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The Carbon Wealth of Nations: From Rents to Risks

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Main Messages

- Carbon wealth—measured as fossil fuel resources—has been a source of prosperity for many countries, but advances in technology that make renewables more competitive and broadening climate policies may diminish the value of carbon assets and undermine traditional development pathways for carbon-rich nations.
- Carbon-rich nations face four challenges: (1) the value of their carbon assets may diminish, (2) they cannot easily monetize their carbon wealth, (3) they face economic and political pressures that may increase their exposure, and (4) the record of countries using their fossil fuel wealth to diversify their asset base has been poor. In some cases, fossil fuel resources have been a curse.
- This chapter discusses policies countries might consider to mitigate these risks, such as a focus on diversification while avoiding increased carbon risk via fossil-fuel-linked industries, skills, and infrastructure. Shifting away from carbon risk by diversifying the economy and the asset base of a country appears to be the ultimate solution, but has so far proven particularly challenging.

Introduction

Mitigating climate change is an enormous challenge and will require ingenuity, funds, and possibly some luck. But, for countries that rely on the production of oil, gas, and coal to generate economic growth and fulfill development targets, the challenge is compounded by a possible future without fossil fuels.

Fossil fuels make up only 3.4 percent of total assets in the world, equivalent to US$39 trillion in 2014. Yet a significant group of countries rely heavily on the production and export of these fuels to fund their governments and propel their economic growth. Many middle-income countries, for example, hold significant oil wealth. In some high-income countries that are not members of the Organisation for Economic Co-operation and Development, including some oil-rich Middle Eastern states, fossil fuel wealth constitutes nearly one-third of their total stock of wealth. Lower-middle-income and upper-middle-income countries hold significant wealth in fossil fuels—6 percent and 4 percent, respectively, of their wealth. These shares are much greater than those at the very bottom of the income ladder, in part because fossil fuel wealth, once discovered, can push poor countries into higher income brackets, and other low-income countries have made major fossil fuel discoveries only recently.

Countries rich in fossil fuels are also relatively concentrated geographically. East Asia and Pacific countries hold only 2 percent of their wealth in oil, gas, and coal. However, fossil fuels constitute 40 percent of wealth in the Middle East and North Africa, and almost 9 percent in Sub-Saharan Africa.

Carbon-rich countries face several challenges. Some of these are well known, such as the so-called resource curse (Barma et al. 2012; van der Ploeg 2011), whereas others are emerging risks linked to the carbon content of their natural wealth (Manley, Cust, and Cecchinato 2016). To realize the benefits of this wealth, carbon-rich nations should follow three steps. First, countries should maximize the revenues from fossil fuels through efficient extraction. Second, because fossil fuels are a depleting, nonrenewable resource, countries should convert some portion of the resource rents into productive assets such as infrastructure or human capital (following the Hartwick rule).[1] This process ensures that the total stock of wealth of the country—both fossil fuels in the ground and productive assets aboveground—does not diminish over time. Finally, countries are encouraged to invest in assets that diversify their economies. Doing so helps protect countries from resource price volatility, a scourge of resource-rich countries and a factor attributed to the resource curse.

This pathway has been a challenge for most developing countries; few have much beyond the fossil fuel resource sector to show for the billions of dollars of resources they have depleted in recent decades (Venables 2016; Warner 2015).

Aside from the resource curse, new carbon-related risks are beginning to emerge that will test these carbon-rich nations. The fossil-fuel-consuming economies of the world may be decarbonizing. A condition that would support this is if growth of gross domestic product (GDP) can decouple from energy demand, with policies pushing a greater share of energy to be supplied by renewable sources. If these policies and innovations decarbonize the global economy, the demand for oil, gas, and coal may fall—and the value of extracting these resources will diminish.

This chapter presents new data on the carbon wealth of nations and explores some of the challenges and opportunities such wealth presents. It discusses the specific challenges posed by climate change and what carbon-rich nations may do to minimize the risks of diminishing value of their natural capital.

Carbon Wealth of Nations

Carbon wealth—oil, gas, and coal—is a key contributor to greenhouse gas emissions and climate change induced by human activity. According to the International Energy Agency (IEA 2017), meeting the goal of keeping the rise in global ground temperature to less than 2° Celsius by 2050 requires leaving 80 percent of coal deposits, 50 percent of oil reserves, and 40 percent of gas reserves in the ground. In other words, most of the stock of commercially viable fossil fuels may have to remain in place, potentially wiping away a large portion of total wealth in carbon-rich nations. Most oil-rich nations hold more than 21 years of reserves at current rates of depletion, meaning they may see the value of these reserves fall, or these subsoil assets may even be stranded if extracting them is no longer economically viable. This concept is referred to as carbon risk (Manley, Cust, and Cecchinato 2016).[2]

Whether such stranding of assets is likely and the time frame in which this might occur are of course uncertain. But the potential magnitude of this risk is so immense that taking it seriously is important. This discussion first examines how much carbon wealth countries probably have, as well as the uncertainties regarding these estimates.

How Much Carbon Wealth Do Nations Have?

The carbon wealth of nations is the sum of the *rental* value of oil-, natural gas–, and coal-based assets held under the ground. For many regions, carbon wealth makes up a substantial share of total natural wealth. For example, the carbon wealth of the Middle East and North Africa is almost 30 percent of the region's total wealth. Sub-Saharan African countries also have a larger-than-average share of carbon wealth (table 5.1).

The income from this carbon wealth also represents a significant share of GDP in some countries. Several countries, such as Kuwait, Iraq, and Saudi Arabia, are estimated to have fossil fuel rents of more than 40 percent of GDP (map 5.1).

Calculating the Carbon Wealth of Nations

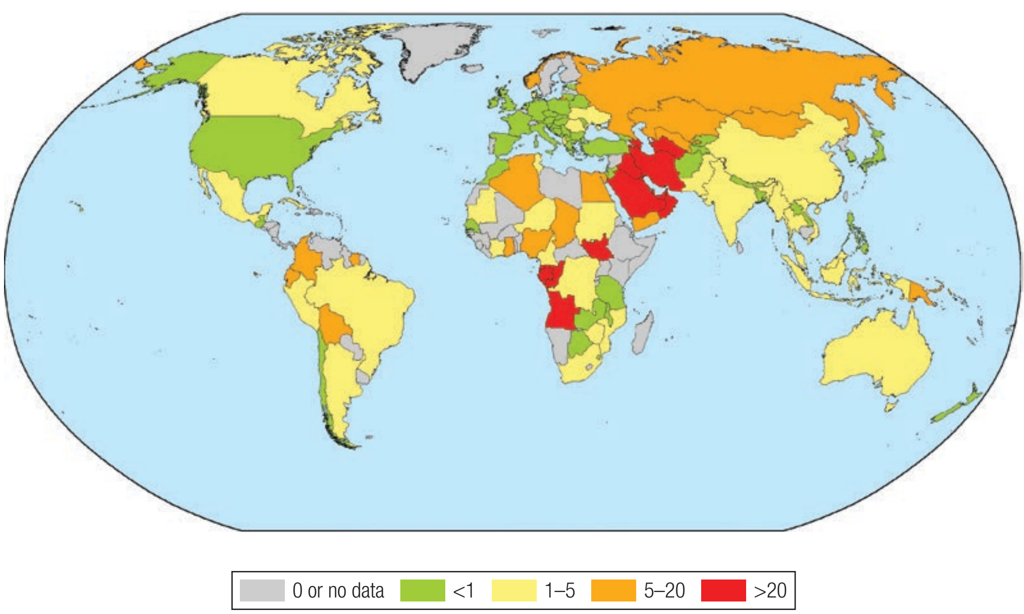
Calculating the carbon wealth of nations is not a straightforward process. This report provides values for three fossil fuels: petroleum, natural gas, and coal. The World Bank calculates these values as the present value of

TABLE 5.1 Wealth Shares, by Region and Income Group, 2014

Region	Carbon assets (% of total wealth)	Natural capital (% of total wealth)	Produced capital (% of total wealth)	Human capital (% of total wealth)
East Asia and Pacific	2	10	28	60
Europe and Central Asia	2	5	33	62
Latin America and the Caribbean	3	18	23	61
Middle East and North Africa	40	44	15	35
South Asia	3	25	26	51
Sub-Saharan Africa	9	36	16	50
Income group				
Low-income countries	1	47	14	41
Lower-middle-income countries	6	27	25	51
Upper-middle-income countries	4	17	25	59
High-income non-OECD countries	26	30	22	42
High-income OECD countries	1	3	26	70

Source: World Bank calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

MAP 5.1 Fossil Fuel Rent as a Percentage of GDP, by Country, 2014



Source: World Bank calculations.
Note: GDP = gross domestic product.

expected rents that may be earned from extracting the resource until it is exhausted. This value, V_t, is given as follows:

$$V_t = \sum_{i=t}^{t+T-1} \frac{\overline{R_t}}{(1+r)^{i-t}} \tag{5.1}$$

where $\overline{R_t}$ is a lagged, five-year moving average of rents in years t (the current year) to t – 4; r is the discount rate (assumed to be a constant 4 percent[3]) and T is the lifetime of the resource. Rents for a given year are calculated as revenues less production costs, including a "normal" rate of return.[4] Appendix A includes a detailed breakdown of the approach to calculating rent values.

For each fossil fuel, the estimates of rents are averages for that fossil fuel across all the extraction projects in a country. Estimating the value of rents per unit of production requires measuring two variables: the price paid for the resource and the cost of producing the resource (including the cost of capital). The World Bank uses Rystad Energy's UCube database, which takes the nearest geographical price benchmark, and a combination of cost data from company statements, interviews, and modeling.[5]

Prices are relatively easy to measure. For instance, most types of crude oil are valued close to price benchmarks such as Brent or West Texas Intermediate. Prices also vary over time; this variation is unpredictable, but the majority of it is at the level of the benchmark price, not the constituent prices of the benchmark.

Costs, however, are more difficult to measure. Unlike prices, there are no observed international benchmarks, and costs are typically far less transparent than prices—companies are much more willing to declare their sales prices than their costs. Nor is it easy to predict costs. Costs vary at a global level over time; for example, as demand for oil rises, the derived demand for the inputs to oil extraction also rises, meaning the costs of these inputs change (Toews and Naumov 2015).

Costs also vary depending on the location of the fossil fuels. It is generally much more costly to drill in offshore fields than onshore, even when the fields are located in the same country. Costs also vary across the project life cycle. For example, for the first few years of an oil field's life, costs are high as the operator develops the oil well. Once the project starts producing, average costs fall and revenues rise. As the field matures, costs can rise again as the remaining reserves are extracted and project sites require cleaning and closing. For all these reasons, any average estimate at the country or regional level may not reflect the rents generated by a single field.

This chapter's estimates of carbon wealth—the net present value of fossil fuel rents—are calculated by subtracting all extraction costs from revenues, including the opportunity cost of fixed capital. But it is not clear to what extent the production costs provided by Rystad factor in a risk-adjusted return on fixed capital, that is, the additional returns needed to compensate owners of capital for the risks of operating in challenging governance contexts (Cust and Harding 2015). As a consequence, the rents and associated asset values calculated here may represent an upper bound for some countries where risk is a major factor (see box 5.1).

BOX 5.1 Uncertainties around Carbon Wealth Estimates

Rent calculations conceptually estimate the compensation a country should receive for resource extraction. But actual estimates may only represent an upper bound of what could accrue to countries that own the resource.

There are two reasons for this uncertainty. First, it is a widely held view (for example, Daniel, Keen, and McPherson 2010) that governments may fail to capture the maximum available rents associated with fossil fuel 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. Using Rystad Energy UCube data, which is the source for this volume's unit rent numbers, we calculate that between 2010 and 2014 governments took, on average, 77 percent of 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 2012).

Second, a related reason for uncertainty stems from the interpretation that the risk-adjusted cost of capital for fossil fuel industries may be higher than measured in the *Changing Wealth of Nations* data set. Here, the rent available for countries to tax may be lower than estimated because of hidden costs, such as the political risk associated with operating in a particular country. In other words, rent values estimated by the data set may not factor in the full cost of capital because the reported cost of capital may not include certain risks faced by investors. Recent evidence has shown that, beyond geological considerations, investors may be deterred from investing in countries with, for example, weaker governance (Cust and Harding 2015). These factors may also help explain why governments are unable to recover the full amount of the estimated rent.

Governments should therefore interpret rent numbers cautiously. Higher rent estimates may signal that additional tax revenues could be captured; however, the means for capturing them may also involve reducing political and other risks or costs of doing business as well as negotiating better deals or taxing more effectively. Managing carbon risk may include squeezing more revenues from existing projects. Therefore, policies that reduce investor risks may help reduce fiscal pressures created in the transition to global decarbonization.

Carbon Risk

Decarbonization of the global economy is a risk for economies that rely on the export of fossil fuel resources. The risk is that global demand for fossil fuels will fall, making countries' carbon wealth significantly less valuable.

Carbon risk may not only affect the value of carbon assets. Countries also have other forms of carbon-linked wealth that the *Changing Wealth of Nations* method does not explicitly measure under fossil fuel wealth. These assets include produced capital (such as power plants and downstream industries and infrastructure), human capital (such as petroleum sector skills and expertise), and other kinds of assets such as government holdings in national oil companies or fossil fuel equities held by sovereign wealth funds (SWFs).

Carbon Wealth at Risk

Various authors and agencies (for example, IEA 2015) state that the world cannot consume much more than 20 percent of existing fossil fuel reserves and still hold global surface temperatures to less than the internationally set 2° Celsius average warming target. Even if the world falls short of this objective, it appears likely that a significant portion of fossil fuel reserves must remain unburned to avoid catastrophic warming. This situation would affect carbon-rich countries differently depending on their domestic cost of extraction (McGlade and Ekins 2015).

Although the transition away from fossil fuels is widely anticipated, it is not yet clear how, or how quickly, such an outcome might occur. At their current trajectories, carbon-mitigation commitments made on a country-by-country basis would fall short of the 2° Celsius goal. Meanwhile, significant cost reductions in alternative energy technologies—such as solar and wind power—may soon begin to undercut the costs of extracting oil, gas, and coal, thus leading to potential reductions in fossil fuel consumption.

On the one hand, the concept of *stranded assets* resulting from climate change policies has received widespread attention from academics, nongovermental organizations, and the media in recent years (Helm 2016; Leaton 2013). However, the concept is often predicated on a hard carbon budget constraint imposed globally. At present, there is little evidence that this will occur. Furthermore, even if such a budget constraint were imposed, the effects on the valuation of private companies—which discount future profits at commercial rates and hold relatively few years' worth of booked reserves on their balance sheets—may be modest. Some argue that, even under a sharp decline in the value of fossil fuels, many firms face low operating costs for existing deposits, while higher-cost deposits become unprofitable. The companies would be able to continue to develop many of these resources under a range of conditions. Helm (2015) provides a discussion of the limitations of the stranded assets concept.

The concept of *stranded nations*, on the other hand, is the public (government) equivalent of the private sector concern about stranded assets. Although the risk of stranded assets may be overstated, according to commentators such as Helm (2015), the risk of stranded nations may be far greater, more salient to public policy, and to date relatively undocumented. Sovereign states are the ultimate owners of carbon wealth. They probably discount the future at a lower rate than private agents and have economies that may be specialized in carbon-related sectors, skills, and infrastructure. Thus, the amount and severity of potential stranding (that is, the loss of value in carbon-linked assets) is significantly higher (see, for example, Cust, Cecchinato, and Manley 2017; Manley, Cust, and Cecchinato 2016).

Four Challenges for Carbon-Rich Nations

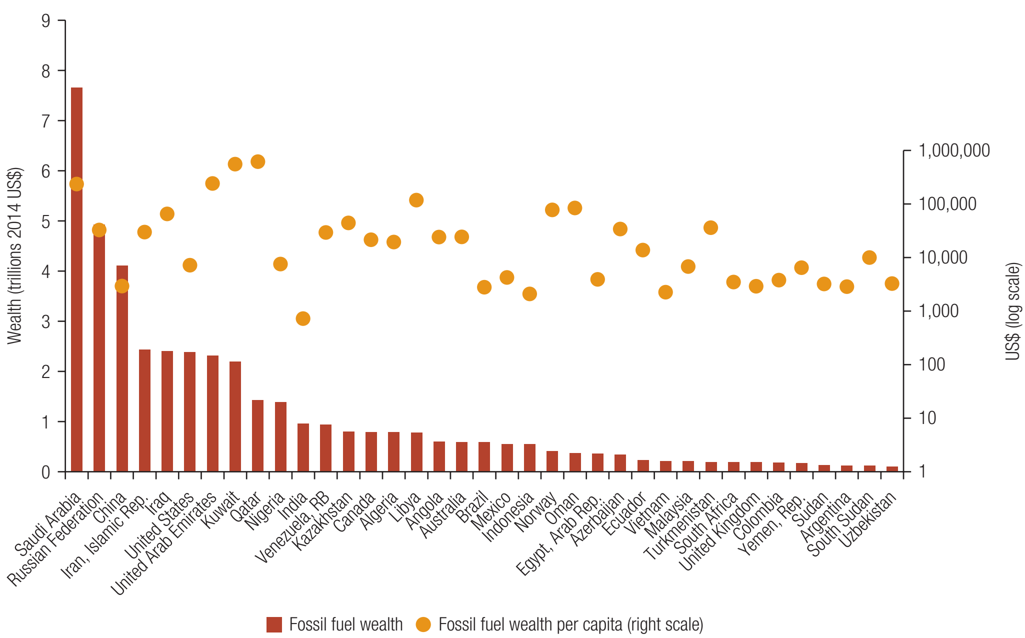
Carbon-rich nations face four special challenges. These challenges arise from the future uncertainty of the value of their carbon-based wealth as the world grapples with mitigating global climate change. They may have little control over the external factors affecting the value of carbon wealth, such as climate policies and technological progress. However, they can take domestic actions that might reduce their exposure to carbon risk.

Challenge 1: Carbon-Rich Nations Are Highly Exposed to Carbon Risk

The first challenge is that carbon wealth could decline in value as the world decarbonizes, putting severe strains on carbon-rich countries' finances (Malova and van der Ploeg 2017). Figure 5.1 shows countries' carbon wealth in absolute and per capita terms. Many countries have a lot at stake, particularly in the Middle East and North Africa.

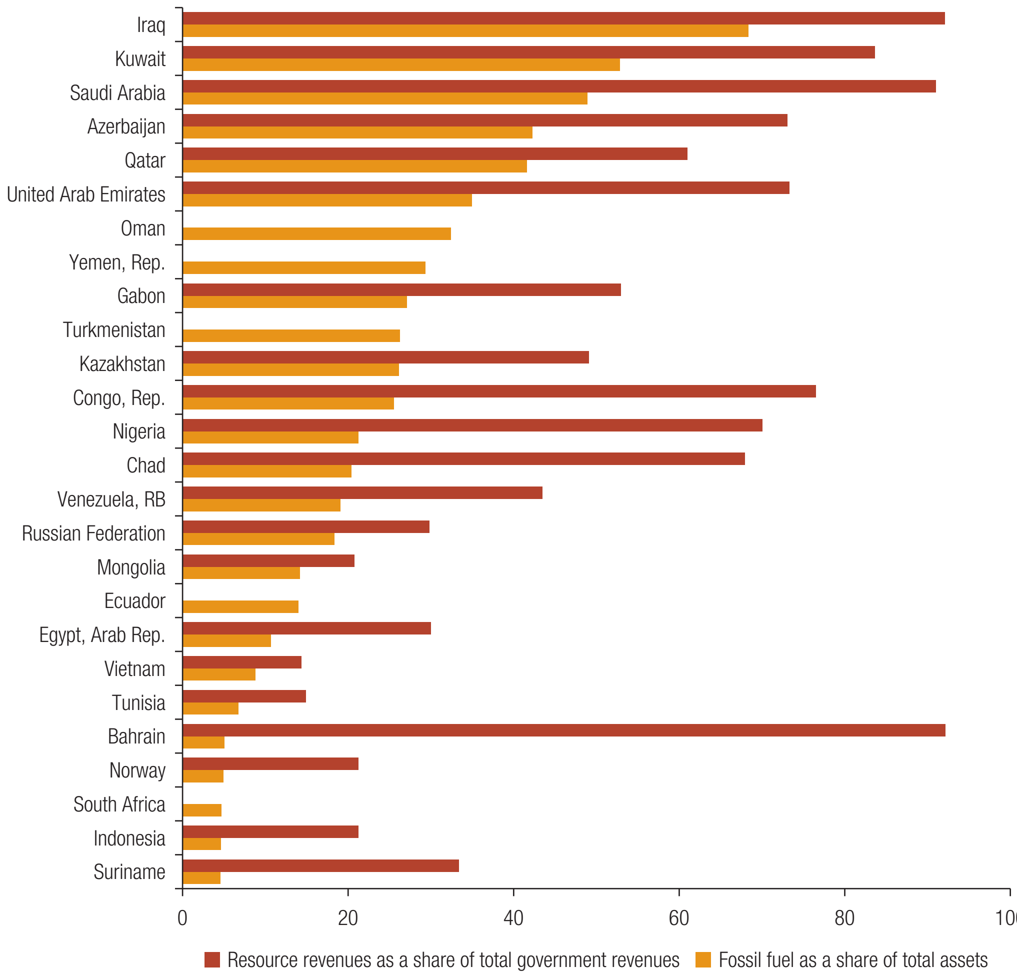
Of the 141 countries in the wealth database, 26 countries have at least 5 percent of their wealth in fossil fuels. The data show that the risk of a permanent drop in fossil fuel demand is worrisome for both poverty and geopolitical reasons. First, most of these countries are classified as low or middle income, and their governments derive more than half their revenues from oil, gas, coal, and other minerals. Poverty alleviation in many of these countries remains a priority; therefore, the risk of a drop in the value of fossil fuel assets has important development implications. Second, 10 of these 26 countries are in the Middle East and North Africa. Although extraction costs are relatively low in this region, the potential loss in government revenues would be significant (figure 5.2).

FIGURE 5.1 Fossil Fuel Wealth, by Country, 2014



Source: World Bank.

FIGURE 5.2 Fossil Fuel Assets Compared with Government Revenues, by Country, 2010–14
percent



Sources: World Bank; ICTD/UNU-WIDER 2017.
Note: The ratio of resource revenues to total revenues was calculated as the average over the period 2010 to 2014, the same period used in the data set. Several countries are missing data for either fossil fuel wealth or government revenues.

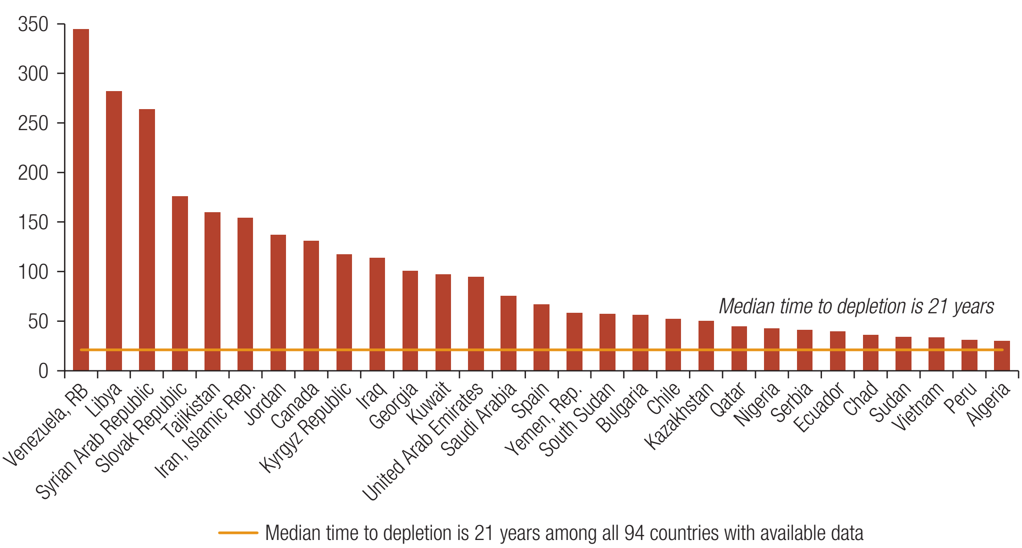
Challenge 2: Carbon-Rich Nations Cannot Easily Monetize Carbon Wealth

Carbon-rich nations hold a lot of their wealth in the form of fossil fuels, but to benefit people this wealth needs to be extracted and sold. However, getting resources out of the ground is costly. These countries may find themselves facing a race to exit the fossil fuel market as producers speed up extraction while prices decline. However, countries face two problems.

The first is that, unlike investors in an oil company who can merely sell their stock, countries cannot easily and quickly monetize their carbon wealth. For example, under current rates of production, as figure 5.3 shows, oil-rich developing countries will take, on average, 21 years to deplete their oil reserves. Increasing depletion rates is difficult. One way to increase production rates is for governments to directly change the production rates of existing wells, fields, or mines. If these projects are run by state-owned enterprises, governments can directly alter the pace of operations. If operated by private companies, governments can regulate the rate of production or establish incentives to change the rate of production. But in both cases these measures can reduce profits, and governments are constrained by the need to ensure projects remain commercially viable. A second way is for governments to change the rate at which they license new fields for exploration and development. However, developing new fields also requires new investment. But, with the risk of prices declining over the lifetime of these new projects, the costs of capital may rise.

The second problem is that, even if fossil fuel producers successfully increase extraction to avoid a future price decline, the sudden increase in supply might quicken the drop in prices. This effect is known as the green paradox. Sinn (2008) describes the paradoxical situation in which climate policies such as a carbon tax could have the opposite effect than the one intended: rather than slowing the burning of fossil fuels, such policies might instead speed it up. In this model, the anticipation of

FIGURE 5.3 Time to Depletion of Oil Reserves, 2014
number of years



Source: World Bank calculations.
Note: The figures are calculated as current reported oil reserves divided by current production. Only countries with depletion horizons of more than 30 years are shown.

carbon taxes encourages fossil fuel producers to accelerate planned extraction to reduce their future tax burden.

Challenge 3: Carbon-Rich Nations' Policies May Increase Carbon Risk Exposure

In seeking to develop and capture the benefits of fossil fuel industries, countries may increase their exposure to carbon risk. Carbon risk exposure is not limited to fossil fuel assets. Many countries choose to develop these resources in ways that may increase their overall risk exposure. These policies include investing in nationally owned resource companies, having SWFs hold equities linked to the price of fossil fuels, and investing human capital and public money in developing skills, businesses, and infrastructure tied to the fortunes of the oil, gas, and coal mining sectors.

Countries have developed downstream industries to complement resource extraction and export. Examples include refining, processing, power generation, and industrial uses of fossil fuels. This can lock countries into more carbon-intensive production and exports, which may be at risk of border taxes and tariffs.

When viewed through the lens of future uncertainty about pathways to decarbonization, these various policies may need to be reevaluated in light of the risks they might pose.

National Oil Companies

Many oil-rich countries have opted to create national oil companies (NOCs) so that the state can participate directly in the sector. In some, such as Saudi Arabia, NOCs have monopoly access to a country's resources; in others, they play a leading operational and commercial role but compete alongside private companies; and, in still others, they are partners, sometimes holding minority stakes.

In such cases, governments have opted to hold public wealth in the form of a nationally owned company. They may do so for a variety of reasons, including to capture as much rent from the petroleum sector as possible, to exercise state control over a key strategic sector, or to build expertise and capabilities. However, a permanent drop in oil prices puts NOCs and their government owners at risk. Furthermore, some countries encourage NOCs to grow and expand operations overseas—such as Malaysia's Petronas and Norway's Statoil. However, this strategy may further increase a country's exposure to carbon risk. To expand beyond domestic markets, NOCs require additional capital, which ties up greater state resources than a domestic NOC. These resources, in addition to the licenses, reserves, and investments the company makes abroad, expose the country to additional carbon market risk should the value of these resources decline in the future.

Table 5.2 illustrates the value of NOCs and state share of that value, measured by company assets. The top 10 largest state-owned oil companies account for more than US$2.3 trillion of state capital.

TABLE 5.2 States' Share of National Oil Companies, by Total Asset Value

Country	State-owned company name	Total assets (billion US$), as of 2014 or 2015	State share (billion US$)
China	China National Petroleum Corporation (includes Petrochina)	576.0	576.0
China	Sinopec Group	321.0	321.0
Russian Federation	Gazprom	319.2	319.2
Russian Federation	Rosneft	227.6	227.6
Venezuela, RB	Petróleos de Venezuela	226.8	226.8
Iran, Islamic Rep.	National Iranian Oil	200.0	200.0
China	China National Offshore Oil Corporation	167.0	167.0
Malaysia	Petronas	164.5	164.5
Bolivia	Yacimientos Petrolíferos Fiscales Bolivianos	103.8	85.1
Angola	Sociedade Nacional de Combustíveis de Angola Unidade Empresarial Estatal	54.5	54.5
Indonesia	Pertamina	50.7	50.7
Kazakhstan	KazMunayGaz	49.3	32.7
Azerbaijan	State Oil Company of the Azerbaijan Republic	30.7	30.7
Ecuador	Petroecuador	9.3	9.3
Timor-Leste	TIMOR GAP	0.004	0.004

Sources: Compiled from annual reports of companies for most recent year available (2014 or 2015); adapted from Manley, Cust, and Cecchinato 2016.
Note: The table does not include a number of smaller national oil companies from fossil fuel–rich developing countries for which data are unavailable: Sontrach, Algeria; Sociètè des Hydrocarbures du Tchad, Chad; Petroamazonas, Ecuador; Sociedad National de Gas, Equatorial Guinea; Gabon Oil Company, Gabon; Myanmar Oil and Gas Enterprise, Myanmar; Nigeria National Petroleum Corporation, Nigeria; Turkmengaz, Turkmenistan; and Uzbekneftegaz, Uzbekistan.

Sovereign Wealth Funds

SWFs are another means by which countries may further expose themselves to carbon risk. SWFs have become popular in many oil- and gas-producing countries. Many countries use these funds to meet short-term stabilization goals while also making longer-term investments on behalf of current and future citizens. In Norway, for example, funds are invested abroad to fund pension obligations of the state. As instruments of long-term investment, SWFs can be one approach to diversifying a country's assets.

A simple objective for long-term funds is typically to balance financial risk and reward to ensure a steady stream of income payments on investments. However, as van den Bremer, van der Ploeg, and Wills (2016) note, funds may not be optimized with respect to the other assets held by the state. In particular, carbon-rich countries should seek to diversify their portfolios away from assets whose value may be positively correlated with their fossil fuel reserves or other state assets linked to fossil fuel prices, such as nationally owned resource companies. Counterintuitively, in the short term, the value of green investments such as renewable energy company stocks also may be positively correlated with the price of fossil fuels. This caution is even more necessary considering the additional carbon risk associated with future decarbonization of the global economy. Such a shift could further damage the value of SWF assets that are linked to fossil fuel extraction.

Countries can help mitigate the aboveground risks by avoiding investments in carbon-linked assets and taking into consideration the combined portfolio of aboveground and belowground assets. In some cases, the strategy might include divestment from carbon-linked assets, or ensuring maximum transferability of carbon-linked skills or carbon-linked sectors into low-carbon alternatives.

Challenge 4: Countries Have Found It Difficult to Diversify Away from Carbon Wealth

Diversification is already acknowledged as a necessary objective of carbon-rich countries (Collier 2010; NRGI 2014). Resource-rich countries can theoretically diversify by following the so-called Hartwick rule (Hartwick 1977), that is, converting their subsoil assets into produced capital and human capital. In the face of carbon risk, diversification becomes an even greater imperative for carbon-rich countries to ensure that the loss in tax revenues, jobs, and other benefits from resource extraction becomes a relatively minor event for their economies (see box 5.2).

Most resource-rich countries have found it difficult to diversify their economies and few have followed the Hartwick rule (Venables 2016; Warner 2015). Data from the *Changing Wealth of Nations* show this clearly in the form of adjusted net saving (ANS). ANS reflects the rate at which a country uses resource extraction to accumulate other assets such as productive aboveground assets. ANS takes into account

BOX 5.2 Climate Strategies of Carbon-Dependent Countries

New analysis by the World Bank identifies the risks faced by carbon-rich countries under different carbon price and policy scenarios. This analysis allows different pathways to risk mitigation, including via the diversification of sectors and assets, to be quantified and examined.

Using computable general equilibrium modeling, the analysis evaluates the impact of carbon policy shocks on different countries and shows how much value may be at stake under business-as-usual as well as carbon diversification strategies. The report develops a set of “vulnerability metrics” to estimate the risk exposure of carbon-rich nations to climate policies in the future.

The report contrasts new approaches to diversification to what it terms “traditional diversification,” which tends to focus mainly on downstream value added (Gill et al. 2014). Such activities build on carbon wealth, and therefore may increase countries’ exposure to carbon risk. As an alternative, the report identifies ways such countries can diversify away from carbon-intensive activities, which can help mitigate the risk of falling demand for carbon energy over the medium to long term.

Source: World Bank, forthcoming.

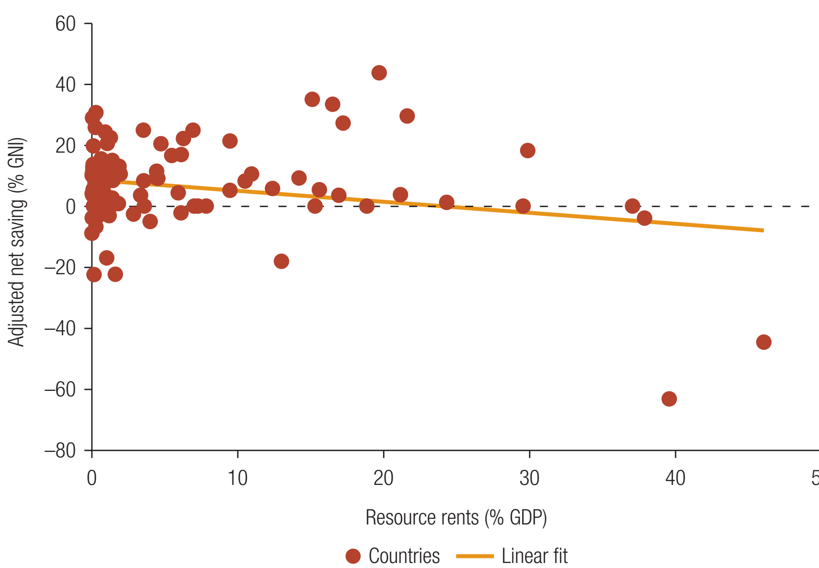
income generated from the depletion of fossil fuels, the depreciation of all forms of capital in the economy (including damage to natural capital), education and health expenditures (representing savings in the form of human capital), and the costs of air pollution damage. Relating to fossil fuel depletion, a positive ANS may indicate the country is depleting the subsoil asset but saving a sufficient share of the cash generated to be accumulating net assets elsewhere in the economy. A negative ANS rate means the country is selling its fossil fuels and running down its overall asset base.

The *Changing Wealth of Nations* data indicate that, since 2004, many resource-rich countries have had low ANS rates. Some of these countries have seen average ANS values of less than zero, meaning that, although they have depleted their fossil fuel reserves, they have failed to use the proceeds to accumulate other assets (see figure 5.4).

Conclusion

Although the scope, timing, and modes of how the global economy may decarbonize are uncertain, the scientific community has arrived at consensus on its importance and urgency. According to IEA (2017), meeting the 2° Celsius warming goal by 2050 requires leaving 80 percent of coal deposits, 50 percent of oil reserves, and 40 percent of gas reserves in

FIGURE 5.4 Adjusted Net Saving and Nonrenewable Resource Rents



Source: World Bank calculations.
Note: Resource-abundant countries only are shown, defined as countries having nonrenewable resource rents greater than 2 percent of GDP averaged over 2004–14. GDP = gross domestic product; GNI = gross national income.

the ground. The global demand for energy would be met by other energy sources (renewables) and increased energy efficiency. If such an energy transition were to occur, it would likely diminish the value of fossil fuel wealth and other carbon-linked wealth (such as nationally owned resource companies). Furthermore, such a drop in value would likely be distributed unevenly, in part because of the mode of the transition, but also because of the degree of carbon risk exposure at the national level.

The wealth accounts in the *Changing Wealth of Nations* show there are 26 countries that have at least 5 percent of their total assets in the form of fossil fuels. If much of this must remain belowground, these countries may see their total assets decline significantly in value, including aboveground assets such as carbon-linked produced and human capital.

To mitigate this carbon risk, countries face four special challenges. First, countries are highly exposed to carbon risk—in many cases much more so than private companies and investors. Second, unlike financial assets, it is difficult to quickly monetize resources that lie under the ground. Third, partly in an effort to maximize the domestic benefits from fossil fuel extraction, these countries often follow policies that actually increase their exposure to carbon risk by investing public and human capital in fossil fuel industries. Finally, diversifying away from carbon risk by diversifying the economy and the asset base of a country appears to be the ultimate solution for countries, but has so far proved to be particularly challenging. As the data show, governments have failed to use their fossil fuel wealth sustainably over the long term. Few carbon-rich countries have successfully followed the Hartwick rule by converting their carbon wealth into producted and human capital.

The problem for policy makers is that a decline in fossil fuel demand is not at all certain. A permanent drop in fossil fuel prices could be many decades away. Fossil fuels could continue to be sold by countries for many more years. For many developing countries, the rents and economic possibilities from fossil fuel extraction may continue to play a critical role in meeting development objectives, including domestic financing for the Sustainable Development Goals. However, the longer the consumption of fossil fuels continues, the more likely many of these countries will face severe negative effects of a changing climate. Managing their fossil fuel industries with such uncertainty and with so much at stake will make an already-difficult task even harder. But all decisions may be made easier with reliable information; in that light, the data in the *Changing Wealth of Nations* are most needed right now.

Notes

1. The Hartwick rule states that all revenues from depletable resources must be invested to transform the belowground fossil fuel wealth into aboveground financial or other assets (Hartwick 1977).
2. Reserves are endogenous to market conditions and exclude undiscovered or unproven resources.

3. The 4 percent assumption is based on the long-term average rate of return on financial assets globally, and therefore represents the opportunity cost of holding wealth as fossil fuels rather than investing in financial assets.
4. It is important to note that, because this is based on long-term average global returns, it does not reflect the country-specific risk premiums that may be necessary to compensate investors for investing in certain environments.
5. For oil, the World Bank uses the Brent benchmark for all but Canada; and, in the Midcontinent and Rocky Mountain U.S. regions, West Texas Intermediate price is used. For gas, Rystad Energy created eight different benchmarks based on regional prices such as Henry Hub.

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