Multidimensional Indicator of Extractives-Based Development: Country Profiles

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Table of contents

Introduction

When countries depend too heavily on the extractive industries, this can pose challenges for their economies. This is particularly the case because, besides being exhaustible by nature, commodity prices tend to be volatile, and price fluctuations can cause shocks that are difficult for the country to manage.

To address resource dependency, we need to be able to measure it—to show its consequences and to make the case to decision-makers to tackle it, and to better analyze what can help to reduce it. [1]

Such measures already exist. But they have been "plagued by biases, statistical misconceptions, and a misleading tendency to lump very different countries together, considering them all to be 'resource-rich'."[2]

This has motivated the creation of the Multidimensional Indicator of Extractives-based Development (MINDEX), as well as NRGI's 'Measuring Extractives Dependency' project.[3] The MINDEX helps indicate and inform whether a country is moving in the right or wrong direction over time in terms of economic diversification, extractive resource mobilization and taxation, and can serve as a diagnostic tool to help identify some of the extractives-related policy challenges that a given country may face at a given time. To find the typology of MINDEX cases, please consult the next section of the document, entitled 'MINDEX case scenarios'.

The MINDEX includes six indicators, namely i) extractives exports in USD per capita, ii) the share (%) of extractives in total exports, iii) extractives rents in USD per capita, iv) government revenues from extractives in USD per capita, v) the proportion (%) of total government revenues that come from the extractive sector, and vi) extractives reserves in USD per capita. These indicators are drawn from international databases and measured using constant 2010 prices. The indicators that are measured in USD per capita are scaled, as shown in the table below.

[1] William Davis, 'Measuring Extractives Dependency: Why It Matters and New Approaches' (Natural Resource Governance Institute, December 2022), resourcegovernance.org/sites/default/files/documents/measuring_extractives_dependency_why_it_matters_and_new_approaches_0.pdf.

[2] Amir Lebdioui, 'Understanding Extractives Wealth and Dependency with Country Profiles with Based on the MINDEX', *Natural Resource Governance Institute* (blog), n.d., resourcegovernance.org.

[3] William Davis, 'Measuring Extractives Dependency: Why It Matters and New Approaches', Natural Resource Governance Institute, 13 December 2022, resourcegovernance.org/publications/measuring-extractives-dependency-why-it-matters-and-new-approaches.

Table 1: Scaling criteria for selected MINDEX indicators[4]

Score	Extractives exports (USD per capita)	Extractives rents (USD per capita)	Extractives reserves (USD per capita)	Government extractives revenues (USD per capita)
1	>13,000	>6,500	>170,000	>3900
0.9	Between 7,500 and 13,000	Between 3750 and 6,500	Between 170,000 and 90,000	Between 3900 and 2250
0.8	Between 4,000 and 7500	Between 2000 and 3750	Between 90,000 and 50,000	Between 2250 and 1200
0.7	Between 2,500 and 4000	Between 1250 and 2000	Between 50,000 and 25,000	Between 1200 and 750
0.6	Between 1000 and 2500	Between 500 and 1250	Between 25,000 and 18,000	Between 750 and 300
0.5	Between 750 and 1000	Between 375 and 500	Between 18,000 and 10,000	Between 300 and 225
0.4	Between 500 and 750	Between 250 and 375	Between 10,000 and 5000	Between 225 and 150
0.3	Between 250 and 500	Between 125 and 250	Between 5000 and 2000	Between 150 and 75
0.2	Between 100 and 250	Between 50 and 125	Between 2000 and 1000	Between 75 and 30
0.1	Between 50 and 100	Between 25 and 50	Between 1000 and 500	Between 30 and 15
0.0	<50	< 25	Below 500	< 15
0.1	Between 50 and 100	Between 25 and 50	Between 1000 and 500	Between 30 and 15

We considered that an interesting next step to our work on measuring dependency would be to use the MINDEX to provide an overview of challenges related resource dependency facing particular countries. In this context, this document uses the MINDEX to provide profiles of resource abundance and dependence in six countries: Algeria, Chile, Colombia, Democratic Republic of Congo, Mongolia and Nigeria. These countries have been selected because they are all countries where diversifying away from natural resource dependency is (or should be) a priority.

The profiles provide an idea of the levels and types of resource dependence and abundance in each country, but also helps us understand trends, different vulnerabilities to transition risks, and different policy challenges to achieve successful natural resource management. The document is not meant to represent a comprehensive analysis of resource dependency in the countries in question (or more generally), but rather provide an example of how multi-dimensional analysis of resource

[4] Amir Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX): A New Approach to Measuring Resource Wealth and Dependence', *World Development* 147 (2021): 105633, doi.org/doi.org/10.1016/j.worlddev.2021.105633.

dependency at the country level could be done and, for each country profile, highlight some of the main issues and high-level policy implications that could be the subject of more in-depth research. In this way, we hope that they can support different stakeholders, including government officials and civil society, in policy analysis / advocacy on natural resource management in their countries.

The global transition towards renewable energy is likely to have strong impacts on the economies of resource-producing countries. For this reason, we thought it important to add an element on countries' exposure to risks related to the energy transition, in addition to the MINDEX indicators listed above. We do this by

- Looking at whether a country's resources are fossil fuels (global demand for which is likely to be threatened by the energy transition, especially coal) or minerals
- Looking at how much of a country's mineral wealth is likely to be in high demand as an input to energy technologies linked to the energy transition
- Referring to the carbon intensity of resource wealth by country (for oil and gas, for which information is now available).

In these profiles, the carbon intensity of resource wealth is measured in CO2 kg/boe (barrel of oil equivalent). In the future, we can expect the carbon intensity of different fossil fuels to play a role in the competitiveness of oil and gas production as buyers seek to move towards less environmentally damaging energy sources. As a result, countries with higher carbon intensity of their resources may be more at risk from the energy transition, unless they can reduce that intensity. Fossil fuel producers with high costs of production also face increased transition risks, since demand (and market prices) for such fuels are likely to fall over time, potentially leading to fossil fuel assets becoming no longer commercially viable to operate ("stranded") and worsening the economic consequences for these countries. As a result, cost competitiveness is likely to be even more important than carbon competitiveness for fossil fuel producers. [5]

The profiles contain the following sections: i) overview, ii) case scenario identification (i.e., description of the type of resource dependence / abundance facing the country – see section 2 of this working paper), iii) evolution over time, iv) composition of resource wealth (and its implications for the country in the context of the energy transition) and v) underlying data.

The profiles included in this document face some limitations. In some cases, the latest available data was several years old. In addition, the classification of commodities for the data disaggregated between fossil fuels and mining revenues varies across countries. This is because different countries have different ways of classifying coal revenues, whether as part of fossil fuel or mining sector revenues. While we also lacked the data to produce the MINDEX at sub-national level, this could be an area for further research. Moreover, as noted above, the data from the MINDEX dependency does not by itself permit us to make detailed policy recommendations – that would require more extensive research.

For more details on the MINDEX and the data sources used for its components, please consult this paper: www.sciencedirect.com/science/article/pii/S0305750X21002485.

[5] David Manley and Patrick R. P. Heller, *Risky Bet: National Oil Companies in the Energy Transition* (Natural Resource Governance Institute, February 2021), resourcegovernance.org/sites/default/files/documents/risky-bet-national-oil-companies-in-the-energy-transition.pdf.

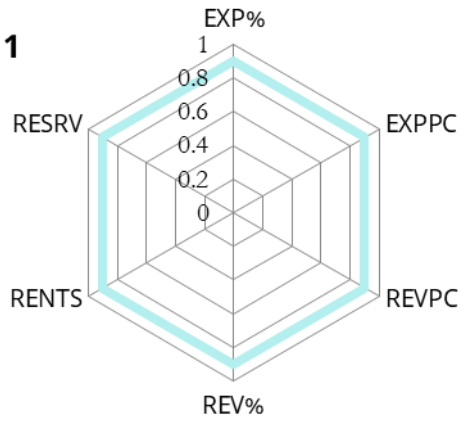
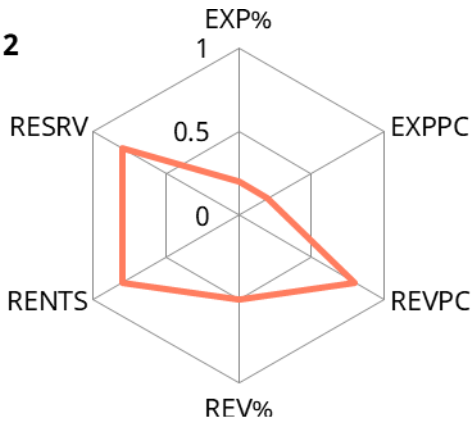
MINDEX case scenarios

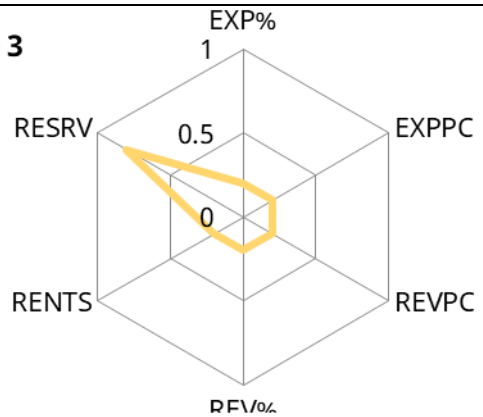
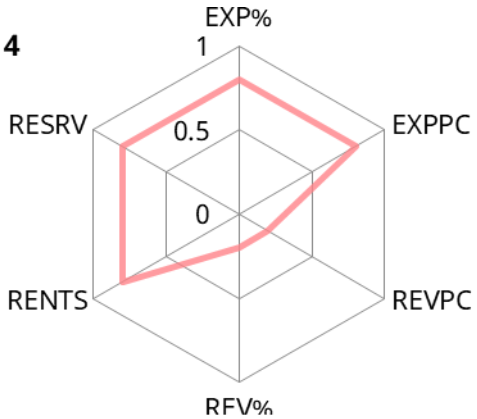
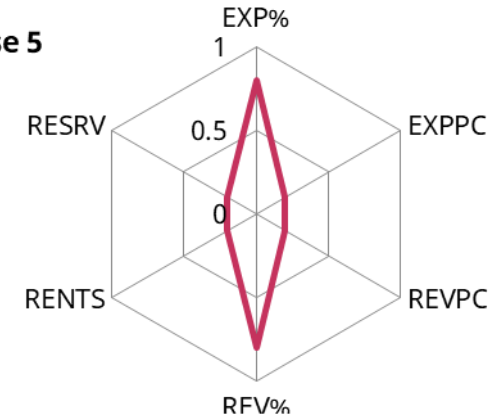
This section presents seven common types of resource dependence / abundance. These are referred to as 'case scenarios' later in the document. Which case scenario applies to a particular country can be determined by examining the radar chart of its MINDEX indicators, as shown in table 2 below.

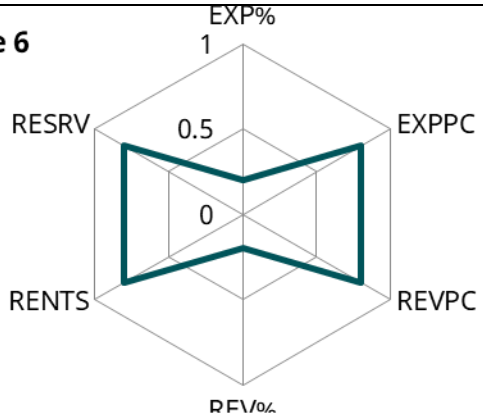
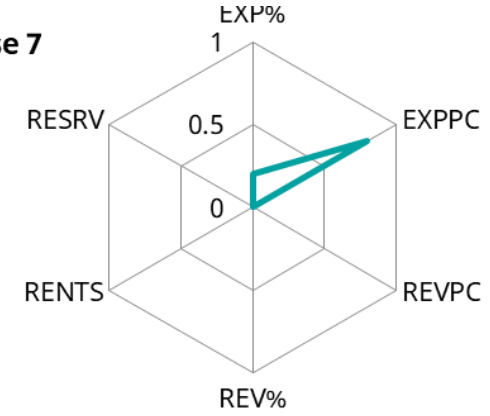
Table 2: MINDEX case scenarios

Key for indicator abbreviations:

EXP%: Share of extractives in total exports;
EXPPC Extractives exports (USD per capita);
REVPC: Government extractive revenues (USD, pc)
REV%: Share of extractives in government revenues;
RENTS: Extractives rents (in USD per capita);
RESRV: Extractives reserves (in USD per capita).

Case Scenario	Description and interpretations
Case 1 	*'Resource-rich and dependent':* *All six indicators are high* The country is both resource-abundant and resource-dependent.
Case 2 	*'Internal resource wealth':* *Resource production is high but exports are low* High domestic consumption of that mineral as a finished product (consumption of oil for electricity generation in Saudi Arabia) or as inputs for value-added activities (e.g., oil used for petrochemical production in the United States) or illegal smuggling of commodities.
	'Below-ground resource wealth': *Resource reserves are high but production/rents are low*

Case 3 	Issue of investment attractiveness in resource activities (due to a poor business climate); limited domestic infrastructure and capabilities to extract minerals; political issues such as an embargo (as in oil-rich Iran and manganese-rich Cuba); conflict (e.g., Libya) restraining resource production and exports; or decisions to leave extractives in the ground for environmental reasons.
Case 4 	*'Unappropriated resource wealth':* *High levels of resource production (or resource rents) but low government revenues from resource exploitation.* The country faces issues of appropriation of resource revenues and possible insufficient taxation on mineral production/exports.
Case 5 	*Resource-poor but resource-dependent:* *Resource production, exports, and reserves are low but the share of minerals in total exports and government revenues are high (vertical stretch).* The country is resource-poor but is highly resource-dependent
	'Resource-abundance without dependence': *In contrast to case 4, mineral production, exports and reserves are high but the share of minerals in total exports and government revenues are low (horizontal stretch).*

Case 6 	The country is resource-rich but has a diversified economy.
Case 7 	*The 'Swiss paradox':* *Extractives exports are high, but mineral rents and reserves are low.* The country is resource-poor but is a re-exporter of imported commodities in crude form or after some processing (India and Israel with diamonds; Switzerland and UAE with gold; Singapore with unrefined petroleum and fuel); or after the illegal smuggling of commodities into the country (e.g., Congo or Liberia with diamonds respectively smuggled from DRC and Sierra Leone).

Algeria

Key messages

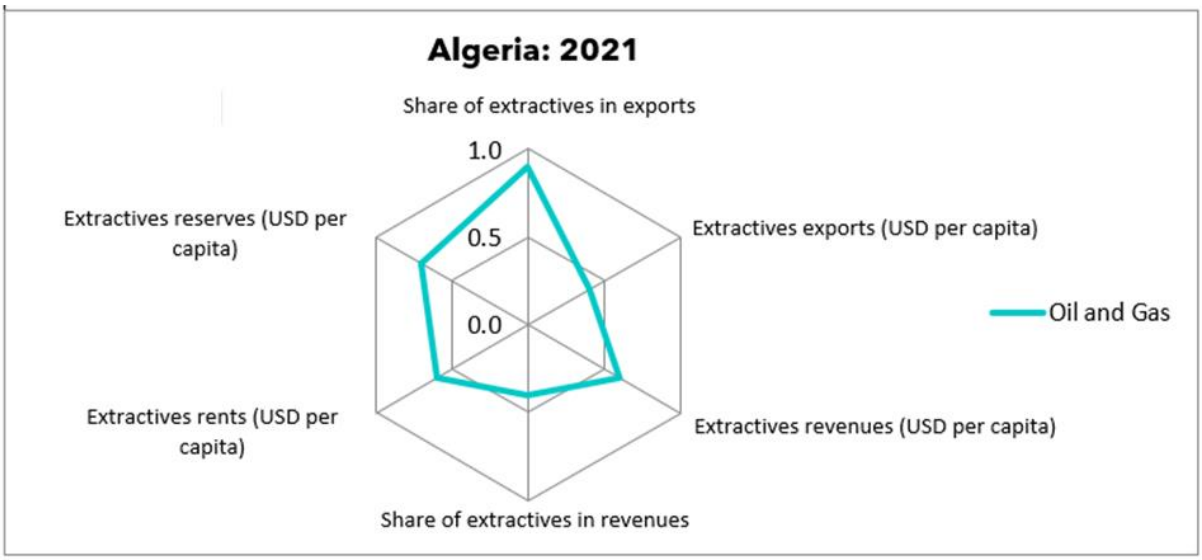
1-There is no time to lose on economic diversification. Diversification must therefore be a key policy priority.

2-Because of a high carbon intensity of its fossil fuel production, Algeria might not be one of the last producers standing. Improve energy efficiency of its oil and gas production its therefore also an important agenda.

Overview

The Algerian economy is highly dependent on oil and gas extraction, accounting for over 90% of exports on average in recent years. The country's resource endowment is large but narrow (predominantly constituted by hydrocarbons, while the mining sector remains nascent). As of 2023, Algeria held the 16th largest reserves of oil and the 11th largest reserves of natural gas.

Figure 1: Algeria case scenario identification: between cases 1 & 5 (highly resource-dependent, but moderately resource-rich)

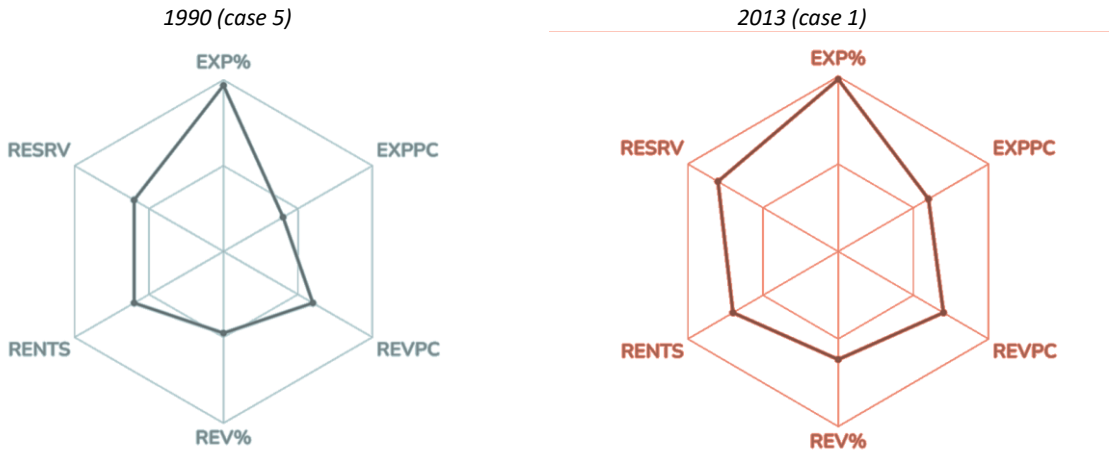


NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[6]

As of 2021, Algeria could be classified as a hybrid case between a case 1 (both resource-abundant and resource-dependent) and a case 5 (resource-dependent in the context of resource poverty). Indeed, Algeria's MINDEX results are characterised by average volumes in terms of extractive resource production, exports, revenues, and reserves but an extremely high share of extractives in total exports and fiscal revenues. As shown in the next section, Algeria's situation and case scenario is highly conditioned by fossil fuel price fluctuations.

[6] Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.

Figure 2: Algeria evolution over time (1994-2014-2016)



EXP%: Share of extractives in total exports;
EXPPC Extractives exports (in USD per capita);
REVPC: Government revenues from extractives (in USD, per capita);
REV%: The share of extractives in government revenues;
RENTS: Extractives rents (in USD per capita);
RESRV: Extractives reserves (in USD per capita).

A country extractive resource is dynamic across time. Since the 1990s, Algeria has been fluctuating between a case 1 and 5 because of the country's vulnerability to fluctuating fossil fuel prices and limited successes at diversifying the national economy. In times of high oil prices (e.g., 2013), Algeria's MINDEX is a case scenario 1, whereby a country is both resource-abundant and resource-dependent. In times of low prices (e.g., 1990 or 2021), it moves closer to a case 5 (extreme dependency but resource poverty).

Composition of resource wealth

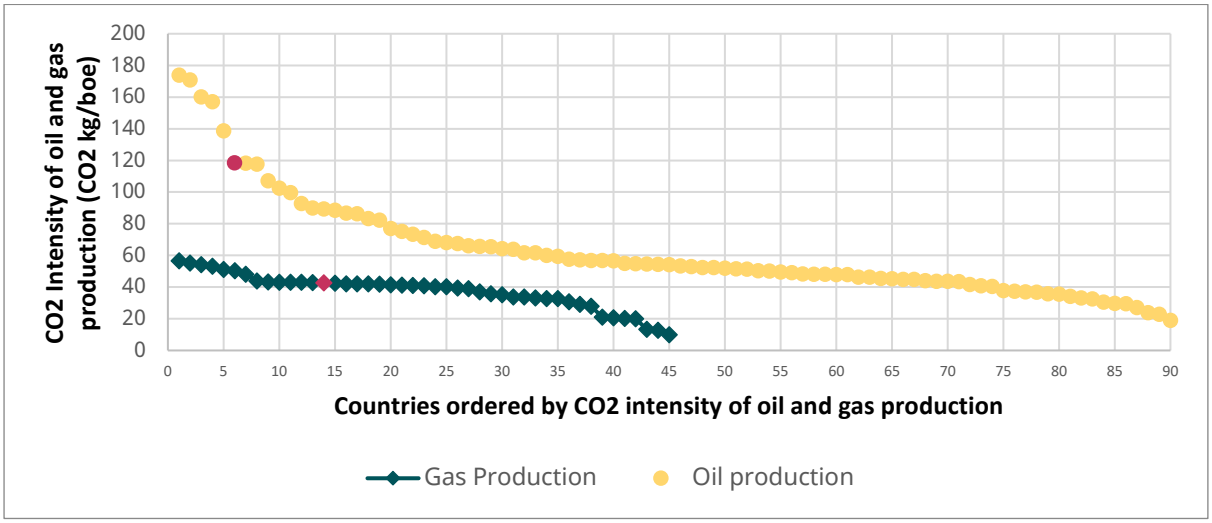
Algeria's resource wealth is mostly composed by oil and gas. Nevertheless, Algeria also boats non-negligible unexploited phosphate and relatively small known iron ore reserves.

Table 3: Composition of Algeria's resource wealth

Commodity	*Latest prices (July 2023)*	*Reserves (current value per capita)*
Oil	77.9 per barrel (Brent)	$21,927
Gas	$3.1 per 1,000 cubic feet	$11,150
Phosphate	$346 per metric ton	$17,232
Iron ore	$112.43 per metric ton	$5,577

Unlike countries that are dependent on a variety of extractive resources, Algeria's over-reliance on oil and gas also exposes the country to transition risks. Furthermore, Algeria's fossil fuel production tends to feature high carbon intensity levels compared to the global standards. As shown in Figure 3 below, out of 50 countries, Algeria has the 6th highest carbon intensity of oil production (118 CO2 kg/boe) out of 50 countries; and the 16th highest carbon intensity of gas production out of 90 countries (43 CO2 kg/boe). Such high carbon intensity is partly explained by persistently high volumes of gas flaring in Algeria and puts the country at particular risks of carbon taxation. To improve the 'carbon' competitiveness of its fossil fuel production, and avoid any potential carbon penalty, Algeria would need to improve the energy efficiency of its fossil fuel production in the short term, while still aiming to diversify its economy beyond oil and gas.

Figure 3: CO2 Intensity of oil and gas production (CO2 kg/boe) [7]



NB: Algeria is highlighted in red.

Table 4: Underlying data for Algeria

	Product/Sector	Unit	2021
Population			44,177,968
Export	Total	USD	35.4 bn
Export	Total extractives	USD	31,576.8 m
Export	Oil and Gas	USD	31,576.8 m
Export	Mining	USD	n/a
Export	Coal	USD	0
Export	Oil and Gas	USD pc	714.7
Export	Oil and Gas	%	89%
Revenues	Oil & Gas revenues	USD pc	464.8
Revenues	Oil & Gas revenues	%	41%

[7] 'Carbon Intensity in the Fossil Fuel Supply Chain'.

Reserves	Reserves fuels	USD pc	33,461
Reserves	Reserves mining (phosphate & iron ore)	USD pc	>22,000
Rents	Oil and Gas	USD pc	886.3
Rents	Mining	USD pc	0

Chile

Key messages

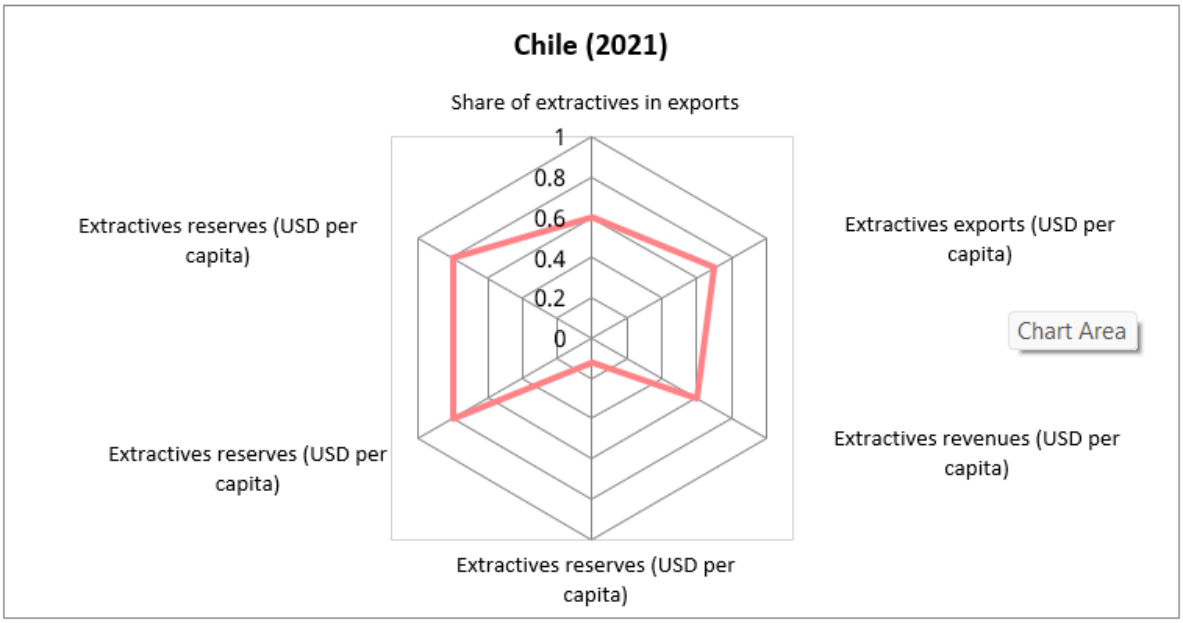
1-Though it has experience solid economic diversification in the past and fiscal revenues don't rely on extractives, Chile's export basket remains overly reliant on copper exports.

2-As with DRC, Chile is well positioned given its abundance in the so-called 'minerals of the future, but the long-term outlook for these minerals is still dominated by uncertainty and risks of technological disruption. Strong technology foresight capabilities will be necessary to inform value addition policies in the mining sector.

Overview

Chile's resource endowment predominantly consists of mined commodities (copper and lithium particularly), while fossil fuel production is minimal (but existent). Chile is the top copper producer in the world, with 28% of global copper production, and is the world's second-largest producer of lithium, with a 22% share of world production. Chile is also an important producer of molybdenum, rhenium, silver, sulfur and potassium.

Figure 4: Chile case scenario identification: case 6 (Resource-abundance with a moderate resource dependence)



NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[8]

Chile is a case of resource-abundance without dependence, as the country has a relatively diversified economy, in combination with its high level of resource wealth. Indeed, in contrast to case 5 (e.g., Algeria and Nigeria, see respective country profiles), Chile's extractive resource production, exports and reserves are high but the share of extractives in total exports and government revenues are low

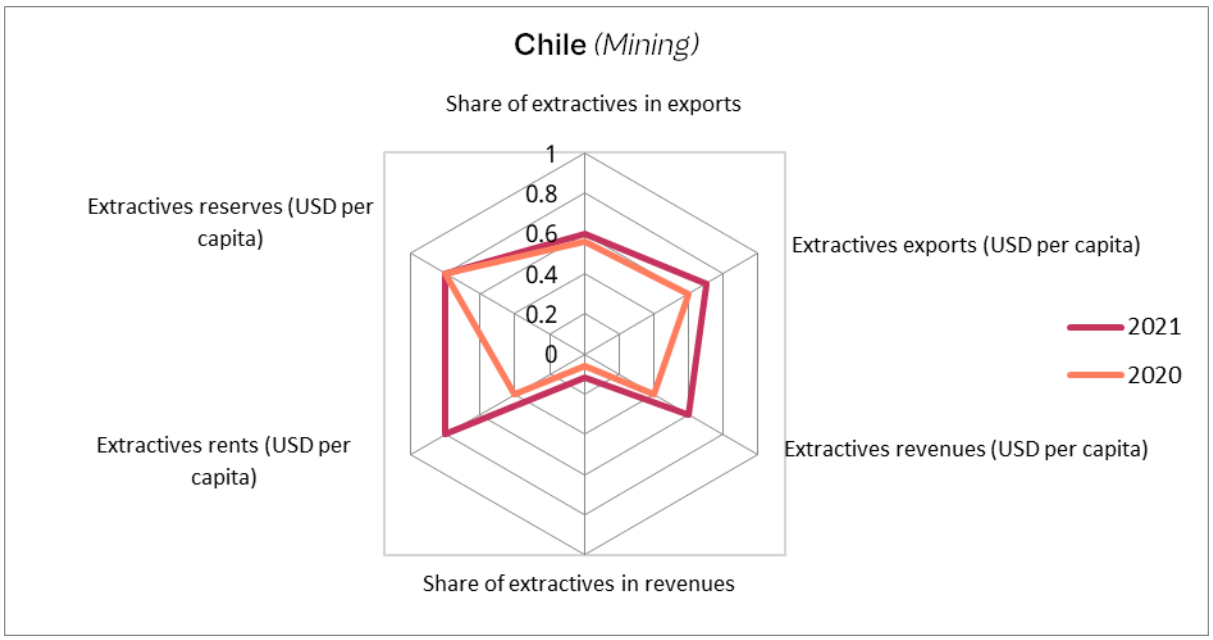
[8] Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.

(there is a horizontal stretch in the radar chart - Figure 4). It is therefore a MINDEX case 6 (see annex). This can be explained that while several mineral resource rich countries have fallen into commodity dependence by failing to diversify, Chile (despite fact that copper still accounts for more than half of total exports for the past decade) has managed to diversify into other sectors and acquire new competitive advantages (See Lebdioui, 2019).[9]

It is therefore worth noting that Chile's reliance on extractives is far more prevalent at the export level than the fiscal revenue level, where extractives have almost systematically represented less than 15% of fiscal revenues in recent years. This is not due to a poor appropriation of extractive revenues (case 4) because the level of extractives revenues per capita is very high. This reveals a particular strong tax collection capacity of the state with a broad revenue base beyond the extractive sector. Meanwhile, copper represents over 60% of Chile's exports in 2021, showing difficulties to pursue the diversification of Chile's economy beyond the successful efforts of the 1980-2010 period.

Evolution over time

Figure 5: Evolution of Chile's mining MINDEX over time



It is interesting to note the speed at which resource dynamics can change, especially in the case of the COVID crisis. Between 2020 and 2021, Chile tripled its mining revenues (from $155 to $481 per capita) and experienced an astonishing eightfold increase in mining rents (from $271 to $2286 per capita). That said, such changes did not dramatically increase Chile's reliance on extractives. This is in line with previous analyses using the MINDEX, showing that, similarly to countries such as Malaysia and Norway (and in contrast to countries such as Algeria, Angola, Nigeria and Venezuela), Chile has relatively managed to keep its reliance on extractives for exports and revenues within healthy limits in times of commodity price fluctuations in recent decades, when compared with other resource-producing countries.

[9] Chile's largest exported products, after copper, are salmon, fresh fruit, forestry products and wine.

Composition of resource wealth and implications for Chile's vulnerability to the global decarbonisation agenda

In terms of composition of resource wealth, Chile holds significant reserves of copper, lithium, but also iron and molybdenum to a lesser extent. Coal mining also takes places in some areas but Chile is not a major coal producer. As shown in the figure below, Chile holds only about 150 million barrels of proven oil reserves as of 2016, ranking 60th in the world, with production also extremely limited.

The composition of Chile's resource wealth has considerable implications in the context of the global decarbonisation agenda. Lithium and copper, given their use as critical inputs in consumer electronics and electromobility technologies, are considered to be part of the so-called 'minerals of the future', which offers the Chilean economy a positive short- and medium-term outlook. However, the long-term outlook for these minerals is still dominated by uncertainty and risks of technological disruption, given the serious research and development efforts globally to generate alternative technologies that rely on substitute materials (to replace the use of lithium with sodium or phosphate in electric batteries, for instance). Chile has also advanced plans to produce green hydrogen, using the high levels of exposure to solar radiation in the north and wind potential in the south of the country. The country has mobilised around 1 billion USD to fund implementation of its hydrogen strategy.[10]

[10] "Chilean Government Announces Creation of US$1 Billion Green Hydrogen Development Fund," Dentons, 3 July 2023, www.dentons.com/en/insights/alerts/2023/july/3/chilean-government-announces-creation-of-usd1000-green-hydrogen-development-fund.

Figure 6: Composition of Chile's resource wealth, 2020

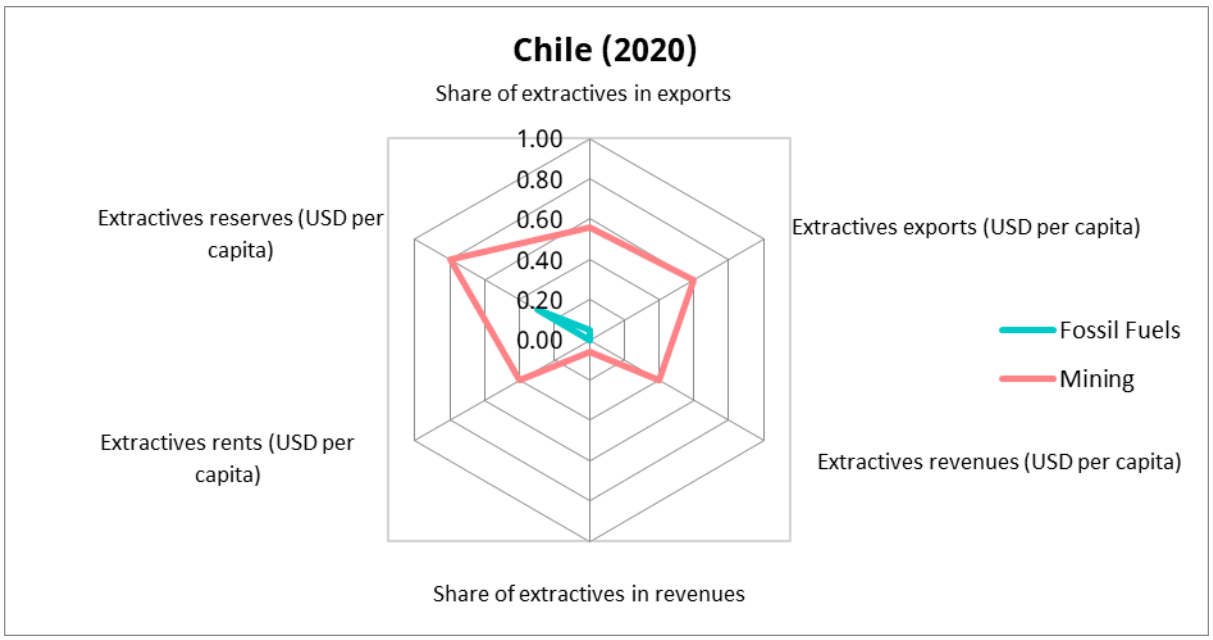


Table 5: Underlying data for Chile

	Product/Sector	Units	2018	2019
Population			19300000	19.49 m
Exports	Total Exports	USD	75500000000	96.1 bn
Exports	Fuel	exp pc	19.56	29.58
Exports	Mining	exp pc	2194.59	3,002.82
Exports	coal	exp pc	n/a	n/a
Exports	Oil and gas	%	0.5%	0.6%
Exports	Mining	%	56.1	60.9
Exports	Coal	%	0%	0%
Revenues	Total			
Revenues	Oil & Gas	USD	n/a	n/a
Revenues	Mining	USD	2993100000	9.3828 bn

Revenues	Oil & Gas	USD pc	n/a	n/a
Revenues	Mining	USD pc	155.0829016	481.4161108
Revenues	Oil & Gas	%	n/a	n/a
Revenues	Mining	%	5.90%	12.40%
Reserves	Reserves total	USD pc	77,100	77,100
Reserves	Reserves fuels	USD pc	1294.0	1294.0
Reserves	Reserves mining	USD pc	65876.8	65,876.8
Reserves	Coal	USD pc	7814	7,814
Rents	Oil and gas	USD pc	3.7	n/a
Rents	Mining	USD pc	270.6	2,286.8
Rents	Coal	USD pc	0.9	n/a

Colombia

Key messages

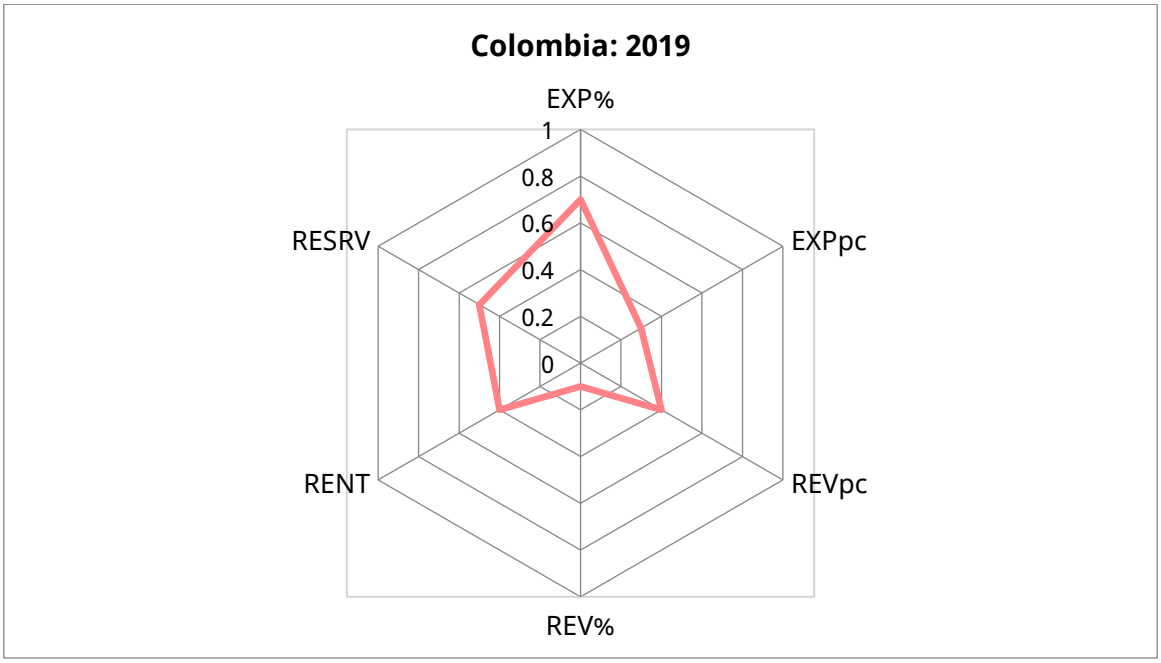
1- Colombia's resource dependence is concentrated at the export level, whereas fiscal dependence on extractives tends to be quite low (typically below 10%).

2-Colombia's oil and gas industry is well positioned in terms of the 'carbon' competitiveness of its fossil fuel reserves (though its coal industry is not). in the long term, it will still need to reduce its reliance on fossil fuels, especially given that oil, gas and coal make up the bulk of Colombia's natural resources.

Overview

Colombia produces oil, gas and coal, as well as minerals like gold, silver and platinum. Colombia is the 12th largest coal producer, the 21st largest oil producer, and the 42nd largest gas producer. The extractive sector plays a major role in the economy as a source of export revenues, fiscal revenues, and employment, but such role is due to reduce under the current government's plan to transition away from fossil fuels by halting the provision of exploration permits.

Figure 7: Colombia case scenario identification: moderate resource wealth and dependence



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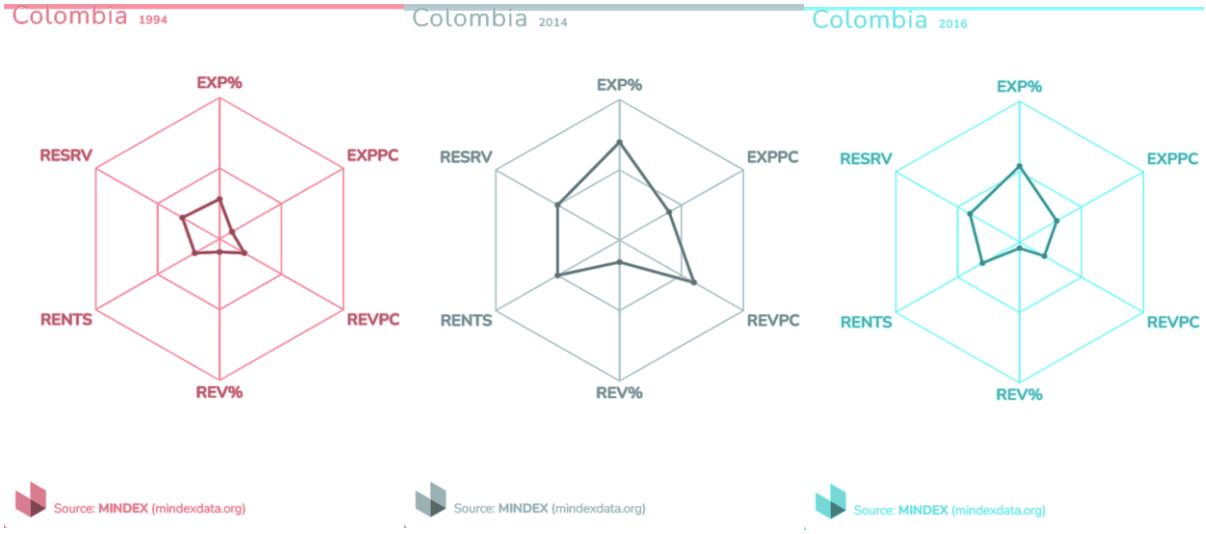
NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[11]

[11] Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.

Colombia's situation can be identified as a MINDEX case scenario 1, whereby the country is both (though moderately) resource-rich and resource-dependent. However, interestingly, Colombia's resource dependence is concentrated at the export level, whereas fiscal dependence on extractives tends to be quite low (typically below 10%), though this can increase to up to 20% when revenues for the national oil company (Ecopetrol) are taken into account.[12]

Evolution over time (1994-2014-2016)

Figure 8: Evolution of Colombia's extractives dependence / abundance from 1994 to 2014 to 2016

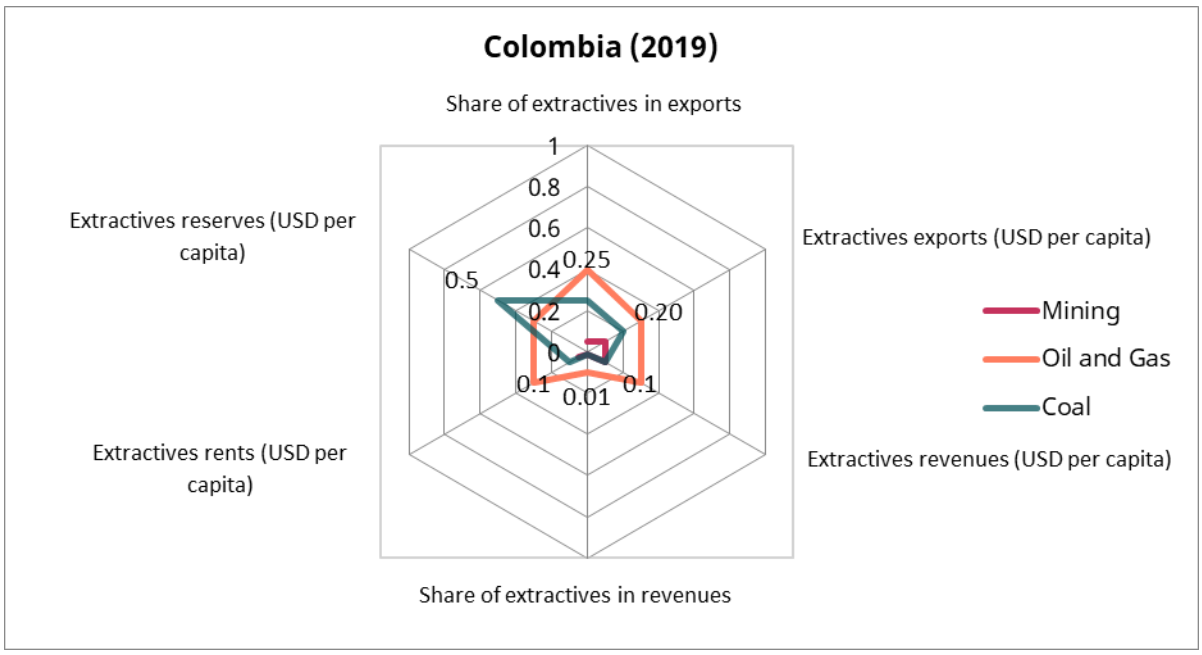


Colombia's case scenario been maintained over the past decade, although the country has witnessed large fluctuations in terms of revenues derived from extractives. Between 2016 and 2019 alone, revenues from extractives doubled (though they have not gone back to their 2014 level).

[12] Fernando Patzy and Silvio Lopez, 'Análisis fiscal de las perspectivas del Carbón y el Petróleo en la transición energética' (Natural Resource Governance Institute, June 2023).

Composition of resource wealth

Figure 9: Composition of Colombia's resource wealth



NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[13]

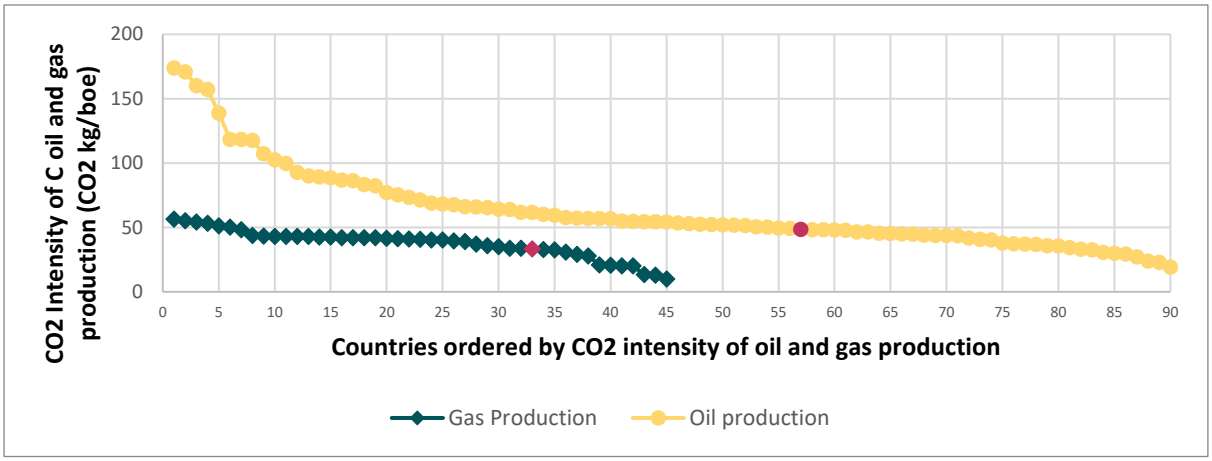
Colombia is endowed with a mix of types of commodities. The disaggregation of the MINDEX by commodities reveals that, oil, gas and coal make up the bulk of Colombia's resource wealth. As of 2019, Colombia's coal reserves were even estimated to be more valuable (at current prices) than its oil and gas reserves.

However, the coal sector provides a much lower contribution to fiscal revenues and the export basket, indicating that the government has a higher fiscal appropriation capacity in the oil and gas sector. Furthermore, coal resources are the most at risk of becoming stranded assets, followed by oil, while natural gas faces more favourable conditions in the short and medium term.[14] Out of 50 countries, Colombia has the 15th lowest carbon intensity of gas production (33 CO2 kg/boe) and 34th-lowest carbon intensity of oil production out of 90 countries (48co2 kg/boe). Colombia's oil and gas industry is therefore well positioned in terms of the 'carbon' competitiveness of its fossil fuel reserves, though its coal industry is not (since coal is the most polluting fossil fuel). In the long term, it will still need to reduce its reliance on fossil fuels to reduce its exposure to transition risks. As mentioned above, the government plans to do this by halting exploration permits.

Meanwhile, the non-coal mining sector remains nascent and does not currently provide a meaningful contribution to the country's extracted wealth.

[13] Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.
[14] This is especially the true because the cost of production of Colombia's coal mines makes it difficult to export to Asia and mean that they country needs to rely on Europe as an export market; and Europe is expected to transition away from coal even faster than Asia.

Figure 10: CO2 Intensity of Colombia's oil and gas production (CO2 kg/boe)[15]



NB: Colombia is highlighted in red.

Table 6: Underlying data for Colombia

	Product/Sector	Units	2018	2019
Population			49280000	50.19 m
Exports	Total Exports	USD	41831520220	39,489,359,461
Exports	Extractives exports	USD	26269617897	23,880,802,188
Exports	Oil and Gas	USD	16763665891	15,930.3306 m
Exports	Mining	USD	2058038944	2,282,142,591
Exports	Coal	USD	7447913062	5,668,328,997
Exports	Fuel	exp pc	340.17	317.40
Exports	Mining	exp pc	41.76	45.47
Exports	coal	exp pc	151.13	112.94
Exports	Oil and gas	%	40.1%	40.3%
Exports	Mining	%	5%	6%
Exports	Extractives (total)	%	63%	60%

[15] 'Carbon Intensity in the Fossil Fuel Supply Chain', Global Registry of Fossil Fuels, 2023, fossilfuelregistry.org/carbon-intensity.

Exports	Coal	%	28%	24%
Revenues	Total			
Revenues	Oil & Gas	USD	5.812268811 bn	7.3 bn
Revenues	Mining	USD	1.343 bn	1 bn
Revenues	Oil & Gas	USD pc	117.9437665	145.4473003
Revenues	Mining	USD pc	27.25243506	19.92428771
Revenues	Oil & Gas	%		9.6%
Revenues	Mining	%		1.3%
Revenues	Coal	USD		923076923.08
Revenues	Coal	USD pc		18.39
Revenues	Coal	%		1.2%
Reserves	Reserves total	USD	4,883.59 bn	
Reserves	Reserves total	USD pc	5,2596.5391	
Reserves	Reserves fuels	USD	120,147 m	120,147 m
Reserves	Reserves fuels	USD pc	1293.991954	1293.991954
Reserves	Reserves mining	USD pc		
Rents	Coal	USD pc	45.92	36.6
Rents	Oil and gas	USD pc	256	244
Rents	Mining	USD pc	9.23	12.7
Rents	Total extractives	USD pc	310	294

Democratic Republic of the Congo

Key messages

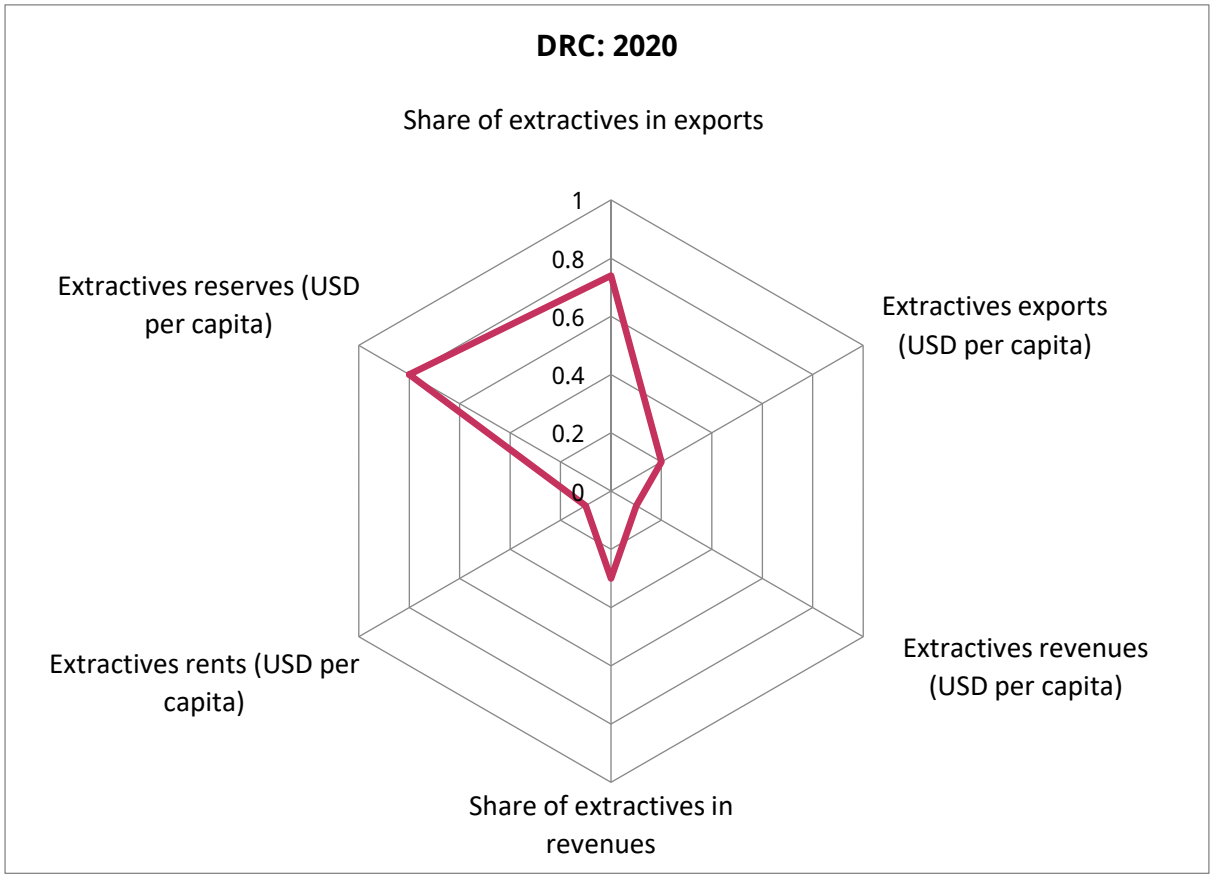
1-Despite recent efforts to improve mining taxation, resource production continues to remain extremely low comparison to the value of extractive reserves, suggesting that extraction capacity is limited, or the potential smuggling of extracted commodities.

2-The DRC is exceptionally well endowed in the so-called 'minerals of the future, but the long-term outlook for these minerals is still dominated by uncertainty and risks of technological disruption. Strong technology foresight capabilities will be necessary to inform value addition policies around cobalt, copper, and other minerals.

Overview

The Democratic Republic of the Congo's economy is highly dependent on the extractive sector, even accounting for over 99% of exports in some years. The country's resource endowment covers at least fifty ores, a dozen of which are exploited, including copper, cobalt, silver, uranium, lead, zinc, diamond, gold, lithium, and manganese. The Democratic Republic of the Congo is the largest producer of cobalt (with an estimated 70% of the world's production) and is the 16th largest producer of mined gold.

Figure 11: DRC case scenario identification: cases 3 & 4: Unappropriated resource wealth and low production



NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[16]

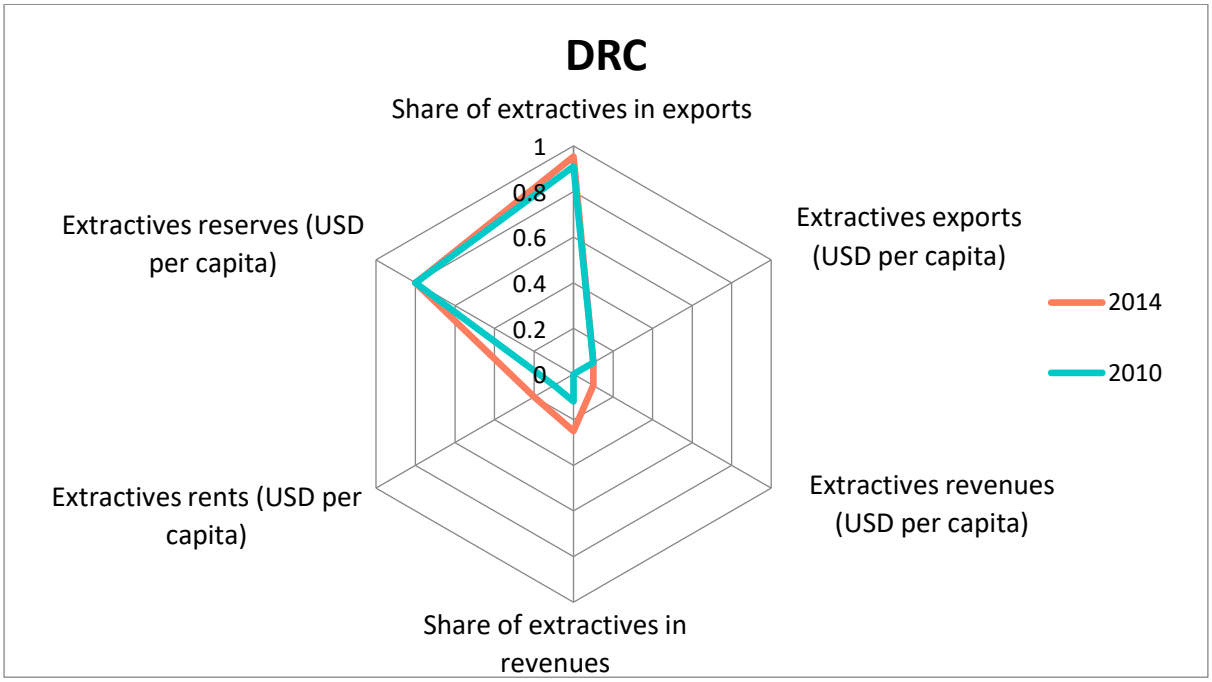
The longitudinal comparisons of the DRC's MINDEX suggest that more resource revenues have accrued to the government of DRC in 2014 than in 2010. This can be explained by the efforts from government towards appropriating more resource revenues, notably through a mining code revision process since 2012. However, the value of extractive exports per capita has also increased between 2014 and 2020, while the level of extractive rents has reduced, which is puzzling. This could be either due to data reporting inaccuracy, increasing production costs, or fiscal information misreporting/transfer pricing by mining companies.

However, resource production (proxied by extractive rents) continues to remain extremely low in comparison to the value of extractive reserves and the level of export dependency on extractives, suggesting that extraction capacity is limited, or potential smuggling of extracted commodities. Analysis by the US Treasury (2022) and Manley et al. (2022) also suggests that extracted commodities may be smuggled out of the country.[17]

[16] Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.
[17] 'Treasury Sanctions Alain Goetz and a Network of Companies Involved in the Illicit Gold Trade', U.S. Department of the Treasury, 10 August 2023, home.treasury.gov/news/press-releases/jy0664. And David Manley, Patrick R P Heller, and William Davis, *No Time to Waste: Governing Cobalt Amid the Energy Transition* (Center for Law, Energy and the Environment and Natural Resource Governance Institute, March 2022), 24, resourcegovernance.org/sites/default/files/documents/no_time_to_waste_governing_cobalt_amid_the_energy_transition.pdf.

Evolution over time

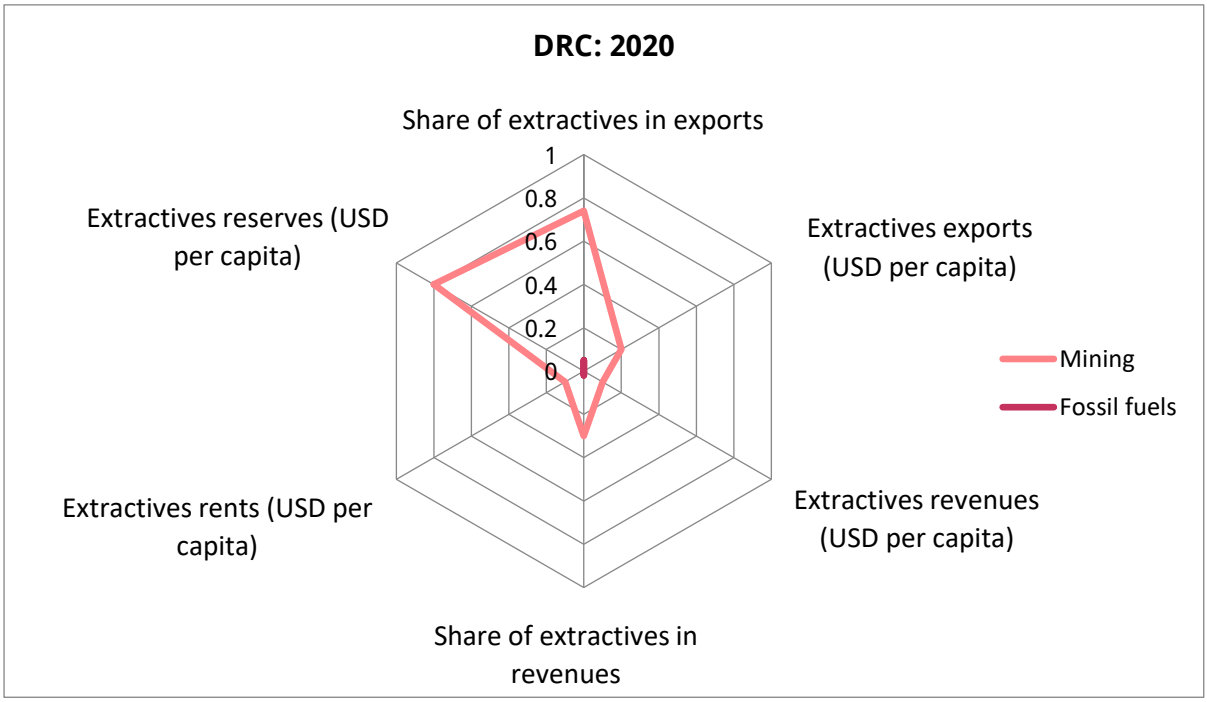
Figure 12: DRC MINDEX evolution over time



EXP%: Share of extractives in total exports;
EXPPC Extractives exports (in USD per capita);
REVPC: Government revenues from extractives (in USD, per capita);
REV%: The share of extractives in government revenues;
RENTS: Extractives rents (in USD per capita);
RESRV: Extractives reserves (in USD per capita).

Composition of resource wealth, energy transition and carbon intensity

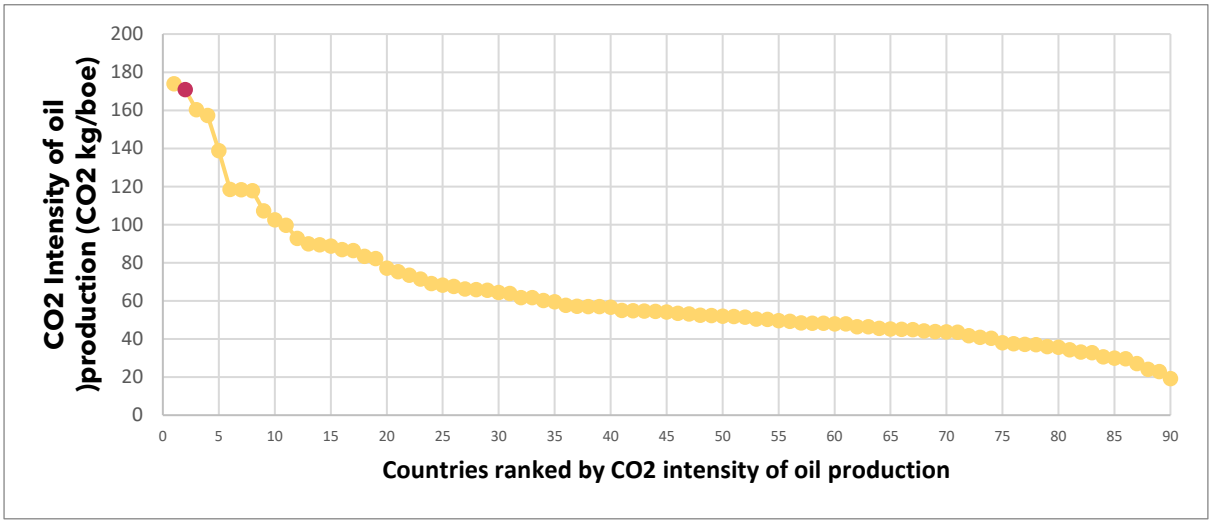
Figure 13: Composition of DRC's resource wealth



Mining makes up the quasi-totality of the DRC's resource economy, driven by the extraction of the so-called minerals of the future that are needed as inputs in a range of low carbon technologies and consumer electronics. However, the long-term outlook for these minerals is still dominated by uncertainty and risks of technological disruption, given the serious research and development (R&D) efforts globally to generate alternative technologies that rely on substitute materials (to replace cobalt in electronics for instance).

Though it is not a large oil exporter, the small-scale oil production in the DRC has the second highest carbon intensity out of 90 countries (171 CO2 kg/boe). Given that producers that generate high levels of emissions when extracting oil are likely to be less competitive in the future, this means that DRC's oil production may be affected more quickly than other countries by the transition away from fossil fuels.

Figure 14: DRC CO2 Intensity of oil production (CO2 kg/boe)[18]



NB: DRC is highlighted in red.

Table 7: Underlying data for DRC

	Product/Sector	Unit	2020
Population			92.85 m
Export	Total	USD	14,122,146,726
Export	Total extractives	USD	10,471,973,670
Export	Oil and Gas	USD	68,856,165
Export	Mining	USD	10,403,109,489
Export	Coal	USD	8016
Export	Fuel	USD pc	0.741584976
Export	Mining	USD pc	112.0421054
Export	Fuel	%	0.5%
Export	Mining	%	74%
Export	Extractives	%	74%

[18] 'Carbon Intensity in the Fossil Fuel Supply Chain'.

Export	Coal	%	0%
Revenues	TOTAL revenue	USD	5.26176 bn
Revenues	Oil & Gas revenues	USD	118,083,328.7
Revenues	Mining revenues	USD	1,600,208,453
Revenues	Oil & Gas revenues	USD pc	1.271764444
Revenues	Mining revenues	USD pc	17.23433983
Revenues	Oil & Gas revenues	%	2%
Revenues	Mining revenues	%	30%
Reserves	Reserves total	USD	4.88359 tn
Reserves	Reserves total	USD pc	52,596.5391
Reserves	Reserves fuels	USD	11,206,424,136
Reserves	Reserves fuels	USD pc	120.6938518
Reserves	Reserves mining	USD	4.87238 tn

Mongolia

Key messages

1-Mongolia is truly multi-resource abundant, with very different types of contribution of different commodity sectors to the national economy. While fossil fuel exports exceed mining exports, most government extractives revenues are generated by the mining sector.

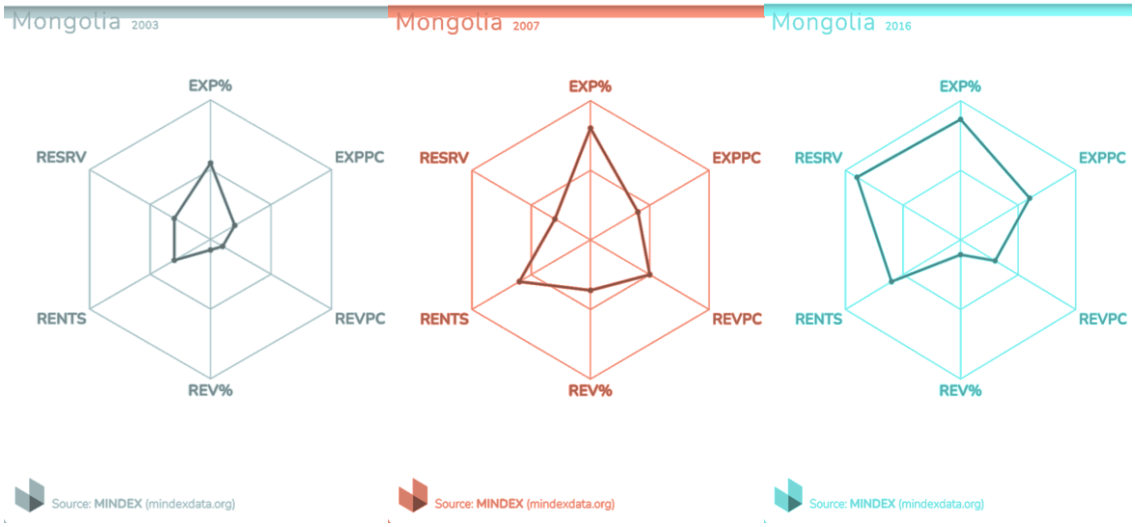
2-Government revenues from fossil fuel exploitation are low compared to the levels of resource production, possibly indicating issues of appropriation and taxation of the fossil fuel industry.

Overview

Mongolia is well endowed with a variety of minerals, including gold, copper, coal and iron ore, while the oil and gas sector is much smaller. Mongolia is the 14th largest coal producer, 19th largest iron ore producer, and the 66th largest oil producer.

Heterogeneous case scenario identification and evolution over time (2003-2007-2016)

Figure 15: Evolution of Mongolia's resource dependence and abundance from 2003 to 2007 to 2016



EXP%: Share of extractives in total exports;
EXPPC Extractives exports (in USD per capita);
REVPC: Government revenues from extractives (in USD, per capita);
REV%: The share of extractives in government revenues;
RENTS: Extractives rents (in USD per capita);
RESRV: Extractives reserves (in USD per capita).
NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[19]

[19] Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.

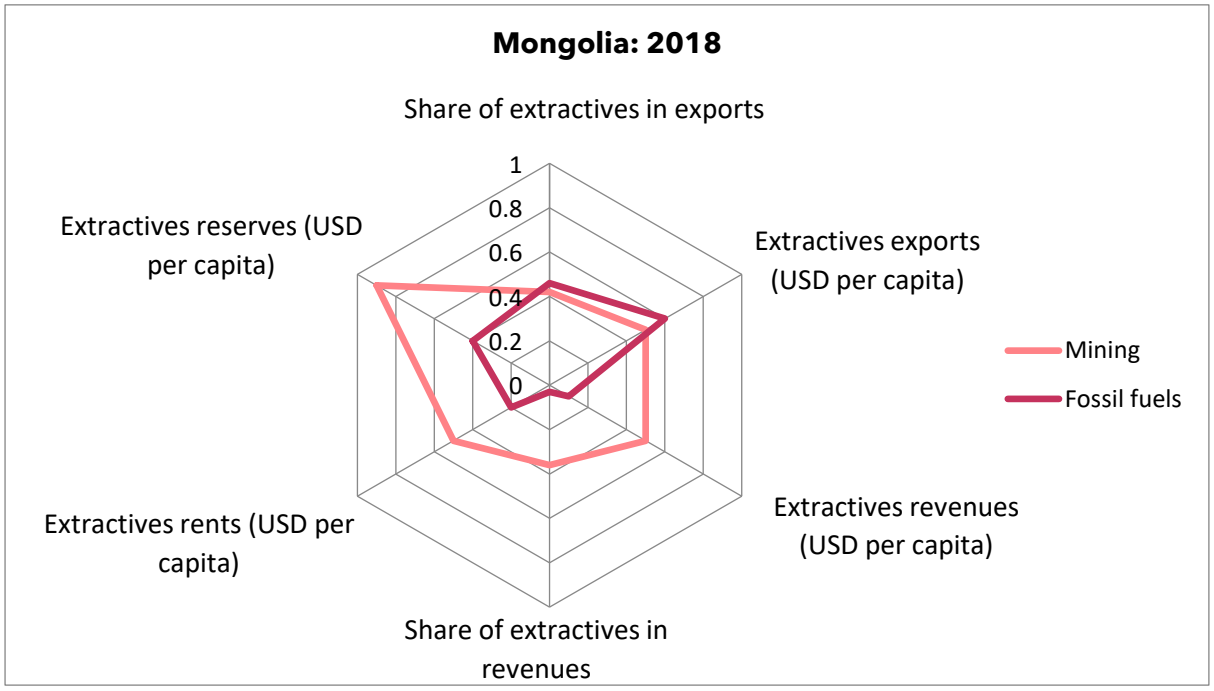
At first glance, Mongolia case would appear to be a similar case to that of Colombia (case scenario 1, whereby the country is both (though moderately) resource-rich and resource-dependent). However, this picture is tainted by the very different contribution of different commodity sectors (see subsection below). Mongolia is therefore a case where the composition of resource wealth matters tremendously to inform analysis. While Mongolia's mining MINDEX is a case scenario 1 exhibiting some features of a case scenario 3 (whereby production/rents are low compared to the value of unextracted reserves); the country's fossil fuel MINDEX is a typical case 4, whereby government revenues from resource exploitation are low compared to the levels of resource production, possibly indicating issues of appropriation and taxation of fossil fuel production.

The mining sector also singlehandedly explains the large fluctuations in the value of Mongolia extractives reserves over the past two decades, with the steady rise of the price of minerals and metals.

Composition of resource wealth

In the below figure, coal is classified as a 'fossil fuel' rather than part of the 'mining' sector.

Figure 16: Composition of Mongolia's resource wealth



The composition of Mongolia's resource wealth can also inform dynamics of energy transition and carbon intensity. Though fossil fuel exports are slightly higher than mining exports, Mongolia MINDEX reveals that the broader economic weight and potential of the mining sector exceeds that of the fossil fuel sector. Furthermore, Mongolia mineral reserves are considerably more important (in terms of value) than the country's fossil fuel reserve. In the future, we can therefore expect the (non-coal) mining sector to overtake fossil sources as a main source of exports. In addition, and interestingly, there is a large disparity in terms of rents generation and fiscal appropriation between fossil fuels and non-coal mining, implying that the profit margin (and subsequent government taxation) is higher for mining activities than in fossil fuel extraction. Coal supplies the vast majority of

Mongolia's energy, so it will be important for the country to increase the shares of other energy sources as part of its domestic energy transition. [20]

[20] 'Mongolia', IEA, accessed 15 August 2023, www.iea.org/countries/mongolia.

Nigeria

Key messages

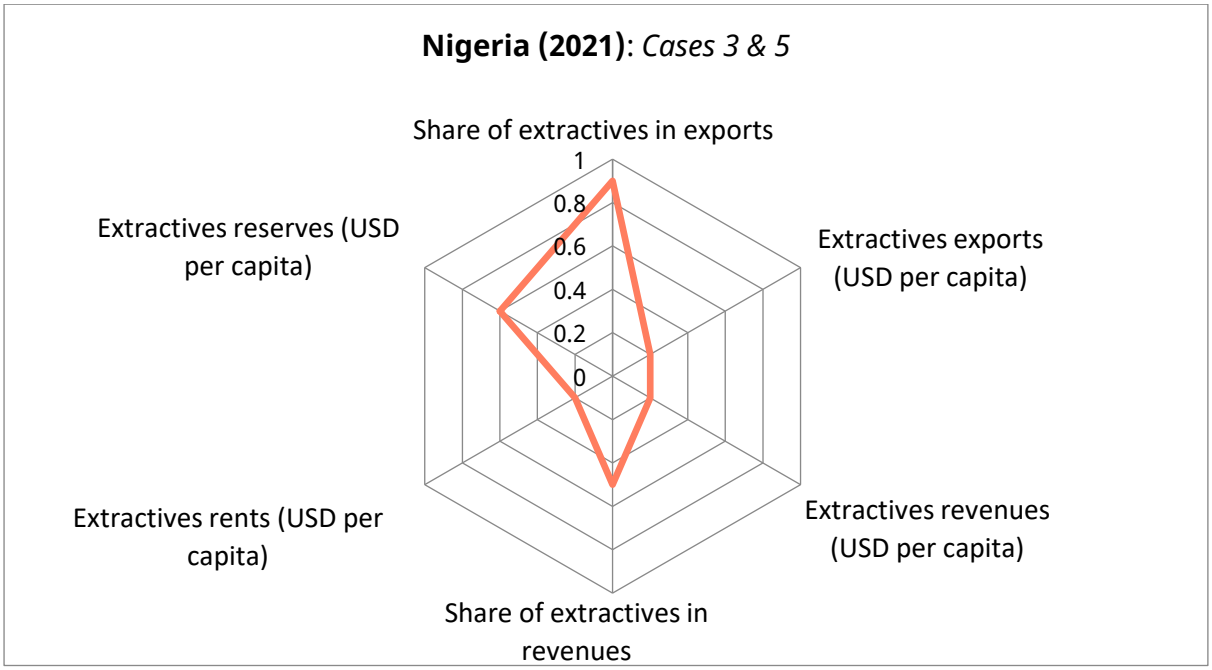
1-There is no time to lose on economic diversification given that Nigeria's resource wealth is low compared to the extent to which is relies on it. Diversification *away* from petroleum must therefore be a key policy priority.

2-Because of a high carbon intensity of its gas production, Nigeria might lose competitiveness in gas production as a resulted of increased global carbon taxation.

Overview

Nigeria is world's 12th largest producer of oil and holds the largest natural gas reserves in Africa. The oil and gas sector plays a significant role in the economy, while the mining sector remains largely underdeveloped. Over the past few decades, Nigeria has suffered from a severe dependence on oil and gas exports.

Figure 17: Nigeria case scenario identification: high resource dependence in the context of limited resource production



NB the figures in USD per capita are not shown in absolute numbers in the chart, they are scaled, as explained in Lebdioui (2021).[21]

As of 2021, Nigeria could be classified as a case scenario 5, which implies high resource dependence in a context of resource poverty (see annex 1). Although Nigeria is commonly thought of as a resource-rich country, Figure 17 above highlights that its *per capita* extractives wealth is low relative to other countries. This may be because Nigeria's per capita resource wealth is divided between its

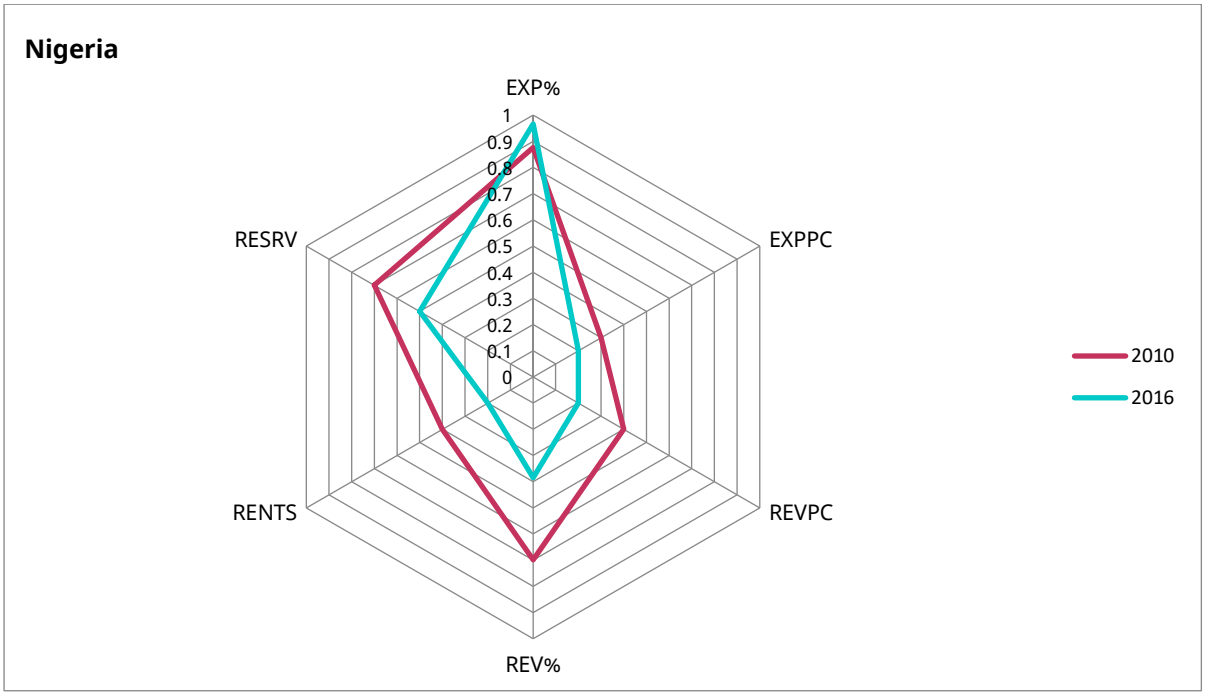
[21] Amir Lebdioui, 'The Multidimensional Indicator of Extractives-Based Development (MINDEX)'.

large population of almost 220 million.[22] Indeed, Nigeria's MINDEX results are characterises by low volumes in terms of extractive resource production, exports, revenues, and reserves but a high share of extractives in total exports. Such situation heavily conditions prospects of resource-based development and influence the suitability of different diversification strategies. Nigeria faces a great urgency to diversify *away* from extractives, rather than sticking to diversifying *around* extractives. This is not only due to the limited scale of production, which can hold back competitiveness of downstream activities; in addition, diversification into other parts of the oil and gas value chain (e.g., processing hydrocarbons or supplying inputs to the sector) might not suffice to provide employment opportunities for Nigeria's large population).[23]

Interestingly, because extractive resource reserves are high in relation to extractives production and rents, Nigeria's MINDEX also shows features of a case scenario 3, which hints at possible issues of under-investment in resource extraction activities, which could be due to a poor business climate or limited domestic infrastructure and capabilities to increase extraction.

Evolution over time

Figure 18: Evolution of Nigeria's resource dependence and abundance from 2010 to 2016



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RENTS: Extractives rents (in USD per capita);
RESRV: Extractives reserves (in USD per capita).

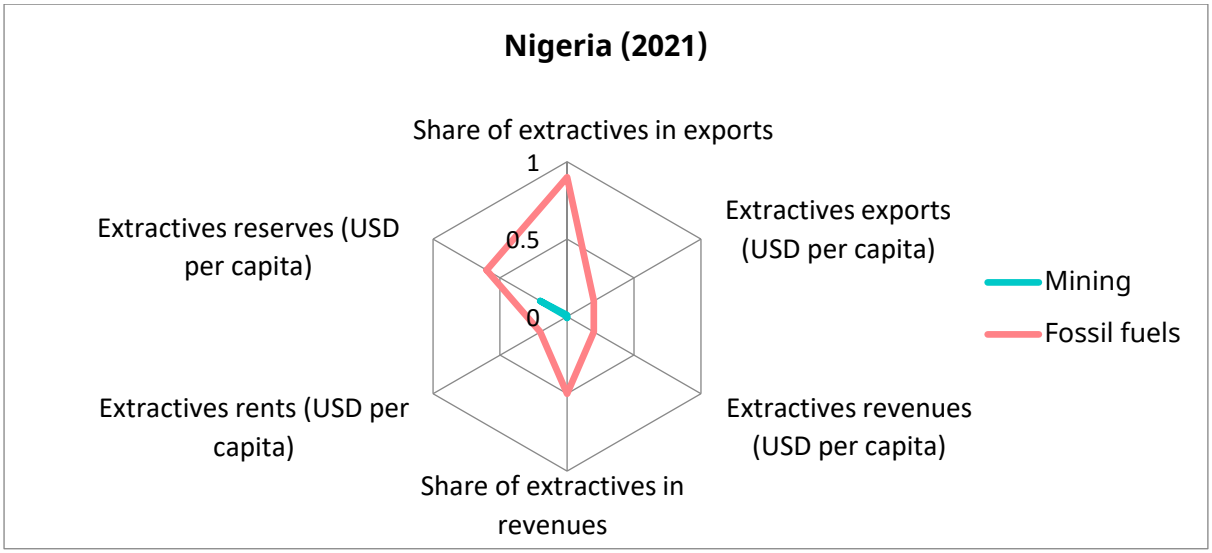
A country's extractive resource dependence is dynamic across time. Interestingly, over the past decade, Nigeria's shift towards a case scenario 5 (extreme dependency) has been accentuated, in large part due to the country's vulnerability to declining fossil fuel prices. In times of high oil prices,

[22] 'Population, Total - Nigeria', World Bank Open Data, accessed 15 August 2023, data.worldbank.org/indicator/SP.POP.TOTL?locations=NG.
[23] Amir Lebdioui and Pavel Bilek, 'Do Forward Linkages Reduce or Worsen Dependency in the Extractive Sector?' (Natural Resource Governance Institute, March 2021), resourcegovernance.org/sites/default/files/documents/do-forward-linkages-reduce-or-worsen-dependency-in-the-extractive-sector.pdf.

Nigeria's MINDEX is closer to a case scenario 1, whereby a country is both resource-abundant and resource-dependent.

Composition of resource wealth

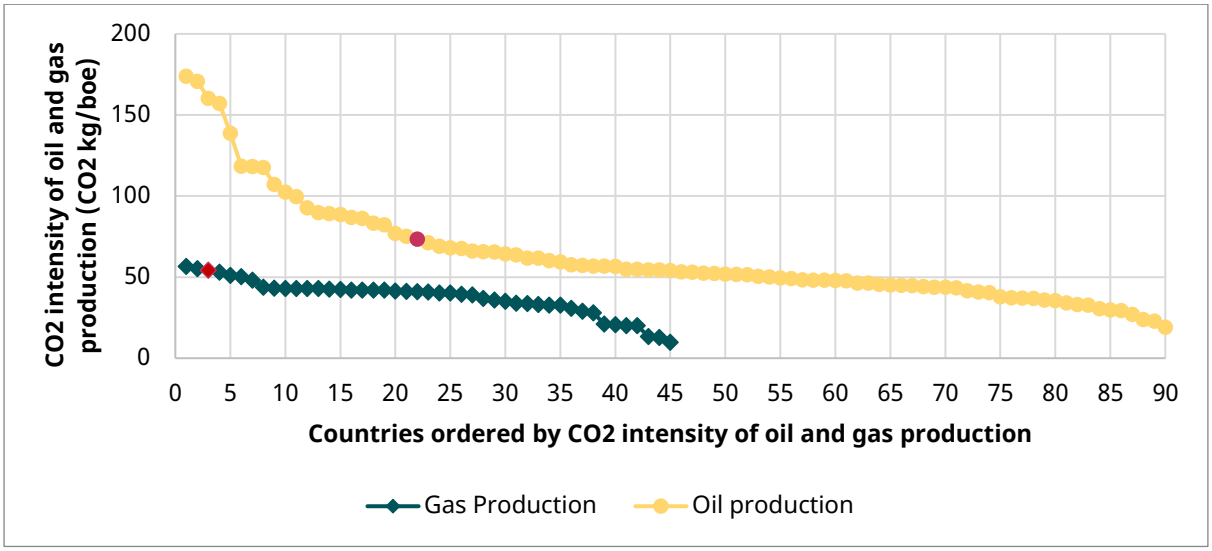
Figure 19: Composition of Nigeria's resource wealth



The composition of Nigeria's resource wealth can also inform dynamics of energy transition and carbon intensity. Though Nigeria possesses reserves of a variety of minerals (esp. iron ore), the mining sector remains nascent, with insignificant contributions to the country's export basket, fiscal revenues, and rents generation.

More so that countries that are dependent on a variety of extractive resources, Nigeria's over-reliance on oil and gas also exposes the country to transition risks. Out of 50 countries, Nigeria has the 3rd highest carbon intensity of gas production (54 CO2 kg/boe) out of 50 countries; and the 22nd highest carbon intensity of oil production out of 90 countries (73 CO2 kg/boe). The intensity of Nigeria's gas resources mean it might be at risk of losing competitiveness in gas production through increasing global carbon taxation (as explained in the introduction).

Figure 20: CO2 Intensity of Nigeria's oil and gas production (CO2 kg/boe)[24]



NB: Nigeria is highlighted in red.

Table 8: Underlying data for Nigeria

	Product/Sector	Unit	2021
Population			213,401,323
Exports	Total	USD	47,231,712,930
Exports	Fuel	USD	42,105,687,983
Exports	Mining	USD	419,745,897
Exports	Fuels	USD pc	197.31
Exports	Mining	USD pc	1.97
Exports	Fuel	%	89%
Exports	Mining	%	0.9%
Revenues	Total	USD	21,223,122,957
Revenues	Fuels	USD	10895.75 m

[24] 'Carbon Intensity in the Fossil Fuel Supply Chain'.

Revenues	Mining revenues	USD	19.5 m
Revenues		USD pc	51.06
Revenues		USD pc	0.09
Revenues	Fuels	%	51.3%
Revenues	Mining	%	0.1%
Rent	Fuels	USD pc	123 (2020 data)
Rent	Mining	USD pc	>0.1
Reserves	Fuels	USD pc	20,488

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