure 2.3) is fuelled by growth in its refining capacity and the relatively poor quality of its domestic bauxite deposits. This increasing import dependence has arisen despite China's efforts to restrict its own exports of bauxite by means of zero VAT rebates at the border and export licensing.

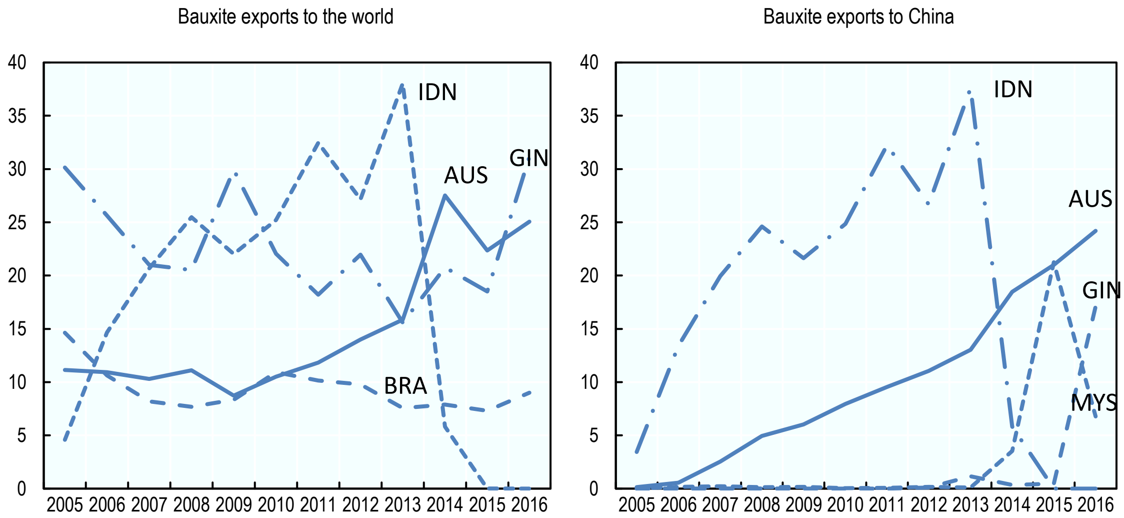
The export bans introduced by Indonesia and Malaysia between 2014 and 2016 affected China much more than other alumina producers. For obvious geographical reasons, China was initially largely dependent on bauxite imported from Indonesia. This led some Chinese companies such as state-owned Chalco to invest in Indonesia, establishing a local presence to secure access to bauxite. The year before Indonesia introduced its 2014

export ban, it accounted for as much as 38% of China's imported bauxite (Figure 4.4),[58] which represented 99% of Indonesia's exports of bauxite. The situation was different for other alumina-producing countries, which either possessed their own domestic resources (e.g. Australia, the Russian Federation, and Saudi Arabia) or relied on other foreign suppliers (e.g. Brazil, Greece, Guinea, or Jamaica).

Bans by Indonesia and Malaysia pushed China to revamp its sourcing strategy, and helped cement the growing importance of Guinea in world bauxite exports. China initially met the supply shortfall that resulted from Indonesia's 2014 export ban by shifting mining activities into neighbouring Malaysia, and by increasing import volumes from Australia and India. Malaysia's export ban in 2016 rendered that strategy short-lived, compelling China to look for other sources of supply. China responded by further increasing its imports from Australia while also investing in Guinea, which became in 2016 the world's largest exporter and the third-largest producer of bauxite in 2017, behind Australia and China itself.

Figure 4.4. Export bans in Southeast Asia have had a profound impact on China's imports of bauxite

Export shares by country (%), in volume terms



Source: OECD on the basis of data from the BACI database.

Chinese aluminium producers have responded in various ways to the export bans in Southeast Asia. Chalco has been forced to idle its facilities in Indonesia, as explained in its 2017 annual report to the US Securities and Exchange Commission (SEC): "Indonesia used to be a major source of our imported bauxite. As a result of the ban imposed by the Government of Indonesia on the exportation of unprocessed bauxite and nickel, since January 2014, we have not been able to export the bauxite produced by our bauxite mines in Indonesia for the use of our alumina refineries in China, and our operation of bauxite mining in Indonesia has been suspended since September 2014." China Hongqiao opted, on the other hand, to comply with Indonesia's requirement that bauxite be processed

58 All trade data mentioned in this section were obtained from the BACI database, unless stated otherwise.

domestically, and has invested in setting up a large alumina refinery in the country, which commenced production in 2016 (CICC, 2016[26]). The company has also invested in Guinea through the SMB-WAP mining and shipping consortium.

There is some evidence that Indonesia's export ban succeeded in increasing domestic alumina refining. While Indonesia did not produce any alumina prior to the introduction of the bauxite export ban in 2014, production has since started and grown every year, reaching 1.5 million tonnes in 2017. According to the US Geological Survey (2018[15]), "two refineries have been completed in Indonesia since 2015 and another under construction was expected to be completed in 2019." That increase in capacity and in the volume of alumina refined in Indonesia has not been matched by a corresponding increase in smelting activity, however. With no discernible impact on primary-aluminium output, it would seem that Indonesia's export ban has so far had limited overall impact. It is, meanwhile, too early to tell if Malaysia's 2016 export ban has had comparable effects.

The impacts of China's export restrictions

Trans-shipments of aluminium have circumvented China's export restrictions

China's export restrictions have proven effective in curbing its exports of primary aluminium (Figure 4.5). As explained above, China combines a 15% export tax with zero VAT rebates at the border, which together result in a *de facto* export tax on primary aluminium (not alloyed) exceeding 30%.[59] This has provided a strong incentive to Chinese smelters not to export their primary aluminium, and instead sell it domestically for lower prices than they would obtain in global markets. That trend has been apparent since the Government decided to increase export taxes on primary aluminium in two successive increments, in 2005 and 2007. Empirical evidence indicates that, on average, a one percentage point increase in China's export taxes reduces quantities of goods exported by more than 5% (Gourdon, Monjon and Poncet, 2017[16]).

The result has been that China does not export a significant amount of primary aluminium, despite being the world's largest producer and having what it acknowledges to be excessive smelting capacity. The main net exporters of primary aluminium are currently Australia, Canada, Iceland, India, Norway, the Russian Federation, and the United Arab Emirates, which together accounted for more than half of global exports of primary aluminium in 2016 (Figure 4.5). By contrast, China accounted for a mere 2% of global exports. The European Union, Japan, and the United States are, meanwhile, large net importers of primary aluminium, but net exporters of aluminium for recycling in the form of waste and scrap, mostly destined for China and India where it is re-melted into aluminium ingots.[60] However, industry sources expect Chinese imports of aluminium waste and scrap to decrease in the future – as they have already been doing over the past few years – as more and more aluminium-based products (e.g. cars, wires, and building products) in China arrive at the end of their useful life and are thus available for recycling.

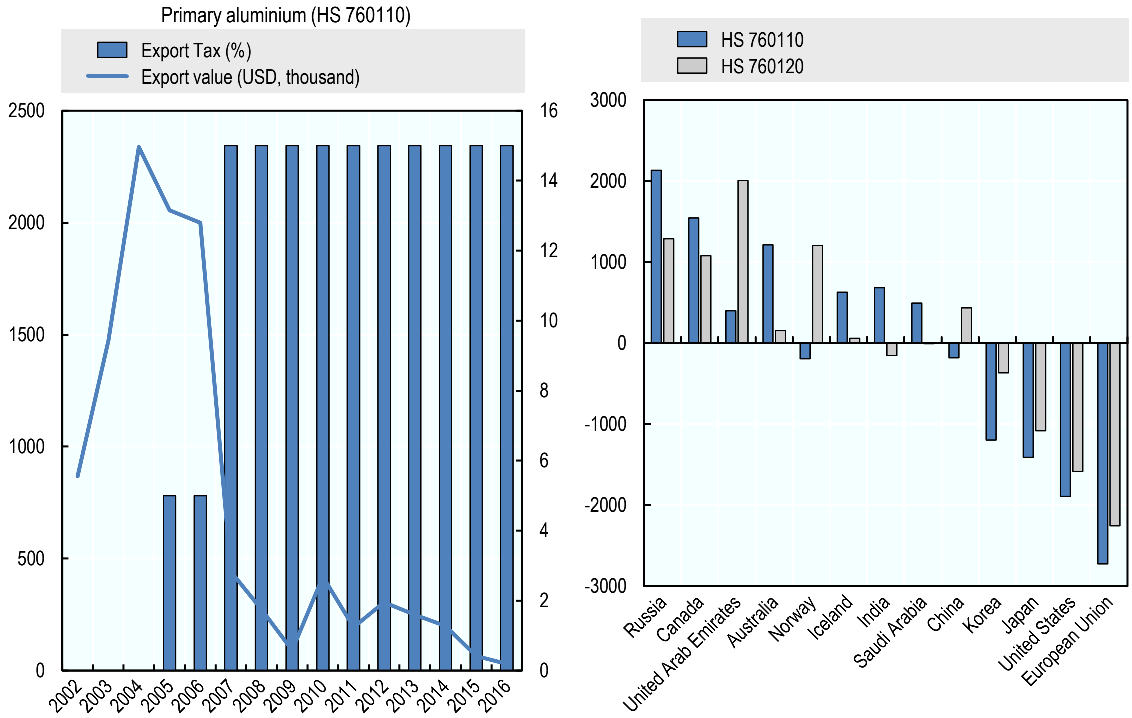
[59] Assuming that China's full 17% rate of VAT applies in this case.

[60] OECD countries remain the largest users of recycled aluminium by volume globally, producing more than 7 million tonnes and exporting only 1.4 million tonnes (net) of aluminium waste and scrap in 2016. That same year, China produced 2 million tonnes of secondary aluminium and imported an additional 1.9 million tonnes (net) of aluminium waste and scrap.

China's export barriers, coupled with smelting output that exceeds domestic demand, have led some exporters in the country to circumvent border restrictions by exporting primary aluminium disguised as semis. The process usually involves trans-shipments through third countries, wherein 'fake semis' are re-melted into primary-aluminium ingots before they are re-exported as such to their final destination (Taube, 2017[17]; USITC, 2017[4]). This enables Chinese exporters to evade the 15% export tax on primary aluminium while at the same time obtaining a partial refund of VAT, which together, and depending on the prevailing price of aluminium on the LME, can make the operation worthwhile.

Figure 4.5. China's export restrictions have proven effective in curbing the country's exports of primary aluminium

Left: export taxes (*ad valorem*) and Chinese exports in value (USD thousand)
Right: net exports of primary aluminium in 2016 (thousand metric tonnes)



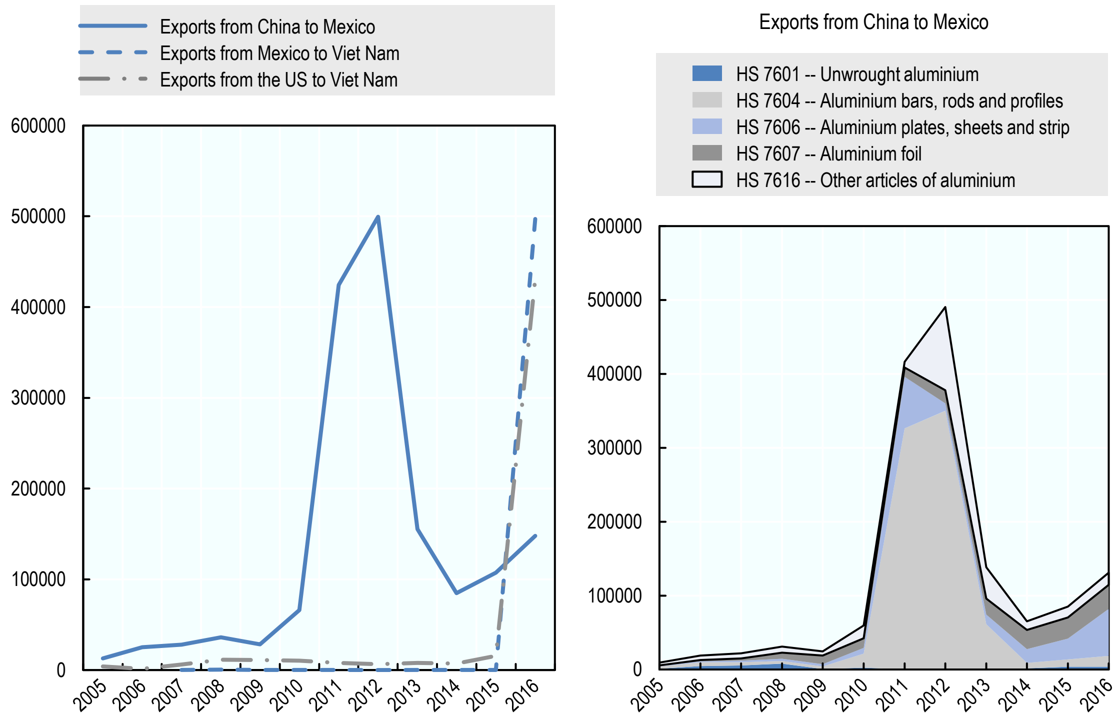
Note: HS 760110 and HS 760120 correspond to 'unwrought aluminium, not alloyed' and 'unwrought aluminium, alloys' respectively.
Source: OECD on the basis of data from the BACI database.

Exports of fake semis are notoriously difficult to measure or track given their inherently "grey" nature. The USITC (2017[4]) estimates, however, that most such flows have transited through three countries, namely Malaysia, Mexico, and Viet Nam, generally under the guise of extrusion products (HS 7604, aluminium bars, rods, and profiles). Trade data certainly appear to give credence to these findings as exports of extrusion products from China to Mexico surged abruptly in the years 2011-12 before resuming their normal trend (Figure 4.6). A few years after reaching Mexico, these fake semis allegedly made their way to Viet Nam following public reports that "a giant stockpile of Chinese aluminium [had been discovered] just below the US border with Mexico" (Business Insider, 2016[40]). The data indicate that similar amounts of extrusion products were shipped from Mexico and the United States to Viet Nam in the year 2016, which

correspond in volume to that which China sent to Mexico a few years earlier (Figure 4.6). This suggests that some of China's fake semis arrived in the United States through Mexico before heading back to Asia. More recently, exports of extrusion products from China to Viet Nam seem to have increased sharply in 2015-16, followed by an increase in exports from Viet Nam to the United States, though it is unclear whether these flows involve fake semis. For now, evidence from the USITC (2017[4]) suggests that "the vast majority of the trade flows of aluminium extrusions from China to Vietnam remain in Vietnamese stockpiles."

Figure 4.6. Some fake semis appear to have transited through Mexico and Viet Nam

Bilateral export flows (in metric tonnes)



Source: OECD on the basis of data from the BACI database.

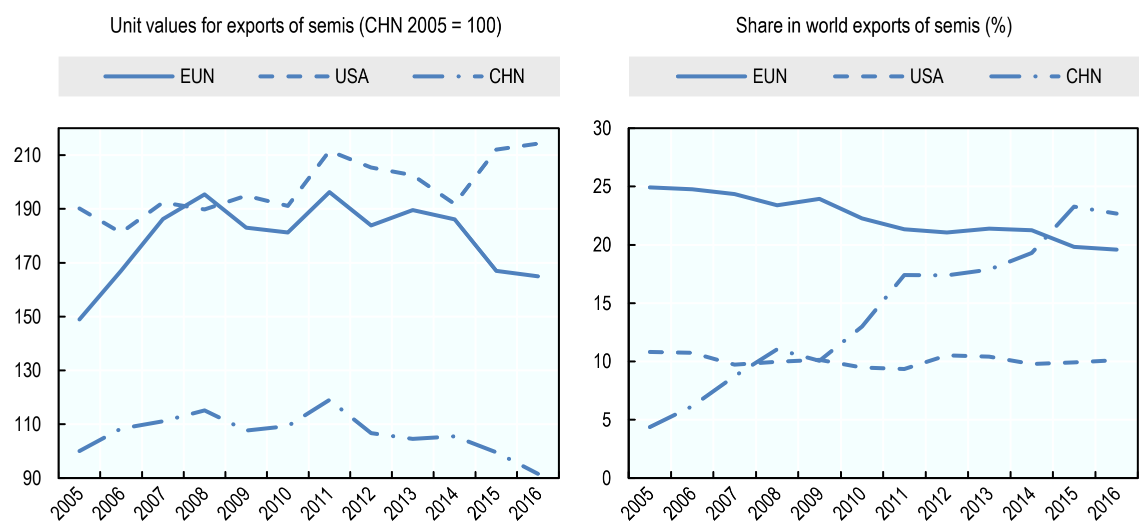
Impacts on the market for semis and other articles of aluminium

For lack of a reliable and consistent export outlet, China's excess supply of primary aluminium has benefitted Chinese producers of semis through lower input costs. Although there are many other factors affecting semis production costs – including cost of labour, domestic regulations, and subsidies[61] – there is little doubt that export restrictions and tariffs have played a role in keeping the cost of primary aluminium as a key input down. As the industry estimates primary aluminium to account for about 75-86% of total production costs for semis, its price is a decisive factor in competitiveness (Section 2).

61 Subsidies and other forms of support are the subject of the next section (Section 5).

Lower production costs for semis have translated into lower export prices that have made China more competitive in most segments of the semis market. China's cost advantage in the production of semis is startling when viewed in terms of value per unit exported (Figure 4.7): across all types of semis, China typically offers export prices that are 50% to 100% lower than the European Union and the United States. While this may reflect partly quality differences, whereby higher-quality products attract a higher price, a significant price difference is nonetheless observed across all product groups, including less sophisticated products like aluminium foils.

Figure 4.7. There is a persistent gap between the prices on semis offered by China and those offered by the European Union and the United States



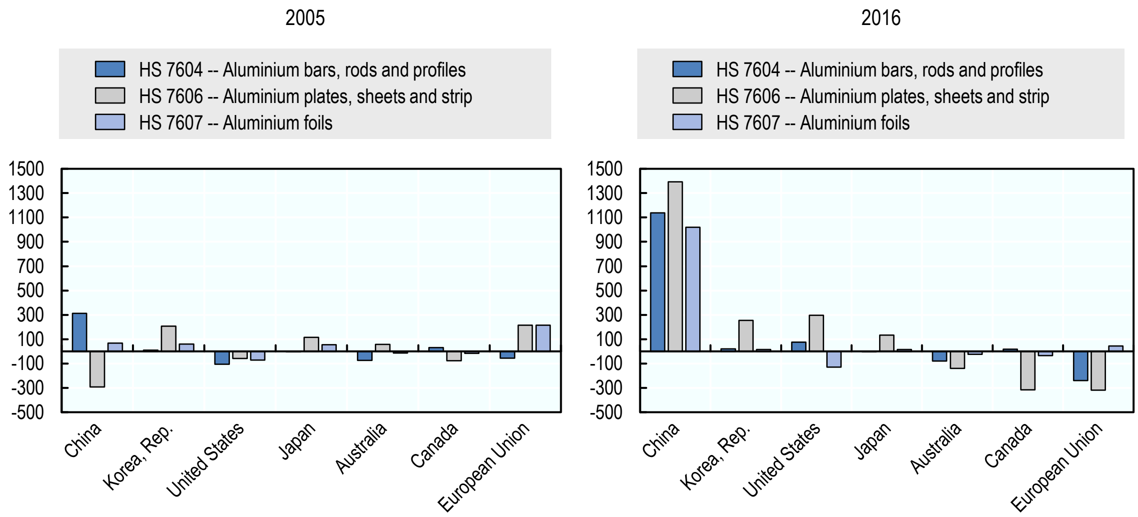
Note: Unit values of exports do not account for possible quality differences between goods under the same HS heading. They should therefore be taken with caution, and are only meant to serve as a proxy for unit export prices. Aluminium semis here comprise: HS 760429, 760611, 760612, 760711, 760719, and 760720.
Source: OECD on the basis of data from the BACI database.

China's cost competitiveness and trade policies have turned the country into a large net exporter of semis. Although China currently dominates exports of aluminium semis worldwide (Figure 4.8), this is a relatively new development. The country was still in 2005 a net importer of aluminium plates and sheets (HS 7606) but it was already a net exporter of extrusion products (HS 7604) and foils (HS 7607), though on a much smaller scale than today. A decade later, China's net exports of semis had increased 40-fold, dwarfing those of other countries. Interestingly, trends in China's semis exports appear to have followed corresponding changes in VAT rebates: rebate increases[62] for certain rolled and extrusion products were accompanied by higher export volumes, whereas decreasing rebates in the case of both aluminium wires and non-alloyed bars and rods corresponded to lower export volumes.

62 Meaning reductions in VAT costs.

Figure 4.8. China has come to dominate semis' exports over the past decade

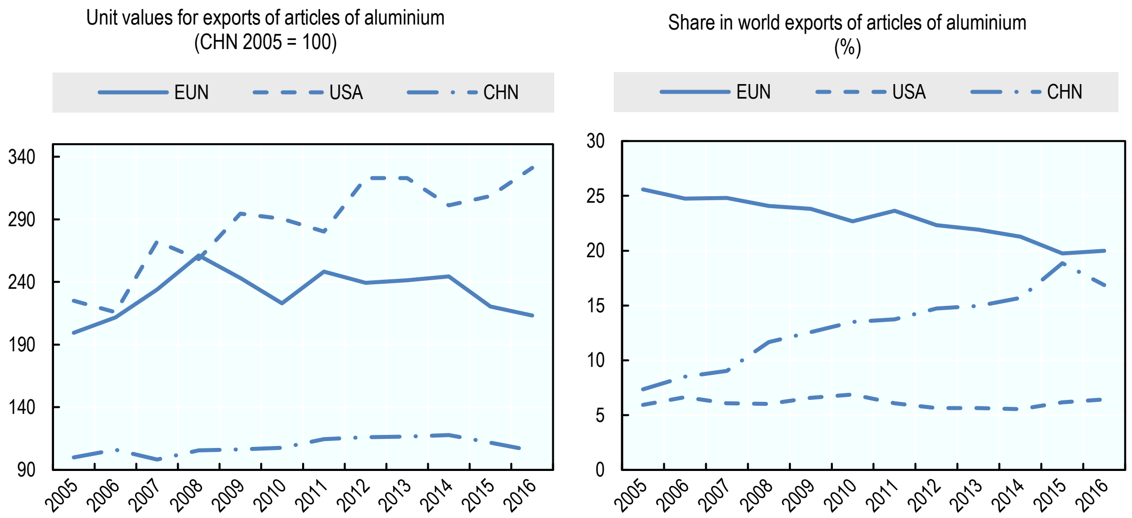
Net exports by country (thousand metric tonnes)



Source: OECD on the basis of data from the BACI database.

The picture is strikingly similar for more processed articles of aluminium, where again lower unit values on exports have made China the largest net exporter by a wide margin (Figure 4.9). One exception is aluminium casks, drums, cans, and boxes (HS 7612), for which Chinese exports have not grown as fast as exports of other articles of aluminium. For the other articles – including tables, kitchen articles, gutters, and aluminium ladders – export growth has been exceptionally fast, increasing China's share of the world market to around 20% overall.

Figure 4.9. Lower unit values have also made China a major exporter of fabricated articles of aluminium



Note: Unit values of exports do not account for possible quality differences between goods under the same HS code. They should therefore be taken with caution, and are only meant to serve as a proxy for unit export prices. Articles of aluminium here comprise: HS 761010, 761090, 761290, and 761519.
Source: OECD on the basis of data from the BACI database.

4.3. Recent trade developments in aluminium: Trade disputes, remedies, and sanctions

China's rapid ascent as the world's largest exporter of aluminium semis, and the policies that appear to have made this ascent possible, have met growing resistance from other aluminium-exporting countries. There has been in particular a series of trade disputes and trade remedies targeting China's policies in the aluminium sector. In January 2017 the United States requested, for example, consultations at the WTO for subsidies that it argued China provides to its producers of primary aluminium, including China Hongqiao and Chalco (WTO, 2017[41]). In the downstream segment, the US Department of Commerce self-initiated in 2017 a countervailing-duty investigation into Chinese subsidies to producers of aluminium common-alloy aluminium sheet, and specifically selected for mandatory investigation large semis producers such as Chinalco's Southwest Aluminium Cold Rolling Co., Ltd. and Henan Mingtai Aluminium Industrial Co., Ltd. Likewise, the US Department of Commerce made a final determination that Chinese producers of aluminium foil had been subsidised and – in conjunction with a determination by the USITC that US foil producers had been injured by the dumping of those subsidised products – imposed final orders for countervailing duties in April 2018.

The year 2018 has also seen the United States impose a 10% tariff on certain aluminium imports pursuant to Section 232 of the Trade Expansion Act of 1962. This followed an investigation initiated by the United States. Department of Commerce in April 2017, which found *inter alia* that "the present quantity of [aluminium] imports adversely impacts the economic welfare of the US aluminium industry" (U.S. Department of Commerce, 2018[42]). The imposition of a 10% tariff by the United States was soon followed by the introduction of commensurate tariffs by other countries, which these governments imposed to guard against import surges resulting from the diversion of aluminium originally bound for the United States.

Although the United States has exempted a few countries (e.g. Argentina and Australia) from the 10% tariff under Section 232, imports from Argentina are subject to an import quota.[63] Meanwhile, companies are able to apply for an exclusion from the 10% import tariffs if it is shown that US producers cannot supply a given product in sufficient quality or quantity, or if there are other specific national security concerns. The US Congressional Research Service reports that "as of July 16, 2018, [the US Department of Commerce] had received over 27 600 petitions, denying 452 and approving 26", and that "some Members of Congress have raised concerns about the exclusion process [… for placing] an undue burden on petitioners and objectors" (Fefer et al., 2018[43]).

Though not a trade policy *per se*, in April 2018 the US Treasury imposed sanctions on UC Rusal, the world's second-largest producer of aluminium, which have constrained supply and pushed aluminium prices higher (Sanderson, 2018[44]). Given UC Rusal's extensive presence overseas (e.g. in Africa, Europe, and the Americas), the industry expects the sanctions to continue having sizable trade effects in the near future (*ibid*).

It is overall too early at this stage to assess what impacts, if any, the above measures will have on trade in aluminium products. In a report released in March 2018, Taube (2018[45]) argues that "the negative trade effects for Germany and Europe [of the United States'

63 See www.cbp.gov/trade/programs-administration/entry-summary/232-tariffs-aluminum-and-steel (accessed on 3 September 2018).

10% import tariff] will not fully materialize until the fourth quarter of 2018." Meanwhile, the US Congressional Research Service has estimated the proceeds from the 10% aluminium tariff to have reached USD 344 million as of mid-July 2018, adding that "the tariffs should cause import demand and therefore tariff revenue to decline over time if US production increases and sufficient domestic alternatives become available" (Fefer et al., 2018[43]). In any event, there is much uncertainty at the moment as policies relating to trade in aluminium products remain in a state of flux.

5. Government support along the aluminium value chain

Section 4 has explored how governments use trade-policy tools to selectively favour certain segments of the aluminium value chain and influence global production locations. This section concentrates on the use by governments of subsidies and other forms of support for domestic firms, building on prior OECD work on government support in agriculture, fisheries, and fossil fuels in a range of developed and developing countries.

5.1. Government support from the perspective of individual firms

Why use a firm-level approach?

Unlike previous efforts at the OECD to estimate government support, the identification and quantification of subsidies and other forms of support for the production of aluminium cannot rely on aggregate, macro-level information. OECD work on measuring support in agriculture, fisheries, and the fossil-fuel industry has usually proceeded from the perspective of countries. Data on support amounts are typically collected by looking at government budget documents and at the difference between domestic and international product prices.[64] Budget documents can, for example, provide aggregate information on different spending programmes that concern the farming or mining sector, as well as reports detailing the different tax concessions that encourage the production and use of motor fuels in the country. Such information tends, however, not to be available from governments for specific industrial activities such as aluminium smelting or alumina refining, if at all. This makes it very difficult to identify government measures benefitting the aluminium industry on the basis of budgetary documents alone.

Depending on the nature of the sector, an approach that looks at support from the perspective of individual producing firms can be necessary given that governments often do not disclose sufficiently detailed information on their support measures. The collection of information on government support as it benefits individual firms can offer much-needed granularity on the many different ways that countries encourage their domestic producers, be it through R&D subsidies, income-tax concessions, cheaper electricity, or concessional finance. The degree of granularity attained can be extremely valuable in subsequently trying to understand how distortive different measures are for global trade. It also makes it possible to capture the support provided by all layers of government down to the level of municipalities, and not just that provided by central government authorities. This is especially important for aluminium since most major producing countries are large federations of states, provinces, and territories that possess considerable autonomy in fiscal policy (e.g. Australia, Brazil, Canada, China, India, the Russian Federation, and the United States).

For all its benefits, an approach that looks at government support from the perspective of individual firms is at risk of losing representativeness and perspective. In most cases,

64 Where market price support confers additional, non-budgetary support to domestic producers, or where domestic consumer subsidies keep local prices artificially low. See OECD (2016[52]).

resource and time constraints will make it impossible for the analysis to cover all existing firms in a sector, which will therefore need to focus instead on a sample of companies. This implies in turn that the degree to which a sector is concentrated largely determines how large that sample should be if it is to be considered representative. Market concentration is fairly high along the aluminium value chain, with the exception of the semis segment (Section 2). The top 10 producers of bauxite and alumina both account for about two thirds of global capacity. In primary aluminium, the top 20 firms represent nearly 70% of global smelting capacity. The collection of information on support for a sample of firms that collectively make up more than half of global output and capacity is therefore feasible in principle in most segments of the aluminium value chain.

Transparent reporting by firms is another roadblock on the estimation of government support at the level of individual companies. International accounting standards normally provide a framework that most firms follow in establishing their financial statements with auditors' help, though these statements are not always disclosed to the public. A key determinant is whether firms are publicly listed on stock exchanges or whether they have offered corporate bonds to the public, as these usually require companies to issue detailed information on their financial performance for use by investors. Although reporting quality can vary greatly, most aluminium-producing firms have opted to either issue shares or bonds to the public. Notable exceptions include the East Hope Group and the Xinfa Group, both of which private Chinese firms that have not disclosed any information to the public.[65]

Constructing a sample of firms

In selecting the sample of firms for which to collect information, we have sought to balance economic significance (e.g. a company's share of global output) with geographical diversity. The sample was thus designed so as to cover firms from different countries and continents, which collectively account for two-thirds of global alumina-refining capacity and half of all smelting capacity. With nine Chinese firms out of 17 companies, the sample also approaches China's share of global primary-aluminium production in 2017 (57%). As explained above, the amount of information disclosed by firms has, however, imposed an additional constraint on sample selection: this study was, in particular, not able to locate sufficiently comprehensive information on the Xinfa Group (China), the East Hope Group (China), and Emirates Global Aluminium [EGA] (UAE). Although all three firms are economically very significant, it was not possible to include them in the sample.

The sample selected for this study comprises 17 large firms operating at different stages of the aluminium value chain. Most of them are multinationals whose activities span multiple countries and continents, though Chinese firms display a stronger tendency to locate the bulk of their activities domestically (Table 5.1). As indicated in Section 1, two business models seem to emerge from that sample: one in which firms specialise either in upstream and smelting activities (e.g. Alba, SPIC, and Alcoa), leaving the production of semis to other specialised firms (e.g. China Zhongwang and Xingfa Aluminium); and another in which firms seek to integrate vertically along the whole value chain by acquiring semis producers (e.g. Hindalco and Norsk Hydro).

65 The Xinfa Group has been portrayed in the Chinese press as a low-profile giant, which rarely appears in rankings of China's largest companies, in spite of its sizeable operations and significant local footprint. Nor does the company have an official website (Caijing, 2013[72]).

Table 5.1. The sample comprises 17 large firms operating at different stages of the aluminium value chain

Firm name	Home country	SOE	Bauxite	Alumina	Smelting	Recycling	Semis
Aluminium Bahrain B.S.C. (Alba)	Bahrain	Y			Bahrain		
Aluminium Corporation of China Ltd. (Chalco)	China	Y	China; Indonesia	China	China		(a)
Henan Shenhuo Coal & Electricity Co. Ltd.	China	Y	China	China	China		
Henan Mingtai Aluminium Industrial Co. Ltd.	China	N					China
China Hongqiao Group Ltd.	China	N (b)	Guinea	China; Indonesia	China		China
Qinghai Provincial Investment Group	China	Y			China	China	China
State Power Investment Corp. (SPIC)	China	Y	China; Guinea	China	China		
Xingfa Aluminium Holdings Ltd.	China	Y					China
Yunnan Aluminium Co. Ltd.	China	Y	China	China	China		China
China Zhongwang	China	N					Australia; China; Germany
Rio Tinto	Australia and United Kingdom	N	Australia; Brazil; Guinea	Australia; Brazil; Canada	Australia; Canada; Iceland; New Zealand; Oman	Canada	
Hindalco (incl. Novelis)	India	N	India	Brazil; India	India	Brazil; Canada; Germany; Korea; United States; Viet Nam	Brazil; Canada; China; Germany; Korea; United States; Viet Nam
National Aluminium Company Ltd. (NALCO)	India	Y	India	India	India		
Vimetco N.V.	Netherlands	N	Sierra Leone	Romania	China; Romania		China; Romania
Norsk Hydro	Norway	Y	Brazil	Brazil	Australia; Brazil; Canada; Germany; Norway; Qatar; Slovak Rep.	Austria; Canada; France; Germany; Luxembourg; Norway; Spain; United Kingdom; United States	Australia; Austria; Belgium; Brazil; France; Germany; Hungary; Norway; United States; etc. (c)
UC Rusal	Russian Federation	N	Guinea; Guyana; Jamaica; Russian Federation	Australia; Guinea; Ireland; Italy; Jamaica; Russian Federation; Ukraine (d)	Nigeria; Russian Federation; Sweden; Ukraine (d)		Armenia; Russian Federation
Alcoa (excl. Arconic)	United States	N	Australia; Brazil; Guinea; Saudi Arabia	Australia; Brazil; Saudi Arabia; Spain; United States	Australia; Brazil; Canada; Iceland; Norway; Saudi Arabia; Spain; United States		Australia; Brazil; Saudi Arabia; United States (rolling mills only)

Note: (a) Chalco's parent, Chinalco, produces semis through subsidiaries such as Southwest Aluminium Group; (b) CITIC, China's state investment fund, acquired a 10% stake in Hongqiao in 2017 through a debt-equity swap; (c) Norsk Hydro operates in many other locations through its subsidiary Hydro Extrusions (formerly Sapa); (d) Disputed ownership.

Although they are all relatively large, the 17 firms studied differ in size (Table 2.2) and in how much of their revenue comes from the aluminium sector. At one end of the spectrum are companies that generate 80% or more of their revenue from the sale of aluminium products: Alba, Chalco, Hongqiao, NALCO, Norsk Hydro, Qinghai Provincial Investment Group, UC Rusal, and Alcoa all fall into that category. A few other companies appear, meanwhile, more diversified, having invested initially into other metals like copper (e.g. Hindalco and Rio Tinto) or into commercial power generation (e.g. SPIC). SPIC is unique in that regard for being one of China's "big five" power-generation SOEs,[66] and as such combines aluminium smelters and refineries with a large portfolio of nuclear- and thermal-power assets. Most other companies in the sample possess nevertheless their own "captive" power plants for generating the electricity they need, as well as their own coal mines in certain cases (e.g. Chalco, Henan Shenhuo, Hindalco, Qinghai Provincial Investment Group, and Vimetco-owned Henan Zhongfu).

5.2. Estimates of direct government support

A taxonomy of support: The OECD matrix of support measures

Support measures differ widely in their design, magnitude, and effects. Following OECD work on agriculture and fossil fuels, this study characterises measures in terms of their transfer mechanism and their formal incidence. The transfer mechanism describes how a transfer is generated, whether through a direct cash transfer; tax or other revenue foregone by the government; transfers induced by regulations or price controls; or the assumption by the government of risks that would otherwise be borne by the private sector. Formal incidence refers to whom or what a transfer is first made, enabling distinctions to be made between support measures that target output levels, unit returns, intermediate inputs (e.g. energy and alumina), or value-adding factors that are either variable (e.g. labour) or quasi-fixed (e.g. capital and land).

Taken together, transfer mechanisms and formal incidence form a matrix (Table 5.2) that encompasses most instruments that governments can use to support particular firms or industries. The particularities of each sector, or the policy question at hand, determine which cells of the matrix will be the focus of the analysis. For example, if the focus is on overcapacity or distortions in capital-intensive sectors, attention may concentrate more, in a first stage, on measures that have the most direct effects on capacity increases, e.g. those that encourage capital investment and asset acquisition (column F); measures that keep loss-making enterprises in business (columns B and F); or interventions that guarantee a certain output price and/or sales volume for extended periods of time (columns A and H). If the focus is primarily on practices that overtly discriminate between domestic and foreign producers, transfers induced by measures such as import tariffs, quotas, local-content obligations, or any government-mandated restrictions on foreign competition (row 5) would be relevant. Additionally, benefits may be conferred not directly by governments, but by governments acting through state enterprises (row 5).

66 The other "big-five"' companies are Datang, Guodian, Huadian, and Huaneng, all of which are centrally managed by the Chinese Government through the State-owned Assets Supervision and Administration Commission (SASAC) (Hervé-Mignucci et al., 2015[11]).

Table 5.2. Indicative matrix of support measures, with illustrative examples

			Statutory or formal incidence (to whom and what a transfer is first given)							
			Production							Consumption
						Costs of value-adding factors				
			A: Output returns	B: Enterprise income	C: Cost of intermediate inputs	D: Labour	E: Land and natural resources	F: Capital	G: Knowledge	H: Direct support to consumers
Transfer Mechanism (how a transfer is created)	1: Direct transfer of funds		Output bounty or deficiency payment	Operating grant	Input-price subsidy	Wage subsidy	Capital grant linked to acquisition of land	Grant tied to the acquisition of assets, including foreign ones	Government R&D	Unit subsidy
	2: Tax revenue foregone		Production tax credit	Reduced rate of income tax	Reduction in excise tax on input	Reduction in social charges (payroll taxes)	Property-tax reduction or exemption	Investment tax credit	Tax credit for private R&D	VAT or excise-tax concession
	3: Other government revenue foregone			Waiving of administrative fees or charges	Under-pricing of a government good or service		Under-pricing of access to government land or natural resources	Debt forgiveness or restructuring	Government transfer of intellectual property rights	Under-pricing of access to a natural resource harvested by final consumer
	4: Transfer of risk to government		Government buffer stock	Third-party liability limit for producers		Assumption of occupational health and accident liabilities	Credit guarantee linked to acquisition of land	Loan guarantee; non-market-based debt-equity conversion		Price-triggered subsidy
	5: Induced transfers		Import tariff or export subsidy; local-content requirements; discriminatory GP	Monopoly concession	Monopsony concession; export restriction dual pricing	Wage control	Land-use control	Credit control (sector-specific); non-market mergers and acquisitions	Deviations from standard IPR rules	Regulated price; cross subsidy
		-- Including advantages conferred through state enterprises						Below-market loan including by state-owned banks		

Note: This matrix is a work in progress and may be refined in the future. Some measures may fall under a number of categories (e.g. debt-equity conversions may involve elements of both risk transfers and revenue foregone). GP = Government procurement. Adapted from OECD (2018[9]).

The OECD matrix of government support measures provides a succinct way to organise the information collected for individual firms in a systematic fashion. While the support measures listed in the matrix are not exhaustive in the sense that they do not explicitly describe all government practices that can distort international trade, the matrix could in principle accommodate even the most complex and multidimensional types of government intervention. It should be viewed as a living taxonomy that can be refined in the context of future work.

While it is not exhaustive, the OECD's broad approach to government support is notably wider than some conceptions of "subsidy": it encompasses any financial or regulatory measures that can affect costs, prices, or the profitability of market actors in any portion of the value chain, wherever they operate. This includes transfers induced by trade-policy instruments (row 5, column A), which were already discussed in Section 4, though not quantified in monetary terms. It also includes support provided through the financial system (rows 3-5, column F), which will be addressed at the end of the present section. In what follows, the analysis first concentrates on measures that confer support to firms through transfers of funds (row 1), tax-revenue foregone (row 2), and other government revenue foregone (row 3).

Data sources

The primary source of information on government support were firms themselves, and the information they disclose in their annual reports, financial statements, sustainability assessments, and bond offerings. Only where information could not be located in firms' own publications or websites did the analysis rely on secondary sources such as industry publications, press reports, and interviews with industry experts. As mentioned earlier, this approach is most successful where firms are publicly listed or have issued corporate bonds on international markets. Listed groups frequently report in their financials the grants they have received from governments under "other income", in accordance with international accounting standards (Deloitte, 2018[46]). Information on tax concessions is sometimes also available in the tax section of company annual reports, where companies can provide estimates of the reduction of tax payments enabled by particular tax credits or allowances.

Other sources of information have included the European Commission's repository of state-aid cases and government budget documents, at both central and sub-national levels, where applicable. This was, for example, the case in the Province of Québec and in the State of Victoria. Budget documents were often complemented by annual reports from state development corporations in the United States (e.g. the Indiana Economic Development Corporation or the Empire State Development Corporation) and other government-related agencies elsewhere (e.g. the State Electricity Commission of Victoria and Hydro Québec). For Brazil, detailed information on tax concessions was obtained from the *Diário Oficial* (official gazette) of the State of Pará, which publishes at regular intervals detailed financial accounts of firms operating in the state, such as *Mineração Paragominas S.A.*

Where information on energy subsidies could not be located in firms' reports or government budgets, estimation at times necessitated assumptions on what energy prices would have been absent those subsidies. There are different ways of estimating energy subsidies; the price-gap approach employed here followed conventional practice at the IEA, the IMF, and the OECD for estimating support to agriculture and fossil fuels. The approach can involve detailed assumptions on the calorific content of coal, the heat rates

of power plants, or the normal power tariffs that would apply to large industrial users of energy.[67]

The use of firms' reports and financial statements as primary data sources hinges on companies providing reliable information and truthful accounts. Although this study assumes this to be the case, there are reasons to believe that certain aluminium producers may have misreported their profits in recent years. There have been, for example, allegations that Hongqiao's financials for the year 2016 may have been incorrect, a theory that finds support in the USD 1.02 billion bailout the company received in 2017 from the CITIC Group, China's state investment company (Box 5.1).[68] According to news reports, one condition for Hongqiao to obtain financial assistance from CITIC was to "complete the audit of its financial results from 2016" (Aluminium Insider, 2017[47]). This example highlights some of the challenges involved in using company reports, and which add to other challenges stemming from significant variability in accounting and reporting standards across firms and countries.

Summary results

Using the taxonomy and the data sources described above, this sub-section looks at the information collected on government support for each firm studied, covering all countries in which these firms operate. This is done by organising the information in terms of the OECD matrix of support measures (Table 5.2) and categorising support according to whether measures target output levels, unit returns, intermediate inputs (e.g. energy and alumina), or value-adding factors that are either variable (e.g. labour) or quasi-fixed (e.g. capital and land). The remainder of the sub-section then highlights particular areas (i.e. cells in the matrix) where support appears more prevalent, such as energy subsidies and tax concessions. Where support takes the form of estimated price gaps (e.g. input-price subsidies), this study has erred on the side of caution as much as possible, opting for the most conservative benchmark. The estimates also do not include additional factors (e.g. under-priced land) in cases where we did not have enough information for estimating the support implied.

Overall picture

Aggregate results for the 17 firms studied show non-financial support to have totalled USD 12.7 billion over the 2013-2017 period[69], i.e. an annual average of USD 2.5 billion. Government support appears fairly common along the aluminium value chain, with all firms examined in the study receiving support in one form or another. That said, their significance varies enormously across individual firms, countries, and types of measures (Figure 5.1).

Government support appears heavily concentrated, with the top five recipients attracting more than 80% of all support. The largest, China Hongqiao, accounted for roughly 30% of all support, followed by Aluminium Bahrain [Alba] (21%) and China's State Power

67 These assumptions are discussed in more detail below.

68 Hongqiao's annual report for the year 2017 documents that CITIC now owns 10% of the company's share as a result.

69 In what follows, support estimates are expressed over a five-year interval given considerable year-to-year variability in the numbers for individual firms (e.g. due to one-off measures).

Investment Corporation [SPIC] (15%). Alcoa and the Qinghai Provincial Investment Group [QPIG] come next, with 12% and 6% respectively. While firm size helps explain why Hongqiao, SPIC, and Alcoa are in the top five, the ranks occupied by Alba and QPIG (two local SOEs) are more surprising given the relatively smaller scale of their operations. Alba stands out in particular given its total smelting capacity of 970 kt. Scaling support amounts using current smelting capacity and annual revenue shows size to be only one part of the story (Figure 5.2). Even controlling for size, the support received by Hongqiao remains, for example, very large.

Box 5.1. Challenges in using company data: the example of the China Hongqiao Group

The Shandong-based China Hongqiao Group ("Hongqiao") has moved in 20 years from producing jeans and denim to being the world's largest producer of primary aluminium by volume and capacity. This growth has been fast by industry standards, raising questions as to its drivers and sustainability.

An anonymous short-seller report released in November 2016 asserted that the high profit margins reported by Hongqiao (on average 18% over the 2011-15 period; see Figure 3.1 for an industry benchmark) were hiding costs and debt that had been moved off the company's books (Anonymous, 2016[48]). The report noted in particular what it perceived as inconsistencies in the financials, whereby Hongqiao was able to post record-high profit margins while at the same time reporting massively debt-funded, negative cash-flow (*ibid*).

This was followed by the release in February 2017 of another report by short-seller Emerson Analytics, which also alleged that Hongqiao had been "under-reporting debt and receiving related-party subsidies" in order to appear more profitable (Emerson Analytics Co. Ltd., 2017[49]). The release of that report caused Hongqiao's stocks to collapse, prompting the company to halt public trading at the Hong Kong stock exchange (Reuters, 2017[50]). Hongqiao reacted by issuing a report of its own in which the firm sought to explain why its electricity costs were lower than those of its Chinese competitors (e.g. Chalco), and how it was able to obtain inputs such as coal and alumina for below-market prices (China Hongqiao Group Limited, 2017[6]).

Hongqiao's refusal to submit to an independent investigation to counter the allegations led Ernst & Young to resign as Hongqiao's auditor (Ernst & Young had assumed that role when Deloitte resigned in 2015). Unable to produce an annual report for 2016 in the spring of 2017, the company turned to Hong-Kong-based auditing firm Baker Tilly Hong Kong Risk Assurance Limited (BT Risk Assurance), which also subsequently resigned (Aluminium Insider, 2017[51]). Hongqiao eventually hired a fourth auditing firm, Shinewing (HK) CPA Limited, to complete its 2016 annual report and financials.

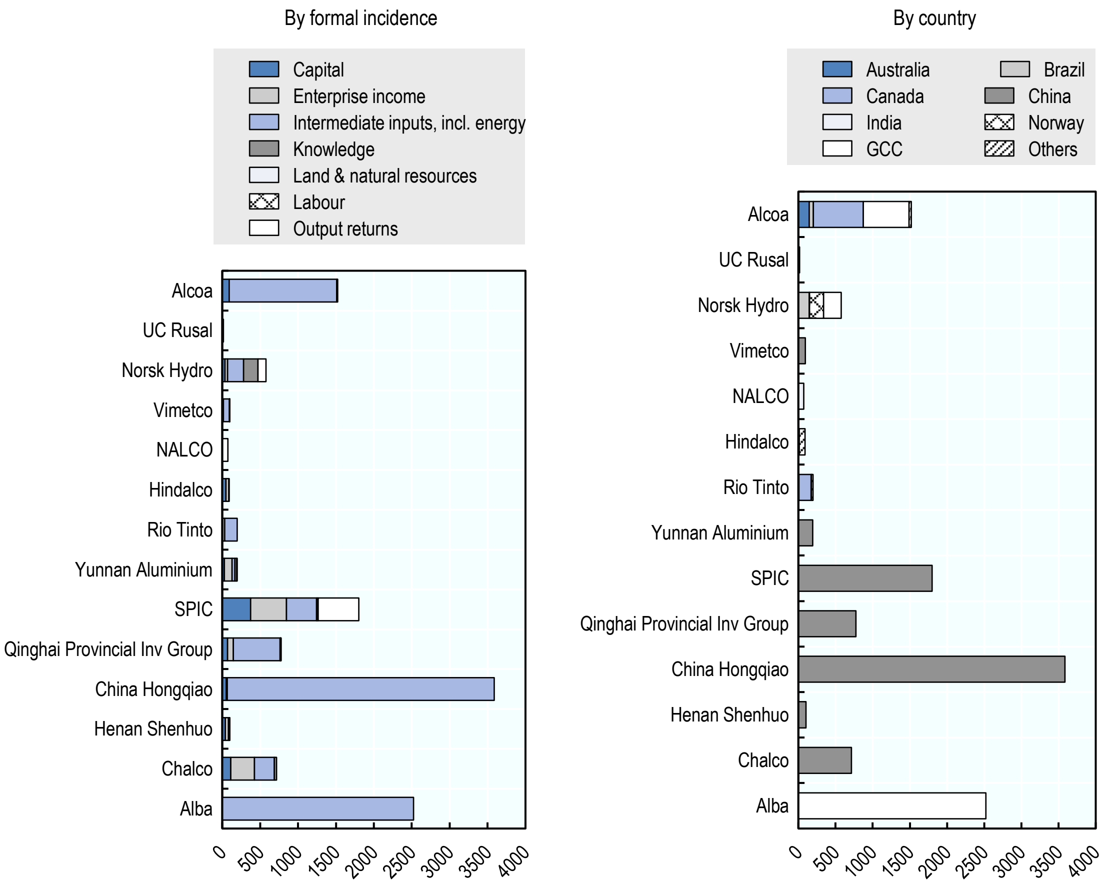
The present study does not seek to endorse any view in the allegations made against Hongqiao. The above example serves, however, to highlight that the use of firm-level data is not immune to data-quality problems.

The Chinese firms in the sample received all of their support from Chinese authorities; by contrast, most other firms received larger amounts of support from countries other than their home base. Outside China, only three firms received all of their support from their home countries, namely Alba (Bahrain), NALCO (India), and UC Rusal (Russian Federation). Alcoa, Norsk Hydro, and Rio Tinto obtained instead relatively little support from the United States, Norway, and Australia[70] respectively, but were, however, able to attract more generous support from the other countries in which they operate, in particular Brazil, Canada, and GCC countries. Aggregating results at the level of individual countries shows China and Bahrain to have the highest levels of non-financial support, followed by Canada, Saudi Arabia, and Qatar (Figure 5.3).

70 Or the United Kingdom, Rio Tinto having two headquarters in two different countries.

Figure 5.1. Support measures are common along the aluminium value chain but differ significantly in scale

Non-financial government support over the period 2013-17 (USD millions, current)



Note: Data for QPIG and SPIC are for the years 2012-16. 'Others' are New Zealand, Russian Federation, Spain, and the United States.
Source: OECD research.

Overall, specialised producers of semis do not seem to receive as much support as smelters (Figure 5.4). The three Chinese companies in the sample that are specialised in the production of semis did not receive large amounts of direct subsidies from Chinese authorities, i.e. less than USD 100 million a year on average. This suggests that the production of semis in China is less subsidised overall than the smelting of primary aluminium, although China Zhongwang, Xingfa Aluminium, and Henan Mingtai may not be representative of the whole sector. Outside of China, Hindalco and Norsk Hydro provide two additional examples, as both companies have important stakes in the production of semis through their acquisition of Novelis and Sapa respectively. In both cases, that element of support that can be related to the production of semis seems modest (e.g. small subsidies to Hindalco from the states of Kentucky and New York) or non-existent (Norsk Hydro). However, the estimates above do not consider the implicit support that subsidies for and export restrictions on primary aluminium may confer to producers downstream.

Although direct subsidies to Chinese producers of semis appear relatively small in the database, this does not account for the large implicit support conferred to these companies by the provision of cheap primary aluminium. Primary aluminium accounts for about 75-86% of total production costs for semis, which makes competitiveness in the semis segment largely dependent on the cost of procuring raw aluminium (Section 2). Combined with the export restrictions identified in Section 4, the different support measures benefitting Chinese smelters have likely depressed domestic prices for primary aluminium, thereby enabling Chinese semis producers to obtain cheaper inputs. While this negatively affects Chinese smelters, whose output sells for less than it otherwise would, it does confer a benefit to Chinese producers of semis that are, generally, not vertically integrated (Table 5.1).

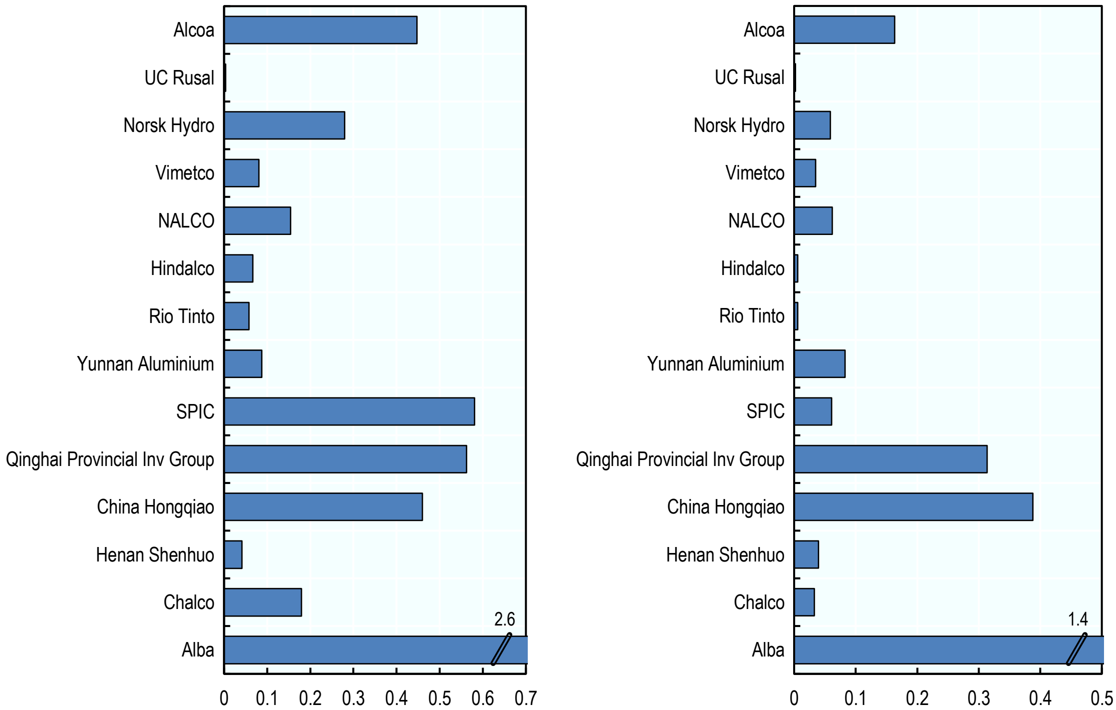
The benefit conferred to Chinese producers of semis in the form of cheaper aluminium is presumably large but hard to estimate. According to standard economic theory, the export restrictions applied on industrial raw materials by a large country such as China should reduce world supply while lowering the domestic price *all other things equal* (Fung and Korinek, 2013[52]). The problem in China's case is that all other things are not equal as government subsidies and other policies have likely had an impact on world supply and international aluminium prices on the LME. This makes it very difficult to obtain a counterfactual that would indicate how much higher prices for primary aluminium would have been in China absent export restrictions and subsidies. This study did not attempt to quantify the implicit subsidy thus conferred.

Government support has generally helped companies in the sample increase their profitability, and even turned losses into profits in certain cases (Figure 5.5). Section 3 noted that the average profit margins of aluminium producers in China and GCC countries had been higher than average, including at a time when aluminium prices were declining (Figure 3.1). The data collected for this study reveal that part of these higher profit margins were likely the result of generous government support. This was especially so for Alba, Hongqiao, and the Qinghai Provincial Investment Group.

The subsidies that helped make Hongqiao and the Qinghai Provincial Investment Group appear more profitable had much to do with the actions of local authorities in China. In Hongqiao's case, the company benefitted enormously from support provided by the municipality of Binzhou, Shandong, which "positively guides and supports the development and growth of the aluminium industry cluster by various policies and arrangements" (China Hongqiao Group Limited, 2017[6]). This support has mostly taken the form of inputs sold at below-market prices to Hongqiao by Binzhou Gaoxin, a local SOE owned by the Zouping Economic and Technological Development Zone State-owned Assets Operation and Management Center, and which "is responsible for the supply of electricity and alumina as well as promoting the implementation of the development plan of the aluminium industry set by the local government, to ensure the stable supply of energy and raw materials for the aluminium industry cluster" (*ibid*).

Figure 5.2. Large differences in non-financial support received by companies are not only explained by size

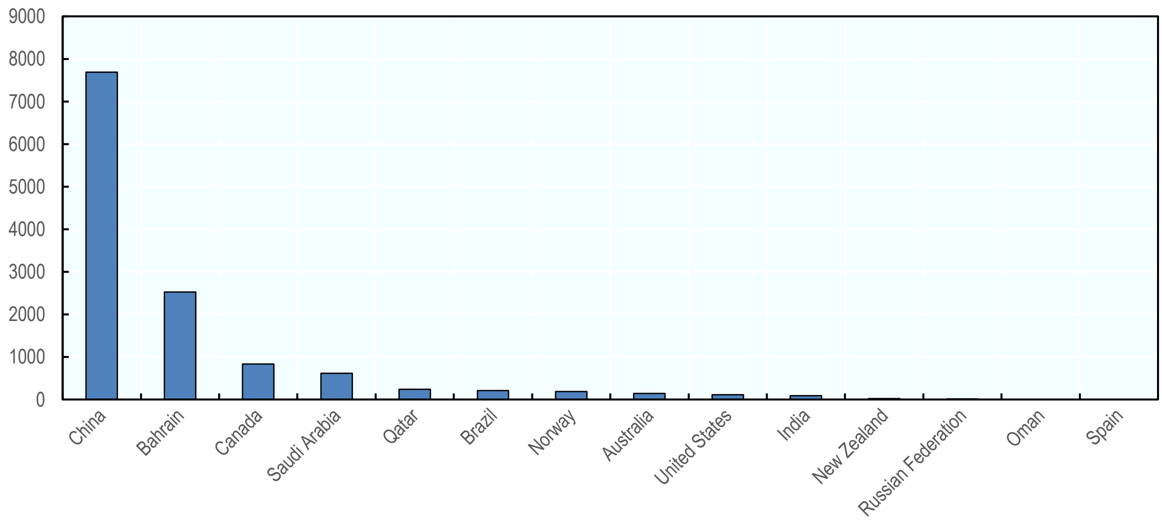
Non-financial government support over the period 2013-17, scaled by smelting capacity (left) and annual revenue (right)



Note: Data for QPIG and SPIC are for the years 2012-16. Smelting capacity is the latest data point available; annual revenue is for 2016.
Source: OECD research.

Figure 5.3. Aggregate results for firms studied show China and Bahrain provide most of the support

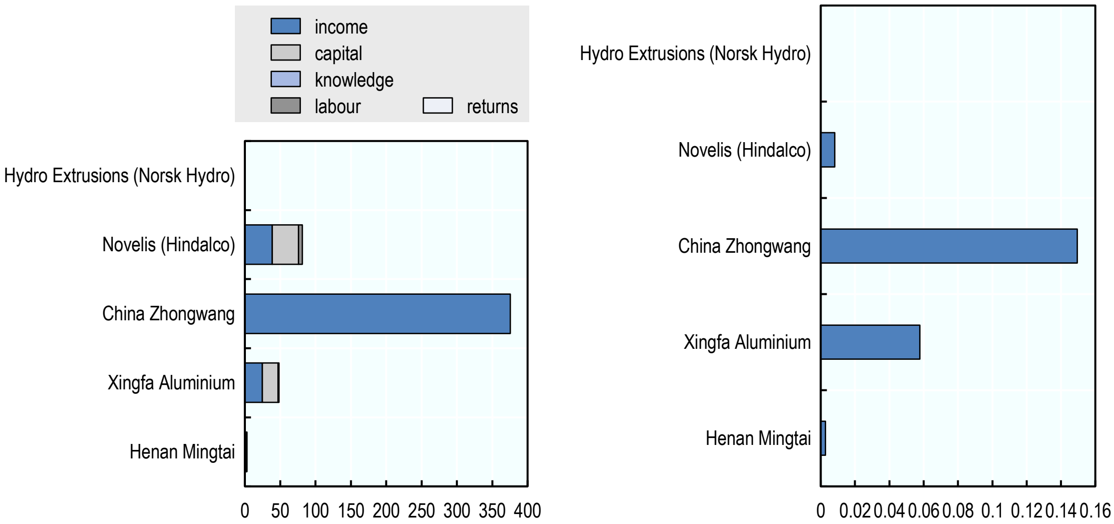
Total non-financial government support over the period 2013-17, by country



Note: The data above are based on a sample of firms and so should not be considered country totals.
Source: OECD research.

Figure 5.4. Specialised producers of semis receive relatively less support globally, but some benefit from support further up the value chain

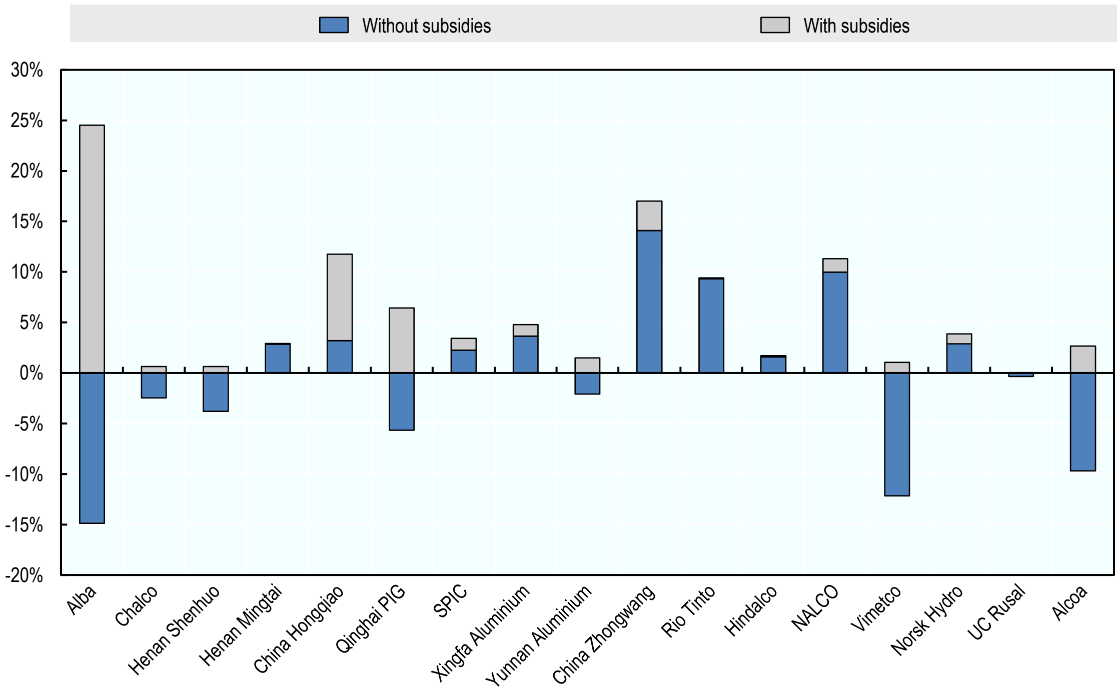
Non-financial government support over the period 2013-17, by formal incidence (left) and scaled by annual revenue (right)



Note: Support for aluminium smelters reached about USD 12.2 billion over the same period. See Figure 5.1.
Source: OECD research.

Figure 5.5. Government support has helped companies increase their profitability

Average profit margins over the 2013-17 period, with and without non-financial government support (%)



Note: Data for QPIG and SPIC are for the years 2012-16, and 2013-16 for Vimetco.
Source: OECD research.

The Binzhou municipality's 2014 *Action Plan for Industrial Upgrading in Binzhou's Five Main Industrial Sectors* corroborates Hongqiao's claims: it singles out explicitly Shandong Weiqiao (a fully owned subsidiary of Hongqiao) so that the company may "develop into a large-scale group offering an integrated aluminium supply chain, from power, alumina, electrolytic aluminium, through to processed products."[71] The *Announcement on Implementing the Made in China 2025 Strategy in Binzhou City*, published in September 2017, further encourages the gradual expansion of local aluminium firms into aluminium deep processing (semis) and finished products.

In the case of the Qinghai Provincial Investment Group (QPIG), the company is 70% owned and managed by the State-owned Assets Supervision and Administration Commission (SASAC) of Qinghai and attracts "strong support from governmental policies" at the province level (Qinghai Provincial Investment Group Co. Ltd., 2017[7]). The firm thus acknowledges receiving (*ibid*):

> *"financial support from the government in the form of capital injections, priority possession rights to mineral resources, governmental grants and subsidies. The Group has also benefited from preferential tax treatment from the Qinghai provincial government in the form of various tax exemptions and concessions. […] In order for the Group to benefit from the subsidies, the aluminium prices needs to be below a certain pricing threshold."*

The company was also able to obtain electricity from the province at cheaper rates; for 2016 that rate was lowered to CNY 0.28 per kWh instead of the prevailing CNY 0.33 per kWh. Yunnan Aluminium, another provincial SOE, likewise obtained cheaper hydro-electricity back in 2012-13.

Industrial zones in China and elsewhere often serve as "subsidy hotspots", wherein governments offer support in numerous forms to investors and established companies. GCC countries also have a number of such zones and parks, where energy-intensive industries (e.g. petrochemicals, aluminium, and fertilisers) concentrate and are able to benefit from tax concessions, facilities, and cheaper inputs. This is, for example, the case in Qatar's Mesaieed Industrial City, where Qatalum, a 50/50 joint venture between Norsk Hydro and Qatar Petroleum, has obtained a ten-year tax holiday coupled with advantageous natural-gas prices that were set for many years at around USD 1 per million BTU (Krane and Wright, 2014[8]).[72] Alcoa, through its 25.1% participation in Ma'aden Aluminium, has also benefitted from the low electricity tariffs offered in the Ras Al-Khair Industrial City in Saudi Arabia. In the Russian Federation, the USITC (2017[4]) has noted that plans are in place to develop "Aluminium Valley", a Rusal-led special economic zone in the region of Krasnoyarsk that would offer an array of tax concessions to encourage foreign investment in the production of semis.

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71 www2.binzhou.cn:8000/xxgkml/html/index.php?tablename=ZFGW_Page_ZFGW&guid=%7B087bd0dd-2cad-40f2-b4f3-3392849f5031%7D (accessed on 30 August 2018).

72 British thermal units. This compares with natural-gas prices in the United States that are between USD 2-4.5 per million BTU, which is already considered a low level in the industry as Asian companies can pay between USD 7-20 per million BTU for their gas in liquefied form.

Overall, the results in Figure 5.1 clearly show input subsidies, and energy subsidies in particular, to constitute the bulk of all support benefitting aluminium producers worldwide. For that reason, the section next takes a closer look at those measures.

A closer look at input subsidies, and energy in particular

Energy subsidies take on particular importance in the context of the aluminium value chain given that electricity accounts for up to 40% of the costs of smelting (Section 2). In the matrix of support measures (Table 5.2), energy subsidies are defined by their formal incidence, not their transfer mechanism. This is because the energy used in the aluminium value chain can be subsidised in different ways, including through direct budgetary transfers (e.g. part of a smelter's energy costs are reimbursed by the authorities), tax revenue foregone (e.g. taxes normally levied on energy use are reduced or eliminated for specific users), other government revenue foregone (e.g. a state-owned utility provides electricity to smelters at below-cost), or induced transfers (e.g. government regulations mandate that energy prices be kept below-market for certain users like aluminium smelters). In all cases, the different transfer mechanisms serve the same purpose, namely to support producers by way of cheaper electricity (or cheaper energy more broadly).

Energy subsidies are relatively easy to estimate where they take the form of direct budgetary transfers or tax concessions (OECD, 2018[9]). Quantifying the value of energy subsidies conferred through other government revenue foregone or through induced transfers can prove much more challenging. The OECD's *PSE Manual* (OECD, 2016[53]) notes that "the associated transfer to producers per unit of input purchased [should be] equivalent to the price reduction accorded to them compared to the price paid by a reference (alternative) buyer of the same input." In the case of electricity subsidies benefitting the aluminium industry, one way to perform this price-gap calculation is to compare the electricity tariff charged to aluminium producers with the average electricity tariff charged to other (large) industrial users in the same country and year (Box A A.3).[73]

Further difficulties arise where aluminium producers operate their own "captive" power plants in order to generate the large amounts of electricity needed in smelting. In this case, information on the costs of captive power generation by aluminium producers may not be readily available, nor would that kind of information necessarily be comparable with the average electricity tariffs charged to other industrial users in the country. An alternative approach is to look for subsidies on the fossil fuels purchased by aluminium producers for their own power generation, be they coal, fuel oil, or natural gas (Kojima and Koplow, 2015[10]). The IEA has been calculating price gaps for fossil fuels since the late 1990s in the context of its annual flagship *World Energy Outlook*, and considerable evidence already exists to suggest that fossil-fuel prices are heavily subsidised in a number of countries (IEA, 2017[54]). Box A A.3 in the Annex provides details on the assumptions and calculations made for this study to estimate energy price gaps.

73 Where countries subsidise electricity on a large scale (e.g. by selling electricity below-cost to all domestic users), the comparison may need to be made with other countries that are sufficiently similar in order to obtain a more accurate benchmark power price. Another option is to estimate an equivalent for the long-run marginal cost of power generation in the country. The IMF, for example, bases its estimates of electricity subsidies on "cost-recovery prices that cover production costs, investment cost, distributional loss, and the non-payment of electricity bills" (Clements et al., 2013[55]).

A large share of the support estimated for Hongqiao, QPIG, and Vimetco[74] (Figure 5.1) originates in the purchase of coal by these companies at below-market prices. Although coal prices have been partly liberalised in China, the government remains heavily involved in the country's coal market, both directly through its ownership of most coal producers (e.g. Shenhua and China Coal, but also provincial coal mines) and indirectly through the provision of finance by policy banks and through regulations (Cornot-Gandolphe, 2014[55]; Hervé-Mignucci et al., 2015[12]). In the case of Hongqiao, the company reports having paid coal prices that are far lower market prices in China (e.g. spot prices quoted at the Qinhuangdao port). Because Hongqiao does not have its own captive coal mines, the Shandong-based company purchases coal from suppliers in Shanxi, from where the coal is then shipped to the company's power plants and smelters by truck (China Hongqiao Group Limited, 2017[6]). Transporting coal by road in China is considered more expensive than rail (Cornot-Gandolphe, 2014[55]), and it is therefore unclear why Hongqiao is able to pay less for its coal than the Qinhuangdao price (Box A A.3).

Government ownership and intervention in energy markets is especially important in GCC countries, with the Middle East accounting for 30% of all price-driven subsidies for fossil fuels according to the IEA (2017[54]). Because the region is energy-rich, most of its subsidies take the form of opportunity costs, i.e. the resource rent that could be recovered if consumers paid world export prices (*ibid*). That being said, several GCC countries producing aluminium have become lately (or are about to become) importers of natural gas, including Bahrain, Oman, and the United Arab Emirates. The energy subsidies measured for GCC countries in this study are very large, echoing higher-level estimates of fossil-fuel subsidies by the IEA and the IMF (Clements et al., 2013[56]; IEA, 2017[54]).

Direct electricity subsidies were also found in several cases, particularly in the Province of Québec in Canada, but also in China and in the states of New York (United States) and Victoria (Australia). In Québec, the subsidies take the form of published government decrees specifying the conditions under which individual aluminium smelters get to purchase electricity from the provincial state-owned power company, Hydro Québec. For certain smelters (but not all), the prices derived from those decrees can be USD 0.01-0.02 per kWh below those paid by other large industrial users of electricity in the province. The lower prices are generally awarded to aluminium producers as *quid pro quo* for additional investments in Québec.[75]

There likely remain important data points that this study has not been able to cover, especially where information on input quantities and prices is scarce or patchy. The prices and availability of land and water are one such area, for which a lack of transparency has hindered efforts to estimate support where it exists. Qualitative information was nevertheless uncovered that suggests the existence of possible land-related support in, at least, Bahrain and China. The Binzhou municipality in Shandong, where Hongqiao's operations are located, offers, for example, rebates for 50% of land-transfer fees paid by companies establishing a presence there. It is unclear whether, and to what extent, Hongqiao has been able to benefit from this measure. Additionally, it appears that land prices in certain industrial zones may be far below prices elsewhere in China: land in the

74 Vimetco owns Henan Zhongfu.

75 See for instance http://news.alcoa.com/press-release/alcoa-reaches-power-agreement-improve-competitiveness-quebec-smelters-secure-3000 (accessed on 31 August 2018).

Zouping Economic and Technological Development Zone in Shandong – an area approved by the Shandong Provincial People's Government and the State Council – appears to sell for much lower than elsewhere in China, i.e. CNY 239 per meter square in 2012[76], compared with prices in Shandong that ranged between CNY 1 050-1 100 per meter square.

Selecting an adequate benchmark price for land – i.e. how much land would cost absent support – is fraught with difficulties, however. In the case of Shandong mentioned above, part of the land there is likely farm land that has been transformed and upgraded into industrial land, with unclear implications for how to price it. A similar issue arises in Bahrain: Alba's 2017 annual report notes that: "the Group is using land leased from the Government of Bahrain […] and land leased from The Bahrain Petroleum Company B.S.C. […]. These leases are free of rent." Yet it is not obvious what that rent should be since land in the GCC is sometimes just land reclaimed from the desert.

More generally, the selection of benchmark prices for estimating input subsidies inevitably involves a number of choices and assumptions, and this study has erred on the side of caution as much as possible, opting for conservative benchmarks at different stages. Coupled with the number of data points that are not covered (e.g. land and water subsidies), this implies that the results presented above should be considered lower-bound estimates.

A closer look at tax incentives and concessions

Besides input subsidies, tax concessions are another important form of support that is found throughout the whole value chain, from bauxite mining to the production of semis. Most of the measures are deviations from normal income-tax rules, whereby companies satisfying specific criteria are subject to lower rates of tax or granted special deductions from taxable income. In other cases, firms are granted an outright tax holiday (i.e. zero taxes) for a pre-defined number of years.

These measures are especially widespread in Brazil, China, and GCC countries. Brazil's SUDAM tax incentives encourage, for example, investment in the country's Amazon region, where they have benefitted the operators of bauxite mine and alumina refineries such as Mineração Rio do Norte and Alunorte.[77] China similarly encourages economic activity in Western provinces (e.g. Gansu, Qinghai, and Xinjiang) through lower rates of income tax under the country's Western Development Strategy. Those are generally the same provinces that have seen new smelting capacity, and which are singled out in the *2016-20 Non-ferrous Metal Industry Development Plan*. China also offers lower rates of income tax (or tax holidays altogether) to companies producing specific goods that the government wants to encourage. This includes certain aluminium semis, such as those produced by China Zhongwang, China's largest extrusion company, which has obtained

76 See http://ezone.mofcom.gov.cn/article/ao/201210/20121008406291.shtml and www.chyxx.com/data/201802/613918.html (accessed on 31 August 2018).

77 Both are joint ventures involving companies from OECD countries (e.g. Alcoa, Norsk Hydro, and Rio Tinto).

the 'High and New Technology Enterprise' status from Liaoning Province and the lower taxes attached to that status.[78]

The bulk of all tax concessions found in this study benefits enterprise income and capital as per the OECD matrix of support measures (Table 5.2). Support for physical capital is especially important for its effects on investment, and thus for favouring the renewal of a company's capital stock. By encouraging a faster replacement of machines or an increase in the stock of physical assets, such measures may give beneficiaries a competitive edge through access to more recent technologies. A consequence for competition may thus be that countries that have subsidised capital the most end up having the most competitive firms, e.g. the most energy-efficient smelters. In turn, those firms that have acquired newer equipment may subsequently be able to compete effectively without subsidies.

Other forms of support

The remainder of measures found in this study are generally smaller and concern support for labour and R&D (i.e. knowledge), which represented 0.1% and 2.2% of all support, respectively. A few one-off 'bail-outs' were also identified, whereby governments seek to prevent a plant from closing and shedding jobs. Those measures generally take the form of direct budgetary transfers and can involve the central government or local authorities (e.g. states or counties). Sometimes both levels are involved: the Federal Government of Australia and the State of Victoria committed jointly AUD 240 million (about USD 173 million) in funding to prevent the closure of Alcoa's Portland smelter following a power outage in December 2016.

Some of these measures are of greater concern than others from a competitive standpoint, particularly those that prevent the exit of older, inefficient plants. Others can be less problematic where they seek to improve working conditions or encourage basic research as opposed to those research activities closer to commercial applications. The Government of Norway provided, for example, a total NOK 1.5 billion (about USD 180 million) over several years to Norsk Hydro for supporting R&D at the Karmøy demonstration plant.[79] The United States Government, through the Department of Energy, likewise supported Alcoa's research efforts into aluminium recycling, high-strength automotive sheet, and CO_2 sequestration. Examples of labour-related support measures would include the subsidies that certain Chinese smelters received in relation to training and social security (e.g. SPIC and Yunnan Aluminium), or the workforce-training grants Alcoa obtained from the States of Indiana and Washington.

5.3. State involvement along the aluminium value chain

Governments are involved at different stages of the aluminium value chain through SOEs and direct participation in mining joint ventures. This study estimates state ownership globally to account for at least 27%, 34%, and 41% of total capacity in bauxite mining, alumina refining, and smelting respectively (Figure 5.6). States have traditionally retained important stakes in their mining sectors given that subsoil resources belong to the public

78 It should be added that government grants are usually free of income tax in China (Taube, 2017[16]).

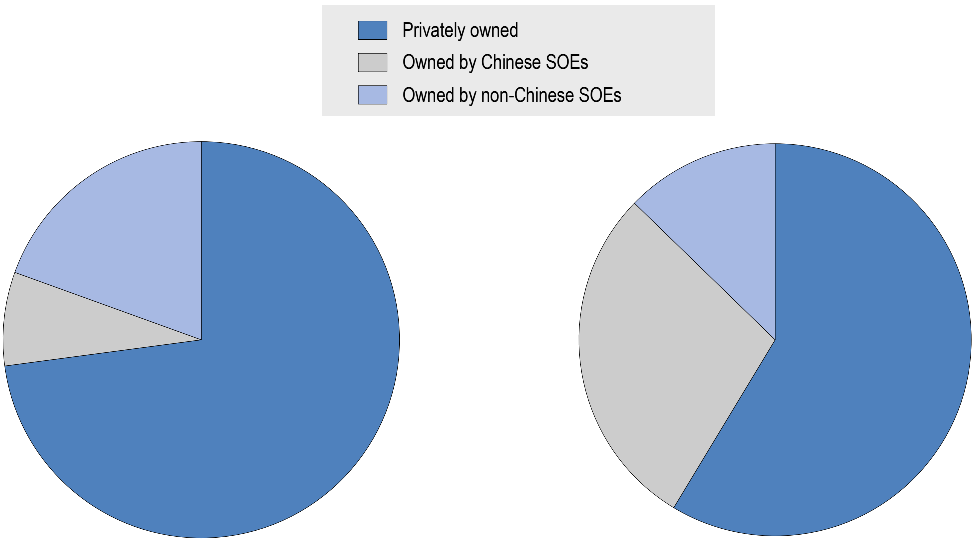
79 Those grants were notified and approved in 2015 as authorised state aid by the EFTA surveillance authority.

in most jurisdictions.[80] It is therefore not surprising that about a quarter of all bauxite-mining capacity is currently in the hands of governments. Growing ownership of capacity by the state moving up the value chain is more surprising and largely accounted for by China, Norway, and the GCC countries. China alone makes up more than two-thirds of all state-owned capacity in both alumina refining and aluminium smelting.

China, Norway, and the GCC countries all have a strong tradition of state ownership in multiple sectors of the economy, including oil and gas extraction (e.g. PetroChina, Equinor, and Saudi Aramco) and airlines (e.g. Air China and Qatar Airways).[81] In China's case, it has been estimated that the country "has more than 150 000 companies that are owned by various strata of government, accounting for about 25% of economic output and one in five urban jobs" (McMahon, 2018[13]). It is therefore not surprising to find governments in these countries owning some or all of the aluminium-smelting capacity, as well as the power plants that generate the electricity for the smelters.

Figure 5.6. State ownership accounts for at least 27% and 41% of total capacity in bauxite mining and smelting respectively

Ownership of total capacity by segment (%)
Left: bauxite mining; Right: aluminium smelting



Note: These estimates do not account for cases where governments own 10% or less of a given facility or company. Companies like China Hongqiao and Aluar Aluminio Argentino S.A.I.C. are therefore considered private.
Source: OECD research.

The ways in which SOEs are managed in different countries, and the extent to which governments exert influence over SOEs' decisions and operations can have important implications for global competition. For example, China's SPIC mentions explicitly in a 2016 bond prospectus that "[it] is one of 52 backbone state-owned enterprises supervised

80 Non-federal land in the United States is an important exception.

81 The Norwegian Government sold its remaining shares in Scandinavian airline SAS in June 2018.

by SASAC[82]" and that "[it] plays a key role in the formulation and implementation of policies in the power sector", for which it "receives comprehensive and sustainable support from the PRC Government" (State Power Investment Corporation, 2016[11]). The Qinghai Provincial Investment Group similarly notes in a 2017 bond prospectus that "the Qinghai provincial government can exert significant influence on the Group" (Qinghai Provincial Investment Group Co. Ltd., 2017[7]).

Ownership forms but one of different ways in which governments can exert influence over companies in the aluminium value chain. Earlier OECD work has emphasised the broader concept of 'state enterprise' since "*ownership* is neither necessary for governments to influence enterprises' operations, nor does it inevitably entail such influence" (Kowalski and Rabaioli, 2017[18]). State influence is evident through the support that private companies such as China Hongqiao, China Zhongwang, and Henan Zhongfu (Vimetco) have obtained from central and local authorities in China, and to a much lesser extent Alcoa from Saudi Arabia. The results discussed in Section 5.2 indeed show that SOEs are not always the largest or the only recipients of support, echoing others' findings that "state subsidies [in China] flow into [SOEs], although some well-connected private firms also benefit from indirect subsidies" (Haley and Haley, 2013[19]), and that "many so-called private companies maintain close connections to government organizations through political, business or personal ties" (Taube, 2017[17]).

This suggests state influence in the aluminium value chain to be a matter of degree, ranging from benign regulatory oversight to stronger forms of government involvement. To be sure, governments have an important role to play in the economy, be it to redistribute income and wealth, to correct market failures, or to ensure the provision of public goods, among other goals. This role becomes, however, problematic where government involvement in an industry serves to favour domestic companies at the expense of foreign firms. The countries covered in this study seem to be located at different points along this spectrum. Some have no state ownership of production facilities and provide relatively little support, if any at all (e.g. Iceland, New Zealand, Spain, and the United States). Other governments own a significant portion of local capacity but provide small support in relative terms (e.g. Norway and Oman). Then are some countries that do not own much capacity but that provide significant support relative to the former two groups (e.g. Brazil and Canada). Finally are countries that both own a sizable portion of local capacity and provide much larger support to local firms (e.g. Bahrain, China, Qatar, and Saudi Arabia).

This last set of countries are usually characterised by administered input prices (e.g. energy) and a strong role of the state in allocating capital across industries and firms. Saudi Arabia's Public Investment Fund, for example, channels the country's wealth into hundreds of companies to diversify the economy away from oil in line with Saudi Vision 2030. What makes China different in this case is the porous and fluid relationship that the government maintains with companies, including through the appointment of key personnel and the day-to-day operation of firms. SPIC mentions in its 2016 bond prospectus that "the Group's Chairman and President is appointed by the State Council, Directors are accredited by SASAC, the Chairman of Board of Supervision is appointed by the State Council directly and the Vice President is appointed by SASAC" (State

82 China's State-owned Assets Supervision and Administration Commission (SASAC), which is itself supervised by the State Council.

Power Investment Corporation, 2016[11]). The same document also notes that "the PRC government continues to play a significant role in regulating industrial development, the allocation of resources, production, pricing and management" (*ibid*).

Critically, the relationship in China between the government and companies generates opacity around the form and scale of government support. One example is the provision of inputs such as coal, alumina, or electricity by Chinese SOEs to other companies – public or private – for prices that are below market, and for which it can be very difficult to identify the specific policies that underlie support (where they even exist). This example illustrates a broader tendency for "provincial and municipal governments [in China to] subsidize purchases of raw materials by requiring other SOEs or pressuring their own suppliers to provide these inputs at below-market or even below-cost prices" (Haley and Haley, 2013[19]). One observer of China's economy thus noted how "the government creates market infrastructure but then fiddles with the rules or applies them inconsistently", thereby allowing it "to blur the line between public and private" (McMahon, 2018[13]). This fluidity in the rules contributes to making Chinese policy opaque to outsiders, rendering it difficult to "ascertain the true policies that underlie the subsidies" (McMahon, 2018[13]; Haley and Haley, 2013[19]).

State influence in China is especially evident in the area of financing, with companies able to borrow from policy banks and other state-owned financial institutions on terms that are much more favourable than those available in private markets. SOEs alone account reportedly for as much as 60% of all corporate debt in China (McMahon, 2018[13]). This points to the complex role that state enterprises play as both recipients and providers of support. Financial support in China takes many forms, including lower rates of interest, longer grace and repayment periods, equity injections, as well as explicit (or implicit) government guarantees. Credit-rating agency Fitch has, for example, aligned its rating of SPIC ('A') with that of the China sovereign[83] on account of its close ties to the Central Government, while noting that the company's stand-alone credit rating was in fact 'B', i.e. a highly speculative investment (Reuters, 2017[57]). Yet SPIC has been able to obtain loans at interest rates that are below the People's Bank of China (PBOC) benchmark, as documented in the next sub-section.[84] Rating agency Standard & Poor's likewise noted in June 2018 that its rating of the Qinghai Provincial Investment Group would likely be reduced by more than one notch should the provincial authorities provide less support to the company.

Recent years have also seen an increase in the number of debt-equity swaps in China, whereby an SOE acting on behalf of the government converts the debt of highly leveraged firms into shares, thus increasing government ownership in the economy. Hongqiao was one of the beneficiaries in 2017 as the company obtained a USD 1.02 billion injection from the CITIC Group, China's state investment company, to

83 At one notch below the sovereign rating, meaning A instead of A+.

84 Interestingly, some of these loans may have been used to fund acquisitions overseas, e.g. bauxite mines in Guinea (Reuters, 2017[73]).

help the firm repay bank loans (Aluminium Insider, 2017[47]).[85] The operation implies that the government now owns 10% of Hongqiao[86], a heretofore private company.

Debt-equity swaps provide assistance in the form of much-needed financial relief to highly leveraged firms. They are problematic, however, where that assistance is offered on non-market terms. Based on the limited evidence available recent debt-equity conversions in China's aluminium sector appear at this stage to have been priced in line with market principles (Taube, 2017[17]). In addition, the IMF recently noted that debt-equity swaps in China may play a useful role "in addressing the problems of excessive corporate debt and impaired bank loans" (Daniel, Garrido and Moretti, 2016[58]). This argument is, however, tempered by the important caveat that debt-equity swaps could "backfire" (e.g. through moral hazard) if not accompanied by a comprehensive strategy of corporate restructuring (*ibid*). Debt-equity swaps also do not address the root cause of firms' excessive leverage, which may itself have resulted from the earlier extension of loans to companies that were not creditworthy. The securitisation of non-performing loans (NPLs) has also been proposed as a preferable alternative to debt-equity swaps in the Chinese context, "insofar as it reduces the exposure of banks to underperforming corporates and the NPLs are acquired by an entity with greater expertise in restructuring the company" (OECD, 2017[28]; Daniel, Garrido and Moretti, 2016[58]).

5.4. Support provided through the financial system

The discussion above on state influence has already hinted at the important role that it plays in the context of China's financial system. In this sub-section, the analysis now turns to that particular aspect of government support in order to quantify the extent to which aluminium firms in the sample have obtained financing on concessional terms. Given the issue's complexity and the assumptions involved, the approach taken here is sequential, considering different scenarios in turn, starting from the most conservative and evolving gradually towards more wide-ranging estimates. A bird's-eye view of the financial health of companies in the sample is also provided first in order to set the broader context for the subsequent estimates.

A bird's-eye view of financial health for firms in the sample

This study uses information contained in financial statements to provide a snapshot of the sampled firms' financial wellbeing. Firms' investment decisions to expand productive capacity are dependent on their ability to generate funds, either through their own internal activities or through external financing. In turn, their performance and financing structure are crucial in determining their ability to raise the necessary funds to pursue their productive and investment activities. These elements are here assessed by developing indicators that can shed light on firms' profitability, their funding structure, and the extent to which they are exposed to financial difficulties. Together, these indicators can also be used to detect financially constrained firms and inconsistencies among the indicators,

85 This occurred despite the company reporting record profits in the years leading up to the bail-out. See Box 5.1.

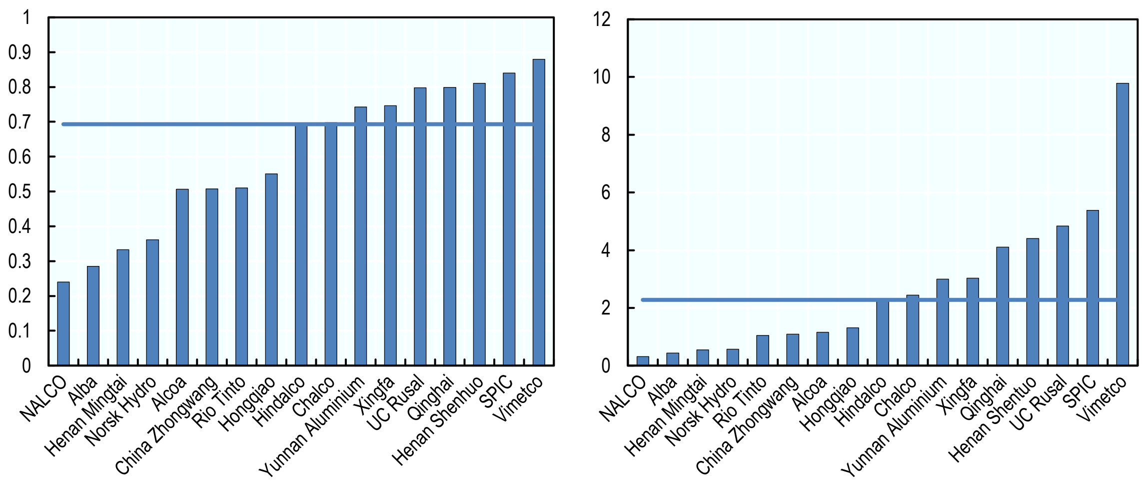
86 This share could increase to 13.3% should the government decide to convert into shares convertible bonds worth USD 320 million.

which could hint at the presence of other factors that are not accounted for by financials and warrant further investigation.

Firms studied appear to have resorted to debt financing as their main source of external funding and to have maintained high levels of leverage over the 201016 period. Debt-to-equity ratios are above one for most of them (Figure 5.7), with debt representing four to nine times the equity level for many companies. The persistent use of debt to raise funds for their activities coincides with high levels of indebtedness, with several firms having a leverage ratio of more than 60%.

Figure 5.7. Firms rely on debt as a source of external funding

Average leverage ratio (left) and average debt-to-equity (right) over the period 2010-16



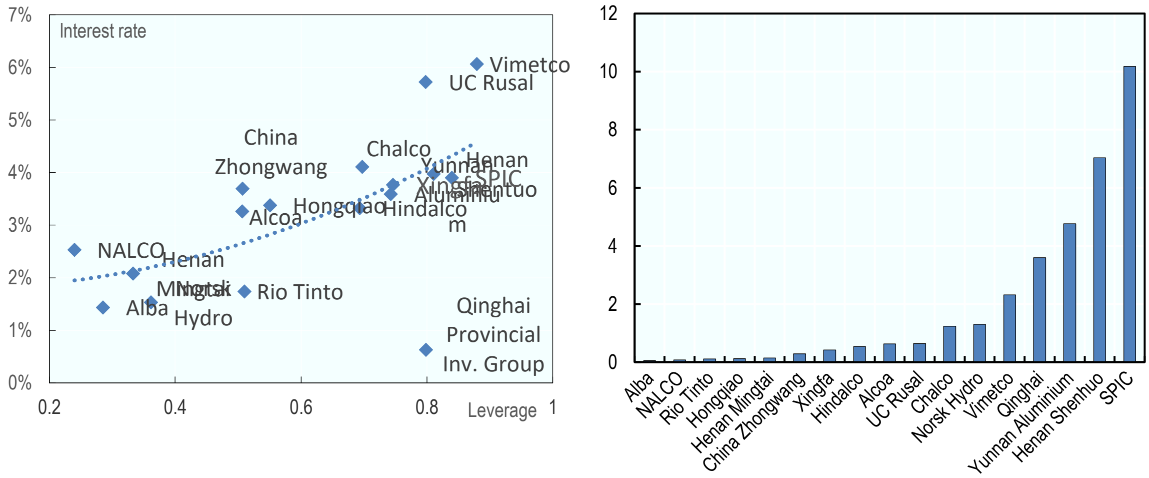
Note: Leverage ratio measures the proportion of debt as a source of external funding used to finance a firm's assets. It is calculated as the ratio of debt to total assets. The blue horizontal line represents the sample median over the period.
Source: OECD calculations on the basis of the Orbis database.

High debt levels are problematic when the debt burden becomes excessive, crowding out productive investment and increasing vulnerability to economic downturns. However, if the firm is indebted at a low cost, or is generating enough cash flow to pay off its debt and invest in future growth, then high leverage ratios can be acceptable. In order to ascertain whether firms are indeed burdened by debt payments, the interest coverage ratio is a metric that informs on whether a firm is able to pay interest with the profit it generates. For a number of firms, interest payments exceed their profits by a multiple of five to seven over the period studied (Figure 5.8).

The interest rate represents the return investors demand for incurring the opportunity cost of foregone alternative projects, as well as the risk of default associated with high levels of leverage. A firm's excessive indebtedness should therefore translate into a higher interest rate: there is generally a positive relationship between the leverage ratio and the implicit interest rate on firms' debt holdings (Figure 5.8). This positive relationship is, however, not satisfied by some firms (e.g. Qinghai Provincial Investment Group), indicating a decoupling between the price of capital and the level of debt.

Figure 5.8. The more leveraged firms face higher interest rates, though there are exceptions

Average interest rate and leverage (left) and inverse interest coverage ratio (right) (2010-17)



Note: The implicit interest rate is a proxy for the cost of financing for firms. It is calculated as the interest payment divided by the average debt level in the same and previous period. The implicit rate is not qualified by the risk profile of countries where firms operate. Therefore information from the graph is partial. The inverse interest-coverage ratio is calculated by dividing interest expenses by operating profits before taxes and interest payments (EBIT).

Source: OECD calculations on the basis of the Orbis database.

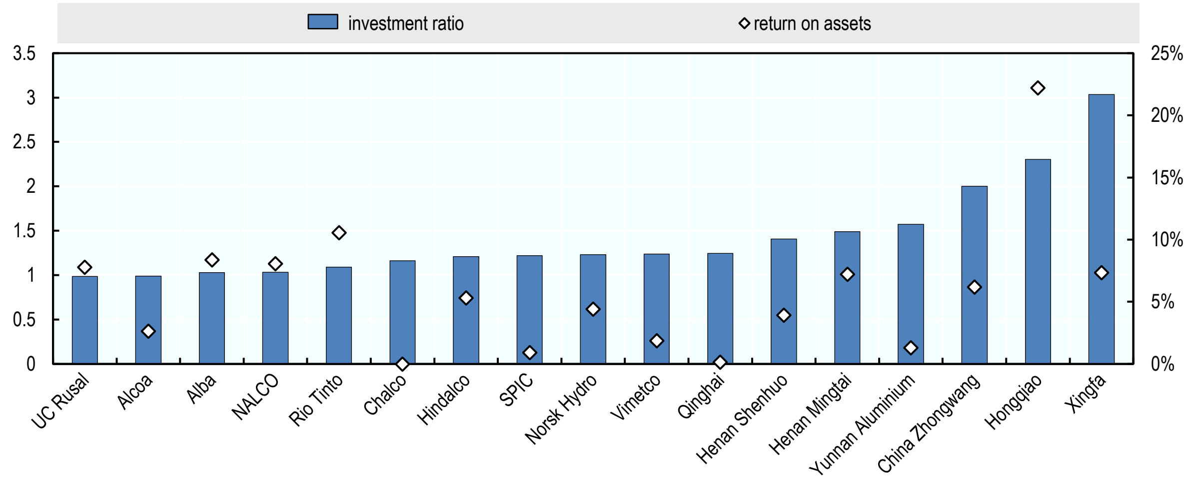
The low interest rates calculated for some firms, despite their high inverse interest-coverage ratios, already hint at the presence of support programmes that mute the role of debt levels in the setting of the price of capital. The impact of leverage on interest rates could, however, be offset were firms' profitability and growth prospects shown to be promising. To see whether that is the case, this study looks at the return on assets as one indicator measuring the overall power of earnings. This indicator measures the earnings generated by the invested capital. On average, firms' return on assets is 6%, with an outlier firm, Hongqiao, reaching 22%.[87] Despite below-average returns on assets, firms have kept investing as evidenced by positive growth rates in capital accumulation (Figure 5.9).

These indicators suggest an inconsistency between the rising debt level on firms' balance sheets and their declining profitability, which would normally suggest a decreased ability to borrow at lower rates. In what follows this top-down approach is complemented with information on concessional borrowing, with a view to determining the extent to which government credit support is affecting firm outcomes and market prices for capital.

87 Box 5.1 has already discussed the questions that surround Hongqiao's financials.

Figure 5.9. Investment remains high despite low returns on asset for several firms

Average investment ratio (left scale) and return on assets (right scale), 2010-16



Note: The investment ratio is measured as the increase in the capital stock; the return on assets is measured as profits (EBIT) divided by the average total assets over two consecutive periods.
Source: OECD calculations on the basis of the Orbis database.

Estimating concessional borrowing at the firm level

Governments can intervene in financial markets by offering firms better contractual terms than those that would have been available in private markets, such as preferential interest rates and longer repayment terms. In addition, they can ease the terms and conditions of private loans through explicit or implicit government guarantee. Such government-backed financial vehicles commonly increase access to financing and lower the cost of capital for recipients, even for projects or firms that are not necessarily financially viable.

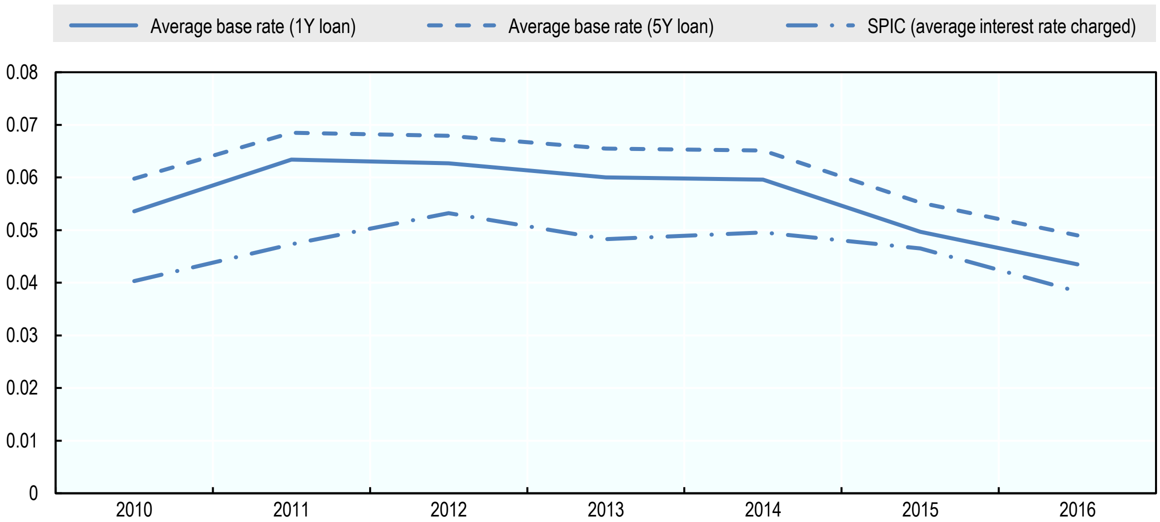
There is anecdotal evidence that certain firms in China have obtained financing on concessional terms. First among these is state-owned SPIC, which in a 2016 bond prospectus explicitly states that it attracts considerable financial support from Chinese policy banks, and that this support bears "interest rate below benchmark" (State Power Investment Corporation, 2016[11]). From 2010 to 2016, for instance, the yearly average interest rates that SPIC paid on its borrowings[88] were lower than the average lending base rate published by the People's Bank of China (PBOC) (Figure 5.10). These numbers are consistent with other reports finding that SPIC and the other 'big-five' power-generation SOEs in China have obtained abundant access to finance at rates below or equivalent to the PBOC benchmark rate (Hervé-Mignucci et al., 2015[12]).

The Qinghai Provincial Investment Group (QPIG) likewise mentions in a 2017 bond prospectus that it maintains strong ties with Chinese banks, including state owned banks, joint-stock banks, and most notably policy banks that have provided QPIG with low-cost financing sources (Qinghai Provincial Investment Group Co. Ltd., 2017[7]). Yet the discussion of aggregate financials above indicated that QPIG has low profitability and high debt levels. There can be many reasons why interest rates are low for SPIC, QPIG, and other firms; however, the stark contrast between poor financial indicators and low

88 Calculated as interest payments over the average of total borrowings in year t and t-1.

interest rates may suggest some potential under-pricing of the risk associated with those borrowers.

Figure 5.10. Average interest rates charged to SPIC have been below Chinese base rates



Source: OECD calculations on the basis of SPIC financials.

In what follows, we seek to gauge the prevalence of concessional borrowing in a systematic fashion for all firms studied. Although estimating the exact amount of subsidy attributable to below-market-rate borrowings is far from straightforward, a comparison can be made between the actual interest rate that firms bear and a hypothetical benchmark rate that could have been charged in private markets (Box 5.2) in order to arrive at a subsidy equivalent. Given the sensitivity of results to the assumptions made and potential data-quality concerns for some firms, the analysis is undertaken incrementally in three tiers, with each tier adding different spreads on top of a base rate:

- *Tier 1* adds to the base rate spreads that reflect the risk profile of USD-denominated debts, taking into account individual company credit ratings.
- *Tier 2* is similar to Tier 1 but considers the risk profile of debts denominated in the local currency.
- *Tier 3* considers the additional interest that would have been charged absent the implicit government guarantee enjoyed by some firms.

Tier 1 analysis finds the total subsidy equivalent during 2013-17 to have reached a total of at least USD 7.5 billion for all companies studied. Of these companies, SPIC (USD 2.5 billion, 33% of the total), Hongqiao (USD 1.4 billion, 18%), and Chalco (USD 0.9 billion, 12%) accounted for the largest portion (Figure 5.11). The bulk of the estimated subsidy arose from loans, with only USD 1 billion stemming from corporate bonds.[89] Furthermore, because both SPIC and Hongqiao only disclose a range for their interest rates rather than weighted averages, actual subsidy equivalents may in fact have

89 Investors assume corporate bonds in China to be implicitly guaranteed by the government (McMahon, 2018[12]).

exceeded these amounts had the upper bound of the range[90] applied, i.e. USD 5.5 billion and USD 1.8 billion for SPIC and Hongqiao respectively. Controlling for firm size changes the picture somewhat, and shows in particular Henan Shenhuo, QPIG, and China Zhongwang (a semis producer) to have obtained disproportionately large financial support.

Box 5.2. The estimation of benchmark interest rates

To assess the interest rates charged, information was collected from firms' annual reports, bond prospectuses, and other company-level documents. Wherever a firm discloses individual interest rates applied on each single loan, or some weighted average of interest rates incurred throughout the year, those rates were taken into account. Where such numbers are not publicly available, the analysis calculated instead implicit interest rates by dividing interest payments in any given year (t) by the average debt outstanding in the same year (t) and the previous year (t-1).

Benchmark rates were established by combining two major components, namely the risk-free base rate and additional spreads corresponding to different credit-risk levels. Risk-free base rates vary by currency and include: interbank rates (e.g. The London Inter-bank Offered Rate [LIBOR], the Euro Interbank Offered Rate [Euribor]), which were utilised in the case of variable-rate loans; government bond yields for fixed-rate, long-term loans and bond financings; and other commonly used base rates reflecting country-specific circumstances. Examples of the latter would be the base rates published by the People's Bank of China (PBOC), which apply in case a loan is denominated in Chinese RMB, and the base rates or Marginal Cost of Funds-based Lending Rates (MCLR) applied to loans denominated in Indian rupee. In all cases, rates are selected to match the currency and tenor to a weighted average life of transactions where information is available.

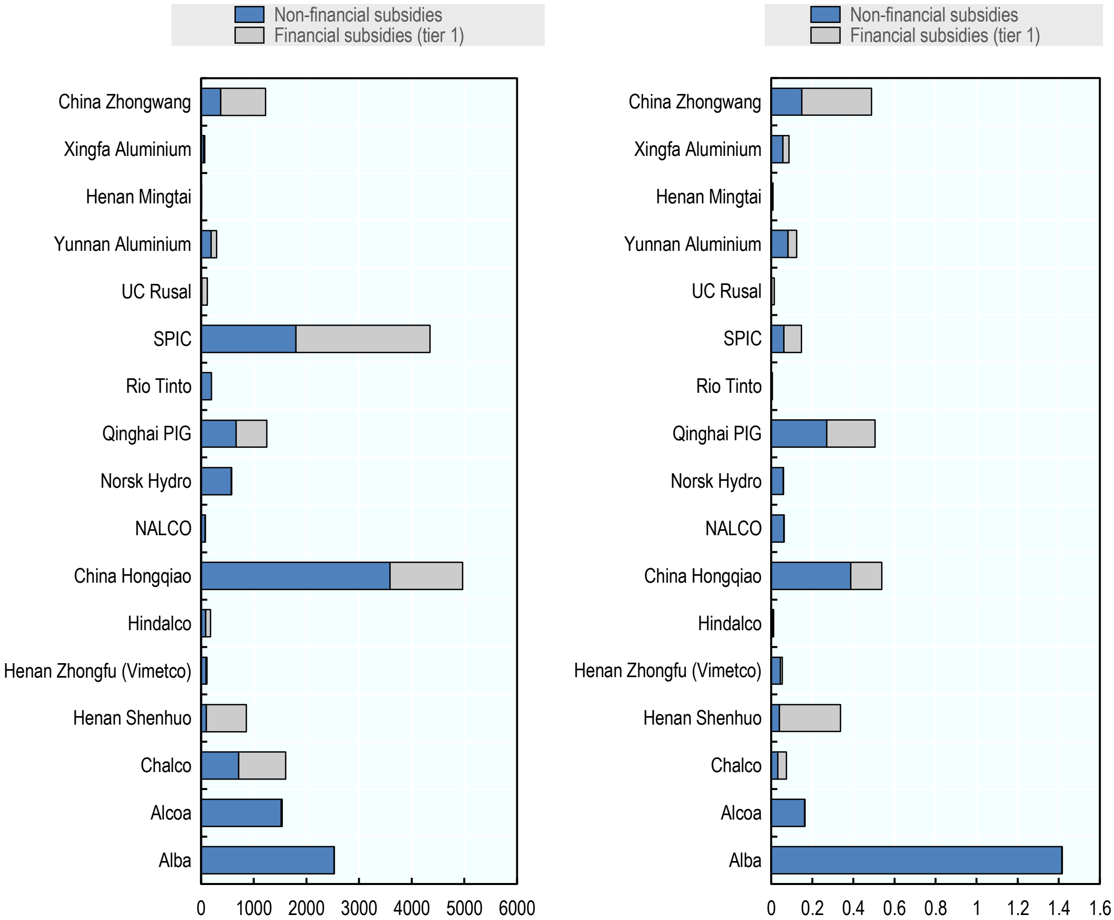
The second component, i.e. risk-adjusted spreads, consists of three tiers that are applied incrementally in the analysis. They are specified as follows:

- *Tier 1*: These are risk-adjusted spreads that are established based on the average spread to Treasury bond yields of US corporate bonds for a relevant industry (e.g. the non-energy mineral sector). Spreads are differentiated by credit ratings and maturities (to match the weighted average life of transactions). In other words, Tier 1 spreads apply uniform risk-adjusted spreads regardless of the currency of transaction.
- *Tier 2*: These spreads account for additional factors attributed to local bond markets or practices. For instance, for debts denominated in Chinese RMB, Tier 2 spreads represent the difference between the credit spreads of corporate bonds denominated in Chinese RMB and bonds denominated in the US dollar.
- *Tier 3*: These correspond to the additional spreads that would have otherwise been charged absent government guarantees for SOEs. The reports of accredited credit-rating agencies usually base firms' stand-alone credit ratings on financial performance and additional external factors, including ties to the government and expected government support in case of financial distress. Considering such information, Tier 3 spreads represent the increase in interest rate that would occur absent such government support.

90 That is, the lowest interest rate in the range.

Figure 5.11. Tier 1 analysis finds financial subsidies to have reached at least USD 7.5 billion

Non-financial vs. financial government support (Tier 1) over the period 2013-17 (USD millions, current)
Left: Absolute amounts; Right: Scaled by revenue in 2016

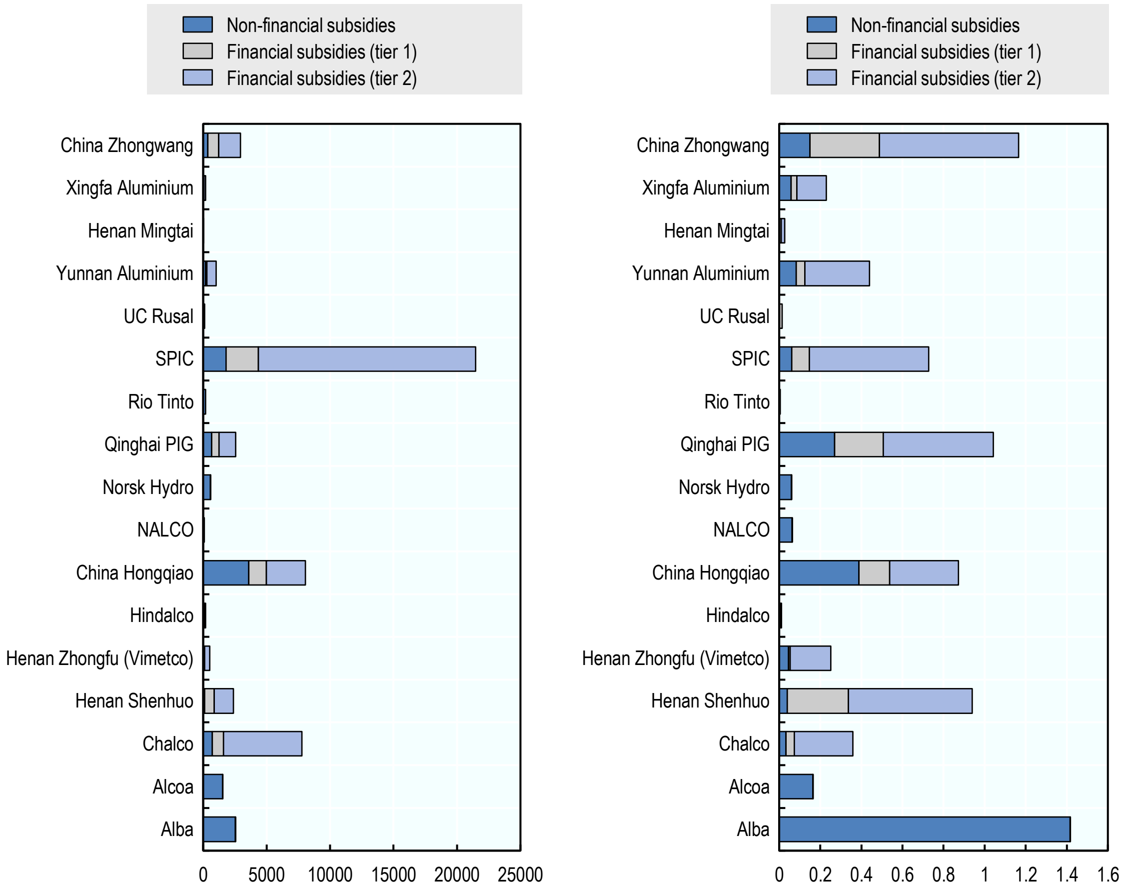


Source: OECD research.

By considering the risk profile of debts denominated in the local currency (e.g. the Chinese yuan), Tier 2 estimates added another USD 32 billion subsidy equivalent over the period 2013-17 (Figure 5.12). This estimation using Tier 2 spreads, which is additional to Tier 1 estimates in Figure 5.11, accounts for the interest rates that would have been charged had local market risks been priced in. The resulting estimates show SPIC to be a clear outlier, with Tier 2 numbers adding a staggering USD 17 billion to the company's subsidy equivalents, which are not explained entirely by size. As shown in Figure 5.10, the company has obtained loans at interest rates that are below the PBOC benchmark, likely due to SPIC's status as one of the "big five" power companies in China that are owned and managed by the Central Government. Those five power companies have reportedly attracted significant support in the form of preferential loans from state-owned banks, equity injections, and VAT concessions (Hervé-Mignucci et al., 2015[12]).

Figure 5.12. Tier 2 estimates added another USD 32 billion financial subsidies

Non-financial vs. financial government support (Tier 1 and Tier 2) over the period 2013-17 (USD millions, current)
Left: Absolute amounts; Right: Scaled by revenue in 2016



Source: OECD research.

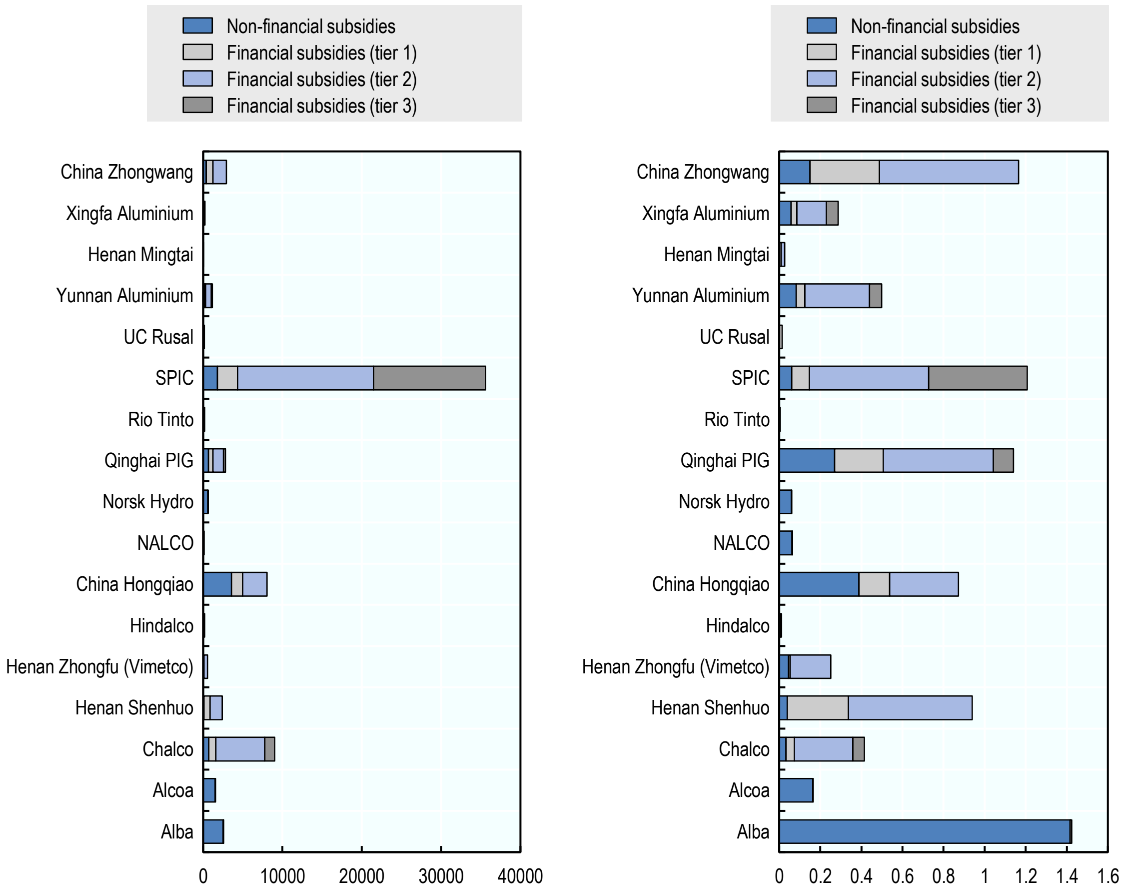
Last, Tier 3 analysis considers the impacts that implicit or explicit government guarantees may have had on the interest rates charged to certain state-owned companies. The resulting estimates add another USD 16 billion to Tier 2 numbers, with SPIC alone obtaining USD 14 billion and Chalco USD 1.2 billion (Figure 5.13). This reflects the credit-rating uplifts of several notches that these companies obtained due to the high probability, as perceived by credit-rating agencies, of the government stepping in should these companies experience financial distress.[91] In the case of Alba, one of the group's parent companies was uplifted in some years to reflect Bahrain's sovereign rating, and this is estimated to have represented an additional subsidy equivalent of USD 12 million. The only exception among SOEs is Norsk Hydro: although it is 34% owned by the

91 See for example (Reuters, 2017[56]) and (Reuters, 2018[74]).

Government of Norway, credit-rating agencies (e.g. Moody's)[92] have judged support from Norwegian authorities unlikely and Tier 3 spreads are thus estimated to be zero.

Figure 5.13. Removing government guarantees increases financial subsidies even further, adding another USD 16 billion

Non-financial vs. financial government support (Tiers 1, 2, and 3) over the period 2013-17 (USD millions, current)
Left: Absolute amounts; Right: Scaled by revenue in 2016



Source: OECD research.

Adding to the estimates discussed above, Alcoa and Rio Tinto both obtained 30-year loans at zero interest rate from Investissement Québec, a state-owned investment company established by the Province of Québec in Canada. These loans were provided in 2003, 2007, 2008 and 2009 and disclosed in the official gazette of Québec province. The loans were conditioned on the beneficiary companies undertaking additional investment at existing facilities. With the planned investments failing to materialise, only part of the loans have been used to date, and the agreements have been renegotiated to prolong the investment time frame and add a penalty clause. Although detailed information on repayment schedules could not be located, these loans have likely saved the two

92 See for instance Moody's rating report dated 28 March 2017, "Rating Action: Moody's affirms Baa2 issuer rating of Norsk Hydro ASA, upgrades the baseline credit assessment to baa2 from baa3, stable outlook".

companies less than USD 100 million in interest payments combined over the period 2013-17.

The estimates presented above paint a picture of financial support that is by and large concentrated in China, with few exceptions. Although all companies in the sample have obtained some form of non-financial support (e.g. R&D or energy subsidies) from one or several countries, the provision of financial support appears to be mostly a Chinese trait. One explanation that has been put forward is that "China's banking system was designed not to serve the interests of the private sector but to provide credit – cheaply and in large amounts – to state-owned companies" (McMahon, 2018[13]). The results above appear to give credence to this assertion in that Chinese aluminium SOEs have attracted the vast majority of all financial support. While not an SOE, Hongqiao nonetheless also benefitted from significant concessional finance. Moreover, this support (including for Hongqiao) was itself largely provided by another group of SOEs, namely state-owned banks (e.g. Agricultural Bank of China, China Construction Bank, and Industrial and Commercial Bank of China) and policy banks (e.g. China Development Bank).

The numbers presented above are nevertheless subject to important caveats and possibly under-estimate the true amount of financial support. For example, the base rates used for loans denominated in the Chinese yuan (i.e. the PBOC benchmark rates) may themselves be suppressed to some extent. Some observers have noted that deposit rates in China have at times been kept below the pace of inflation to enable "banks to charge less for loans than would otherwise have been possible" (*ibid*).[93] To the extent this is true, it would have the effect of increasing further benchmark interest rates and therefore the estimated financial support.

Another caveat relates to the consideration of what investors in a private market would view as a reasonable rate of return on equity. Because the true cost of capital represents a weighted average of the cost of debt and equity, a "fair-value" approach to estimating the cost of financing for SOEs should not only consider SOEs' borrowing costs, but also the returns they generate for their shareholders (i.e. the state, but also other investors where the state does not fully own the company). To estimate the extent to which SOEs in the sample have generated adequate returns for their shareholders, these companies' return on equity is compared with a notional expected return on equity calculated on the basis of the capital asset pricing model as in Lucas (2014[14]) (Box 5.3). This model has been widely applied to estimate the required rate of return on assets taking into account their riskiness.

Bearing in mind the approximate nature of the calculations, the estimates in Table 5.3 show that the return on equity for the different SOEs in the sample varies considerably around the currency-based benchmark in either direction. While the numbers do not necessarily imply the existence of a "subsidy" as such, they are nonetheless indicative of a tendency for certain SOEs to not be subject to the same market discipline as other firms in the industry. This is especially so for Chalco, NALCO, QPIG, and Yunnan Aluminium. One possible explanation is that "SOEs acting as agents of a sovereign

93 This policy predates the Great Recession of 2008-09 and the ensuing policy responses that lowered interest rates in many countries. It also differs in nature given that China's monetary institutions have traditionally sought to regulate the quantity of credit directly rather than to use interest rates as instruments to influence its supply (McMahon, 2018[12]). Efforts have, however, been made since 2015 to gradually liberalise interest rates in China (OECD, 2017[27]).

government […] are not necessarily (dependent on the priorities communicated to them by their government owners) expected to maximise profits and long-term corporate value" (OECD, 2016[59]). The position occupied by those SOEs contrasts with Xingfa's, a Chinese state-owned producer of semis, which appears to have realised high returns on equity over the period considered.

Box 5.3. A benchmark for expected returns on equity in the aluminium industry

The calculation for estimating expected returns on equity (ROE) for SOEs in the sample replicates the methodology discussed in Lucas (2014[14]). The approach is based on the capital asset pricing model, whereby:

$$E(r_m) = r_f + (\beta_i \times \mu)$$

where $E(r_m)$ is the expected market return on equity, r_f is a risk-free rate, β_i is the unlevered beta for industry *i*, and μ is a market-risk premium fixed at 6.5%.

Risk-free rates were approximated using different short-term sovereign-bond yields depending on the currency in which companies are borrowing. The unlevered beta was obtained from Damodaran online's database[94] of betas by sector, hosted by the Stern School of Business at New York University. The 102 firms covered in the database's "Metals & Mining" industry include most firms studied: e.g. Alba, Alcoa, Chalco, China Hongqiao, China Zhongwang, Rio Tinto, and Yunnan Aluminium.

Table 5.3. Certain SOEs are not subject to the same market discipline as other firms in the industry

Company name	Actual average return on equity	ROE benchmark	Difference
Alba	8.13%	6.26%	1.87%
Chalco	**1.50%**	**8.84%**	**-7.34%**
NALCO	**6.72%**	**13.40%**	**-6.68%**
Norsk Hydro	4.15%	6.54%	-2.39%
QPIG	**0.70%**	**8.84%**	**-8.15%**
SPIC	6.83%	8.84%	-2.02%
Xingfa	18.66%	8.84%	9.81%
Yunnan Aluminium	**2.47%**	**8.84%**	**-6.38%**

Note: Actual returns on equity are averaged over the period 2013-16; the benchmark over the period 2013-17. Data for Henan Shenhuo were not available at the time of writing.
Source: OECD calculations on the basis of Lucas (2014[14]).

Finally, one last caveat concerns the prevalence of shadow banking in China, and the role it could have played in enabling certain companies to borrow more than what was on offer from state-owned banks. Shadow banking takes many forms in China, including unregulated lending and entrusted loans, sometimes with implicit government back-up (McMahon, 2018[13]). There is evidence that some firms in the sample[95] have provided entrusted loans to associates or related parties, though it is unclear whether this has conferred a significant benefit to borrowers. Due to the lack of transparency surrounding such loans, this study has not attempted to identify them systematically, much less estimate a subsidy equivalent.

94 See http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html (accessed on 6 September 2018).

95 For example, Chalco's 20-F report to the US SEC for the year 2017.

6. Conclusions and policy implications

This report has sought to provide new insights on trade distortions and government support in the aluminium industry by drawing on and mobilising information from a large range of sources covering all large producing countries: satellite-based capacity estimates; export restrictions in the form of export bans, taxes, and incomplete VAT rebates; import tariffs; energy subsidies; budgetary support and tax concessions; and concessional finance in the form of loans provided on preferential terms and below-market returns on equity. In doing so, the OECD matrix of support measures (Table 5.2) provides a prism through which to understand and organise the different measures.

In addition, the study has taken the view that government support in the aluminium industry is best measured and understood at the level of individual firms at all stages along the aluminium value chain. This novel approach to measuring support has enabled the identification and measurement of more support measures than would have otherwise been possible. It has also offered much-needed granularity on the different ways in which governments support their aluminium producers. Taken together, the matrix and the data collected form a 'heat map' that helps identify where government support measures (and trade distortions more generally) concentrate in the aluminium value chain. The remainder of this section reflects on the policy implications that can be drawn from all of the report's findings.

Government support needs to be understood in the context of value chains

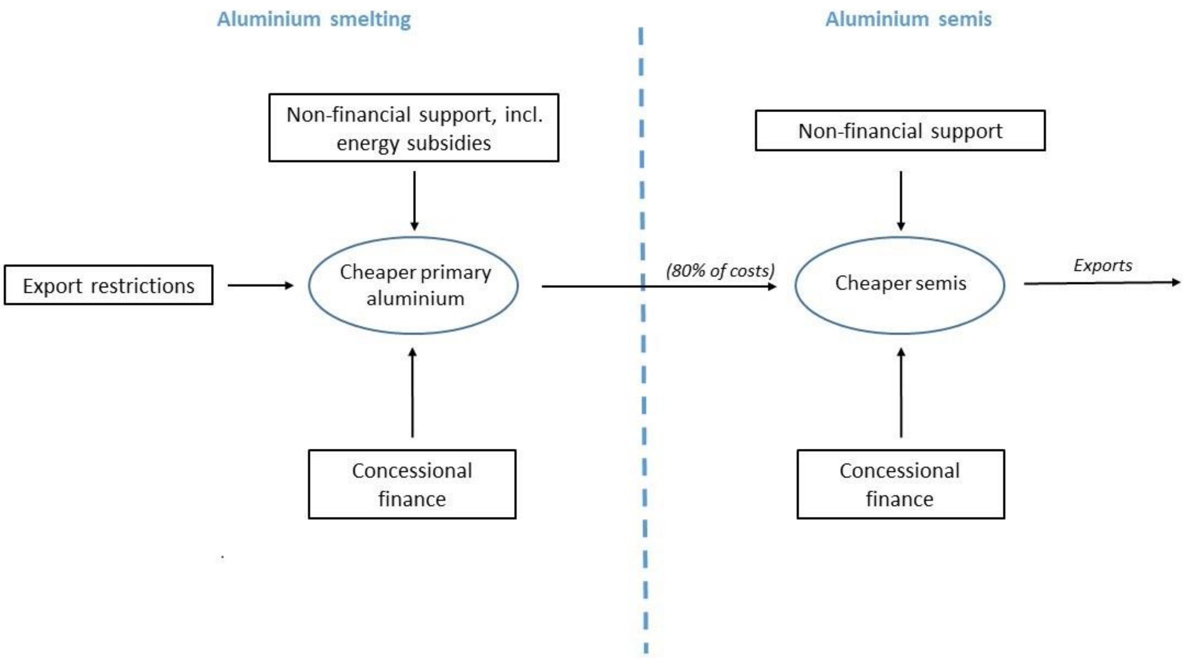
Government interventions appear widespread all along the aluminium value chain, though some stages in the chain seem to attract more support than others. This is especially the case with aluminium smelting, for which support is relatively large and primarily takes the form of energy subsidies and concessional finance. The effects of support provided at the smelting stage have repercussions at various points in the aluminium value chain, and in particular downstream in the manufacturing of semi-fabricated products of aluminium ("semis").

The effect of support for smelting has been most pronounced in China, due to both its export restrictions (in particular as Chinese firms account for almost 60% of world output in volume terms) and much larger domestic support.[96] The combined effect of these measures has been to make aluminium cheaper in China than it would otherwise have been, which in turn has conferred a cost advantage to Chinese producers of semis. It is therefore not surprising to observe that China's exports of semis have grown very rapidly

96 There is empirical evidence showing production subsidies in China to have been an important determinant of export performance at the intensive margin (Girma et al., 2009[75]). In the case of primary aluminium, however, export restrictions make it difficult for production subsidies to increase exports so that the subsidies end up benefitting downstream users (i.e. semis producers), increasing their exports thanks to lower unit costs.

over the past years, on the back of unit costs that are much lower than competitors'. Figure 6.1 depicts graphically the situation for China.

Figure 6.1. Government policies in key parts of the aluminium value chain in China



The effects that government support and other policies (e.g. export restrictions) have all along the aluminium value chain suggest that trade rules may need to be revisited to better account for the greater complexity of international production. The WTO's Agreement on Subsidies and Countervailing Measures is, for example, "premised on trade involving goods that are produced in one country and sold to another" (Hoekman, 2016[20]). Despite aluminium being a relatively simple value chain (compared with, say, smartphones and aircrafts), policy spill-overs between segments of the chain are already apparent, e.g. whereby coal sold at below-market prices finds its way into cheaper electricity, cheaper primary aluminium, and eventually cheaper aluminium semis that are exported in world markets. Likewise support for smelting increases derived demand for alumina and bauxite, with implications for the companies that compete in those segments.

Subsidy rules need to better account for the influence of the state

Government ownership is also prevalent all along the aluminium value chain across a range of countries, especially downstream towards aluminium smelting. Ownership is not, however, the only way in which governments can exert their influence in the aluminium value chain, nor does it inevitably entail such influence (Kowalski and Rabaioli, 2017[18]). The evidence points to the role of state influence in orienting production and investment decisions, in particular through government management of input prices and the flow of credit to aluminium producers. State influence is most prevalent in China and the GCC countries, with SOEs being not only recipients but also providers of support.

As others have indicated, "more policy attention and resources must be devoted to international data collection and monitoring of the use of subsidy policies" as "data […] are notoriously patchy and incomplete" (Hoekman, 2016[20]). Yet the fluid relationship observed in China between the state and companies creates issues for transparency in relation to government support policies. The definition of government support itself becomes blurry where the government is heavily involved in the day-to-day financing and management of companies, making it difficult to identify the precise policy actions and documents that underlie the support provided, where they exist at all. This has implications for the notification of subsidies in the WTO, which are usually couched in terms of individual policies, and more generally for understanding the impacts, positive and negative, that support has on global competition and trade.

With heavy state management of the economy making it more difficult to connect government support to individual policies, improving information on subsidies and other forms of support may need to also draw upon the estimation of price gaps. By focussing on economic outcomes rather than policy inputs, price-gap estimates can provide a more accurate and all-encompassing picture of government support in important areas such as energy inputs and concessional finance. There are, however, many limitations in price-gap analysis, and greater efforts will need to be devoted to refining the approach and defining best practices for appropriate guidelines and disciplines, including for use in the WTO context.

More generally, transparency remains fundamental in enabling information on support to be collected and compared across firms, countries, and stages of the value chain. The results presented in this study were obtained through extensive research at the level of individual firms and countries; yet the remaining data gaps underscore the necessity for governments to improve disclosure of information on support, including support provided to and through state enterprises, at a sufficient level of detail to allow for meaningful analysis.

State influence and government support in the aluminium value chain and beyond

The data on government support collected for this study are evidence that at least some of the increases in smelting capacity of recent years have been excessive in a *structural* sense.[97] By causing market distortions, government support measures can affect investment decisions and result in more capacity than would otherwise be the case under normal market conditions. This study has shown government support to be common along the aluminium value chain, but particularly high in China and the GCC countries.

Excess capacity appears in that sense to be a genuine concern in the aluminium industry, and one that has implications for global competition as production moves where governments have offered the most support. To the extent this does not coincide with a natural comparative advantage in energy-intensive industries, government support has wider implications in terms of economic efficiency, and potentially even environmental outcomes.

97 In the sense of having been driven by non-market forces, and subsidies in particular. See Section 3 for a discussion.

The evidence also has implications for the design of trade rules designed to discipline government support, notably in terms of the need to take account of the impact of actions along the value chain, and the need to take account of the role of the state, including in terms of the priority of increasing transparency. Additionally, the nature of the measures identified in this sector suggest that government support may not only be confined to aluminium, but may represent broader economic trends warranting further analysis.

This study of the aluminium value chain has highlighted in particular the importance of energy subsidies and concessional finance in government support for aluminium producers, as well as the role of state enterprises as both recipients and providers of that support. This raises the question of whether similar patterns can be observed in other sectors and value chains, particularly as one moves into more technology-oriented markets with different cost structures and demand patterns. Sector characteristics and data permitting, the approach pioneered in this study could usefully be applied to other industries and value chains in order to provide a more representative and systematic view of government support, and industrial policy more broadly across a range of sectors. The matrix of support measures discussed in Section 5 could serve as a kind of 'heat map' with different areas of support varying in importance across sectors and value chains. In this way, it could provide the foundation for building a broader understanding of government support in all its forms.

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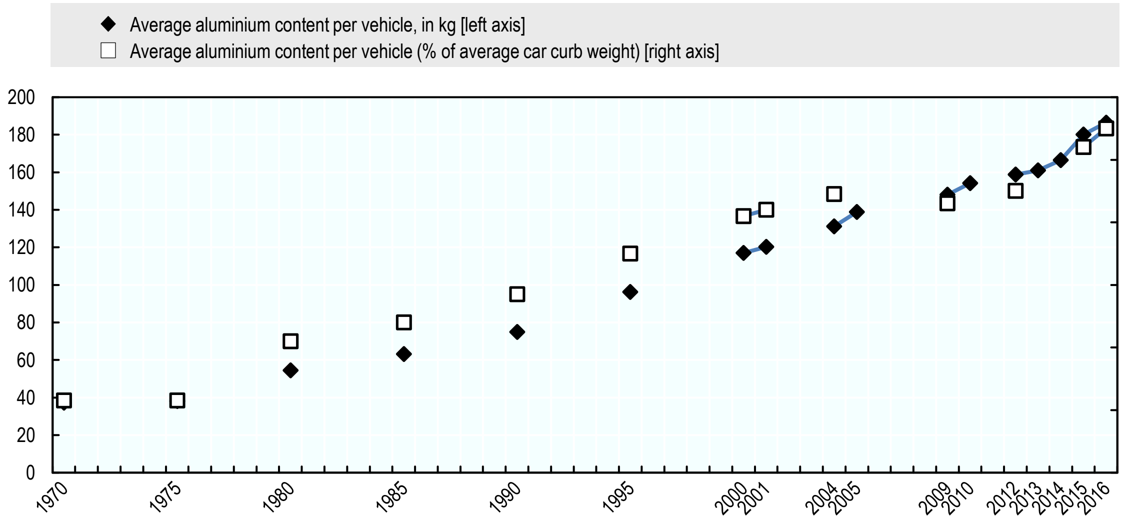
Annex A. Technical appendix

Figure A A.1. The aluminium content of road vehicles has been increasing over time

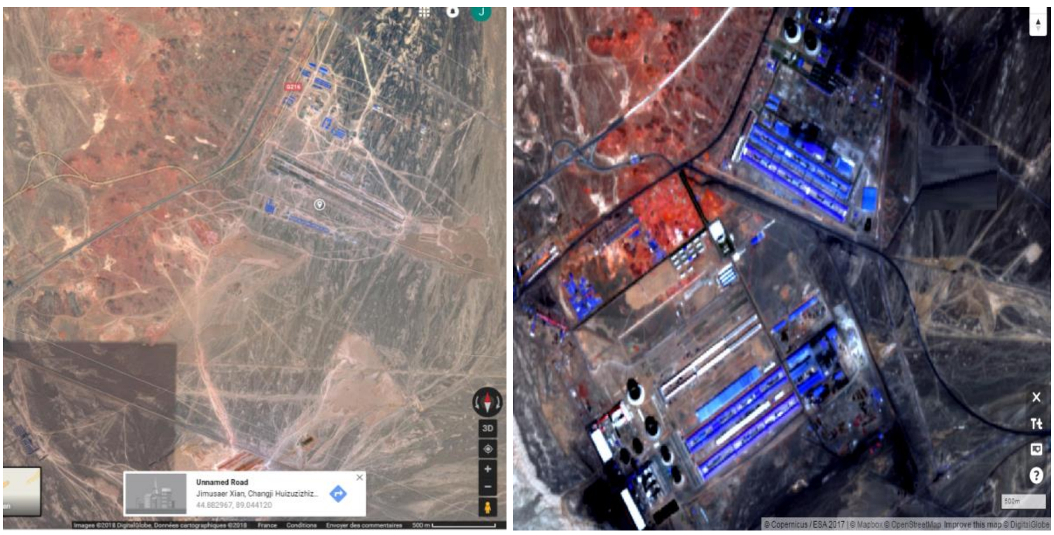
Average aluminium content of light road vehicles built in the United States, 1970-2016



Source: OECD on the basis of Buckingham (2005[60]) and online presentations from Ducker Worldwide.

Figure A A.2. An accurate view of current smelting capacity in Chinese frontier provinces

Satellite view of Wucaiwan, Jiamusaer, Xinjiang, 44°53'05.9"N 89°02'36.8"E
(Left: Google Maps, satellite view, date unknown; Right: Sentinel, ESA, dated 21 May 2018)



Source: Google Maps and European Space Agency.

Box A A.1. Calculating the cost of incomplete VAT rebates in China

According to Chinese circular Cai Shui No. 7 (2002), the official formula used in calculating VAT payable for general trade and processing exports with purchased imported materials is as follows:

VAT payable = output VAT – input VAT + NCNR

where output VAT is the VAT collected on domestic sales; input VAT is the VAT paid on domestically purchased inputs; and NCNR is a non-creditable and non-refundable amount, which is evaluated as follows:

NCNR = (X – BIM) x (VAT rate – VAT refund rate)

where X denotes exports and BIM refers to bonded imported materials.

If VAT payable is positive, taxpayers (i.e. companies) must pay VAT to the tax bureau; if VAT payable is negative, the tax bureau will refund it to taxpayers. The amount of refundable VAT is, however, capped at (X – BIM) x VAT refund rate.

For the purpose of this report, the VAT cost on exports is defined as:

(VAT rate – VAT refund rate) / VAT rate

Source: (Gourdon, Monjon and Poncet, 2017[16]).

Box A A.2. Measuring tariff escalation

Tariff escalation is calculated in this report as import-tariff wedges, i.e. differences between nominal tariffs applied on imports of output commodities and tariffs applied on imports of input commodities.

The import-tariff wedges shown in Figure 4.3 are thus calculated as TW = TO – TI, where TW is the nominal tariff wedge; TO is the tariff in *ad valorem* equivalent charged on the output commodity; and TI is the tariff in *ad valorem* equivalent levied on the input commodity. Tariff escalation therefore occurs where TW > 0; tariff de-escalation takes place where TW < 0; and tariff parity is defined as TW = 0.

In the case of alumina, tariff wedges correspond to the difference between tariffs on alumina (HS 281820) and tariffs on bauxite (HS 260600); for primary aluminium they correspond to the difference between tariffs on primary aluminium (HS 7601) and tariffs on alumina; for semis wedges refer to the difference between average tariffs for HS 7603-7609 and tariffs applied on primary aluminium. In the case of fabricated aluminium products, tariff escalation is calculated as the wedge between average tariffs on HS 7610-7616 and average tariffs on semis. At each stage, a positive difference indicates tariff escalation whereas a negative one indicates de-escalation.

Box A A.3. The estimation of price gaps for electricity and energy products

Estimates of energy subsidies using the price-gap method are very sensitive to assumptions about what energy prices would be absent any subsidies and other forms of support. In selecting price benchmarks, it is therefore important to consider a country's specific context (e.g. its position in world energy markets) as well as quality and transportation issues for the energy products under consideration.

For net-energy-importing countries (e.g. China), the IEA[1] recommends using import-parity prices while using export-parity prices for net-energy-exporting countries (e.g. Qatar). In the latter case, the implied subsidy is "implicit and [has] no direct budgetary impact. Rather, [it represents] the opportunity cost of pricing domestic energy below market levels, i.e. the rent that could be recovered if consumers paid world export prices" (*ibid*). Electricity can present additional complications since it is not often traded internationally, with the exception of the EU and Norway.

Below are some of the assumptions made in this study to estimate those energy subsidies that do not take the form of direct budgetary transfers or tax concessions. In all such cases, the assumptions we made can be considered conservative and our resulting numbers on support lower-bound estimates.

Natural-gas prices in Oman and Qatar: Both Qatalum (a Norsk Hydro joint venture) and Sohar (a Rio Tinto joint venture) rely on natural gas to feed the captive power plants that generate the electricity their smelters need. In both countries, natural-gas prices have for years been kept artificially low by government policy, though significant reform progress was made in Oman in recent years (KAPSARC, 2016[61]; Lahn and Stevens, 2014[62]). Because Qatar is a large net exporter of gas, these low prices represent foregone revenue for the government, which fully owns energy companies like Qatar Petroleum.

Most exports of Qatari gas are in liquefied form and destined for Asia (e.g. China, Japan, and Korea), where they sell for about USD 7-16 per million BTU depending on the years. These prices are, however, too high for the purpose of determining a market benchmark since they include extensive costs for liquefaction, transportation, and regasification. Qatalum does not need to incur such costs since it obtains gas in gaseous form from nearby facilities. The benchmark used in this study is therefore the price Qatar obtains for selling its gas in gaseous form to neighbouring Oman and the UAE through the Dolphin pipeline. Financial statements from Dolphin Energy LLC were used to obtain an average price for gas sold through the pipeline. The resulting benchmark prices are in the range of USD 1.5-2 per million BTU and are consistent with secondary sources reporting on Dolphin prices (Lahn, 2016[63]; Krane, 2015[64]; Rogers, 2017[65]).

Because Oman is a net importer of gas from Qatar through the Dolphin pipeline, this study also uses the estimated Dolphin prices as the benchmark for gas purchased by Sohar.

Coal prices in China: Almost all smelters in China use coal for generating at least part of their electricity in their captive power plants. A notable exception is Yunnan Aluminium, which relies on hydro-power. Although it is the world's largest producer of coal, China is also the world's largest importer as its demand has consistently outpaced domestic supply over the past decade. One important factor in this increased import dependency was "the higher cost of domestic coal relative to international prices" (Cornot-Gandolphe, 2014[55]). Another has been expensive freight rates for shipping domestic coal from mines in the north to consumption centres elsewhere in the country. As explained in Section 4.2, coal production in China remains largely in the hands of SOEs, with the government continuing to intervene at times to manage prices. Local regulators have also been found to influence energy prices in spite of the price guidelines set centrally by the National Development and Reform Commission (NDRC) (Haley and Haley, 2013[19]).

The benchmark price for Chinese coal used in this study is the Qinhuangdao spot price, net of VAT (17%), with a calorific content of 5 000 kcal per kg. Qinhuangdao, Hebei is the world's largest coal port and as such "serves as a reference for domestic coal prices" in China (Cornot-Gandolphe, 2014[55]). In a 2014 bond prospectus Hongqiao notes in particular that "the Qinhuangdao coal price is the most frequently quoted benchmark price in the coal markets *in Shandong Province* and other regions in China" (own emphasis).

The prices paid for coal by Hongqiao, Qinghai Provincial Investment Group (QPIG), and Henan Zhongfu (Vimetco) were obtained from the firms' own reports, bond prospectuses, or the reports of Chinese credit-rating agencies. Adjustments were made where the calorific content of coal was said by companies to differ from 5 000 kcal per kg. The coal that Hongqiao purchases from Shanxi is, for example, reported by the company to have a real calorific value between 4 800 and 6 500 kcal per kg (China Hongqiao Group Limited, 2017[6]). For companies that have their own coal mines (e.g. QPIG), the estimates only consider that portion of the coal that firms purchase externally, i.e. from outside suppliers. No information on coal prices and external purchases could be located for SPIC, Henan Shenhuo, and Chalco (to the extent these companies buy coal to complement their own captive coal mines).

Electricity prices in Québec: The Government of Québec publishes decrees in the official provincial gazette that specify the different formulae used in calculating electricity prices for aluminium smelters in the province. Formulae usually vary for each individual smelter, resulting in electricity prices that are tailored at the plant level and that vary with fluctuations in the price of aluminium on the LME. Decree 666-2016 of

6 July 2016 specifies, for instance, the conditions under which the Alouette smelter is to purchase electricity from Hydro Québec, the state-owned provincial power company.

The price formulae annexed to the published decrees make it possible to replicate the approximate electricity price that each smelter in the province faces. These prices are then compared to the average prices that Hydro Québec charges to large industrial users of electricity in the province. The latter prices were obtained from Hydro Québec's annual reports and from the website of the Ministère de l'Énergie et Ressources Naturelles du Québec. They correspond to Hydro Québec's revenue from sales of electricity to large industrial users in Québec divided by the corresponding volume of electricity sold.

Electricity prices in Saudi Arabia: Unlike Qatalum, Sohar, and Alba, Ma'aden Aluminium does not have its own captive power plant and thus purchases electricity from a local power provider in the Ras Al-Khair Industrial City (i.e. the Saline Water Conversion Corporation's 2 400 MW plant). Detailed information on the prices charged to Ma'aden by the SWCC are not available, and so these prices are assumed to match the power tariffs applying in Saudi Arabia for large industrial users of electricity. Those tariffs were obtained from KAPSARC for the years 2010-14 and from the Saudi Electricity & Cogeneration Regulatory Authority thereafter.

The benchmark prices used for estimating electricity subsidies to Ma'aden are the tariffs Dubai applies for large industrial users, and which have reportedly been cost-reflective since 2011 (Lahn, 2016[63]). The resulting price gap amounts to roughly USD 0.05-0.06 per kWh on the basis of the tariffs published by the Dubai Electricity & Water Authority.

Natural-gas prices in Bahrain: Until recently, Bahrain did not import nor export any natural gas, relying solely on domestic production for meeting its energy needs. With Alba's projected expansion of its smelter (the Line 6 project), demand for gas in Bahrain is poised to increase further. This has prompted the government to build the country's first LNG import terminal offshore since domestic gas supplies are becoming insufficient to meet the smelter's growing needs. By way of comparison, Alba's estimated electricity use is more than what the whole rest of the country consumes.

This study therefore uses LNG import prices as the benchmark for natural gas used in Alba's captive power plant, especially since Bahrain does not have any pipeline connection with neighbouring countries (such as Qatar's Dolphin pipeline). Given Bahrain's proximity with gas-rich countries, LNG prices are assumed to be lower than those charged to Asian customers owing to lower transportation costs. The calculation uses the US Henry Hub natural-gas price as a base in light of its growing role as global gas benchmark (Sider and Matthews, 2017[66]), to which a conservative liquefaction margin of USD 3 per million BTU is then added (Ripple, 2016[67]). This yields a benchmark price of about USD 6-8 per million BTU, which corresponds roughly to what Kuwait pays for importing LNG from Qatar (Lahn and Stevens, 2014[62]).

The resulting subsidy numbers are very high, but consistent with secondary sources: officials cited by the local press, including Minister of Energy Dr. Abdulhussain Mirza, have estimated that "thirty-five companies, including Bahrain's Alba, are benefiting from natural gas subsidies, estimated at 610 million dinars (USD 1.62 billion) annually" (Bahrain Mirror, 2018[68]; Lahn, 2016[63]). Given Alba's large share of the country's total electricity consumption, this implies very sizeable annual gas subsidies.

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1. See www.oecd.org/site/tadffss/methodology/ (accessed on 30 August 2018).

Table A A.1. Total government support over the period 2013-17, by firm and type of support

(USD millions, current)

	Other non-financial support	Support for energy and other intermediates	Financial subsidies (Tier 1)	Financial subsidies (Tier 2)	Financial subsidies (Tier 3)
Alba	–	2 522	2	–	13
Alcoa	102	1 418	20	–	-
Chalco	452	262	895	6 164	1 243
Henan Shenhuo	100	–	758	1 534	-
Henan Zhongfu (Vimetco)	16	79	18	415	-
Hindalco	90	–	184	–	-
China Hongqiao	64	3 522	1 384	3 096	-
NALCO	73	–	–	–	< 1
Norsk Hydro	363	213	–	–	–
QPIG	155	18	583	1 321	245
Rio Tinto	33	163	–	–	–
SPIC	1 406	395	2 544	17 127	14 120
UC Rusal	17	–	104	–	–
Yunnan Aluminium	152	41	98	737	139
Henan Mingtai	3	–	7	20	–
Xingfa Aluminium	48	–	24	120	49
China Zhongwang	375	–	850	1 704	–
TOTAL	3 451	9 233	7 470	32 238	15 808

Note: Data on non-financial support for QPIG and SPIC are for the years 2012-16.
Source: OECD research.

Table A A.2. Total government support over the period 2013-17, by firm and country

USD millions, current

	Australia	Brazil	Canada	China	India	Norway	GCC	Others
Alba	–	–	–	–	–	–	2 532	5
Alcoa	145	71	669	–	–	–	616	40
Chalco	–	–	–	9 016	–	–	–	–
Henan Shenhuo	–	–	–	2 392	–	–	–	–
Henan Zhongfu (Vimetco)	–	–	–	527	–	–	–	–
Hindalco	–	–	31	–	135	–	–	108
China Hongqiao	–	–	–	–	–	–	–	–
NALCO	–	–	–	–	73	–	–	–
Norsk Hydro	–	144	5	–	–	189	238	–
QPIG	–	–	–	2 921	–	–	–	–
Rio Tinto	–	7	163	–	–	–	6	20
SPIC	–	–	–	35 592	–	–	–	–
UC Rusal	–	–	–	–-	–	–	–	121
Yunnan Aluminium	–	–	–	1 168	–	–	–	–
Henan Mingtai	–	–	–	31	–	–	–	–
Xingfa Aluminium	–	–	–	241	–	–	–	–
China Zhongwang	–	–	–	2 930	–	–	–	–
TOTAL	145	222	851	62 882	144	189	3 392	277

Note: Data on non-financial support for QPIG and SPIC are for the years 2012-16. “Others” are New Zealand, Russian Federation, Spain, and the United States.
Source: OECD research.