PART III

Applying Wealth Accounts for Policy Analysis
Main Messages

• Nonrenewable assets make up a significant share of total wealth in many countries: for example, 31 countries have more than 5 percent of their total wealth in nonrenewable natural capital.

• Despite being a depleting asset, the nonrenewable wealth of nations more than doubled between 1995 and 2018, from US$13 trillion to US$30 trillion.

• Overreliance on nonrenewable natural capital has proven risky. Price drops since 2014 have seen nonrenewable wealth decline by 35 percent in just four years—down from US$46 trillion to US$30 trillion by 2018. Nonrenewable natural resource–rich countries have failed to diversify their exports. A focus on diversification of their asset base may help promote resilience and sustain economic growth.

• Nonrenewable wealth forms an inverted-U shape, similar to the Environmental Kuznets curve. This means it often forms a low but rising share of wealth at lower income levels, and a higher but declining share for countries with higher levels of national income.

• The low-carbon transition may significantly alter the demand for and prices of fossil fuels, posing additional risks. Countries abundant in metals and minerals that are important for low-carbon technologies, such as batteries and wind turbines, may see growing demand.
Introduction

Nonrenewable resources, comprising oil, natural gas, coal, metals, and minerals, make up only 2.5 percent of total wealth in the world, equivalent to about US$30 trillion in 2018 or 36 percent of global gross domestic product (GDP). However, these assets are distributed unevenly and can constitute a major share of total wealth in some countries. For example, there are 31 countries where nonrenewable natural capital exceeds 5 percent of total wealth. As a consequence, they form an important source of export income and government revenue for many countries.

In fossil fuel–rich countries, the share of nonrenewable natural capital can reach more than 90 percent of the nation’s total natural capital or more than one-third of its total wealth. These countries can be found all across the world, from Saudi Arabia in the Middle East and North Africa region (MENA) to Equatorial Guinea in Sub-Saharan Africa, Azerbaijan in Central Asia, and to Trinidad and Tobago in Latin America and the Caribbean. In addition, some countries have a high share of nonrenewable natural capital derived from metals and minerals, rather than carbon dioxide–emitting fossil fuels. For example, more than 50 percent of Chile’s and almost 25 percent of Guinea’s natural wealth was held in mineral resources in 2018, representing 6 and 15 percent of these countries’ total wealth, respectively. Latin America and the Caribbean and Sub-Saharan Africa are the regions with relatively higher shares of mineral wealth compared to their fossil fuel wealth.

The extraction of nonrenewable natural capital generates an economic rent that can make it a major source of government income and a big part of the economy. The annualized flow of nonrenewable resource rents between 1995 and 2018 reached more than 50 percent of GDP in many oil-rich countries, including Equatorial Guinea, Iraq, Kuwait, Libya, and the Republic of Congo. In other countries, such as Mongolia and Suriname, the combination of the rents obtained from the extraction of fossil fuels and metals and minerals reached one-third of the total value of their economy in the same period.

Traditional Risks from Natural Resource Abundance

The high share of government revenues formed by nonrenewable resources and the associated economic dependence on them can present many challenges to these countries. Previous studies have discussed these challenges and warned of their risks, most famously referred to as the resource curse (van der Ploeg 2011). The resource curse hypothesis posits that abundance of nonrenewable resources can lead to worse economic outcomes than might occur in their absence. One example of how the resource curse can manifest is via a distortion of the real exchange rate, driven by resource booms, known as the Dutch disease (Barma et al. 2012; Corden and Neary 1982). This in turn can undermine competitiveness of the economy and shrink, or hold back, traded sectors such as manufacturing and commercial agriculture.

The record of economic performance among resource-rich countries is mixed. Natural resources can raise the income of a country, and
successful countries have used the proceeds from resource extraction to invest in other forms of capital, including diversification of economic activity and enhancement of human capital via health and education investments (Bravo-Ortega and De Gregorio 2005; Stijns 2006). However, natural resource booms can shift labor from non-resource-intensive to resource-intensive sectors, favoring lower-skill jobs, increasing the opportunity cost of education, and otherwise impeding the growth of other sectors that rely more on highly-skilled human capital. These channels may lead to a reduction or a delay in human capital accumulation, particularly in lower-income resource-rich countries, where there is generally scarce human and physical capital (van der Ploeg and Venables 2011).

Human capital is not the only form of wealth that can suffer. The economic rents generated by natural resource extraction can also induce other rent-seeking behavior that can lead to unequal fiscal distribution, inefficient and unproductive revenues, poor governance, and corruption (Arezki and Gylfason 2013; Robinson and Torvik 2005). This can undermine the overall level of capital accumulation in the economy, limiting the extent to which countries offset the loss of wealth from resource extraction with increases in other capital stocks. Chapter 11 explores the process of wealth diversification, which resource-rich countries have found particularly difficult to navigate. Chapter 12 examines the impact of natural resource abundance on human capital accumulation.

**New Risks from Natural Resource Abundance**

Beyond the resource curse, the twenty-first century brings a new set of challenges that may exacerbate economic challenges associated with natural resource abundance. For example, van der Ploeg and Rezai (2020) discuss the risk facing fossil fuel–rich countries of assets being stranded at the end of the fossil era and unanticipated changes to the timing and intensity of global climate policy. Manley, Cust, and Cecchinato (2016) suggest that effective global climate policies might lead to “stranded nations,” referring to economies with significant fossil fuel reserves. As global energy consumption shifts away from fossil fuels, the economic viability of extracting these resources may decline, and incentive for additional exploration may also fall. Since subsoil resources are almost universally owned by countries rather than companies, it is likely that countries will bear the brunt of this risk. The BP Energy Outlook (2020) predicts a decline in the demand for fossil fuels over the next 30 years, suggesting that a net zero scenario would lead to a halving of 2020’s level of fossil fuel demand, while renewable sources of energy will fill that gap.

How the world navigates the low-carbon transition could determine how the value of nonrenewable natural capital evolves into the future and, in turn, how the overall wealth of resource-rich countries is affected (Peszko et al. 2020). This issue, and the potential policy pathways to manage this risk, is explored in more detail in chapter 10.

It is not just fossil fuels that would be affected by a global carbon transition. Helm (2017) suggests that renewable energy sources will benefit from sustained technical progress and climate policy, eventually
ending the fossil fuel age. Such a transition could drive additional demand for metals and minerals, as highlighted in recent World Bank studies (Peszko et al. 2020; World Bank 2017). This may present an economic opportunity to expand production of these metals and minerals in resource-abundant countries. However, capitalizing on this opportunity will depend on how rapidly countries can adjust supply to meet this rising demand (Galeazzi, Steinbuks, and Cust 2020).

This chapter presents the distribution of fossil fuel and mineral nonrenewable natural capital in different countries and across regions of the world. It explores how these wealth estimates are constructed and the uncertainties associated with valuing nonrenewable assets. Finally, the chapter discusses the risks and challenges faced by countries with high dependence on nonrenewable resources and the drivers of change in nonrenewable wealth over the past two decades.

Global Distribution of Fossil Fuel and Mineral Wealth

Fossil fuel and mineral assets are unequally distributed around the world. Some regions, like MENA, have vast stores of nonrenewable wealth, exceeding 35 percent of total wealth in the region. This wealth is almost entirely based in fossil fuels. In other regions, such as Latin America and the Caribbean, nonrenewable resource wealth is spread roughly equally between fossil fuel wealth and mineral wealth. The latter includes metals such as copper and iron ore. Similarly, while low-income countries and those of the Organisation for Economic Co-operation and Development (OECD) have the lowest shares of nonrenewable wealth in total wealth, the group of non-OECD high-income countries’ nonrenewable wealth reached 30 percent of the income group’s total wealth in 2018. This reflects the special characteristics of these countries, many of which are classified as high-income largely as a consequence of the scale of natural resource revenues generated in their economy.

Given the wide variation in nonrenewable natural capital combinations, each region faces different challenges and opportunities posed by the low-carbon energy transition. Table 9.1 shows the distribution of wealth in different regions and income groups.

Fossil fuel wealth is more abundant than mineral wealth in the world; most of it is concentrated in MENA and upper-middle-income countries. According to the latest Changing Wealth of Nations (CWON) data, MENA is the region with the largest amount of global fossil fuel wealth (see figure 9.1, panel a), holding 52 percent of the world’s total. This primarily comprises petroleum resources. This massive amount of fossil fuel wealth located in countries around the Persian Gulf is more than three times the amount found in any other region.

By income groups, the countries with the largest share of fossil fuel wealth are those classified as upper-middle-income, as figure 9.1, panel b, shows. Not only do they hold almost half of the world’s fossil fuel wealth (46 percent), but they also hold the largest share of metals and minerals wealth (45 percent). This group of countries includes large economies, led
by the Russian Federation, China, and the Islamic Republic of Iran, and another 36 countries with nonrenewable natural capital that exceeds US$1 billion.

When a country derives a large share of its GDP, export receipts, or government revenues from natural resource wealth, it is often referred to as resource rich or resource dependent (IMF 2012b). This classification can similarly be extended to countries with large shares of wealth concentrated in these assets. By this metric, the largest number of resource-dependent countries in terms of fossil fuels are found in the MENA region. Meanwhile, the economies with the highest dependence on mineral wealth are located Latin America and Sub-Saharan Africa. One of these Sub-Saharan African countries, Guinea, is the only country in the world where metal and mineral assets exceed 15 percent of the country’s total wealth.

Resource dependence based on wealth is closely related to measures of resource dependence based on revenues, such as share of total government revenues. This is because subsoil resources are typically owned by governments and are taxed or sold with a significant share of the proceeds going to government. Governments as resource owners have the objective to capture the economic rents arising from resource extraction and sale.

### TABLE 9.1 Distribution of Wealth, Including Nonrenewable Wealth, by Region and Income Group, 2018

<table>
<thead>
<tr>
<th>Region and income group</th>
<th>Natural capital</th>
<th>Produced capital</th>
<th>Human capital</th>
<th>Nonrenewable natural capital</th>
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<td>25.5</td>
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<td>World</td>
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<td>31.2</td>
<td>63.6</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Source: World Bank staff calculations.

Note: The first three columns may not sum to 100 because the category of net foreign assets is not shown. OECD = Organisation for Economic Co-operation and Development.
Nonrenewable natural resource rents are the difference between the cost of production and the estimated revenue from the sale of fossil fuels or minerals (annex 9A details how these rents are calculated). In 67 countries, the rents from nonrenewable natural capital exceed 1 percent of the nation’s GDP (see figure 9.2). Among these, there are 16 countries in East Asia and Pacific, Europe and Central Asia, MENA, and Sub-Saharan Africa where rents obtained from nonrenewable natural capital exceed 20 percent of the countries’ GDP. In all these countries, the largest source of rents comes from fossil fuel assets. For example, in the Republic of Congo, fossil fuel rents reached 43 percent of the country’s GDP in 2018. It is important to note that rent numbers reported by CWON are estimates. Because, among other things, the costs of production are not readily observable and vary over the lifetime of an extraction project, there can be significant uncertainty contained within these estimates. Further, while governments seek to tax the rents generated from extraction, it has proven very challenging to capture the full rental value as revenues for government. Box 9.1 discusses these issues in more detail.

Since 1995, the world’s fossil fuel wealth has more than doubled. This has been accompanied by increasing fossil fuel wealth in most countries in the world (95 in total). Between 1995 and 2018, the world’s fossil fuel wealth increased from US$12 trillion to US$26 trillion, an increase of

**FIGURE 9.1** Distribution of Fossil Fuel and Mineral Wealth, by Region and Income Group, 2018
FIGURE 9.2 Nonrenewable Natural Capital Rents’ Share of GDP, by Region and Country, 2018

Source: World Bank staff calculations.

Note: The figure displays only those countries with nonrenewable natural capital rents greater than 1 percent of GDP. North America is not shown because only Canada has nonrenewable natural capital rents greater than 1 percent of GDP (1.8 percent from oil, 0.1 percent from gas, 0.8 percent from coal, and 0.1 percent from minerals). GDP = gross domestic product.
Rent calculations estimate the difference between the cost of extraction and the typical price of sale. Conceptually, this can be thought of as equivalent to the compensation the resource owner—typically a country—should receive for resource extraction. Meanwhile, the company is entitled to recoup its costs plus a reasonable return on its capital investment. However, estimates of rents provided in the Changing Wealth of Nations (CWON) do not distinguish between what the government gets and what the company receives. As such, rent numbers should be considered closer to an upper bound of what might accrue to the country that owns the resource.

There are two reasons why rents do not equal government revenues. First, it is a widely held view (see, for example, Daniel, Keen, and McPherson [2010]) that governments fail to capture the maximum available rents associated with nonrenewable resource extraction. The reasons for this may include differential risks being borne, significant uncertainties across time, asymmetries of information, and the difficulties tax administrators experience in measuring companies’ tax bases (Cust and Manley 2018). Using data from Rystad Energy UICube, which is the source for this CWON’s petroleum unit rent numbers, it is calculated that between 2010 and 2014, governments took, on average, 77 percent of the total rents available. This is similar to the 65 to 85 percent discounted average effective tax rates considered “reasonably achievable” by the International Monetary Fund (IMF 2012a).

The second reason is that the risk-adjusted cost of capital for fossil fuel industries may be higher than captured by the rent estimates. If the risk-adjusted cost of capital is high in a particular country, the rent available for the country to tax may be lower than estimated in the CWON data set. This might be because of hidden costs, including political risks, that raise the risk premium for investors to operate in a particular jurisdiction. Investors may be deterred from, and therefore require greater compensation for, investing in countries with, for example, weak governance (Cust and Harding 2020). This could help explain why governments are unable to recover the full amount of potential rent.

Governments should therefore interpret the rent numbers cautiously. Higher rent estimates may signal that additional tax revenues could be captured. The means for capturing them, however, may involve reducing political and other risks, reducing costs of doing business, as well as negotiating better deals or taxing more effectively. Managing low-carbon transition risk may increase pressure for governments to try to squeeze more revenues from existing projects, especially if petroleum prices start declining. Therefore, policies that reduce investor risks may help increase the rents available to be taxed.

Furthermore, efforts to support better rent capture by governments, such as providing technical assistance to governments engaged in contract negotiations or assistance in auctioning fossil fuel extraction rights, might be helpful in the global effort to mitigate carbon emissions. The reason is that any undertaxation of extraction by the government functions as a form of implicit production subsidy. This subsidy might therefore induce overextraction relative to a situation where producers face the full social cost of carbon (that is, a carbon tax or price) and the full private cost of extraction (that is, including full rent taxation). If the low-carbon transition places downward pressure on fossil fuel prices, governments might even be tempted to lower taxes to maintain production levels. However, if this comes at the expense of rent capture, it may also shortchange citizens as the ultimate beneficiaries of subsoil wealth.
approximately 117 percent. Rising oil prices and new petroleum discoveries contributed to this growth. The prices of oil, natural gas, and coal started to rise rapidly during the first years of the 2000s, peaked between 2008 and 2013, and started to drop after 2014 (figure 9.3, panel a). For example, the average price of oil was US$18.69 (real 2010 US dollars) per barrel in 1995 and reached its maximum in 2012, an average of US$95.31, a rise of 400 percent. At this peak, the world’s fossil fuel wealth was already three times higher than the global value of fossil fuel wealth in 1995 (figure 9.3, panel b). But the effect of oil prices falling in 2014 led to a reduction in fossil fuel wealth, from US$41 trillion to US$27 trillion by 2018. However, despite this decline, fossil fuel wealth is still at least five times larger than metals and minerals wealth.

Fossil fuel wealth has not expanded or shrunk at the same rate in all countries. Different depletion speeds and the discovery of new reserves have affected the magnitude of fossil fuel wealth in each. Since 1995, more than 240 giant petroleum and natural gas fields have been discovered, with 14 of them holding more than 5 billion barrels of oil equivalent (Cust, Mihalyi, and Rivera-Ballesteros, forthcoming). For example, Brazil found at least 22 fields holding more than 500 million barrels of oil equivalent between 1995 and 2018, which, alongside rising production volumes, has contributed to almost tripling the country’s fossil fuel wealth. By contrast, 20 countries and regions saw significant declines in their fossil fuel wealth between these years, mainly driven by increasing depletion.

FIGURE 9.3 Fossil Fuel Prices, and Fossil Fuel and Metals and Minerals Wealth

Source: World Bank staff calculations.
Note: Fossil fuel wealth includes crude oil, natural gas, and coal. Metals and minerals wealth includes bauxite, copper, gold, iron ore, lead, nickel, phosphate, silver, tin, and zinc. mmbtu = million British thermal units; mt = metric tons.
falling production volumes, and limited numbers of new discoveries (see map 9.1). For example, according to World Bank staff estimates, fossil fuel depletion in Mexico increased five times, from US$5 billion in 1995 to US$25 billion in 2018, while the country discovered fewer than five fields the size of those found in Brazil. This has contributed to a decline in Mexico’s fossil fuel wealth, which fell from US$400 billion in 1995 to US$227 billion in 2018, a decline of 43 percent in 23 years.

Since 1995, total global mineral wealth has more than tripled as a consequence of the increasing mineral wealth in 77 countries and regions. The world’s mineral wealth grew from US$1.0 trillion to US$3.1 trillion between 1995 and 2018. In 77 of 121 countries and regions with positive mineral wealth, the value of minerals and metals has increased, and for 65 of them, mineral wealth has more than doubled. The increase in the prices of several metals and minerals during the 2004–14 commodity boom and new reserves through the discovery of new deposits brought a fast increase of mineral wealth, particularly after 2008. Between 1995 and 2018, the real prices of all metals and minerals covered by this wealth measure increased (figure 9.4, panel a). The price of gold had the largest increase, tripling over this period. It rose from an average of US$418 per troy ounce in 1995 to US$1,247 per troy ounce in 2018, and it has continued to increase, especially when the COVID-19 pandemic started. The increase in the price of gold is followed by increases in the prices of silver, iron ore, lead, tin, and nickel. The latter more than tripled over 2004–14 but slightly declined after 2014. The price of nickel went from US$8,951 per metric ton (mt) in 1995 to US$39,013 per mt in 2007 and declined to
US$13,928 per mt in 2018, still almost twice the price in 1995. These jumps in prices contributed to the increase of metals and minerals wealth from US$1.3 trillion in 2005 to US$7.3 trillion in 2012, a fivefold increase over about seven years (figure 9.4, panel b).

Newly discovered metal and mineral deposits have contributed to the increase in countries’ mineral wealth. New metal and mineral deposits have been found all over the world, contributing to a rapid increase in the use of metals and minerals in production. According to the United States Geological Survey Mineral Yearbook (USGS 2020), global gold mine production went from 2,200 mt of gold content in 1995 to 3,260 mt in 2018. In some countries, these new discoveries have significantly increased mineral wealth. According to the same Mineral Yearbook data, Burkina Faso reached gold production of 46,000 kilograms of gold content in 2017; it was only about 1,000 kilograms in the late 1990s. Thus, mineral wealth in Burkina Faso rose from US$125 million in 1995 to US$4.8 billion in 2018, an increase of about 3,700 percent. However, in almost one-fourth of the 105 countries and regions with mineral wealth data, the value of their mineral assets decreased between 1995 and 2018 (see map 9.2). Countries that saw falling mineral wealth include mineral-rich countries, like Papua New Guinea and South Africa, where mineral wealth dramatically dropped after the end of the commodity boom, in large part because of the price effect. Mineral wealth in Papua New Guinea went from US$15 billion in 1995 to US$30 billion in 2010 but quickly dropped to US$7 billion in 2018. Similarly, mineral wealth in South Africa went from US$60 billion in 1995 to US$100 billion in 2010 but dropped to
Annex 9A describes the conceptual approach to valuing nonrenewable natural capital. However, there are significant uncertainties about the future value of nonrenewable natural capital. For example, since 2018, the final year of the CWON 2021 wealth accounts, the price of oil and other commodity prices have experienced major fluctuations for several reasons: for example, as a consequence of the COVID-19 pandemic in 2020. Wealth measures depend on making assumptions about the future path of rents, which in turn are a function of many factors, including future production and prices. The CWON methodology adopts a standard approach of applying a five-year average price and extrapolating it forward. However, no one knows how prices will evolve, and therefore estimates of current wealth—since they depend on the estimated net present value of future rents—are not certain. Additional uncertainty comes from expectations about the global carbon transition. Chapter 10 explores the implications if future fossil fuel prices are affected by this transition and associated policy responses, and it examines the implications for wealth.

**Challenges for Nations Rich in Nonrenewable Resource Wealth**

Countries with a high share of fossil fuel–based natural capital face four interlinked policy challenges related to the carbon intensity of their wealth: (1) high exposure to low-carbon transition risks, which could
reduce the value of subsoil wealth; (2) high potential for reduced government revenues derived from fossil fuel wealth; (3) policies and investments that might further increase low-carbon transition risk; and (4) the difficulty of diversifying away from nonrenewable natural capital (Cust and Manley 2018).

Future market prices of fossil fuels are uncertain, but they may be lower as the world transitions to low-carbon energy sources. The value of nonrenewable natural capital in the CWON core accounts does not take account future changes in prices or policies as part of the global low-carbon energy transition and the changing climate. Therefore, the net present values are unlikely to yield correct predictions of the path of rents in the future. For example, a decline in demand for fossil fuels due to climate policies and the falling costs of alternative energy technologies might permanently lower the value of a country's fossil fuel wealth if demand and prices fall in the future. In other words, countries that are rich in fossil fuel wealth may face significant but uncertain downside risks in the future. These risks, and how policy might respond, are discussed in detail and simulated quantitatively in chapter 10.

Market prices for some metals and minerals may rise as part of the low-carbon transition. And rising demand for transition minerals could drive higher prices in the future (Galeazzi, Steinbuks, and Cust 2020)—for example, prices for those metals and minerals that may be needed for low-carbon energy technologies, such as lithium or cobalt for batteries. This would imply that the current mineral wealth estimates understate how valuable these assets may be going forward. In other words, countries that are rich in transition minerals may face upside risks in the future from changes in technology deployments and new global trends (Hund et al. 2020).

Fossil fuel–rich countries and mineral-rich countries may face divergent futures. This might also imply a policy bifurcation—whereby carbon-rich countries may need to mitigate downside risks, for example by accelerating diversification away from fossil fuel dependence and exposure to low-carbon transition risk. Meanwhile, countries that are rich in transition minerals may seek to position themselves to benefit from the upside risks—such as by increasing production of key minerals or developing more downstream value addition in key strategic sectors. The future of countries that are rich in nonrenewable natural capital will depend on how they manage to diversify their asset portfolio: for example, by investing in human capital or building their stock of productive assets and enhancing the value of renewable natural capital. Diversification in assets offers an alternative to traditional diversification recommendations, which often focus on export diversification—which can be difficult in the face of the Dutch disease induced by nonrenewable exports (Harding and Venables 2016; Ross 2019)—or downstream value addition—which in the case of fossil fuels might lead to increasing carbon intensity of the economy and, therefore, additional carbon risk (Peszko et al. 2020).

A diversification approach that focuses on enhancing the stock of other assets—human capital, productive capital, and renewable natural capital—may help mitigate these risks. Indeed, this may prove to be a
more expedient pathway for economic diversification and sustainable prosperity, not least since it does not face the same competitiveness obstacles as export diversification. Asset portfolio diversification is further discussed in chapter 11 and in Peszko et al. (2020).

**Exposure to Low-Carbon Transition Risks**

The countries with the largest amounts of nonrenewable natural capital are also the countries with the highest exposure to low-carbon transition risks. Indeed, 18 of the 25 countries with the largest amounts of nonrenewable natural capital in the world are not well prepared for a low-carbon transition, according to Peszko et al. (2020). In these 18 countries, fossil fuel wealth exceeds more than US$0.1 trillion and can reach more than US$100,000 per person (figure 9.5). The countries that currently enjoy rents from these vast resources might not continue doing so in the future. With recent efforts to decarbonize the global economy, the demand for oil, gas, and coal could pull down the prices of these commodities, negatively impacting the rents from their extraction. More diversified economies with large amounts of nonrenewable natural capital, like Australia and the United States, might face a lower impact, since they are less exposed to low-carbon transition risks.

**FIGURE 9.5 Nonrenewable Natural Capital of the Top 25 Countries, 2018**

[Diagram showing nonrenewable natural capital of the top 25 countries, 2018, with countries listed on the x-axis and nonrenewable wealth per capita on the y-axis.]
Other countries have managed to transition from a high share of fossil fuel wealth to a higher share of mineral wealth. For example, after the 2008 financial crisis, mineral wealth became the most important type of nonrenewable natural capital in Brazil, where oil wealth was between 60 and 70 percent of its total nonrenewable natural capital in previous years. In 2018, Brazil’s oil wealth share of total nonrenewable wealth dropped to less than half, and minerals reached 53 percent of nonrenewable wealth. The income generated by this wealth dwarfs that which currently is derived from Brazil’s rich and biodiverse renewable natural capital.

The high rents from nonrenewable natural capital generate outsized government revenues in countries that are abundant in such resources. Put another way, government resource revenues are high in countries where nonrenewable natural capital is a large share of total wealth. Resource revenues in MENA countries can reach half of total revenues. And many countries in Sub-Saharan Africa have a high dependence on nonrenewable natural capital and resource revenues, including Gabon, the Republic of Congo, Chad, Guinea, Mozambique, and Nigeria (figure 9.6, panel a).

Since nonrenewable wealth may be at risk from the low-carbon transition, countries’ fiscal position—and governments’ ability to finance development priorities—would likewise be placed at risk. These countries may

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**FIGURE 9.6 Nonrenewable Natural Capital and Natural Resource Revenue, Top Countries, 2018**

Source: ICTD/UNU-WIDER 2020; World Bank staff calculations.
Note: Some countries have missing resource revenues for recent years and are left blank in panel b.
need to start accelerating the transformation of their revenue sources to other sectors of the economy as associated assets—such as human, productive, and renewable capital—to avoid the potential negative consequences of reduced global demand for fossil fuels.

**Potential for Reduced Revenues from Reserves Depletion and Exhaustion**

Considering current amounts of fossil fuel reserves, 18 countries would have oil reserves that could last for more than two generations. According to the US Energy Information Administration’s annual petroleum reserves and production data (EIA 2020), oil reserves in fossil fuel–dependent countries, such as the República Bolivariana de Venezuela and the Islamic Republic of Iran, could last for more than a century (figure 9.7). But other oil-producing countries, like Nigeria and Ecuador, could entirely deplete their oil reserves in fewer than 50 years at current depletion rates, assuming no other significant oil fields are discovered or become commercially viable. Natural gas reserves could last longer. However, some countries, such as Israel and Canada, might exhaust their gas reserves before they exhaust their oil reserves. Nonetheless, with the decarbonization efforts and the reduction in the prices of other sources of energy, much of these resources could become uncommercial with reduced importance in a nation’s total wealth before full exhaustion is reached. The order in which reserves become stranded will likely be a function of the cost of production and world prices, among other factors.

**FIGURE 9.7 Time to Depletion of Oil and Gas Reserves, 2018**


Note: Median time to depletion for oil is 14.8 years among 95 countries with oil production data. Depletion rates are calculated by dividing annual reserves data over annual oil or gas production numbers. Only countries with depletion horizons of more than 30 years and production above 1 million barrels per day are displayed.
Policies and Investments Increasing Low-Carbon Transition Risks

Many countries with high rents from nonrenewable natural capital have not invested sufficiently to offset the depleting asset. This is expressed in terms of negative adjusted net savings. This is true not only for hydrocarbon-rich countries, such as Iraq and Nigeria, but also for some mineral-rich countries, such as Guinea and Sierra Leone. The negative adjusted net savings in these countries is a lead indicator of unsustainable wealth management. If continued, it will negatively impact the value of future wealth. This is because the value of a depleting nonrenewable asset is being consumed rather than invested in offsetting asset accumulation—such as via human capital or productive capital investment. Therefore, governments may need to consider policies that would better preserve and build wealth or look for alternative sources of income to raise their net savings.

Investments in renewable natural capital and human capital could help countries to diversify their asset portfolio and reduce their dependence on nonrenewable natural capital. Peszko et al. (2020) suggest that an asset diversification strategy where a country invests in renewable natural capital and intangible assets, like knowledge, innovation, and institutions, could help reduce the exposure to low-carbon energy transition risks. They also suggest that this strategy increases the flexibility, resilience, productivity, and climate mitigation co-benefits. This is different from traditional diversification, in which nonnatural resource-intensive traded sectors are subsidized, which has been the prevailing growth model in many fossil fuel–dependent countries (Peszko et al. 2020). According to 2018 data, on average, low-income countries had the highest natural capital share of total wealth, which translates into a higher dependence on this type of wealth. By contrast, high-income countries had on average the lowest share of natural capital, indicating less reliance on this type of capital. In other words, on average, the higher the income level is, the lower is the share of wealth concentrated in natural capital. The natural capital share of total wealth in low-income countries could be five times higher than that in upper-middle-income countries (figure 9.8). Similarly, the higher the income level is, the higher is the human capital share of total wealth, consistent with the strategy proposed by Peszko et al. (2020). Chapters 11 and 12 explore in depth the asset diversification strategy and its implications for wealth and growth. Moreover, when a capital stock is low—human and physical capital in low- and lower-middle-income countries—the returns of investing in them can be higher (Venables 2016). These investments should not be independent of each other, because human and physical capital are interconnected; produced capital is more productive with more human capital, and human capital is more productive with better infrastructure or physical capital (de la Brière et al. 2017). Countries should use their natural resource rents to fund the accumulation of these other capitals, but the evidence suggests that these rents are not always reinvested successfully (van der Ploeg 2011).
Diversification and Nonrenewable Natural Capital

The share of mineral wealth in total wealth has grown over the past two decades, compared with the share of fossil fuel wealth. Fossil fuel wealth has been the main source of nonrenewable natural capital for many years. However, during the 2008 financial crisis when oil prices dropped dramatically for the first time since the commodity boom started, the share of mineral wealth in total wealth started to grow more rapidly, while the share of fossil fuel wealth declined (figure 9.9). In 1995, global mineral wealth was only 8 percent of total nonrenewable natural capital; the remaining 92 percent corresponded to fossil fuel wealth. However, the commodity boom incentivized the exploration of new mines, which led to new discoveries that contributed to mineral wealth rising to 15 percent of total nonrenewable natural capital in 2012. When the commodity boom ended, mineral wealth did not decline as much as fossil fuel wealth, principally due to the oil price crash in 2014–15. The transition to new wealth sources has already started in countries like Brazil, the Democratic Republic of Congo, and Turkey. Figure 9.10 shows that before 2005, these countries had significant amounts of fossil fuel wealth, but in the past decade, mineral wealth overtook oil wealth, becoming the most important source of nonrenewable natural capital in these countries.

Globally, there is still a long way to go in the transition to a low-carbon energy scenario. Over the past two decades, fossil fuel wealth more than doubled, from about US$13 trillion in 1995 to about US$30 trillion in 2018, reaching a peak during the commodity boom. This situation reflects the scale of the challenge to decarbonize the global economy.
FIGURE 9.9 Global Nonrenewable and Renewable Natural Capital, 1995–2018

a. Global nonrenewable natural capital

b. Global total renewable and nonrenewable natural capital

Source: World Bank staff calculations.

FIGURE 9.10 Nonrenewable Wealth in Brazil, the Democratic Republic of Congo, and Turkey, by Type, 1995–2018

a. Brazil

b. Democratic Republic of Congo

c. Turkey

Source: World Bank staff calculations.
Galeazzi, Steinbuks, and Cust (2020) argue that the so-called mineral energy materials may face upside market risks as the global economy increases demand for low-carbon technologies that are intensive in these minerals. However, estimates of trade elasticities suggest that to capitalize on this opportunity, many countries will need to become more responsive to increased demand or otherwise face intense competition from other established mineral producers.

Global mineral wealth in 2018 reached US$3.1 trillion, still less than the US$3.4 trillion of coal wealth or the US$30 trillion of fossil fuel wealth in the same year. This means that global fossil fuel wealth in 2018 was 10 times the amount of mineral wealth. However, there is some extent of heterogeneity across regions. Fossil fuel wealth is the dominant type of nonrenewable natural capital in all regions of the world, but Latin America and the Caribbean has been the only region that has shifted this trend. As shown in figure 9.11, after the oil price shock of 2008, minerals became almost as important as fossil fuels in the region’s total wealth. This region has the lowest difference between fossil fuel wealth share and mineral wealth share in the world. A higher share of mineral wealth may therefore provide some risk mitigation from the global transition away from fossil fuels.

Due to the low-carbon energy transition, the annual demand for five minerals is expected to increase by more than 100 percent over the next 30 years. However, there are still important uncertainties around the future of their demand. According to Hund et al. (2020), the demands for graphite, lithium, cobalt, indium, and vanadium are expected to more than double by 2050. In the case of graphite, lithium, and cobalt, which are needed to produce batteries, annual demand is expected to increase by almost 500 percent under a 2-degree Celsius global warming scenario. The demand for aluminum is projected to have a more modest increase of less than 10 percent, but the world will continue demanding more than 5 million tons of this metal annually to continue building lightweight technology and other new technology components. Figure 9.12 shows the projected annual demand for 17 minerals compared with annual production in 2018. All these minerals play a critical role in the low-carbon energy transition, and their demand is projected based on deployed battery technology. However, Hund et al. (2020) raise three main uncertainties around the future demand for these minerals: the mineral composition of new technologies, the amounts of these types of technologies deployed in the future, and which of the new technologies will actually be deployed.

**Nonrenewable Natural Capital and the Environmental Kuznets Curve**

On average, the nonrenewable natural capital share of total wealth in low- and high-income countries is smaller compared with the share in middle-income countries. This forms an inverted-U shape, with low and rising shares at lower incomes, then transitioning to higher but declining shares at upper levels of national income.
FIGURE 9.11 Total Fossil Fuel and Mineral Wealth Share of Total Wealth, by Region, 1995–2018
This inverted-U pattern is similar to the Environmental Kuznets Curve. The concept of the Environmental Kuznets Curve was introduced by Stern, Common, and Barbier (1996) to describe the supposed relationship between income change and environmental degradation. This concept is derived from the Kuznets Curve proposed by Kuznets (1955), who found that the relationship between income inequality and economic development follows the shape of an inverted-U. The Environmental Kuznets Curve proposes that environmental degradation first rises and then falls as income per capita increases.

This chapter finds that the relationship between nonrenewable natural capital and GDP per capita, considering all countries in the world, follow a similar inverted-U shape. According to 2018 data, countries with a lower GDP per capita, such as Ethiopia and Tanzania, had lower levels of nonrenewable natural capital (figure 9.13). Similarly, as countries experience rising incomes, moving to the right along the x-axis in figures 9.13 and 9.14, nonrenewable natural capital first increases and then declines. Between 1995 and 2005, the nonrenewable natural capital of countries like Ethiopia and Tanzania rose as their GDP per capita increased. But between 2005 and 2018, the growth rate of their nonrenewable natural capital diminished as their income per capita continued to increase.

The relationship observed between rising income and an inverted-U shape in nonrenewable natural capital does not imply causality between the two. However, given the important role of nonrenewable wealth in driving increases in GDP per capita among poorer countries—whose
FIGURE 9.13 Kuznets Curve of Nonrenewable Natural Capital and GDP per Capita, Selected Countries at Different Income Levels

a. Nonrenewable natural capital: US$

b. Nonrenewable natural capital: Share of total wealth

Source: World Bank staff calculations.

FIGURE 9.14 Kuznets Curve of the Nonrenewable Natural Capital and GDP per Capita, All Countries

a. Nonrenewable natural capital: US$

b. Nonrenewable natural capital: Share of total wealth

Source: World Bank staff calculations.
Note: Yellow lines indicate changes between 1995, 2005, and 2018, where available. Blue lines indicate countries shown in figure 9.13.
wealth in other categories is much lower—it is perhaps unsurprising that the curve is upward-sloping at first. Likewise, given the important roles of structural transformation, industrialization, and human capital accumulation in explaining countries’ graduation from middle- to upper-income levels, the declining importance of nonrenewable wealth is no surprise. Nonetheless, this relationship does reflect how resource dependence is not fate. Indeed, countries successfully achieving higher-income status have often done so with declining shares of resource wealth, rather than the opposite.

This relationship may be a useful guide for policy makers who seek to emulate the path of countries at aspirational levels of GDP per capita. It further underscores the declining importance of nonrenewable natural capital as countries move toward higher income levels, reflecting the faster rate of accumulation of other assets, such as human capital, productive capital, and the enhanced value of renewable natural capital. This is consistent with policy insights found elsewhere in this report—resource wealth can and should be used to enhance asset accumulation elsewhere in the economy. Revenues from resource extraction provide a special opportunity for governments to enhance other categories of wealth and to drive structural transformation of the economy.

**Decomposition Analysis: What Is Driving the Changes in Nonrenewable Natural Capital?**

A decomposition analysis is useful to quantify the magnitudes of the different factors that are used to estimate the value of nonrenewable natural capital (Hoekstra 2021).³

The factors that produce changes in fossil fuel wealth are different from the factors that change mineral wealth. According to nonrenewable natural capital decomposition data, the five cumulative decomposition factors—production (rents), unit costs (rents), unit prices (rents), stocks (lifetime), and production (lifetime)—have changed the carbon and mineral wealth of nations in different ways. Nonrenewable natural capital in low-income and lower-middle-income countries has changed little, because these factors changed slightly compared with the other income groups. Nonrenewable natural capital has changed the most in the upper-middle-income group. On average, production has been the main factor increasing nonrenewable natural capital wealth for most countries, while increases in unit costs have been the main factor reducing it.

However, other factors have contrasting effects on carbon and mineral wealth. Fossil fuel wealth benefited from resource unit prices derived from the high oil prices during the commodity boom. But for mineral wealth, increases in resource stocks—for example, via discoveries—have been the main driver of wealth accumulation. This has happened mainly in upper-middle-income countries where most of the new mineral deposits have been found. The high exploration and investment costs to produce fossil fuel assets have negatively affected countries’ nonrenewable natural capital, but they have had a smaller effect for mineral assets. Accelerating
mineral depletion has become the main factor reducing mineral lifetime production and mineral wealth. Figure 9.15 shows the magnitudes of the fossil fuel and mineral wealth decomposition factors between 1995 and 2018, by income group.

Over the past two decades, global nonrenewable natural capital has increased thanks in part to the production effect. However, fossil fuel wealth is at risk because of high unit costs, and mineral wealth is at risk because of high depletion rates. Nonrenewable natural capital has more than doubled, despite its finite nature, especially during the commodity boom. High commodity prices during the 2000s incentivized the production of nonrenewable natural capital and exploration for new reserves. This is illustrated by the large decomposition effects of production (rents) and unit prices, at US$10.3 billion and US$9.2 billion, respectively, in 2018 (figure 9.16). The main factor contributing negatively to the changes in wealth was the rising nonrenewable unit cost—the cost of getting the resource out of the ground. Increasing unit costs of extraction led to a US$4.9 billion reduction in fossil fuel wealth. The implication is that if unit costs continue to increase because of the growing complexity of oil and gas extraction, and if oil or gas prices continue declining, wealth will diminish significantly. Due to the drop in rents, some production projects might not be profitable and could become stranded assets. The countries with the highest unit costs are most at risk of this development.

The 1995–2018 cumulative increase in mineral wealth was US$2.1 billion (figure 9.17). The increase was thanks to mineral production and
new discoveries expressed as lifetime stocks, so that mineral wealth tripled. A striking difference between fossil fuels and minerals is that the effect of unit prices is negative for minerals. That means that over this period, prices decreased and led to a decrease in wealth. However, looking at the detailed decomposition results shows that this trend is dominated by the effect of price changes in iron ore (about one-third of total
mineral wealth). Bauxite and nickel wealth were also affected by negative unit price effects, but all the other mineral resources showed growing wealth due to price increases (see Hoekstra 2021 for details). The implication is that the mineral wealth of countries will be dependent on the type of mineral in question. Depending on the prospects for unit price, unit cost, production, and discoveries, countries can assess the prospects for declining or increasing mineral wealth. Some minerals, such as lithium and cobalt, are likely to benefit from a low-carbon future, while others may suffer.

Conclusion

Although nonrenewable natural capital accounts for just 2.5 percent of total wealth in the world, in monetary terms it is equivalent to more than one-third of the world’s GDP. Many economies rely heavily on nonrenewable natural capital for export earnings and government revenues, a scenario sometimes referred to as resource dependence. Countries with high levels of dependence on nonrenewable natural capital already face several macr...
Annex 9A: Methodology for Valuing Nonrenewable Natural Capital

The Changing Wealth of Nations (CWON) 2021 follows the same conceptual approach to valuing nonrenewable natural capital as CWON 2018 (Lange, Wodon, and Carey 2018). As described in Cust and Manley (2018), the value of a nation’s stock of nonrenewable natural capital is measured as the present value of the stream of expected total rents that may be extracted from the resource until it is exhausted. Implementing this approach requires (1) estimating rents and (2) projecting the future flow of rents. Due to the high volatility of commodity prices and rents, smoothing rents over a period of five years or so could provide a better indication of long-term value, the aim of wealth accounting.

Under the current CWON implementation, asset value, \( V_t \), is given as

\[
V_t = \sum_{i=t}^{t+T-1} \frac{R_i}{(1+r)^{i-t}}, \tag{9A.1}
\]

where

- \( \overline{R}_t \) = lagged, five-year moving average of annual total rents, \( R_t \), in years \( t \) (the current year) to \( t-4 \),
- \( r \) = the discount rate (assumed to be a constant 4 percent), and
- \( T \) = the lifetime of the resource.

Total rents in the current year are calculated as

\[
R_t = \pi_t q_t, \tag{9A.2}
\]

where

- \( \pi_t \) = unit rents and
- \( q_t \) = quantity of resources extracted.

Unit rents, \( \pi_t \), in year \( t \) are calculated as

\[
\pi_t = (p_t - c_t), \tag{9A.3}
\]

where

- \( p_t \) = average unit price,
- \( c_t \) = average unit production costs including a “normal” rate of return on fixed capital and the consumption of fixed capital.

Rents, \( R_t \), are converted into constant US dollars at market rates using country-specific gross domestic product deflators before averaging to obtain \( \overline{R}_t \). \( \overline{R}_t \) averages unit rent and quantity.

While rents are expected to capture the estimated compensation from resource extraction in a country, they may represent only an upper bound of the volume of rents that a government actually succeeds in
taxing or otherwise capturing from the extraction of these resources (Cust and Manley 2018).

Notes

1. While this risk is measured using current levels of reserves—and in this report, levels of fossil fuel wealth—it is likely that significant fossil fuel resources remain undiscovered. Recent research suggests the undiscovered resources may be concentrated in countries with historically weaker political institutions, which skews toward lower-income countries (Cust and Harding 2020). For this reason, estimates of the scale of risk faced by these countries may constitute a lower bound compared to their true level of fossil fuel deposits, many of which are yet to be found.

2. Although some international organizations make predictions about future commodity prices, deep uncertainty exists given the complexities of the demand and supply for these resources. Economic theory has in the past proposed methods for forecasting future oil prices, such as the Hotelling Rule. However, these methods proved to have limited predictive power during the 20th century. Furthermore, with expectations around future climate policies and competition in energy technologies driving falling costs, the prospects for future prices are even more uncertain.

3. For technical details on how the decomposition analyses are calculated, please see Hoekstra (2021).

4. This approach will be revised in the future to smooth only the unit rents, not total rents. The lagged average unit rent will be applied to annual production, unsmoothed.

References


