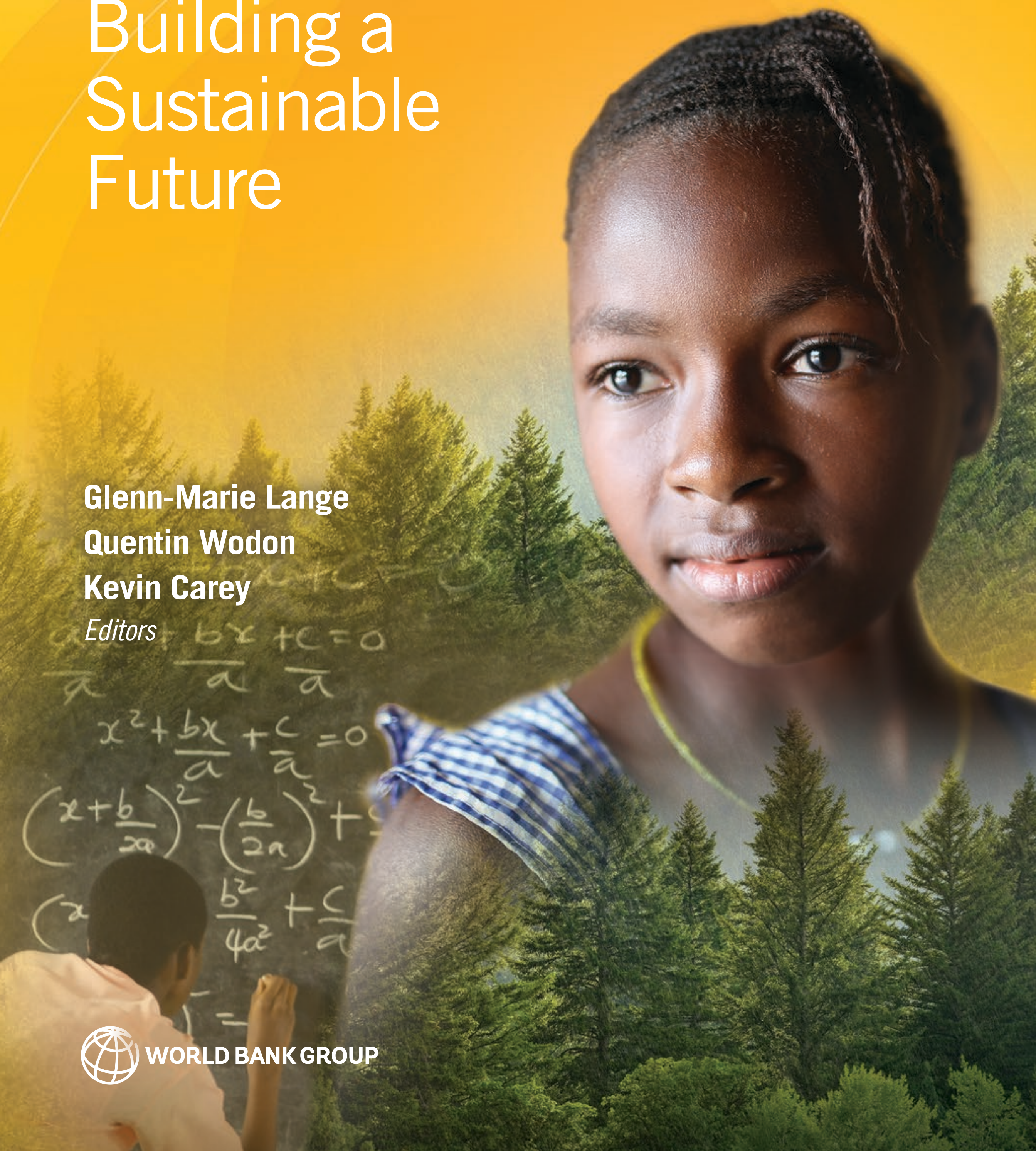
The Changing Wealth of Nations 2018

Building a Sustainable Future

Glenn-Marie Lange
Quentin Wodon
Kevin Carey
Editors



WORLD BANK GROUP

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Foreword

A decade ago, the World Bank launched the book *Where Is the Wealth of Nations?*, which first introduced the concept of wealth as a complementary indicator to gross domestic product (GDP) for monitoring sustainable development in a country. For the first time, we showed that development is about managing a broad portfolio of assets—produced, human, and natural capital. Just as a company measures its value by looking at both its income statement and balance sheet, a look at comprehensive national wealth signals if GDP growth can be sustained over the long run.

There is some good news from the analysis presented in *The Changing Wealth of Nations 2018*—global wealth grew significantly between 1995 and 2014 and middle-income countries are catching up to high-income countries in terms of their wealth, mainly because of rapid growth in Asia. More than two dozen low-income countries, where natural capital dominates the composition of wealth, have moved to middle-income status, in part by investing resource rents into infrastructure and education and health, which increases human capital.

However, the wealth accounts also indicate areas of concern. Some low-income countries—especially in Sub-Saharan Africa—saw a decline in per capita wealth as rapid population growth outpaced investment. We also see that in 12 countries the percentage of people living in extreme poverty has jumped over the last decade. Looking at this disturbing trend through the lens of wealth accounting shows that the 'demographic dividend' from population growth can be realized only with rapid investment in infrastructure and education, and by managing the natural asset base sustainably in the long run. In high-income countries, human capital accounts for 70 percent of wealth, whereas for low-income countries, natural capital is still the biggest asset.

Of the 24 countries that have remained low-income since 1995, 13 are classified as fragile and conflict states and out of these a majority are resource-rich. This helps us see better the links between poverty, fragility, and governance. It is not a coincidence that several fragile countries are rich in resources but cannot at present use resource rents to build their institutions and people.

In *The Changing Wealth of Nations 2018*, which covers 141 countries over 20 years (from 1995 to 2014), we have made huge strides in how we measure comprehensive wealth. For the first time, we have a sound estimate of human capital, drawing from a unique database of more than 1,500 household surveys maintained by the World Bank. New data has greatly improved our estimates of natural capital as well.

This new volume sets the stage for addressing development through a comprehensive measure of wealth, which underpins income and well-being. We hope that the results will be used by policy makers and others to improve measures of economic progress and lead to policies that improve lives for generations.

Kristalina Georgieva
Chief Executive Officer
World Bank

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Abbreviations

ANS	adjusted net saving
ARIES	Artificial Intelligence for Ecosystem Services
EC	European Commission
ECD	early childhood development
FAO	Food and Agricultural Organization
GDP	gross domestic product
GLEAM	Global Livestock Environmental Assessment Model
GNI	gross national income
IHME	Institute for Health Metrics and Evaluation
IMAGE	Integrated Model to Assess the Global Environment
IMF	International Monetary Fund
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
MENA	Middle East and North Africa
MEY	maximum economic yield
MFP	multifactor productivity
MSY	maximum sustainable yield
NOC	national oil company
OECD	Organisation for Economic Co-operation and Development
PPP	purchasing power parity
PWT	Penn World Table
REDD	Reducing Emissions from Deforestation and Forest Degradation
SDG	Sustainable Development Goal
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
SWF	sovereign wealth fund
UN	United Nations
WDI	World Development Indicators

Executive Summary

Glenn-Marie Lange, Quentin Wodon, and Kevin Carey

Key Findings

- Global wealth grew significantly between 1995 and 2014. Middle-income countries are catching up in large part because of rapid growth in Asia, but inequality in overall wealth persists. Because wealth underpins national income, measuring changes in wealth permits us to monitor the sustainability of development, an urgent concern today for all countries.

- Although total wealth increased almost everywhere, per capita wealth did not. Several low-income countries experienced a decline in per capita wealth because population growth outpaced investment, especially in Sub-Saharan Africa. As per capita wealth declines, the ability of countries to maintain per capita income will decline.

- Human capital, measured as the value of earnings over a person's lifetime, is the most important component of wealth globally. Human capital wealth on a per capita basis is typically increasing in low- and middle-income countries. In some upper-middle- and high-income countries, aging and stagnant wages are reducing the share of human capital in total capital.

- Women account for less than 40 percent of human capital wealth because of lower earnings, lower labor force participation, and fewer average hours of work. Achieving higher gender parity in earnings could generate an 18 percent increase in human capital wealth.

- A country's level of economic development is strongly related to the composition of its national wealth. Natural capital is the largest component of wealth in low-income countries (47 percent in 2014) and accounts for more than one-quarter of wealth in lower-middle-income countries.

- Getting rich is not about liquidating natural capital to build other assets—natural capital per person in high-income Organisation for Economic Co-operation and Development (OECD) countries was three times that in low-income countries in 2014, even though the share of natural capital in high-income OECD countries was only 3 percent.

- Growth is in part about more efficient use of natural capital and investing the earnings from natural capital sources, such as minerals, into infrastructure and education. This investment then results in growth of total wealth.

- Renewable resources—agricultural land and forests and protected areas—can produce benefits in perpetuity if managed sustainably. In low- and middle-income countries, the monetary value of renewable assets more than doubled, keeping up with population growth on average, which is good news, with greater gains in value of agricultural land than forests.

- In contrast with renewable resources, nonrenewable natural capital—such as fossil fuels and minerals—offer a one-time chance to finance development by investing resource rents. Nearly two-thirds of countries that have remained low income since 1995 are classified as resource-rich, or fragile and conflict states, or both. This shows that resources alone cannot guarantee development: strong institutions and good governance are needed to ensure that rents are invested and not used entirely for consumption.

- In conclusion, wealth should be used as an indicator of sustainability to complement GDP, which measures only current income.

Why Should We Measure Wealth?

National income and well-being are underpinned by a country's assets or wealth—measured comprehensively to include produced capital, natural capital, human capital, and net foreign assets. Sustained long-term economic growth requires investment and management of this broad portfolio of assets. Although a macroeconomic indicator such as GDP provides an important measure of economic progress, it measures only income and production and does not reflect changes in the underlying asset base. Used alone, GDP may provide misleading signals about the health of an economy. It does not reflect depreciation and depletion of assets, whether investment and accumulation of wealth are keeping pace with population growth, or whether the mix of assets is consistent with a country's development goals.

Nobel Laureate Joseph Stiglitz observed that a business is always evaluated by both its income statement and its balance sheet[1] (assets and liabilities, or wealth). Similarly, a prospective homeowner can obtain a mortgage only by demonstrating both his or her income and net assets—income in any given year can always be made to look good by selling off assets, but liquidating assets undermines the ability to generate income in the future; the true picture of economic health requires looking at both income and wealth. The economic performance of countries, however, is only evaluated based on national income; wealth has typically been ignored. Indeed, one of the primary motivations for the early natural capital accounting efforts in the mid-1980s was concern that rapid GDP growth in resource-rich countries was achieved through liquidation of natural capital—a temporary boost to consumption that created no basis for sustained advances in wealth and human well-being (for example, Repetto et al. 1989). Monitoring wealth, including natural capital, was part of the solution to the challenge of long-term sustainability.

The goal of this book is to broaden the measures economists, policy makers, the private sector, and civil society use to assess economic progress. Without a forward-looking indicator, it is difficult to conclude that we can accurately measure economic progress. Wealth, by its nature, concerns the future—the flow of income that each asset can generate over its lifetime. Measuring changes in wealth permits us to monitor the sustainability of development, an urgent concern today for all countries, and a critical, yet-to-be-defined indicator for the Sustainable Development Goals (see box ES.1). GDP indicates whether a country's income is growing; wealth indicates the prospects for maintaining that income and its growth over the long term. They are complementary indicators. Economic performance is best evaluated by monitoring the growth of both GDP and wealth.

This book covers a wide range of topics related to produced, natural, and human capital, as well as total wealth as an indicator of sustainability. This is an intentional strategy for building bridges across disciplines by demonstrating how the comprehensive wealth approach provides a useful, indeed essential, lens for viewing a broad set of development concerns—the sustainability of development.

What Is New in This Version of *The Changing Wealth of Nations?*

Measuring national wealth and changes in wealth is part of an ongoing effort by the World Bank to monitor the long-term economic well-being of nations. *The Changing Wealth of Nations 2018* builds on two previous World Bank reports—*Where Is the Wealth of Nations? Measuring Capital*

BOX ES.1 Wealth Accounting and the Sustainable Development Goals

The Sustainable Development Goals (SDGs) came into force at the beginning of 2016. They build on the Millennium Development Goals and set a new global development agenda to eradicate poverty and shift the world onto a sustainable development path by 2030. The SDGs are comprehensive and include goals on poverty reduction, education, health, the environment, and peaceful and inclusive societies. The 17 SDGs and their 169 targets are interrelated, given that progress toward one goal can enhance progress in others.

The comprehensive wealth accounts provided in this book can primarily contribute to SDG 17, which aims to revitalize the global partnership for sustainable development. Under the systemic issues articulated in this goal, the wealth accounts contribute to (1) policy and institutional coherence, by providing a common and sound analytical framework for assessing sustainable development; and (2) the targets related to data, monitoring, and accountability. The final target of the entire SDGs is target 17.19:

> By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity building in developing countries."[a]

At present, there is no agreed-upon macroeconomic indicator of sustainability, but measures of a country's change in wealth per capita over time can help fill this void. The World Bank's data on trends in wealth per capita for 141 countries can provide an indicator for this target. Moving forward, countries may start implementing this approach to produce balance sheets in their own statistical agencies, and ultimately contribute to improvements in measuring sustainable development.

a. See http://www.undp.org/content/undp/en/home/sustainable-development-goals.html.

for the 21st Century (2006) and *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (2011).

This book reports wealth for 141 countries for the period 1995 to 2014. The wealth accounts include the following asset categories:

- *Produced capital and urban land*—machinery, buildings, equipment, and residential and nonresidential urban land, measured at market prices.[2] For brevity, the term *produced capital* is used in the book to include produced capital and urban land.
- *Natural capital*—energy[3] (oil, gas, hard and soft coal) and minerals (10 categories), agricultural land (cropland and pastureland), forests (timber and some nontimber forest products), and terrestrial protected areas (for brevity, referred to simply as protected areas in the book). Marine-protected areas are not currently included. Natural capital is measured as the discounted sum of the value of the rents generated over the lifetime of the asset.
- *Human capital*—human capital disaggregated by gender and employment status (employed, self-employed). Human capital is measured as the discounted value of earnings over a person's lifetime.
- *Net foreign assets*—the sum of a country's external assets and liabilities,[4] for example, foreign direct investment and reserve assets (for further explanation, see Lane and Milesi-Ferretti 2007, 2017)

This book covers a much longer period (1995–2014) with better data and country coverage than previous reports. The focus of the book is on natural capital and human capital since information for produced capital and net foreign assets has been well established by other institutions. For the first time, explicit estimates of human capital, which is the largest component of global wealth, are provided. The availability at the World Bank of a unique global database of more than 1,500 household surveys has made possible the first-of-its-kind[5] global implementation of the well-known Jorgenson-Fraumeni lifetime earnings approach (Jorgenson and Fraumeni 1989, 1992a, 1992b) for measuring human capital based on individual data from household surveys. The estimates of human capital are presented by gender. In addition, drawing on work from the Penn World Table (Feenstra, Inklaar, and Timmer 2015), human capital is estimated for both employed and self-employed workers. Estimating human capital explicitly using household survey data enables us to calculate comprehensive wealth by summing up direct estimates of each component of wealth, thereby providing a more accurate indicator of sustainability. By contrast, previous versions of wealth accounts only measured produced capital and natural capital directly; total wealth and human capital were inferred.

Since the first version of the book in 2006, great progress has been made in data availability. Asset and country coverage have increased and deepened, although critical components of natural capital are still missing, specifically water, important minerals, some ecosystem services such as pollination and protection from natural hazards, and the condition of natural capital (for example, pollution and land and forest degradation). Market prices used to value natural capital typically do not reflect these ecosystem services or their value is not explicit, making it more difficult to manage natural capital to promote sustainable, long-term growth. With a 20-year time series of country wealth accounts, we can now examine in much greater depth the dynamics of wealth and development, which we began with a 10-year time series in the last version published in 2011. The introduction of human capital accounts in this book opens a new avenue for understanding sustainability. In addition, more analytical work is under way using various components of the wealth accounts. Overall, our hope is that this work presents insights into development issues that, in some cases, may not be new but are grounded in an approach to wealth accounting and long-term sustainability that is quantifiable.

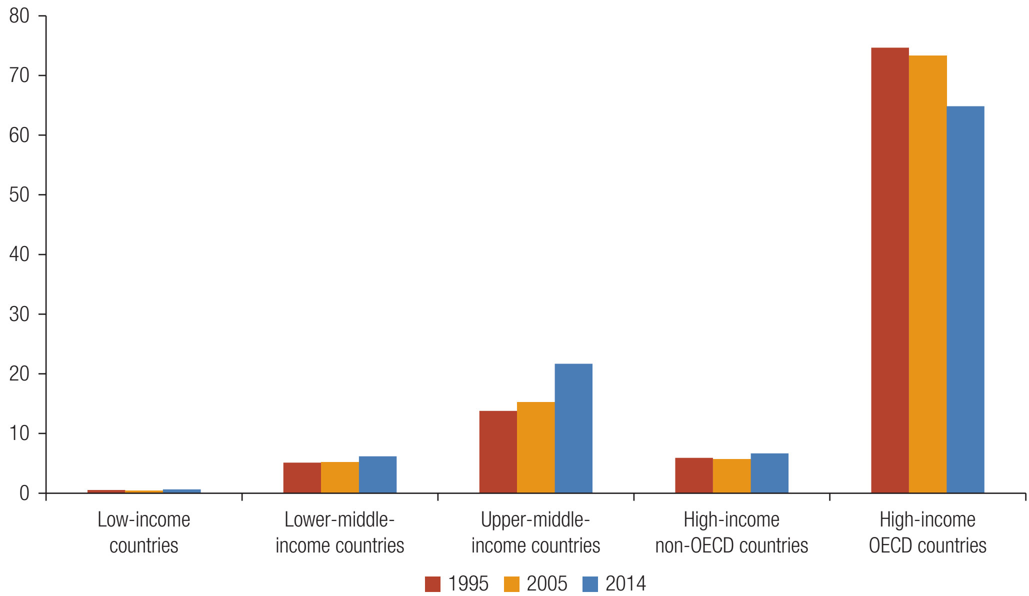
Sustainability into the 21st century will depend not only on produced capital, but also on investments in human capital, the strength of our institutions and governance, and the integrity of our natural capital. This new volume sets the stage for addressing these issues in an integrated manner. This executive summary presents some of the main findings.

Global and Regional Trends from 1995 to 2014

Middle-Income Countries Are Catching Up to High-Income Countries

Global wealth increased 66 percent from 1995 to 2014 (from $690 trillion to $1,143 trillion, in constant 2014 U.S. dollars at market prices), marked

FIGURE ES.1 Shares of Global Wealth, by Income Group, 1995, 2005, and 2014



Source: World Bank calculations.

by a sharp rise in the share held by middle-income countries from 19 percent to 28 percent over the period, while the share of high-income OECD countries declined from 75 percent to 65 percent (see figure ES.1). This change largely reflects the phenomenal rise of Asia, which has gone from mostly low- to middle-income status (except for Nepal) in one generation.

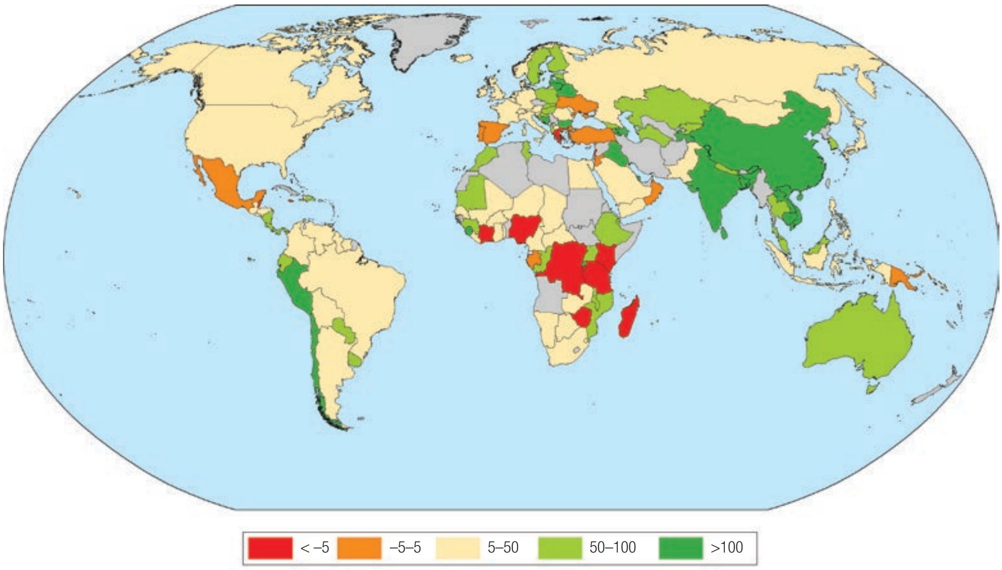
Mixed Progress in Some Low-Income Countries

The share of global wealth held by low-income countries, mainly in Sub-Saharan Africa, barely moved from less than 1 percent throughout the period 1995–2014, even as those countries' share of world population grew from 6 percent to 8 percent. However, this result masks divergent trends in this group. Although wealth in many countries increased substantially, these gains were offset by slower progress and in some cases losses in wealth in a few large low-income countries in this group, such as the Democratic Republic of Congo, Madagascar, and Tanzania.

Although Total Wealth Increased in Most Countries, Per Capita Wealth Did Not

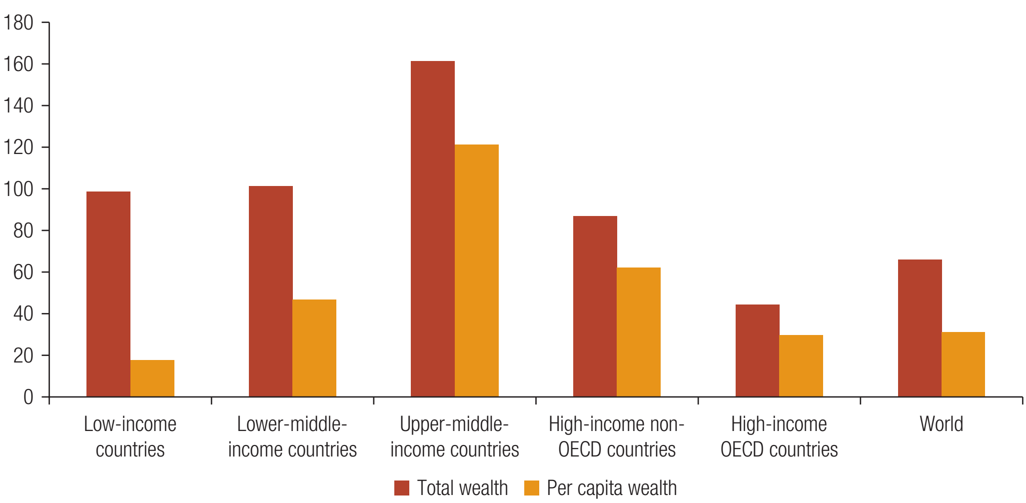
Per capita wealth grew fastest in middle-income countries and in some low-income countries, contributing to convergence in levels of wealth. However, convergence is a very slow process; in addition, per capita wealth changed very little or fell in some countries (see map ES.1). Particularly hard hit were some of the low-income countries in Sub-Saharan Africa, several carbon-rich countries in the Middle East, and a few OECD

MAP ES.1 Percent Growth in Total Wealth Per Capita, 1995–2014



Source: World Bank calculations based on wealth data and population figures from World Bank 2017.

FIGURE ES.2 Changes in Total Wealth and Per Capita Wealth, 1995–2014
percent



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

countries affected after 2009 by the financial crisis. Although the growth of wealth from 1995 to 2014 in many Sub-Saharan African countries matched that of other regions, the growth was not sufficient to keep up with relatively high population growth in some of them. Countries with similar or even less investment growth over the period still increased per capita wealth because of lower population growth rates (see figure ES.2).

The "demographic dividend" of a rapidly growing, younger population can only be realized if investment is sufficient to provide each potential new worker with the same (or more) human, natural, and produced capital. High population growth rates make meeting this goal more challenging.

Natural Capital and Development

Natural Capital Is the Most Important Asset for Low-Income Countries

Natural capital constituted 47 percent of wealth in 2014, and a major part of wealth in lower-middle-income countries as well (27 percent). As a gift from nature, natural capital has historically been the most abundant asset available to all countries at one point in their development, although the endowment has varied enormously among countries. At low incomes, economies are largely built around this relatively abundant asset, investing the proceeds in the relatively scarce assets—produced and human capital—to foster development. So, it is not surprising that low-income countries rely primarily on natural capital for their development (see table ES.1).

Richer countries clearly have greater wealth per person than low-income countries, but a strong relationship between development and the composition of national wealth can also be discerned. The share of natural capital gradually declines as countries graduate from low- to middle- and high-income status. Human capital reaches 70 percent of wealth in high-income OECD countries (and natural capital only 3 percent)—not by reducing the amount of natural capital but by adding more produced capital, especially human capital. This makes sense because economies can only move beyond subsistence production of food and shelter to manufacturing and services with the addition of human capital, infrastructure, and other produced capital. The exception is high-income non-OECD

TABLE ES.1 Wealth, by Type of Asset and Region, 2014

Type of asset	Low-income countries (%)	Lower-middle-income countries (%)	Upper-middle-income countries (%)	High-income Non-OECD countries (%)	High-income OECD countries (%)	World (%)
Produced capital	14	25	25	22	28	27
Natural capital	47	27	17	30	3	9
Human capital	41	51	58	42	70	64
Net foreign assets	–2	–3	0	5	–1	0
Total wealth	100	100	100	100	100	100
Total wealth, US$ billion	$7,161	$70,718	$247,793	$76,179	$741,398	$1,143,249
Total wealth per capita	$13,629	$25,948	$112,798	$264,998	$708,389	$168,580

Source: World Bank calculations.
Note: Figures for wealth are in constant 2014 US dollars at market exchange rates.

countries, dominated by the high-income oil and gas producers of the Middle East, where natural capital remains a large component of wealth.

Getting rich is not about liquidating natural capital to build other assets—natural capital per person in high-income countries is three times that in low-income countries, $19,525 versus $6,421 in 2014, even though the share of natural capital in high-income OECD countries is only 3 percent. Development is about more efficient use of natural capital (and its sustainable management in the case of renewable natural capital), bringing to bear other assets to increase productivity, together with the strong institutions and policies that make investment attractive. In 1995, 52 countries were classified by the World Bank as low-income countries; 28 of these countries are now middle-income countries. Of these 28 middle-income countries, the majority (23) were highly dependent on natural capital in 1995. More than half (15) were considered resource-rich and managed their energy and mineral wealth (nonrenewable natural capital) to build a broader set of assets, joining the middle-income group of countries. Another 8 countries, including India Kenya, Pakistan, and Senegal, were heavily dependent on agricultural land and forests (renewable natural capital), and have now built larger and more diverse portfolios of assets, especially human capital, but also infrastructure and other produced capital.

At the global level, the value of natural capital assets doubled between 1995 and 2014. Most of the growth was in nonrenewables (308 percent), largely because of changes in both volume and prices, while renewable resources grew by 44 percent. The increase in the value of energy and minerals might seem surprising since extraction depletes these stocks. But these resources, which of course existed long before 1995, only become productive assets for an economy and are added to the balance sheet when they are economically proven—that is, discovered and profitable to extract with available technology at a given price. The value of renewable resources can increase by bringing more land into productive use or by using the resource more productively, for example, by improving crop yields or developing nature-based tourism on forestland. The different trends for renewables and nonrenewables require a closer look. But first we examine what this information about natural capital assets can add to our understanding of growth at the macroeconomic level.

Natural capital accounts can help inform policy decisions by improving measures of economy-wide productivity gains. Economic growth is key to poverty reduction and better living standards. An economy can grow by either increasing the use of inputs, such as labor and produced capital, to produce more, or by improving productivity—that is, how efficiently a country produces goods and services using a given set of inputs. Traditionally, economists measure productivity, termed multifactor productivity,[6] by considering only two factor inputs: stocks of labor and produced capital. Multifactor productivity is assumed to represent factors such as more efficient management and technological change not directly embodied in capital stocks. However, the traditional two-factor approach to measuring multifactor productivity ignores the role of natural capital in economic growth, and may send misleading signals about a country's economic progress, for example, by overestimating economic growth in countries that rely on natural resource depletion (OECD 2017).

To correct the mismeasurement of productivity, the OECD (Brandt, Schreyer, and Zipperer 2017) recently added environmentally adjusted multifactor productivity to its headline indicators for green growth in OECD countries (OECD 2017). The OECD found that some countries, such as Japan, Finland, Germany, and the Russian Federation, achieved economic growth almost entirely through productivity gains. But economic growth in other countries—notably Brazil, China, India, and Turkey—has relied much more on increased use of labor, produced capital, and natural capital. Comprehensive wealth accounts, which include all three factors (produced, human, and natural capital), enable countries to apply this more accurate productivity diagnostic, providing new insights into productivity and growth. This approach is applied for selected resource-rich countries in the book.

Natural capital poses different development challenges for countries dependent on renewable resources (agricultural land, forests, and protected areas) versus nonrenewable resources (fossil fuels and minerals) (see box ES.2). Renewable resources are unique in that, if managed sustainably, they can produce benefits in perpetuity. Improvements in productive use of renewables can increase the benefits they generate and, consequently, the value of these assets, even if the land area does not increase, or even decreases, which has been the case for a number of countries. By contrast, nonrenewable natural capital offers a one-time chance to finance development by investing the resource rents[7] in other assets to replace the depleted natural capital. Some, but not all, countries have made good use of this opportunity. In all cases, these assets, similar to others in our wealth accounts, are valued at market prices or by using market price information to derive a value, as explained in appendix A.

Looking more closely only at low- and middle-income countries, natural capital grew in all regions. Nonrenewables, particularly oil and coal, accounted for most of the increase, but there were also gains in renewables in all regions except Sub-Saharan Africa. As a share of wealth, natural capital increased in three out of six regions—Latin America and the Caribbean, Europe and Central Asia, and the Middle East and North Africa (see figure ES.3). On a per capita basis, natural capital increased in all regions except Europe and Central Asia and Sub-Saharan Africa. A closer look at each type of natural capital will help provide a better understanding of the role of renewables and nonrenewables in development in these regions.

In low- and middle-income countries, the value of renewable assets—agricultural land, forests, and protected areas—more than doubled from 1995 to 2014, with better progress for agricultural land and protected areas than forests. In 1995, agricultural land was the most important asset after human capital in many countries, especially in South Asia and Sub-Saharan Africa. In Nepal, for example, natural capital—mostly agricultural land—accounted for 50 percent of total wealth in 1995 and remains a

BOX ES.2 Renewables, Nonrenewables, and the Challenge of Development

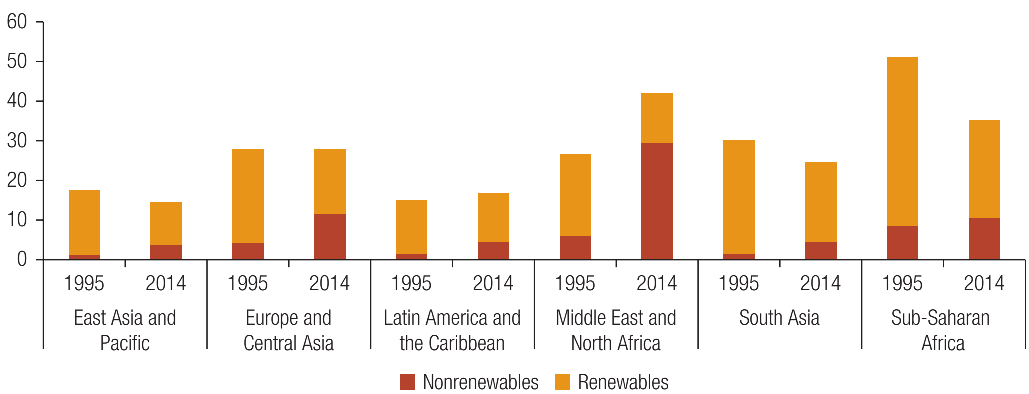
For countries that are dependent on nonrenewables, the development challenge is twofold: recover rents from usually private (often foreign) operations and invest rents to build other assets. The use of nonrenewables, by definition, is unsustainable, and these resources will eventually be depleted, but the income from these assets can be plowed back into other assets, especially infrastructure and human capital, to build an economy and support long-term growth. However, nonrenewables often involve highly capital-intensive mining operations that do not generate many jobs or support livelihoods, and can result in factors that hinder development associated with the "resource curse."

Revenue from nonrenewables can finance investments for sustainable wealth, but this requires careful macroeconomic management and strong institutions, both of which are lacking in some countries. Countries such as Botswana and Chile have succeeded in using resource wealth for development by recovering the resource rents generated and investing them in other assets. Of the 52 countries classified as low-income in 1995, 28 used their natural capital effectively to build wealth and move into the middle-income group of countries. Of the 24 countries that have remained low-income since 1995, 12 are classified as resource-rich, and of those, 8 are also classified as fragile-conflict states. For these 24 countries, characterized by low rankings on various dimensions of institutions, governance, and policy such as the World Governance Indicators, resource wealth alone has not been sufficient to ensure rapid development. Using the wealth accounts for Ghana and Niger—together with indicators of political economy and macroeconomic policy—demonstrates the complex interplay between resource wealth and development; for example, Ghana, which invested in human capital, has managed the challenges more successfully than Niger.

Renewable natural capital is a unique asset. If managed sustainably, it can produce benefits in perpetuity, in contrast to nonrenewables. For countries that are highly dependent on renewable assets, long-term growth requires maintaining or improving the productivity of these natural resources and managing them sustainably. Substantial investments may be needed to improve agricultural yields, use scarce water resources more efficiently, or switch to higher-value crops. Increasing productivity may also require managing land for a different mix of goods and services over time. For example, a forest once managed primarily for timber may generate higher value and employment as an ecotourism resource or as a source of clean, sediment-free water for downstream hydroelectric power.

FIGURE ES.3 Shares of Renewable and Nonrenewable Natural Capital in Total Wealth, by Region,1995 and 2014

percent



Source: World Bank calculations.
Note: Only low- and middle-income countries are included.

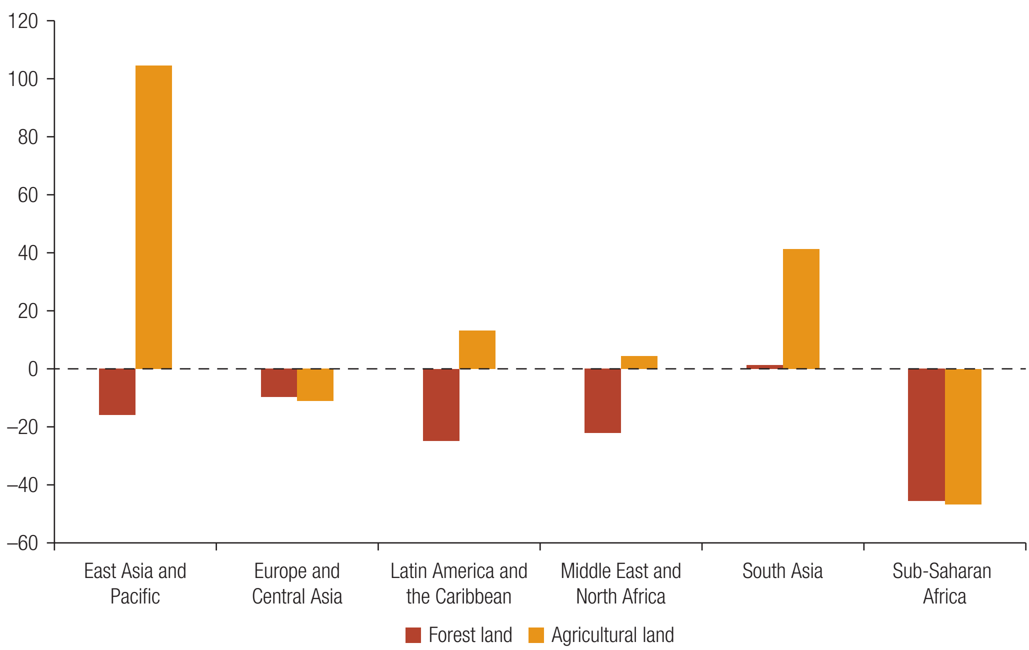
significant source of wealth today. The asset value of agricultural land has gone up sharply in most countries, especially in Asia and Latin America. Part of the gain is due to expansion of area under cultivation, especially in Latin America and Sub-Saharan Africa.

Despite growth in the value of agriculture land in Sub-Saharan Africa, it did not keep pace with population growth in 18 of the 35 countries in the data set, and per capita agricultural land value declined (see figure ES.4). Significant numbers of people rely on agriculture for livelihoods in these countries, including in Côte d'Ivoire, Gabon, Ghana, Mali, Nigeria, Tanzania, and Zambia. By contrast, significant gains were achieved in Ethiopia, The Gambia, Mozambique, Namibia, Togo, and Uganda.

A positive development is the rapid increase in protected areas, which provide critical ecosystem services. These areas have increased in all regions, both in extent and value. In low- and middle-income countries, the extent of land in protected areas increased 65 percent, accounting for 17 percent of these countries' total land area in 2014, up from 10 percent in 1995.

But the extent of forestland declined by 4 percent overall as a result of conversion to agriculture and other land uses, notably in forest-rich Africa and Latin America. Of concern is the decline in forestland area,

FIGURE ES.4 Change in Per Capita Value of Forest and Agricultural Land, 1995–2014
percent



Source: World Bank calculations.
Note: Only low- and middle-income countries are included.

although the regional averages conceal significant variation between countries. In East Asia, for example, the reported gains in forestland area in countries such as China, the Philippines, Thailand, and Vietnam outweigh significant losses in Cambodia and Indonesia. The loss in forestland area was more extensive in Latin America (7 percent) and Sub-Saharan Africa (9 percent), where conversion to agriculture was widespread.

By contrast, the asset value of forests stayed roughly constant from 1995 to 2014 across the regions while populations grew, and, thus, on a per capita basis, forest asset value per capital declined everywhere (see figure ES.4). The widespread loss of forestland can have significant, potentially irreversible effects that are not fully accounted for in the monetary value of forests included in the wealth accounts—for example, adverse impacts on water regulation, loss of protection from natural hazards, and reduced biodiversity and carbon storage. The conversion of forestland to other uses may be far worse than the monetary accounts indicate because the accounts are largely based on market prices that do not fully reflect the loss of nonmarket ecosystem services and externalities.

In contrast with renewable resources, nonrenewable natural capital—fossil fuels and minerals—offer a one-time chance to finance development by investing resource rents. The challenge of development for countries rich in energy and minerals has been well documented in the literature on the "resource curse." Resource-rich economies face unique development challenges to transform an exhaustible resource, such as oil, into assets that can continue to generate income and employment once the oil is gone. Oil rents, for example, provide substantial revenues for financing development and moving a country onto a higher growth trajectory, but this goal can only be achieved with the right institutions and governance to capture the rents and invest them effectively in other, productive assets (human capital, produced capital, renewable natural resource capital), an issue addressed further in chapter 3.

An endowment of natural resources alone may not ensure rapid development. Of the 24 countries that have remained low-income since 1995, 12 are classified as resource-rich; of those, 8 are also fragile-conflict states. The importance of strong institutions and sound policies for managing resource revenues is essential to turn these riches into sustainable development (see box ES.2).

Fossil fuel energy—carbon-based wealth—grew faster than any other asset, but that asset is increasingly at risk because of price uncertainty, advances in technology, and large-scale attempts at global decarbonization to slow climate change. These risks may diminish the value of carbon-based assets and undermine traditional development pathways for carbon-rich nations (see box ES.3). The major energy producers of the Middle East, as well as countries such as Brazil, China, Mexico, and the Russian Federation, have greater resources with which to address these risks. However, some smaller producers—many of them low- and lower-middle-income countries in Africa—rely heavily on carbon wealth for development and have fewer resources with which to address the risks.

BOX ES.3 The Carbon Wealth of Nations at Risk

Carbon assets—oil, gas, and coal—make up a significant share of wealth in many countries. In the Middle East and North Africa, carbon assets average almost 30 percent of total wealth, exceeding the amount of produced capital, and they average nearly 10 percent in Sub-Saharan Africa. However, carbon wealth is becoming increasingly risky because of price uncertainty. Furthermore, large-scale attempts at global decarbonization may diminish the value of carbon assets and undermine traditional development pathways for carbon-rich nations.

Carbon-rich developing nations hold a median of 45 years of reserves of carbon resources at current depletion rates. If the international effort to hold global warming below 2° C is to be achieved, a large share of resources must remain in the ground for a far longer period (hundreds or thousands of years instead of decades). Estimates suggest this could leave about 25 percent of Africa's oil and 35 percent of its gas stranded, while the Middle East could see almost 40 percent of its oil stranded and more than 60 percent of its gas. Globally, the top 10 state-owned carbon-resource companies account for $2.3 trillion of state-owned produced assets related to extraction and processing of fossil fuels. Mitigating the risks they face will require diversifying the total wealth portfolio away from carbon, including belowground natural capital (oil, gas, coal) and the associated aboveground physical and human wealth.

Human Capital: Driver of Development

Human capital wealth is measured for the first time as the present value of the future earnings of the labor force using household surveys for 141 countries. Human capital is often interpreted to include, among other factors, the years of schooling of the population, the actual learning taking place in school and after leaving school, and health investments. In this book the measure of human capital is based on the present value of the expected earnings of the labor force, a measure that is consistent with the concept of capital used for other assets. This measure factors in not only the number of years of schooling completed by workers, but also the earnings gains associated with schooling (which implicitly factors in the quality of the learning taking place in school) and how long workers can work (which implicitly accounts for health conditions through life expectancy, among others).

In per capita terms, human capital wealth stood at $108,654 per person in 2014 versus $88,874 in 1995, accounting for roughly two-thirds of global wealth. This share declined over the past two decades, from 69 percent in 1995 to 64 percent in 2014. This decline is observed only for comparatively richer countries—in most developing countries, the share of human capital in total wealth is rising. This rising trend is expected to continue. In simple terms, a skilled labor force appears to be the key to future development in an increasingly globalized economy. This book highlights significant facts on human capital, with a companion volume providing additional insights into how the data can be used for policy (see box ES.4).

Growth rates in human capital wealth per capita are presented in figure ES.5. At the global level, growth in human capital is driven

BOX ES.4 Using Human Capital Data for Policy: A Summary of the Companion Volume

The new estimates of human capital wealth are a significant improvement over past estimates by the World Bank, where total wealth included a large unexplained residual called "intangible capital." This residual, it turns out, consists for the most part of human capital. Since these new estimates of human capital wealth have important implications for wealth accounting and policy work, we prepared a companion volume—*Human Capital and the Changing Wealth of Nations: Investing in People for Sustainable Development* (Wodon, forthcoming)—specifically on human capital.

Apart from a more detailed description of the methodology for constructing estimates of human capital, the companion volume includes an analysis of human capital wealth along the life cycle. After introducing a simple framework for looking at investments across a person's life, various chapters provide examples of how the data on human capital wealth can be used for simulations of the benefits from specific investments. One chapter focuses on investments in early childhood development, specifically considering the benefits that could be reaped from ending under-five stunting. Another chapter examines investments in basic education, showing that such investments tend to have high benefit-to-cost ratios. Still another chapter considers the transition to adulthood, using the issue of child marriage as an illustration to show how ending the practice could bring large benefits, specifically higher earnings in adulthood.

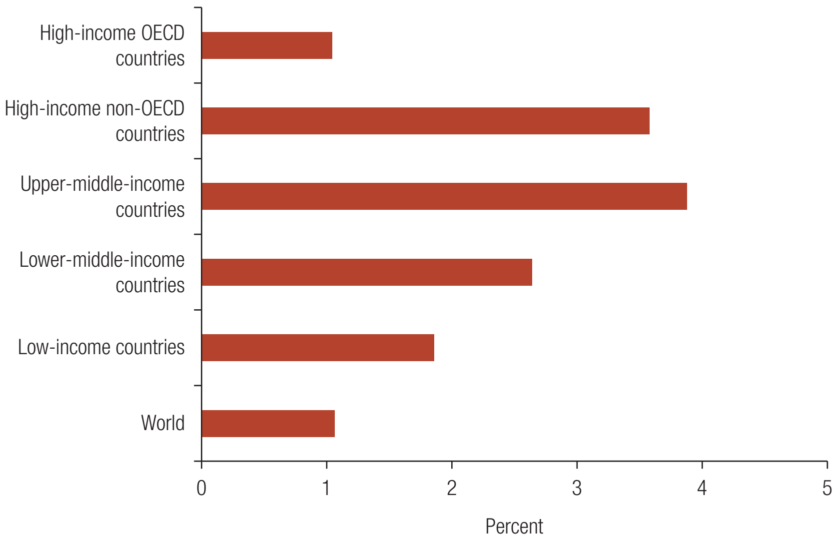
The companion volume also considers inequality in the wealth of nations, including inequality in human capital wealth. It compares the treatment of human capital in wealth accounting with that treatment in adjusted net savings. Finally, the volume provides examples of how estimates of human capital wealth can be used for country-level work.

The various chapters in the companion volume by no means cover all the ways in which the data on human capital can be used, but we hope they will encourage other researchers and policy analysts to apply the data to their own work. The new measures of human capital wealth provided in this book and in the companion volume are a powerful new resource for advocacy of investments in human capital as well as policy analysis.

primarily by shifts taking place in OECD and upper-middle-income countries, which account for 87 percent of global wealth (65 percent for the OECD and 22 percent for upper-middle-income countries) and an even larger share of human capital wealth. In these countries, the share of human capital wealth in total wealth is falling, as labor earnings (as a share of GDP) have declined because of factors such as technological change, stagnating wages, and aging in many countries. Aging reduces the remaining years in the labor force for part of the population, hence the time over which future lifetime earnings are estimated.

Whereas in some high-income countries human capital as a share of total wealth is declining, in low-income and lower-middle-income countries the share of human capital wealth in total wealth is rapidly increasing. In low-income countries this share increased from 32 percent to 43 percent over two decades, consistent with the growth path discussed earlier in which development occurs by increasing investment in human capital and produced capital. In lower-middle-income countries, it rose from 44 percent to 52 percent. Many of these countries are experiencing a demographic transition and are reaping the benefits of the demographic

FIGURE ES.5 Annual Growth Rates in Human Capital Wealth Per Capita, 1995–2014 (%)
percent



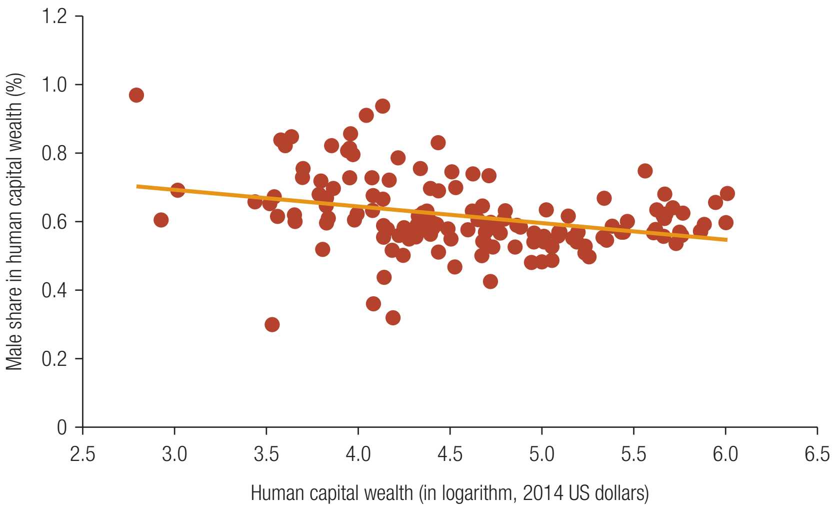
Source: World Bank calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

dividend as population growth rates are being reduced and the population is becoming better educated.

Globally, women account for just 38 percent of human capital wealth, versus 62 percent for men, because of lower earnings. In types of employment, the differences are even more striking. These lower earnings are likely due to multiple factors, including lower levels of pay, lower labor force participation, and fewer average hours of work. Globally, the self-employed account for only 9 percent of human capital wealth, whereas employed workers account for 91 percent of that wealth. Global figures can be misleading, however, simply because most human capital wealth is concentrated in upper-middle and high-income countries, so that these countries are more heavily weighted in global estimates. Figures ES.6 and ES.7 show the relationship between the share of human capital wealth attributed to men (both employed and self-employed) and that attributed to self-employed workers (both men and women) as a function of the level of human capital wealth achieved, which is highly correlated with GDP per capita.

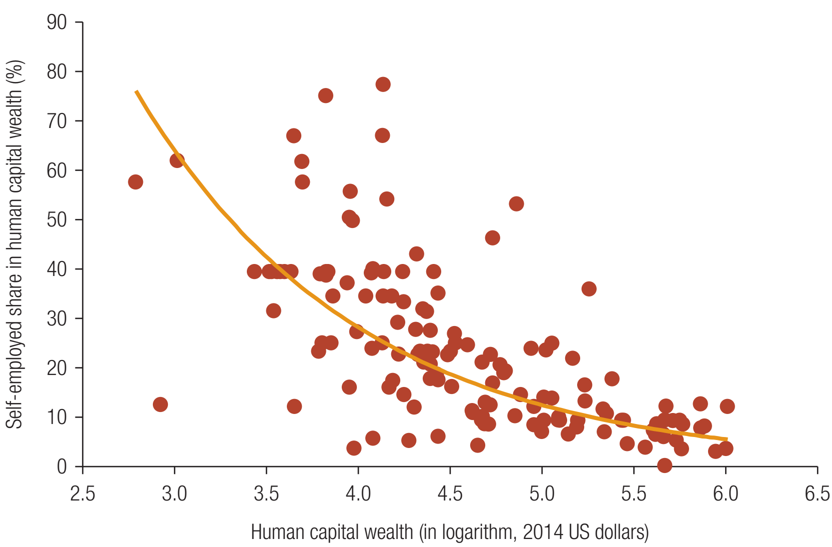
Figure ES.6 shows a weak downward relationship between the share of human capital attributed to men and the level of human capital wealth. Countries with higher levels of human capital wealth have slightly higher shares of wealth attributed to women. However, there is also a lot of variation among countries. By contrast, the relationship between human capital wealth or economic development and the share of the wealth attributed to the self-employed is much stronger in figure ES.7. Self-employment is

FIGURE ES.6 Male Share in Human Capital Wealth, 2014



Source: World Bank calculations.

FIGURE ES.7 Self-Employed Share in Human Capital Wealth, 2014

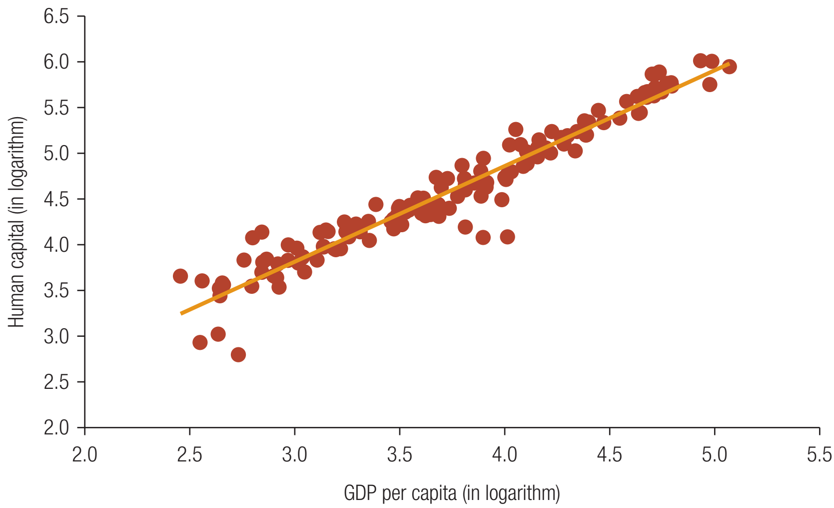


Source: World Bank calculations.

much higher in countries with lower levels of human capital wealth. This finding was expected, given that many individuals in those countries are working in subsistence agriculture and very small businesses in the informal sector.

Achieving higher gender parity in earnings could generate large increases in wealth. Consider the case of gender differences in human

FIGURE ES.8 Human Capital Wealth Per Capita and GDP Per Capita



Source: World Bank calculations.

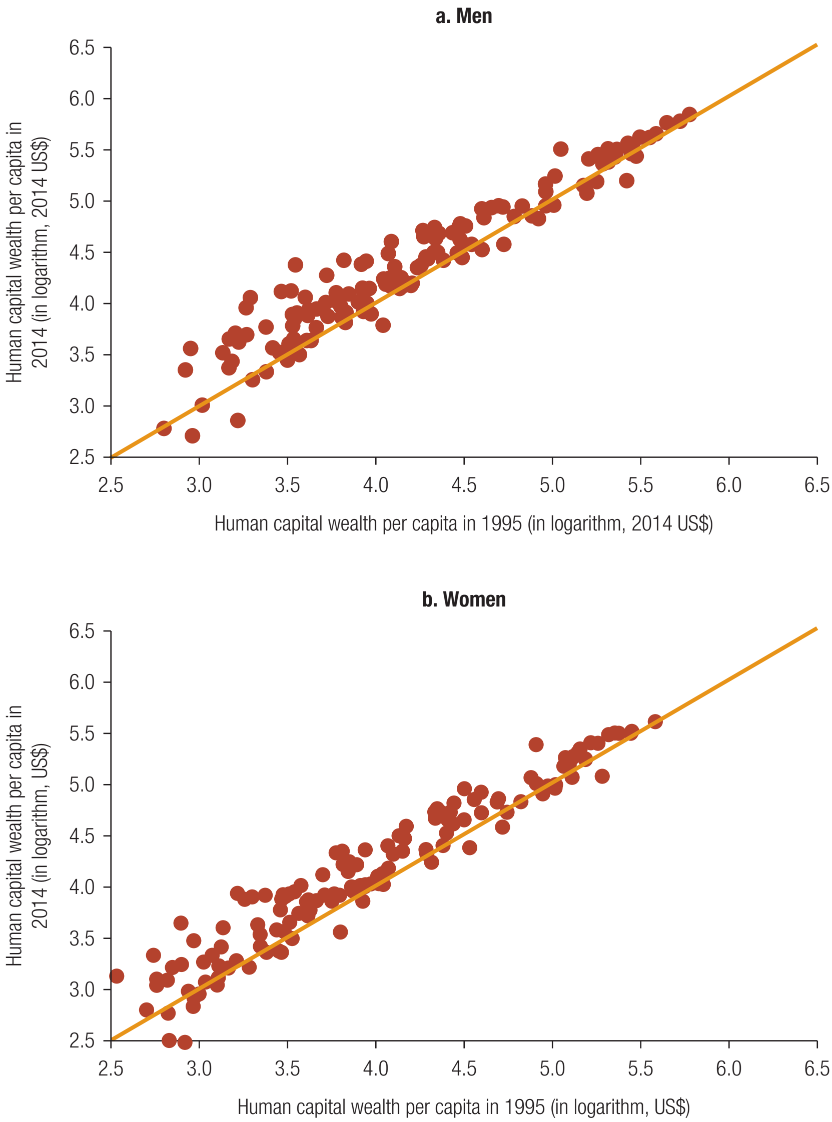
capital wealth. Assume for the sake of simplicity that the working-age population is equally divided between men and women. Simple calculations show that gender parity in earnings would increase global human capital wealth by 18 percent, with notably large potential gains in South Asia.

Another finding is that estimates of human capital wealth are highly correlated with GDP per capita (figure ES.8). The orders of magnitude are different, with human capital wealth per capita typically 7–10 times larger than GDP per capita. However, as expected, the two measures remain highly correlated.

Growth rates in human capital between countries appear to be converging, with poorer countries catching up with richer countries. Are poorer countries catching up with richer ones through higher growth in human capital wealth per capita? It does seem to be the case as shown in figure ES.9, which displays levels of human capital wealth per capita in 1995 (on the horizontal axis) and in 2014 (on the vertical axis). For both men and women, most countries lie above the diagonal, suggesting that an overwhelming majority of countries increased human capital wealth per capita between 1995 and 2014. However, a few countries, below the diagonal, have lost ground, often because of a conflict or other shocks.

Higher growth in human capital wealth per capita in lower-income countries is confirmed by further analysis in the book, which also suggests that demographic factors play an important role in these growth rates, pointing again to the importance of the demographic dividend. An example of the role of human capital in building wealth in Morocco is given in box ES.5 and explored in greater detail in chapter 8 of the book.

FIGURE ES.9 Convergence in Human Capital Wealth Per Capita, by Gender



Source: World Bank calculations.
Note: Observations along the diagonal line indicate that human capital wealth per capita is the same in 2014 and 1995; those above the diagonal show that wealth increased while those below the line show that wealth decreased over the period.

Organization of the Book

The book is divided into three parts. The first part presents the overall approach, trends in wealth accounts over the past two decades, and examples of how wealth accounting is used in policy assessments and analysis. The second part describes the new work on human capital and its uses for policy analysis. A companion volume goes into greater detail about

BOX ES.5 Intangible Capital and Diversification as the Engine for Development in Morocco

As an example of the use of human capital data at the country level, this book includes a case study for Morocco. Morocco achieved strong growth in per capita wealth from 2005 to 2014, with notable gains in produced capital and the values of agricultural land and minerals. However, this growth masks relatively low levels of investment in human capital wealth, which may hold the country back from achieving upper-middle-income status. In 2014, 41 percent of Morocco's total wealth was human capital, a share well below that of countries such as Tunisia (55 percent), Lebanon (65 percent), and Jordan (55 percent). As shown in table ES.6.1, this gap in human capital essentially explains why total wealth per capita in Morocco is well below the average for those three countries.

In a 2014 speech, the King of Morocco highlighted the role of intangible capital—which consists in large part of human capital—in powering the country's development. One of the factors leading to insufficient levels of wealth per capita in Morocco is the gap in human capital—and thereby in wealth—by gender. Women account for only about a fifth of total earnings and human capital in Morocco. If gender parity in earnings were achieved, human capital wealth in Morocco could increase by more than a third. In governance, another aspect of intangible capital, Morocco leads its North African peers on rule of law, but is less strong on political stability, voice, and accountability. Levels of trust also tend to be low.

Reforms outlined in the government of Morocco's 2040 strategy could make a significant difference. The strategy prioritizes not only macroeconomic reforms, but also human capital growth through education and labor market reforms as well as efforts to increase gender equality. Equally important will be institutional reforms to create a modern administration, to improve public investment and financial management, and to increase voice and accountability and access to information.

TABLE BES.6.1 Wealth Per Capita in Morocco and Comparator Countries

US$

	Total Wealth	Produced Capital	Natural Capital	Human Capital	Net Foreign Assets
Individual countries					
Morocco (1)	40,488	13,616	12,372	16,490	–1,990
Egypt, Arab Rep.	38,470	5,605	11,229	22,591	–955
Jordan	49,287	17,577	8,876	27,312	–4,478
Lebanon	65,148	31,015	4,131	42,153	–12,151
Tunisia	45,150	14,838	10,178	24,796	–4,662
Spain	342,470	142,821	10,298	215,593	–26,241
Upper middle income	112,798	28,527	18,960	65,742	–432
MENA-3 (Jordan-Lebanon-Tunisia)					
Average for MENA-3 (2)	53,195	21,143	7,728	31,420	–7,097
Morocco versus MENA-3					
Difference (2) – (1)	12,707	7,527	–4,643	14,930	–5,107

Source: World Bank calculations.
Note: Figures are in constant 2014 US dollars at market exchange rates. MENA = Middle East and North Africa.

human capital and development. The last part of the book reports on new developments for natural capital that had been poorly measured in the past or not measured at all, and prospects for including them in future work on wealth accounts: air pollution, marine fisheries, and ecosystems and their services.

Summing Up

Great progress has been made in estimating wealth since the first volume of the wealth of nations was published in 2006. But much work remains to be done. The major innovation in this edition is the explicit estimation of human capital, with breakdowns by gender and type of employment. These estimates should be considered a first attempt at measuring human capital wealth within a coherent national accounts framework. Improvements to the methodology can, and will, be made in future work. But the available data can already inform policy. The companion volume to the *Changing Wealth of Nations* presents several such analyses and their policy implications for development.

Regarding natural capital, the measure of energy and mineral assets has greatly improved[8]; renewable natural capital, however, is still not fully represented in wealth accounts. Some important ecosystem services are certainly undervalued or omitted. Thus, our understanding of how countries leverage natural capital—still the main asset for low-income countries—for sustainable development is not complete, and the market prices used to value these assets may provide misleading signals about the costs and benefits of land conversion. Renewable natural capital is a unique asset. If managed sustainably it can produce benefits in perpetuity. At present, data about forests, for example, do not include information about forest condition, and degradation of forests has potentially serious impacts on the future well-being of countries and the planet. Natural capital is also subject to irreversible changes in natural systems and thresholds that may precipitate catastrophic events—but great uncertainties surround these factors. None of the uncertainty, including potential climate change impacts, is currently incorporated in the value of renewable natural capital.

Given these limitations, wealth accounts must be interpreted with some sensible caution. Changes in total wealth provide a measure of what economists call "weak" sustainability, that is, it assumes a high degree of substitution possibilities among different kinds of assets. Where assets are complements rather than substitutes, and where serious irreversibility is likely to occur, this assumption does not hold. For example, an increase in fishing vessels cannot compensate for heavily depleted fish stocks. We have seen that in some countries, the conversion of forestland to agricultural land did not reduce total wealth, but the impacts on sustainability are likely not fully captured. Wealth should be paired with biophysical measures of natural capital, particularly critical natural capital (natural capital that performs important and irreplaceable functions), as well as measures of good governance and institutions needed for sound management of wealth.

The wealth accounts provide a new lens for assessing economic performance and sustainability, complementing traditional measures such as GDP. Sustainability into the 21st century depends not only on economic wealth but also on the strength of our institutions and governance to manage wealth productively and the integrity of our various forms of capital.

Notes

1. *Balance sheet* generally refers to a presentation of information about assets, liabilities, and net worth in a specific format defined by a formal accounting framework such as the System of National Accounts or business accounting frameworks. This book generally uses the terms *wealth* and *assets* synonymously but without the same presentation structure.
2. Urban land is a nonproduced asset in the System of National Accounts, but the book separates it from other nonproduced assets (natural capital) to focus on the other forms of natural capital.
3. Energy accounts only include fossil fuels at this time. When the text refers to energy, it means fossil fuel energy, unless otherwise stated.
4. Domestic financial assets do not add to national wealth because "assets + liabilities" sum to zero. Nevertheless, it would be useful to have such information; unfortunately, data are not readily available for many countries.
5. This work builds on household survey–based estimates of human capital in a number of countries, as described in chapter 6.
6. *Multifactor productivity* may also be called *total factor productivity*. The terms are used interchangeably in the book.
7. Resource rent is the price of a natural resource in situ whose supply is fixed at a point in time, thus resulting in scarcity relative to demand. Markets for many natural resources in situ are missing or very limited, so there is no observed market price, or rent. The rent is incorporated in the market price of the resource only after it is extracted and sold, along with the costs of other inputs used for extraction. Rent is commonly measured as the difference between the market price of a resource and its costs of production.
8. Although some important resources are still not included because of a lack of data, notably platinum group minerals, diamonds, and other minerals, as well as renewable energy sources such as solar, hydropower, and wind.

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1

Estimating the Wealth of Nations

Glenn-Marie Lange and Quentin Wodon

Main Messages

- This third World Bank report on the wealth of nations provides new measures of the changing wealth of nations for 141 countries over the period 1995 to 2014.
- In a major departure from the earlier approach, comprehensive wealth is calculated by summing up estimates of each component of wealth: produced capital, natural capital, human capital, and net foreign assets. For the first time, we also are able to estimate human capital directly with estimates by type of employment (employed and self-employed) and by gender using household surveys for all countries.

Complementary Measures: GDP and National Wealth

Imagine a firm trying to raise capital to fund investments that will ensure its future growth and competitiveness. The firm only releases its annual income statement to potential investors, without disclosing its entire balance sheet. Or consider a potential homeowner applying for a real estate loan. The homeowner provides a bank with information on annual income, but not existing debts and assets. That firm and that homeowner are unlikely to obtain financing, simply because annual income statements provide an incomplete assessment of the firm's or homeowner's financial health. The same is true for countries. The annual income statement of a country—as summarized by its GDP or another similar measure—provides only a partial picture of the country's economic health and potential for future growth. This is especially clear for resource-rich countries, which could deplete their natural resources for short-term gains—increasing GDP per capita at the expense of long-term sustainability and future growth.

To assess a country's economic health, measures of annual economic activity such as GDP per capita need to be complemented with measures of the country's asset base or wealth, noting that the asset base of countries is what enables them to generate future income. This volume, the third in a series of studies on the wealth of nations published by the World Bank, provides new measures of the changing wealth of nations and illustrates how these measures can inform policy. A key innovation in this volume is the estimation of countries' human capital wealth using household surveys for 141 countries. A separate companion volume looks in more detail at human capital wealth accounts and their use for policy (Wodon, forthcoming).

Wealth accounts are an integral part of the System of National Accounts (SNA) (EC et al. 2009). The SNA provides the basis for measuring national economic progress by governments, the private sector, international organizations, and many other stakeholders around the world. However, wealth accounts are not nearly as widely implemented as the measures of annual production and income, such as GDP. This might appear somewhat puzzling, since standard business accounting systems developed for the private sector include both an income statement (revenues, costs, and so on), as well as a balance sheet (assets and liabilities).[1]

National wealth accounts have not yet been widely implemented by countries for two main reasons. First, the focus of the SNA and statistical offices on national production and income is largely the result of historical conditions. The idea of national economic accounts has been around for several centuries, but only came to be widely implemented after World War II in response to a combination of, first, serious social and political crises arising from the Great Depression and then the financing of World War II and, second, the development of Keynes' macroeconomic theory that explained what needed to be done to counteract a depression. The theory addressed itself essentially to the short-term challenges of macroeconomic management, not long-term sustainability. National economic accounts were developed as a tool for measuring the economy and informing macroeconomic policy, and were guided in part by the information needs of this relatively short-term perspective (see, for example, Coyle 2015).

A second reason is related to the first. Because the primary focus was on the measurement of economic production and income, the development of an internationally agreed-upon methodology and the collection of data needed to measure wealth were not given the same attention as measures of output and income. Agreement on measurement for some natural capital was only achieved in 2012 (UN et al. 2014). There is still no agreement on the measurement of human capital, although methodologies for doing so have now been developed. The data requirements for constructing comprehensive wealth accounts have also been a significant constraint.

For example, to measure human capital wealth, survey data on earnings for the labor force are needed. Although these data have long been available in developed countries, household and labor surveys have become systematically available in low- and lower-middle-income countries only relatively recently.

Today, the data required to make reasonable estimates of wealth and how it changes over time are available in many countries. The need to measure countries' wealth—and the interest in such measurement—has spiked in recent years. The 2008 global economic crisis, which largely affected housing and financial assets, as well as the work of Thomas Piketty (2013), illustrate growing public concern over inequality not only of income, but also of wealth. More generally, there is increasing concern about the long-term environmental sustainability of the planet and the impact of environmental and climate conditions on the poor. These concerns have led to new efforts to track natural capital and its connections with economic development. These efforts were instrumental in leading to the path-breaking extension of the SNA to record stocks and flows of natural capital in the System of Environmental-Economic Accounting (SEEA) (UN et al. 2012), which was adopted by the UN Statistical Commission in 2012.

Finally, wealth accounts can support the Sustainable Development Goals (SDGs), especially SDG 17, which aims to revitalize the global partnership for sustainable development. The final target of the entire SDGs is target 17.19: "By 2030, build on existing initiatives to develop measurements of progress on sustainable development that complement gross domestic product, and support statistical capacity-building in developing countries." Currently, there is no agreed-upon macroeconomic indicator of sustainability, but measures of a country's change in wealth per capita over time can potentially help fill this void.

This book builds on these broader trends to show how wealth accounts can be implemented for a large number of countries. The book presents a wide range of examples and analyses—from global and regional trends to country case studies—to show how wealth accounts can deepen our understanding of development that is both sustainable and inclusive. This, in turn, can start to motivate a broader conversation about sustainable development to include wealth as well as income, or stocks as well as flows.

How We Measure Wealth

Measuring national wealth and changes in wealth is part of an ongoing effort by the World Bank to monitor the long-term economic well-being of nations. *The Changing Wealth of Nations 2018* builds on two previous World Bank books—*Where Is the Wealth of Nations? Measuring Capital for the 21st Century* (World Bank 2006), and *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (World Bank 2011)—as well as on work on adjusted net saving that was started in the late 1990s and is published annually in the World Bank's *World Development Indicators*.

This volume introduces significant changes in methodology and data to improve the coverage and quality of wealth estimates. The main changes in methodology and data sources for this version of comprehensive wealth accounts (and a comparison with the earlier approach) are summarized in the annex to this chapter. Appendix A to this volume provides a more detailed technical explanation of methodology and data sources.

In a major departure from the earlier approach, comprehensive wealth in this volume is calculated by summing up estimates of each component of wealth: produced capital, natural capital, human capital, and net foreign assets. This method represents a shift from a "top-down" approach used in earlier estimates to a "bottom-up" approach, which is possible because human capital is now measured as an explicit component of the wealth accounts for each country. The World Bank has developed a unique global database of more than 1,500 household surveys, which provides the foundation for a first-of-its-kind global implementation of the well-known Jorgenson-Fraumeni lifetime earnings approach for human capital (Jorgenson and Fraumeni 1989, 1992a, 1992b). Drawing on work from the Penn World Table (Feenstra, Inklaar, and Timmer 2015), we also are able to estimate human capital for both employed and self-employed workers and by gender.

Wealth accounts are grounded in the framework of the SNA. The SNA measure of wealth is actually much narrower than what is presented here because the SNA asset boundary includes only produced assets, some natural resource assets, and net foreign assets. Although there has been experimentation with human capital, it is not yet part of the SNA national balance sheet. This volume reports wealth data for 141 countries for 1995 to 2014. (Because of space constraints, data in this book are reported at five-year intervals only. The dataset is available on the wealth accounting page of the World Bank website.) The wealth estimates are provided according to four asset classes:

- *Produced capital and urban land*—machinery, buildings, equipment, and residential and nonresidential urban land, measured at market prices.[2] For the sake of brevity, the abbreviated term produced capital is used in the volume to include both produced capital and urban land.
- *Natural capital*—energy[3] (oil, gas, hard and soft coal) and minerals (10 categories), agricultural land (cropland and pastureland), forests (timber and some nontimber forest products), and protected areas. Natural capital is measured as the discounted sum of the value of rents generated over the lifetime of the asset.
- *Human capital*—the value of skills, experience, and effort by the working population over their lifetimes disaggregated by gender and employment status (employed, self-employed). Human capital is measured as the discounted value of earnings over a person's lifetime.
- *Net foreign assets*—the sum of a country's external assets and liabilities;[4] for example, foreign direct investment and reserve assets (for further explanation, see Lane and Milesi-Ferretti 2007, 2017).

Not all assets or countries are included in the wealth database. Additional assets could be included in the database in the future when the necessary data become available for a large number of countries (at least 100), are updated regularly to provide a time series, and are publicly available. These criteria set a rather high bar for some assets for which such data are not readily available. For some assets, such as produced capital and net foreign assets, the asset values used in this volume are directly available from other sources. The value of natural capital and human capital is estimated using data collected from a wide range of global sources, as described in appendix A. Given the need to harmonize data across countries, these wealth accounts for any country are unlikely to be as accurate as the accounts that the country might construct itself using its own, more comprehensive data sources. The value added in this book lies in the provision of comparable measures of wealth for many countries, with countries included when data for the core set of assets are available or can be reasonably estimated.

The construction of the wealth accounts in this volume is guided by the concepts and methods of the SNA. While values for produced capital and net foreign assets are generally derived from widely used methods based on observed transactions for these assets, the value of natural capital and human capital must be estimated. The approach to asset valuation is based on the concept that the value of an asset should equal the discounted stream of expected net earnings (resource rents or wages) that it earns over its lifetime.

The SEEA guides estimates of natural capital. The SEEA is an extension of the SNA, uses consistent concepts and structure, and provides the basis for the estimates of the value of natural capital. No such standard yet exists for human capital, but a great deal of experimental work has been done on this topic based on the Jorgenson-Fraumeni approach, including some work by national statistical offices. To maintain consistency with the SNA, human capital estimates are restricted to earnings that are recorded in the SNA or that can be reasonably derived from data in a country's SNA. Although the SNA includes unpaid household production of some goods, it excludes the production by households of services for final consumption within the household, such as family care, meal preparation, or home repairs. Women provide a disproportionate share of this unpaid work (for example, Blackden and Wodon 2006). Because these services are excluded from the SNA, they are also excluded from the human capital estimates reported here.

Comprehensive wealth presently is measured at market exchange rates in constant 2014 US dollars. An alternative would be to value wealth accounts using purchasing power parities (PPP), which provide a better measure of the well-being derived from assets, just as GDP can be measured using both market exchange rates and PPP. This is a topic of great importance for future work and is explored further in box 1.1.

BOX 1.1 Measuring Wealth in Purchasing Power Parity Terms

The wealth accounts presented in this book are valued at market exchange rates. For example, to value cropland, land rents are measured as the value of crops produced at local prices minus the economic cost of production (input costs including labor plus an assumed "normal" return on capital). The value of agricultural land then equals the present value of all the rents associated with agricultural production in local prices. This value is converted to US dollars using the market exchange rate (averaged over the year) between the local currency and US dollars. Although using market exchange rates is a practical way to put all asset values for different countries in a common unit for cross-country comparisons, the values may not necessarily capture well-being adequately.

To provide a better measure for comparison of well-being, an alternative would be to rely on "international dollars" at purchasing power parity (PPP). PPP-adjusted aggregate national accounting takes into account the purchasing power that a dollar has in a given economy. For example, table B1.1.1 compares GDP per capita for China in 2014 using both market exchange rates and PPP. The valuation using PPP is almost twice the valuation at market exchange rates.

PPP estimates are obtained from the International Comparison Program, a joint effort by the World Bank and its partners using regular surveys (the most recent being 2011) to measure the purchasing value of a dollar across countries at a highly detailed level of aggregation for the goods considered. PPP values for individual products and services are used to arrive at weighted aggregate PPP values for aggregate final demand and for GDP. Both market exchange rates and PPP have their uses, and, for example, countries' GDPs are reported in both units. The use of PPP in addition to market exchange rates is currently under discussion for future editions of wealth accounts.

TABLE B1.1.1 Alternative Measures of GDP Per Capita in China, 2014

Local currency (yuan renminbi)	47,203
US dollars at market exchange rates	7,684
International dollars at purchasing power parity	13,440

Source: World Development Indicators.

Wealth, Adjusted Net Saving, and Sustainability

Income measures such as GDP can be understood as the annual production generated by a country's use of its asset base. Said differently, income is the annual return that a country derives from its wealth. Therefore, the key to increasing economic well-being in the future lies in building national wealth. This, in turn, requires savings to finance this investment, as well as good institutions and governance to make productive use of assets. From a wealth accounting perspective, development can be viewed as a challenge of portfolio management, with countries deciding how much to save or consume each year, what assets to invest in, and how to make the most efficient use of their assets.

The wealth accounting approach provides two related sets of information: comprehensive wealth accounts (a stock measure in total and per capita values), and adjusted net (genuine) saving (a flow measure). Adjusted net saving (ANS) is measured as gross national saving minus depreciation of produced capital, depletion of subsoil assets and timber resources, the cost of air pollution damage to human health, plus a credit for education expenditures. The rule for interpreting ANS is simple: if ANS as a percentage of gross national income (GNI) is negative, the country is consuming more than it is saving, which will undermine long-term sustainability; if ANS is positive, it is adding to wealth and future well-being.

For countries with growing populations or aspirations to higher standards of living, maintaining wealth is not sufficient; per capita wealth must be growing, or at least not declining. Comprehensive wealth accounts show the value of various assets at a particular time and they can also be used to monitor whether per capita wealth is maintained or is increasing over time. This is a simple criterion for sustainable, long-term growth. ANS provides a complementary indicator to help us understand some of the dynamics that drive the changes in wealth from one period to the next by capturing some of the important policy-induced dynamics.

Measured annually, ANS provides policy makers with immediate feedback about the direction of the economy and possible actions they may need to take to ensure long-term growth. Breaking down the components of ANS makes it easy to discuss policy interventions that could improve a nation's ANS, such as increasing the level of gross saving, improving the quality and maintenance of built capital to achieve a longer lifetime and enhance its resilience to reduce depreciation of fixed capital, increasing investment in education and innovation to boost human capital, optimizing use of natural capital (sustainable use of renewables and efficient extraction of nonrenewables), or improving air quality to reduce pollution damage costs.

Although ANS is a very useful concept, it is important to note that it does not correspond exactly to changes in wealth for reasons explained in box 1.2. Many factors affecting wealth are not included in ANS because of SNA conventions regarding saving and investment. This means that it is possible to observe negative (positive) ANS and an increase (decrease) in wealth, even if this is typically not the case for most countries. Given that much of the difference between ANS and changes in wealth result from exogenous factors, increased prudence in the government's fiscal and investment management is warranted when ANS is observed to be negative even though wealth may be increasing. More generally, squandering existing wealth, especially exhaustible resources that can finance future investment, is never prudent.

BOX 1.2 Savings and Changes in Wealth

In economic theory, investment net of depreciation and depletion equals the change in wealth. As a result of both practical data limitations faced in measuring adjusted net saving (ANS), as well as accounting definitions for savings and investment in the System of National Accounts (SNA), this is not the case for this volume's wealth accounts. A significant gap between ANS and the change in wealth may sometimes occur.

A number of factors affecting national wealth are currently omitted from ANS because of a lack of data (a weakness that could be corrected in the future). These factors include changes in the extent of agricultural land, as well as changes in the present value of earnings for the labor force (our measure of human capital) that need not reflect investments through the public budget in education (the measure used for ANS).

In addition, certain factors affecting national wealth are not included in saving and investment according to SNA conventions, but are part of changes in wealth:

New discoveries of subsoil assets, which are only added to the balance sheet, not ANS.

Some capital gains and losses from commodity price changes, which are included in wealth accounts when the GDP deflator is used to value an asset in constant prices.

Changes in technology, world prices, and management that affect the productivity of an asset, or the volume of resources that are now economically feasible to exploit.

- Improvements in extraction technology for energy and minerals can make extraction of previously uneconomic resources feasible, increasing the volume of resources and adding to wealth, but changes in technology may reduce the demand for other resources (for example, shale gas can reduce the demand for and value of coal resources, or cheaper renewable energy sources may reduce the demand for fossil fuel energy).
- Changes in world prices may increase the volume of resources, adding to wealth resources that were not previously profitable to exploit (a separate effect from capital gains and losses).
- Agricultural land will increase in value if a farmer switches to higher-value crops or changes to a technology that results in higher yields, or simply improves efficiency of management.

Policy changes may affect asset value; for example, trade policy, transport infrastructure, or environmental regulation may influence a country's costs. Education, labor markets, and changes in the business environment may affect the opportunities for human capital and other assets. The effect would show up in higher returns and higher asset values in wealth accounts, but not in ANS.

Other exogenous impacts on assets such as civil unrest, natural disasters, or similar events.

Negative ANS often suggests that opportunities to increase future well-being may be wasted for short-term gains.

The Role of Institutions, Governance, and Social Capital

Following the SNA, the wealth accounts presented here seek to measure productive assets and how they contribute to national income. Like the SNA, they do not attempt to provide a full measure of economic welfare. But country institutions, governance, and even what has been called social capital can influence how efficiently productive capital is used, the returns generated, and hence the value of an asset. These factors can vary over time within a country, or across countries even for an asset that is physically identical.

The work on human capital in China reported in *The Changing Wealth of Nations* (World Bank 2011), for example, shows a very rapid increase in urban human capital from the mid-1990s, in part because of the transition to a market-oriented economy that provided opportunities for much higher returns. A wide range of indicators are available with which to assess institutions, governance, and policy, such as the World Governance indicators or the Ease of Doing Business indicators. Several chapters explore this issue in greater detail, showing that sustainable development depends on a combination of accumulation of capital and sound political economy and macroeconomic policy.

Social capital is based on the idea that more cooperative behavior can facilitate economic activity and increase well-being. A widely accepted definition of social capital is that it constitutes "networks together with shared norms, values and understandings that facilitate co-operation within or among groups" (OECD 2001, 41). A broad literature has coalesced around "social trust" as a key indicator of social capital. Social trust is usually measured using a standard question in the World Values Survey: "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?" We have not yet been able to incorporate social trust in these analyses, as we have started to do for institutions and governance.

A Roadmap for the Book

This book is divided into three parts. The first part presents overall trends in wealth accounts over the past two decades. The second part describes new work on human capital, focusing on broad trends in human capital wealth and whether there is convergence between countries in this component of wealth as well as other factors affecting its growth. (A companion volume goes into much greater detail about human capital and development, especially with regard to policy analysis [Wodon, forthcoming].) The last part of the report discusses new developments for increasing the coverage of natural capital accounting to include important assets that are currently not measured.

Part 1. Global, Regional, and Country Perspectives on Wealth and Sustainable Development

The main goal of this volume is to broaden the measures used to assess economic progress by providing forward-looking indicators based on wealth, which is defined to encompass most productive assets. Chapter 2 begins with the big picture, showing broad trends in wealth at the global level over the past two decades. The chapter explores how the volume and composition of wealth have changed over time for different income groups and takes a closer look at wealth in low- and middle-income countries by geographic region.

Resource-rich economies face unique development challenges to transform an exhaustible resource, such as oil, into assets that can continue to generate income and employment once the oil is gone. Oil rents provide essentially "free" revenue for financing development and moving a country onto a higher growth trajectory, but this jump can only be achieved with the right institutions and governance. Drawing on previous work (de la Briere et al. 2017; Gill et al. 2014), chapter 3 explores the relative success of several resource-rich African countries, combining the wealth accounting approach with a rapid assessment of political economy and fiscal policies.

Chapter 4 reviews new work by the Organisation for Economic Co-operation and Development (OECD) on total factor productivity or multifactor productivity (MFP),[5] a standard analytic tool used by macroeconomists to assess long-term economic performance. MFP is typically based on the contribution to GDP growth of labor and fixed capital alone. Based on a new methodology proposed by the OECD (Brandt, Schreyer, and Zipperer 2017), this analysis shows how including natural capital along with fixed capital and human capital changes the measure of MFP.

Fossil fuel resources are a significant component of wealth for many countries, including many low-income countries. Chapter 5 explores the risks to the value of these assets faced by carbon-intensive nations from technological advances in alternative energy and wider adoption of climate policies.

Part 2. Human Capital and the Wealth of Nations: Global Estimates and Trends

Investing in human capital can be a springboard for diversification of national wealth and the economy, reducing the dependence on natural capital of many countries and the commodity-driven boom-and-bust cycles common to so many low- and middle-income countries. Previous work (World Bank 2011) shows that the accumulation of human capital has been a key factor in economic growth, sustainable development, and the reduction of poverty. Providing an explicit measure of human capital contributes greatly to making wealth accounts more useful for monitoring progress and for policy analysis. Part 2 of the report examines human capital accounts in more detail.

Chapter 6 provides the first-ever set of comparable estimates of human capital wealth based on household survey data for 141 countries over two decades, from 1995 to 2014. The measures of human capital wealth are essentially estimates of the present value of future wages and earnings for the labor force. In addition to countrywide estimates, estimates of human capital wealth are provided by gender and type of employment. The human capital of the self-employed accounts for a large share of the total in many of the poorest countries where the agriculture sector and informal employment are significant.

Chapter 7 provides an analysis of some of the factors that may affect growth in human capital wealth on a per capita basis. Because human capital wealth measures can be disaggregated by gender, the analysis is conducted separately for men and women. The modeling approach follows similar work to test for convergence in economic growth, with an emphasis placed on demographic and labor market factors that may affect growth rates.

Chapter 8 is devoted to a case study of Morocco to address the role of intangible capital in powering the country's development. Within the context of the Morocco 2040 strategy, the chapter combines the wealth accounting approach with a brief institutional assessment to discuss priorities for growth and macroeconomic reforms, including areas such as education and labor markets to promote human capital growth, opportunities to increase gender equality, and institutional reforms.

The estimates of human capital provided in this volume should be considered a first attempt at measuring human capital within a coherent national accounts framework. Future work should yield further improvements to the methodology. But even with the data now available, analysis and simulations can be undertaken to inform policy. A companion volume to this study presents illustrations of such analyses and their policy implications for development (Wodon, forthcoming).

Part 3. New Developments in Measuring Natural Capital

The third part of the volume reports on three new developments for natural capital that had been poorly measured in the past or not measured at all and prospects for including them in future work on wealth accounts: air pollution, marine fisheries, and ecosystem services.

Chapter 9 reviews estimates of the impact of air pollution, specifically particulate matter with a diameter of less than 2.5 microns ($PM_{2.5}$), on premature deaths, using new data from the Institute for Health Metrics and Evaluation. As a leading health risk, air pollution causes a loss of human capital and national wealth. This annual cost is captured explicitly within the framework of the ANS indicator, and implicitly in the annual survival rates used to calculate human capital.

Chapter 10 describes how fisheries accounts could be constructed for future versions of wealth accounts based on the pioneering work of the Institute for the Oceans and Fisheries at the University of British Columbia. This work identifies rents and subsidies for fisheries at the country level, including information on small-scale fisheries that is not always fully reflected in data from the Food and Agriculture Organization (FAO). The present volume uses this information to identify where fisheries contribute to national wealth because they generate positive rents, and where they do not because they do not generate rents as currently managed. This is the first step in estimating fisheries wealth.

Chapter 11 reviews progress in measuring ecosystem services. One of the characteristics of renewable natural assets is that they often provide multiple services. Some of these can be measured reasonably well, for example, the timber produced by forests. But the value of other services—such as soil retention services provided by forests or protection of coastal communities against natural hazards by mangroves and coral reefs—are often not included because of lack of information. The final chapter in this book reviews recent advances in estimating ecosystem services to identify which services are likely candidates for inclusion in future versions of the wealth accounts.

Summing Up and Future Research

The goal of this volume is to broaden the measures used to assess economic progress by complementing indicators of current outcomes—such as GDP or GNI—with a forward-looking indicator, namely wealth and changes in wealth. To achieve this objective, this work constructs comprehensive wealth accounts and illustrates how they can provide information useful for policy.

Great progress has been made since the first version of the *Wealth of Nations* was published in 2006 (World Bank 2006). Asset and country coverage have increased and deepened. With a 20-year time series of country wealth accounts, the dynamics of wealth and development can now be examined in greater depth. The introduction of human capital accounts opens up a new avenue for understanding sustainability. This volume presents insights into development issues that may not be new, but it grounds them in a comprehensive measurement of wealth that emphasizes by its very nature long-term sustainability in development.

Still, much work remains to be done. The measures of fossil fuel energy and mineral assets are reasonably sound,[6] and their role in development has been studied a great deal. Renewable natural capital, including renewable energy, however, is still not adequately represented in wealth accounts. Renewable natural capital is a unique asset. If managed sustainably, it can produce benefits in perpetuity. Some important ecosystem services are undervalued or omitted. As a consequence, our understanding of how countries leverage natural capital—the main asset for low-income countries—for development will require additional work.

At present, data on renewable natural capital are limited. For example, information about the extent of forest cover is available, but not about its condition. This is problematic for wealth as an indicator of sustainability because degradation of forests has potentially serious impacts on the future well-being of countries and the planet. Natural capital also is subject to potentially irreversible thresholds in natural systems that may precipitate catastrophic events. Great uncertainties surround these issues. None of the uncertainty, including potential climate change impacts, is currently incorporated into the value of renewable natural capital.

There are also limitations in the estimates of human capital provided in this volume. The estimates are based on an analysis of household survey data that could be improved in the future with additional sensitivity analysis to test for the robustness of the estimates to methodological assumptions and choices. For example, one issue relates to modes of interpolation and extrapolation when countries have a limited number of comparable surveys with which to generate estimates. Another issue relates to the specifications used to estimate the impact of years of education and experience on earnings in wage regressions, and whether to include additional controls in those regressions.

Given these various limitations, interpreting our wealth accounts as a measure of sustainability must still be approached with some sensible caution. In addition, beyond issues of estimation and comprehensiveness in the assets included in the measures of wealth, changes in total wealth over time provide us with only a measure of "weak" sustainability that implicitly assumes a high degree of substitution among different kinds of assets. In an aggregate wealth measure, whether wealth comes from natural, produced, or human capital does not make much difference. However, at the country level, the mix of wealth can make a difference for development prospects and exposure to various risks, and the interaction between various components of wealth may be crucial.

New conceptual work will be needed to help countries develop and use wealth accounts. The role of social capital, institutions, and governance is explored only tangentially in this volume, and could be the topic of further work. The development of better measures of investments in human capital is also needed to align these new measures of human capital in the wealth accounts with the current emphasis on public expenditure for education in the ANS. Other future developments could include the use of PPP in addition to market exchange rates in constructing comparable wealth accounts across countries.

To conclude, this volume describes some of the main findings emerging from the new wealth accounts. The analysis and the abundance of data—which are available online on the wealth accounting page of the World Bank website—should generate new questions about development, the dynamics of how countries accumulate wealth, and how to promote efficient and equitable use of wealth. Sustainability into the 21st century will depend not only on our assets base, but also on the strength of our institutions and governance, and the integrity of our natural capital. This new volume sets the stage for addressing these issues in an integrated manner. Our hope is that it will help generate new research and insights for policy.

Annex 1A: Changes in Methodology and Data Sources for the Wealth Accounts

The new wealth accounts database covers the period 1995–2014 for 141 countries. It accounts for the following:

- Produced capital and urban land—buildings, structures, machinery and equipment, urban land
- Natural capital—oil, natural gas, hard coal, soft coal, bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, zinc, cropland, pastureland, forest (timber and nontimber forest resources), protected areas
- Human capital
- Net foreign assets.

The Changing in the Wealth of Nations 2018 builds substantially on previous reports but with significant changes in methodology and data. These changes are the result of sector studies conducted in recent years and of discussions with experts to identify new, improved data sources and improvements to the underlying methodology. Major changes are summarized below; a detailed description of the changes is provided in appendix A.

Major changes to wealth estimates comprise the following:

- Total wealth in the new approach is calculated by summing up estimates of each component of wealth: produced capital, natural capital, human capital, and net foreign assets. This represents a significant departure from past estimates, in which total wealth was estimated by (1) assuming that consumption is the return on total wealth and then (2) calculating back to total wealth from current sustainable consumption (see supplemental materials for previous *Changing Wealth of Nations* reports). In previous estimates, produced capital, natural capital, and net foreign assets were calculated directly, then subtracted from total wealth to obtain a residual.

  The unexplained residual, called "intangible capital," was largely attributed to human capital—see chapter 5 in World Bank (2011)—as well as to missing or mismeasured assets and possible effects of social capital. But the unexplained residual accounted for 50–85 percent of the total wealth indicator, making it a weak indicator for policy. This approach was taken because of the lack of data for directly measuring human capital. We now have a method and data for estimating human capital directly and will measure total wealth as the sum of each asset category.

  The advantage of the earlier approach was that the residual included human capital, unmeasured assets, and the influence of institutions and governance on wealth. The disadvantage was that the various components of the residual could not be disentangled and it was calculated assuming the same return on assets in all countries.

- Produced capital: A new data source available from the Penn World Table group at the University of Groningen provides more detailed information about the composition of produced capital for a larger number of countries, (1) allowing us to provide more accurate estimates of the lifetime and depreciation of produced capital and (2) filling critical data gaps to provide a longer time series for a larger number of countries than in the past.

The Penn World Table follows the general guidance for national accounts regarding the lifetime of each type of produced capital asset. The lifetime for structures is 50 years, and varies between 5 and 8 years for other categories of produced capital. This is a major departure from the 25-year cap on the lifetime applied to every asset in the previous work on wealth accounts. The team also does additional gap-filling for a few countries using the approach from the 2006 and 2011 reports.

- Natural capital: Scoping studies to improve the benchmark data were conducted for subsoil assets, forest assets, and agricultural land. Recommended changes that were implemented include the following:
  - Subsoil assets: The actual lifetime of reserves is used rather than the previous cap of 25 years for all energy and mineral resources. We use data obtained from commercial databases (Rystad Energy, Wood Mackenzie) for production, country-specific prices, regional rental rates, and proven reserves to develop new, more accurate country-specific resource rent estimates for oil, gas, and coal.
  - Agricultural land: We use the FAO's producer price to value output (rather than its export unit values, used in earlier estimates) and continue to rely on the FAO for production data. We use new regional land rental rates for both crops and pastureland. We also remove the 25-year cap on the time horizon. The agricultural land values indirectly affect the value of protected areas, which is estimated as the opportunity cost of the lowest-value agricultural land in a country.
  - Forest: Given the continued reliance on the FAO's export unit value for timber prices, the regional rental rates have been revised to account for the price differential between domestically consumed versus exported timber. For nontimber forest products and services, the 1995 per hectare estimates are replaced with updated values derived from a meta data analysis that includes nontimber forest products, hunting and fishing, recreation, and water services. The 25-year cap on the time horizon is also removed.
- Human capital: Human capital in the past was not measured explicitly but included as part of the "residual," accounting for 50–85 percent of total wealth in past estimates. We apply the well-known Jorgenson-Fraumeni lifetime earnings approach to measuring human capital globally. We use a unique database developed by the World Bank, the International Income Distribution Database, which contains more than 1,500 household surveys.
- Net foreign assets: This data set is compiled by the Research Department of the IMF and is used for the wealth accounts without any changes.

Notes

1. And more recently, publicly traded companies in the extractive industries are required by the major international stock exchanges—on which many of these companies are listed—to include in their annual reports the value of their natural resources reserves and resources, the natural capital component of their balance sheets.
2. Urban land is a nonproduced asset in the SNA, but here it is separated from other nonproduced assets (natural capital) to focus on the other forms of natural capital.
3. Energy accounts only include fossil fuels at this time. Whenever the text refers to energy, it means fossil fuel energy, unless otherwise stated.
4. Domestic financial assets do not add to national wealth because assets and liabilities sum to zero. It would be quite useful to have such information, but data are not readily available for many countries.
5. The terms have been used interchangeably.
6. Some important resources are still not included because of lack of data, notably platinum group minerals, diamonds, and others.

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2

Richer or Poorer? Global and Regional Trends in Wealth from 1995 to 2014

Glenn-Marie Lange, Esther Naikal, and Quentin Wodon

Main Messages

- Global wealth—produced capital, natural capital, human capital, and net foreign assets—grew 66 percent from 1995 to reach $1,143 trillion in 2014, accompanied by a significant reduction in the concentration of wealth among high-income countries. Wealth is starting to be spread among a larger set of countries in the middle and at the top, but low-income countries are still lagging behind.
- At the global level and for most countries, human capital, measured as the net present value of lifetime earnings of the labor force, is the most important component of wealth. But in low-income countries, natural capital constitutes the largest share of wealth (47 percent in 2014).
- An overwhelming majority of countries increased per capita wealth between 1995 and 2014, with the fastest growth in middle-income countries. Much of the convergence in wealth is due to the accumulation of human capital, which has benefited from massive investments to improve education and health outcomes. But for 25 countries per capita wealth stagnated or declined. Sub-Saharan Africa as a whole has been affected by a decline in total wealth per capita, but the trend is mixed, with losses in a few large countries and gains in others.

Introduction

This chapter tells the story of how the wealth of nations—the sum of produced capital, natural capital, human capital, and net foreign assets—has changed over the past two decades, from 1995 to 2014. It consists of two main parts. The first part discusses trends in wealth accumulation, while the second considers adjusted net saving (ANS), a concept that deepens our understanding of how wealth changes over time.

The chapter first looks at the global picture and assesses how wealth has evolved for the world as a whole as well as across income groups and geographic regions (see annex 2A for distribution of countries in the dataset). Then it discusses the contribution of the various sources of wealth to total wealth, showing how gains achieved over time were not necessarily achieved through the same asset classes for countries at various levels of economic development. Within natural capital, the analysis considers the role played by both renewables and nonrenewables, particularly for low- and middle-income countries for which natural capital is such an important asset. The next section assesses whether wealth generation is converging across countries. Are levels of wealth per capita in low-income and lower-middle-income countries growing faster than in upper-middle and high-income countries? If so, which component of wealth—produced, natural, or human capital—accounts for this apparent convergence? The chapter then briefly discusses trends in wealth in the various regions of the world.

Finally, the discussion considers ANS. Although exogenous factors—including the discovery of new mineral resources, commodity price swings, technological advances, and natural disasters such as droughts and floods—all matter for the wealth of nations, the accumulation of wealth is nevertheless strongly driven by endogenous factors, such as the policies and decisions that influence savings and investment as well as depreciation and depletion of capital. ANS captures important components of the endogenous, policy-induced change in wealth, so this indicator is used to better understand the dynamics of building national wealth.

Trends in Global Wealth

Global wealth reached $1,143 trillion in 2014, growing 66 percent since 1995 (table 2.1). On a per capita basis, average wealth grew from $128,921 to $168,580, a real rate of growth of 1.3 percent per year. This is good news, since national income (or GDP) is generated from a country's asset base. For wealth distribution, some trends observed over the past two decades are encouraging. Wealth is starting to spread to a larger set of countries in the middle and at the top (figure 2.1). As a group, low-income countries appear to be lagging behind, but this trend masks divergent tendencies among these countries. Wealth increased substantially in many low-income countries, such as Cambodia, Ethiopia, Rwanda, and Sierra Leone, while it stagnated in a few large economies in this group, such as the Democratic Republic of Congo, Madagascar, and Tanzania.

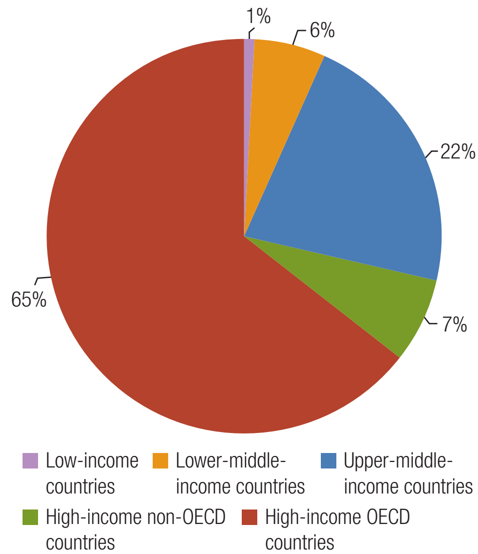
TABLE 2.1 Wealth and Population, by Income Group, 1995–2014

	Wealth (US$)					Population (thousands)	
Aggregate (billions)	**1995**	**2000**	**2005**	**2010**	**2014**	**1995**	**2014**
Low-income countries	3,616	3,731	4,194	5,552	7,161	311,706	525,385
Lower-middle-income countries	35,249	36,511	46,075	60,724	70,718	1,989,505	2,725,398
Upper-middle-income countries	95,105	113,259	135,849	199,813	247,793	1,859,615	2,196,796
High-income non-OECD countries	40,886	41,794	51,112	66,818	76,179	249,567	287,471
High-income OECD countries	515,086	595,577	651,823	691,757	741,398	940,935	1,046,598
World	689,942	790,872	889,053	1,024,664	1,143,249	5,351,327	6,781,649
Percentage shares	**1995**	**2000**	**2005**	**2010**	**2014**	**1995**	**2014**
Low-income countries	1	1	1	1	1	6	8
Lower-middle-income countries	5	5	5	6	6	37	40
Upper-middle-income countries	14	14	15	20	22	35	32
High-income non-OECD countries	6	5	6	7	7	5	4
High-income OECD countries	75	75	73	67	65	18	15
World	100	100	100	100	100	100	100
Per capita wealth (US$)	**1995**	**2000**	**2005**	**2010**	**2014**		
Low-income countries	11,601	10,435	10,240	11,802	13,629		
Lower-middle-income countries	17,718	16,745	19,426	23,675	25,948		
Upper-middle-income countries	51,142	57,623	66,224	93,811	112,798		
High-income non-OECD countries	163,827	163,232	194,243	241,224	264,998		
High-income OECD countries	547,419	614,791	653,078	672,866	708,389		
World	128,929	138,064	145,891	158,363	168,580		

Source: World Bank calculations.
Note: OECD = Organisation for Economic Co-operation and Development. Figures for wealth are in constant 2014 US dollars at market exchange rates.

The increase in wealth has been accompanied by a significant reduction in the concentration of wealth among high-income countries. The wealth of middle-income countries, especially upper-middle-income countries, surged from 19 percent to 28 percent of global wealth, while the share of high-income Organisation for Economic Co-operation and Development (OECD) countries declined from 75 percent in 1995 to 65 percent in 2014. However, wealth is still quite unevenly divided.

FIGURE 2.1 Distribution of Global Wealth, by Income Group, 2014



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

Low-income countries accounted for less than 1 percent of global wealth in 2014, about the same share as in 1995, even though their share of the world's population grew from 6 percent to 8 percent. On average, an individual in an OECD country was implicitly endowed with $708,389 in wealth at birth in 2014. For an individual born in a low-income country, the estimate was just $13,629. The ratio of per capita wealth between high-income OECD and low-income countries was 47 in 1995. It increased to 52 by 2014, an issue taken up later in this chapter.

Development and the Composition of Wealth

In the previous editions of *The Wealth of Nations*, intangible wealth—the wealth of countries not made up of produced, natural, or physical capital—accounted for most of the countries' wealth. This book shows for the first time that much of intangible wealth is actually human capital, estimated as the net present value of the population's future labor earnings. Human capital turns out to be the most important component of wealth, even though its share in total wealth decreased from 69 percent in 1995 to 64 percent in 2014 (table 2.2). After 2000, this decline in the share of human capital wealth was entirely due to upper-middle and high-income OECD countries, which together account for more than 80 percent of global wealth as well as most human capital wealth. The factors that led to this decline include the aging of the labor force (which reduces the remaining years of earnings) in many high-income OECD countries, as well as in China, which dominates the upper-middle-income country group, and declining wage shares in GDP, particularly in many high-income OECD countries (ILO 2015). By contrast, in low- and

TABLE 2.2 Global Wealth, by Type of Asset, 1995 and 2014

	1995		2014	
	Billion US$	**Percent**	**Billion US$**	**Percent**
Produced capital	164,781	24	303,548	27
Natural capital	52,457	8	107,427	9
Forests and protected areas	14,515	2	18,290	2
Agricultural land	25,859	4	39,890	3
Energy resources (fossil fuels)	11,087	2	39,094	3
Metals and minerals	997	<1	10,154	1
Human capital	475,594	69	736,854	64
Net foreign assets	–2,890	<1	–4,581	<1
Total wealth	689,942	100	1,143,249	100

Source: World Bank calculations.
Note: Figures are in constant 2014 US dollars at market exchange rates.

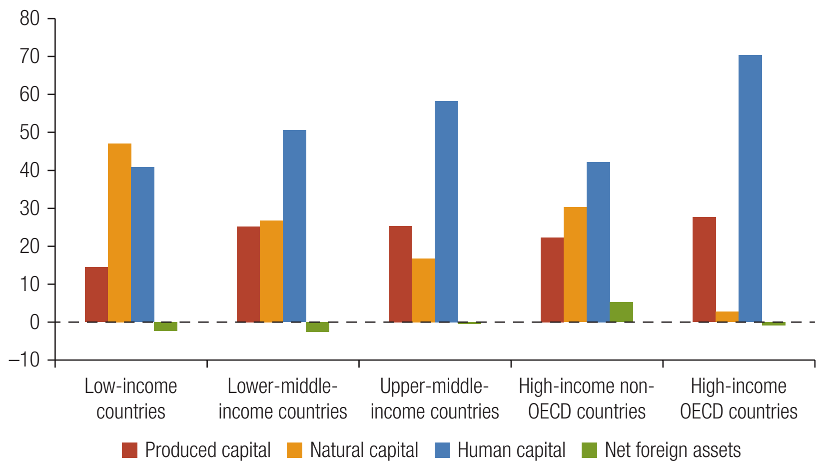
lower-middle-income countries, which account for the majority of the world's population, the share of human capital in total wealth is rising.

Trends in human capital wealth are explored in more detail in chapter 6, both in overall terms and also by gender and type of employment. The data suggest that the share of human capital wealth accounted for by women is rising, albeit slowly and not in all countries. With regard to type of employment, wage workers account for the bulk of human capital wealth worldwide, but in many low-income countries, self-employment, notably in agriculture and the informal sector, accounts for the largest share and has not changed over time even as total human capital grew.

The other two major components of wealth are produced capital and natural capital. Both grew rapidly, increasing their shares of global wealth to 27 percent and 9 percent, respectively. Natural capital increased its share from 8 percent to 9 percent, largely because of an increase in subsoil assets. Energy resources are the largest component of subsoil assets, but metal and mineral resources, starting at a low base, increased very rapidly.[1] The value of renewable assets—agricultural land, forests, and protected areas—increased, but not fast enough to maintain the same share as in 1995 (6 percent, down to 5 percent in 2014). Finally, at the global level the value of net foreign assets—the last category of wealth in this accounting framework—in theory should balance to zero because every financial asset must have a matching liability. However, reporting is not complete, so there is a slight negative balance at the global level, estimated at less than 1 percent of total wealth.

There are important differences in the composition of wealth by income group (figure 2.2). As a "free gift from nature," natural capital has been, historically, the most abundant asset available to all countries at one point in their development, although the endowment has varied enormously among countries. At low incomes, economies are largely built around this relatively abundant asset, the proceeds of which are invested in the relatively scarce assets—produced and human capital—to foster development.

FIGURE 2.2 Composition of Wealth, by Income Group, 2014
percent



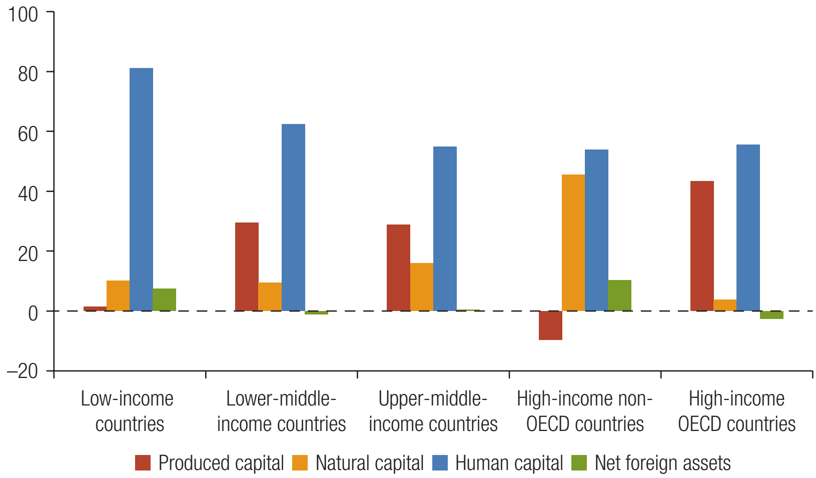
Source: World Bank calculations.
Note: OECD = Organisation for Economic Co-operation and Development.

It is not surprising that, natural capital is the largest component of wealth in low-income countries, constituting 47 percent of wealth in 2014. By contrast, in high-income OECD countries, human capital accounts for 70 percent of total wealth, produced capital for 28 percent, and natural capital for only 3 percent.

Richer countries clearly have greater wealth per person than low-income countries, but development and the composition of national wealth are strongly related. The share of natural capital gradually declines as countries graduate from low- to middle- and high-income status. The share of produced capital doubles, from 14 percent in low-income countries to 28 percent in high-income OECD countries, and human capital reaches 70 percent of wealth in high-income OECD countries—not by reducing the amount of natural capital but by adding more produced capital, especially human capital. This progression makes sense because economies can only move beyond subsistence production of food and shelter to manufacturing and services with the addition of human capital, infrastructure, and other produced capital. The exception is high-income non-OECD countries, dominated by the high-income oil and gas producers of the Middle East, where natural capital remains a large component of wealth.

But getting rich is not about liquidating natural capital to build other assets. Although the share of natural capital in high-income OECD countries is only 3 percent, their per capita value is three times that in low-income countries, $19,525 compared with $6,421 in 2014. Development is about more efficient use of natural capital, and its sustainable management in the case of renewable natural capital, bringing to bear other assets to increase productivity, together with the strong institutions and policies that make investment attractive.

FIGURE 2.3 Contribution to Growth of Wealth, by Type of Asset, 1995–2014
percent



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

Net foreign assets are negative for all groups except high-income non-OECD countries, reflecting the predominance of the oil producers as net creditors to the world (which is also why natural assets are substantial in those countries).

The human capital asset class contributed most to gains in wealth in all regions between 1995 and 2014 (figure 2.3). These gains are discussed further in chapter 6. This outcome is not surprising since development goes hand in hand with a rapidly increasing share of human capital in wealth. As expected, in part because of differences in natural endowments, there is considerable variation in the accumulation of natural capital between countries. In high-income non-OECD countries, dominated by fossil fuel producers, gains in energy resources accounted for a very large share of total gains. But this variation was also observed in low- and middle-income countries as a result of increases in agricultural land assets. Surprisingly, there was relatively little investment in produced capital in low-income countries, despite the need for massive infrastructure investment, which suggests unbalanced investment and may have contributed to these countries remaining low income. In other regions, produced capital investment contributed significantly to increasing wealth.

Regional Trends in Low- and Middle-Income Countries

This section closely examines trends in the 97 low- and middle-income countries in the data set, excluding the 44 high-income countries, which are structurally different. The analysis focuses on the per capital level of

TABLE 2.3 Trends in Wealth Per Capita in Low- and Middle-Income Countries, by Region, 1995–2014
US$

	1995	2000	2005	2010	2014	Annual growth (%)
East Asia and Pacific	31,261	37,507	44,097	71,423	91,581	5.8
Europe and Central Asia	51,967	47,276	56,494	66,066	70,530	1.6
Latin America and the Caribbean	108,167	108,250	116,989	128,859	133,614	1.1
Middle East and North Africa	24,973	27,263	34,790	46,548	48,495	3.6
South Asia	9,251	10,523	12,511	15,710	18,400	3.7
Sub-Saharan Africa	26,403	21,964	22,669	25,362	25,562	–0.2
All low- and middle-income countries	32,198	34,085	38,512	51,515	59,783	3.3

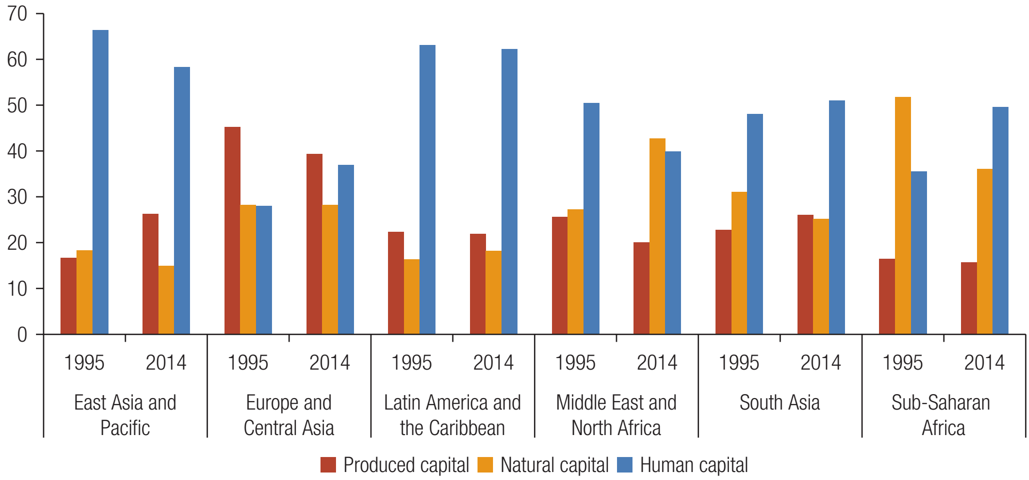
Source: World Bank calculations.
Note: The table includes 97 low- and middle-income countries out of the data set of 141 countries. Figures are in constant 2014 US dollars at market exchange rates.

wealth, which is a better indicator of development than total national or regional wealth. As shown in table 2.3, when considering regions, the biggest story—not surprisingly—is the rapid growth observed in East Asia and Pacific and South Asia, in part because of the role played by China and India, the largest economies in these regions. Most other regions also benefited from gains in wealth per capita, but in Sub-Saharan Africa per capita wealth fell by 2 percent in part because of declines in some of the largest countries, such as Nigeria and Tanzania, where population was also growing rapidly, and also because of slow growth in other large economies such as South Africa.

What about trends by region and asset class? Figure 2.4 shows that the share of human capital in total wealth declined in East Asia, in large part because of the aging of the labor force. In Sub-Saharan Africa, the share of natural capital declined, in part as a result of a decline in the value of agricultural land, but also because of investments in education and growth of the labor force that led to a rising share of human capital. The large share of natural capital in the Middle East and North Africa reflects energy and mineral wealth; small increases in natural capital wealth in other regions are largely associated with energy and mineral wealth.

Given the importance of natural capital for low-income and middle-income countries, this investigation takes a closer look at this asset and how it has changed over time. Natural capital can itself be disaggregated into nonrenewables (fossil fuel energy and minerals) and renewables (agricultural land, forest, and protected areas), which pose quite different challenges for development (box 2.1). Some countries have met these challenges over time, while others have not. In 1995, 52 countries in our data set were classified as low income; 28 of these countries are now middle income. Of these 28 middle-income countries, the majority (23) were highly dependent on natural capital in 1995. More than half (15) were considered resource rich and managed their energy and mineral wealth to

FIGURE 2.4 Regional Composition of Wealth, 1995 and 2014
percent



Source: World Bank calculations.
Note: The table includes 97 low- and middle-income countries.

BOX 2.1 Renewables, Nonrenewables, and the Challenge of Diversification

For countries dependent on nonrenewables, the development challenge is twofold: recover rents from usually private (often foreign) operations and invest rents to build other assets. The use of nonrenewables, by definition, is unsustainable, and these resources will eventually be depleted, but the income from these assets can be plowed back into other assets, especially infrastructure and human capital, to build an economy and support long-term growth. But nonrenewables often involve highly capital-intensive mining operations that do not generate many jobs or support livelihoods, and can result in factors that hinder development associated with the "resource curse."

Revenue from nonrenewables can finance investments for sustainable wealth, but this process requires careful macroeconomic management and strong institutions, both of which are lacking in some countries. Countries such as the United Arab Emirates and Botswana have succeeded in using resource wealth for development. Of the 52 countries classified as low income in 1995, 28 used their natural capital effectively to build wealth and move into the middle-income group of countries. Of the 24 countries that have remained low income since 1995, 12 are classified as resource rich, and of those, 8 are also classified as fragile or conflict states. For these 24 countries, characterized by low rankings on various dimensions of institutions, governance, and policy by the World Governance Indicators, resource wealth alone has not been sufficient to ensure rapid development. The wealth accounts for Ghana and Niger, discussed in chapter 3—together with indicators of political economy and macroeconomic policy—demonstrate the complex interplay between resource wealth

(continued on next page)

BOX 2.1 Renewables, Nonrenewables, and the Challenge of Diversification *(continued)*

and development. For example, Ghana, which invested in human capital, has managed the challenges more successfully than Niger.

Renewable natural capital is a unique asset. If managed sustainably, it can produce benefits in perpetuity, in contrast to nonrenewables. For countries that are highly dependent on renewable assets, long-term growth requires maintaining or improving the productivity of these natural resources and managing them sustainably. Substantial investments may be needed to improve agricultural yields, use scarce water resources more efficiently, or switch to higher-value crops. Increasing productivity may also require managing land for a different mix of goods and services over time. For example, a forest once managed primarily for timber may generate higher value and employment as an ecotourism resource or as a source of clean, sediment-free water for downstream hydroelectric power.

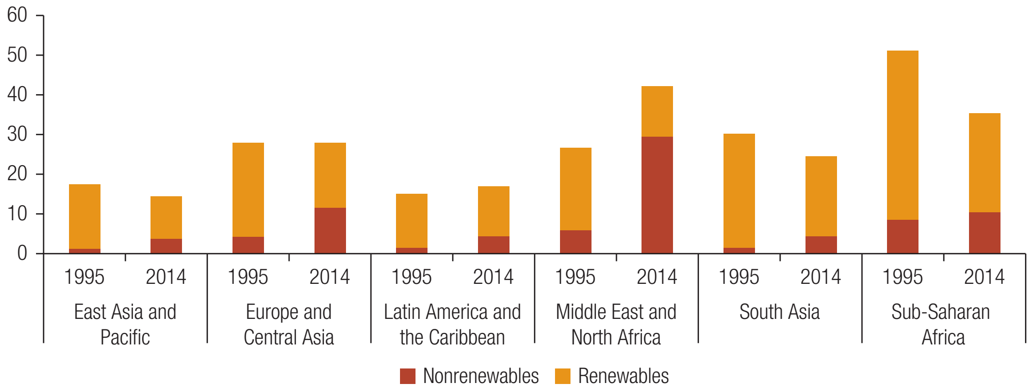
build a broader set of assets, joining the middle-income group of countries. Another 8 countries, including India, Kenya, Pakistan, and Senegal, were heavily dependent on agricultural land and forests (renewable natural capital), and have now built larger and more diverse portfolios of assets, especially human capital, but also infrastructure and other produced capital.

Among the low- and middle-income countries (figure 2.5) natural capital as a share of wealth increased in three of six regions—Latin America and the Caribbean, Europe and Central Asia, and the Middle East and North Africa. In these regions, nonrenewables—particularly oil and coal—accounted for most of the increase, and the share of renewables declined. A closer look at each type of natural capital provides a better understanding of the role of renewables and nonrenewables in development in these regions.

The share of renewable resources in total wealth declined as low- and middle-income countries built produced and human capital, but the total value of renewables more than doubled from 1994 to 2014. Progress was best for agricultural land and protected areas across most regions, but mixed for forests. In 1995, agricultural land was the most important asset after human capital in many countries in South Asia and Sub-Saharan Africa. In Nepal for example, natural capital—mostly agricultural land—accounted for 50 percent of total wealth in 1995 and remains a significant source of wealth in Nepal today.

Agricultural land value has gone up sharply in most countries, especially in Asia and Latin America. Although some of the gains are due to expansion of area under cultivation (table 2.4), especially in Latin America and Sub-Saharan Africa, increasing productivity in agriculture also contributed to gains in land asset value. Despite growth in agricultural assets in Sub-Saharan Africa, growth did not keep pace with population growth in a large number of countries, and per capita agricultural land value declined (figure 2.6). These are countries where significant numbers of people rely on agriculture for livelihoods, such as Cote d'Ivoire, Nigeria, Tanzania, and Zambia. By contrast, significant gains were achieved in countries such as Ethiopia, Mozambique, Namibia, and Uganda.

FIGURE 2.5 Shares of Renewable and Nonrenewable Natural Capital in Total Wealth, by Region,1995 and 2014
percent



Source: World Bank calculations.

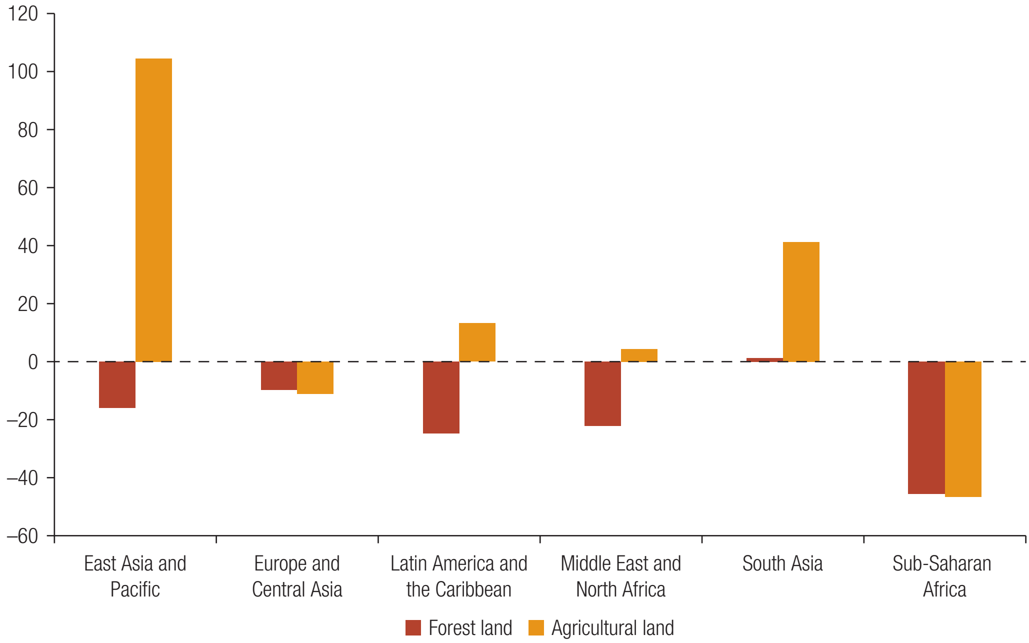
TABLE 2.4 Land Cover for Forest, Crops, Pasture, and Protected Areas in Low- and Middle-Income Countries, 1995 and 2014

	Forest, total area (1,000 square kilometers)			Agricultural land area (1,000 square kilometers)			Protected areas (1,000 square kilometers)		
	1995	2014	Percent change	1995	2014	Percent change	1995	2014	Percent change
East Asia and Pacific	4,082	4,360	7	7,379	7,469	1	1,944	2,440	26
Europe and Central Asia	540	576	7	3,953	3,895	–1	165	318	92
Latin America and the Caribbean	8,978	8,313	–7	5,170	5,481	6	1,628	3,829	135
Middle East and North Africa	74	84	14	798	809	1	30	279	831
South Asia	751	792	5	2,329	2,318	0	259	296	14
Sub-Saharan Africa	5,703	5,166	–9	7,523	8,082	7	2,289	3,261	42
All low- and middle-income countries	20,131	19,292	–4	27,156	28,057	3	6,317	10,424	65

Source: World Bank calculations based on Food and Agriculture Organization data for agricultural land and forestland, and International Union for Conservation of Nature data for protected areas as reported in World Bank 2017.

A positive development is the rapid increase in protected areas, which provide critical ecosystem services and, in some countries, provide the basis for valuable nature-based tourism. These areas have increased in all regions, both in extent and value. In low- and middle-income countries land in protected areas increased 65 percent, accounting for 17 percent of these countries' total land in 2014, up from 10 percent in 1995.

FIGURE 2.6 Change in Per Capita Value of Forest and Agricultural Land, 1995 to 2014
percent



Source: World Bank calculations.

But forestland area declined by 4 percent overall because of conversion to agriculture and other land uses, notably in forest-rich Africa and Latin America. On a per capita basis, forest asset value declined everywhere (figure 2.6). Of concern is the decline in forestland area (table 2.3), although the regional averages conceal significant variations across countries. In East Asia, for example, the reported gains in forestland area in countries such as China, the Philippines, Thailand, and Vietnam outweigh significant losses in Cambodia and Indonesia. The loss in forestland area was more widespread in Latin America (7 percent) and Sub-Saharan Africa (9 percent), where conversion to agriculture has become widespread.

The extensive loss of forestland can have significant, potentially irreversible impacts that are not fully accounted for in the wealth accounts—for example, adverse impacts on water regulation, loss of protection from natural hazards, and reduced biodiversity and carbon storage.

By contrast with renewable resources, nonrenewable natural capital—fossil fuels and minerals—offer a one-time chance to finance development by investing resource rents. Some countries have made good use of this opportunity, but others have not. The challenge of development for countries rich in energy and minerals has been well documented in the literature on the "resource curse." Resource-rich economies face unique development challenges in transforming an exhaustible resource, such as oil, into assets that can continue to generate income and employment once the oil is gone. Oil rents, for example, provide essentially "free" revenue for financing development and moving a country onto a higher growth trajectory, but this objective can only be achieved with the right institutions and governance to capture the rents and invest them effectively in other, productive, assets (human capital, produced capital, renewable natural resource capital).

Fossil fuel energy—carbon-based wealth—grew faster than any other asset, but an endowment of energy and mineral resources alone may not ensure rapid development. Of the 24 countries that have remained low income since 1995, 12 are classified as resource rich; of those, 8 are also fragile or conflict states. Strong institutions and sound policies for managing resource revenues are essential to turn these riches into sustainable development. Adding to the management challenge, fossil fuel energy resources—carbon-based wealth—are increasingly at risk because of price uncertainty, advances in technology, and large-scale attempts at global decarbonization to slow climate change. These risks may diminish the value of carbon-based assets and undermine traditional development pathways for carbon-rich nations. The major energy producers of the Middle East, as well as countries such as Brazil, China, Mexico, and Russia, have greater resources to address these risks. But some smaller producers—many of them low- and lower-middle-income countries in Africa—rely heavily on carbon wealth for development and have fewer resources with which to address the risks.

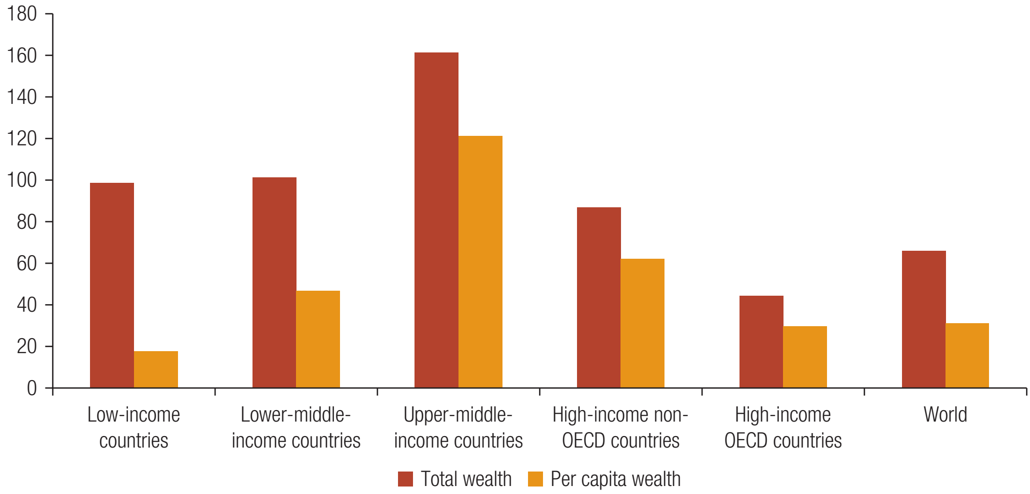
Convergence in the Wealth of Nations

Is there convergence in the growth of the wealth of nations on a per capita basis? Are comparatively poorer countries catching up with comparatively richer ones? To some extent, the answer depends on how we look at the data. Considering the averages for groups of countries defined by income level—with these averages heavily influenced by countries with large populations, such as Ethiopia, Nigeria, India, or China—the data suggest that low-income countries and to some extent even lower-middle-income countries are falling behind. In part, this trend is due to higher population growth in some of those countries, which makes it more difficult to achieve gains in wealth per capita.

Between 1995 and 2014, global wealth grew by two-thirds (66 percent), but population grew by 27 percent, so that the net increase in per capita wealth was only 31 percent (figure 2.7 and map 2.1). Per capita wealth grew fastest in middle-income countries, raising their share of global wealth, but the largest growth in absolute terms occurred in upper-middle-income countries (at nearly 120 percent), in part because of China. Low-income countries increased their total wealth by nearly 100 percent—more than high-income OECD countries or the global average—but only by 17 percent on a per capita basis because population growth was highest in those countries (up 69 percent from 1995 to 2014).

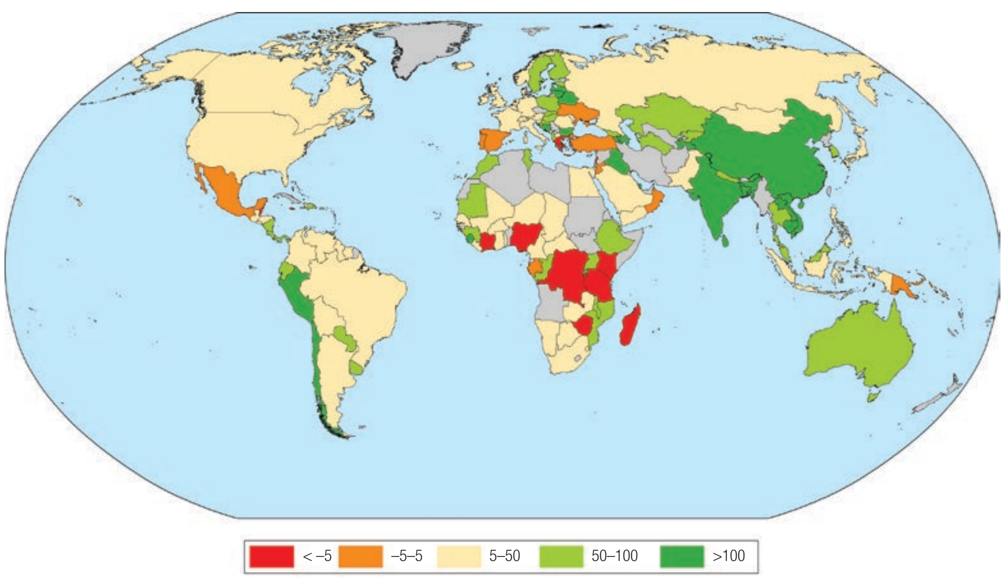
In each income group, growth of per capita wealth varied greatly between countries (map 2.1). Per capita wealth changed very little, or actually fell, in 25 countries, particularly some of the low-income

FIGURE 2.7 Changes in Total Wealth and Per Capita Wealth, 1995 to 2014
percent



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

MAP 2.1 Percent Growth in Total Wealth Per Capita, 1995–2014



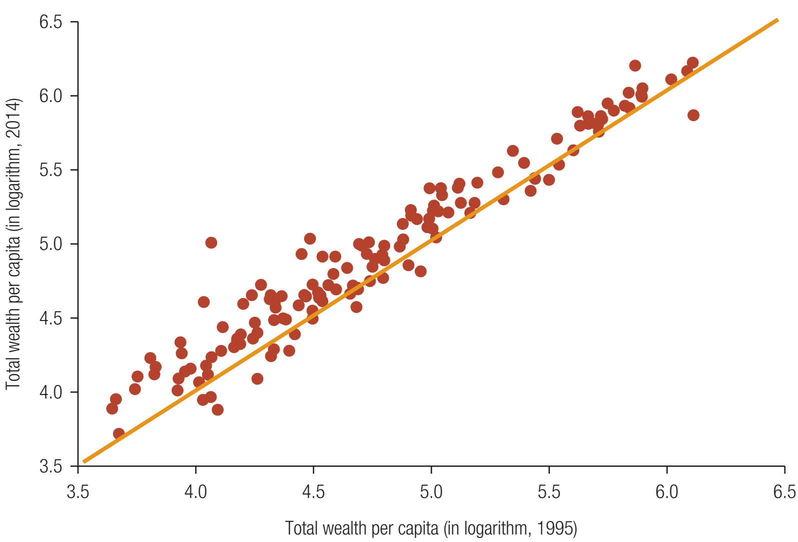
Source: World Bank calculations.

countries in Sub-Saharan Africa, as well as in a few OECD countries affected after 2009 by the financial crisis. Although many countries in Sub-Saharan Africa invested as much as several other regions from 1995 to 2014, in some of them the investment was not sufficient to keep up with relatively high population growth. Countries with similar or even less investment over the period still increased per capita wealth because of lower population growth rates. The "demographic dividend" of a rapidly growing, younger population can only be realized if investment is sufficient to provide each potential new worker with the same (or more) human, natural, and produced capital. High population growth rates make meeting this goal more challenging.

However, if all countries are weighted equally, as is normally done when looking at convergence, the diagnostic is a bit different. Consider figure 2.8, which displays levels of wealth per capita for 141 countries estimated in 1995 and in 2014. Since estimates are in logarithms, the difference between values for 2014 and the diagonal for a country approximately represents (when estimates are not too large) the cumulative growth in total wealth per capita observed over two decades for that country. The diagonal across the scatterplot provides a simple illustration of the countries that have achieved gains in total wealth over time (above the diagonal) and those that have not (below the diagonal).

Two observations emerge from figure 2.8. First, most countries lie above the diagonal, suggesting that an overwhelming majority of countries benefited from an increase in wealth per capita between 1995 and 2014. This outcome is not surprising, given that levels of wealth per capita are

FIGURE 2.8 Convergence in the Wealth of Nations Per Capita, 1995 and 2014



Source: World Bank calculations.

closely related to GDP per capita, and most countries experienced substantial economic growth over the past two decades. Second, the cumulative growth rates in human capital tend to be slightly higher for countries with lower levels of initial wealth. Observations for countries with lower initial levels of wealth tend to be located farther away from the diagonal than for countries with higher levels of initial wealth. In other words, some level of convergence in wealth can be detected, with poorer countries catching up. Note that there is one clear outlier in the figure with a level of wealth per capita of about five in logarithm in 2014, versus about four in 1995. That country is Iraq, which had a dramatic increase in oil wealth over the period.

Since total wealth is estimated as the sum of produced, natural, and human capital (plus net foreign assets), all three main sources of wealth can be examined to assess which source appears to be responsible for the convergence observed in figure 2.8. In figure 2.9, initial levels of wealth (in logarithm) are displayed on the horizontal axes for all three types of capital. The vertical axes represent growth for each type of capital as approximated by the difference in values (in logarithm) between 1995 and 2014. There is a clear declining slope for the regression line across the scatterplot for human capital, whereas the slopes are not so steep for produced and natural capital. This suggests that much of the convergence in wealth over the past two decades is largely due to human capital.

FIGURE 2.9 Growth in the Main Components of the Wealth of Nations, 1995–2014

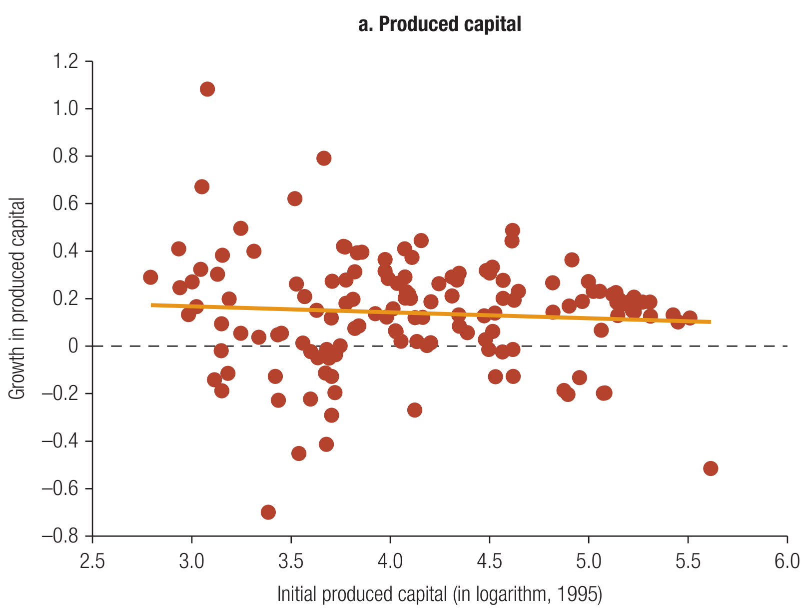


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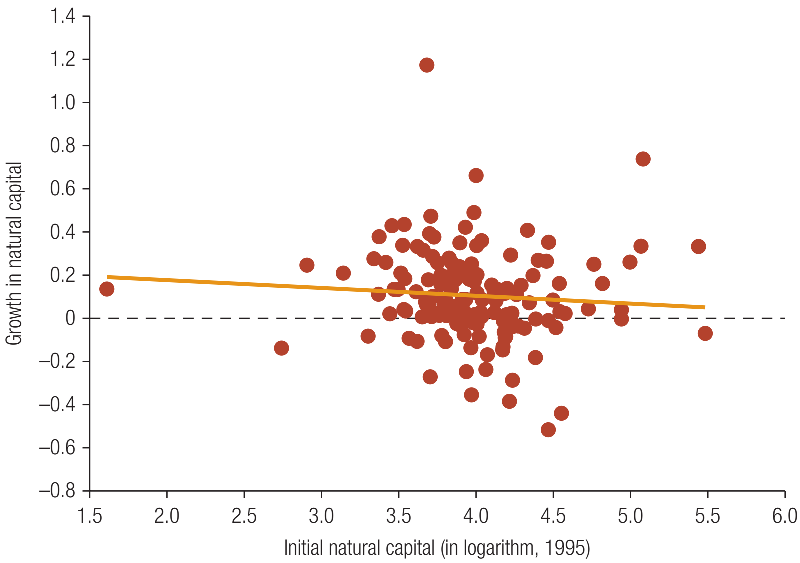
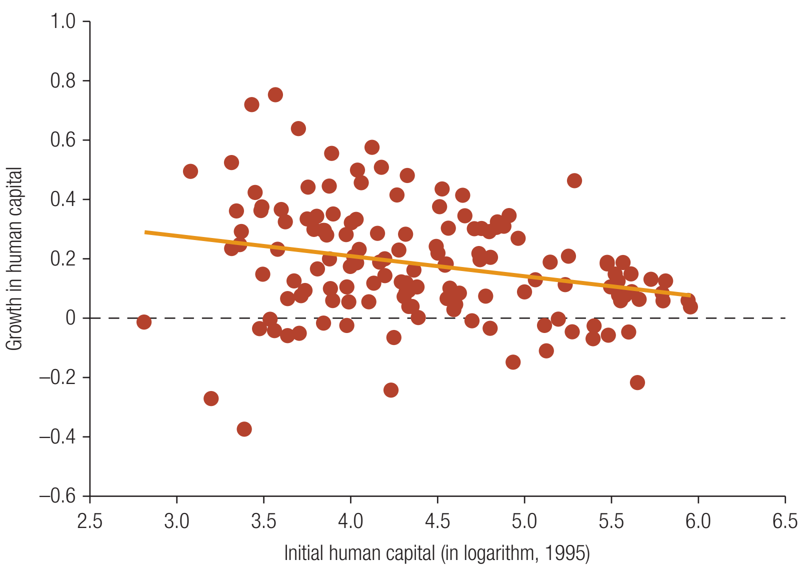
FIGURE 2.9 Growth in the Main Components of the Wealth of Nations, 1995–2014 *(continued)*

b. Natural capital



c. Human capital



Source: World Bank calculations.

Investments to improve education and health outcomes were especially large in low- and lower-middle-income countries (see figure 2.3), for example, through the Education for All initiative. It is also interesting to note that dispersion around the central tendency is often smaller at higher levels of capital, at least for produced and human capital, suggesting that those countries are less sensitive to various types of shocks.

In the literature, testing for convergence is typically accomplished using econometric models of the growth in GDP per capita as a function of the initial level of GDP per capita, as well as a number of other variables that may have an effect on growth. The same types of models can be used to assess convergence in wealth per capita, as illustrated in chapter 7 for growth in human capital wealth per capita. Although not shown here because of space constraints, regression analysis suggests convergence in total wealth per capita did occur among countries from 1995 to 2014. Although encouraging, it will still take a very long time for poorer countries to catch up with richer ones.

Savings and Changes in National Wealth

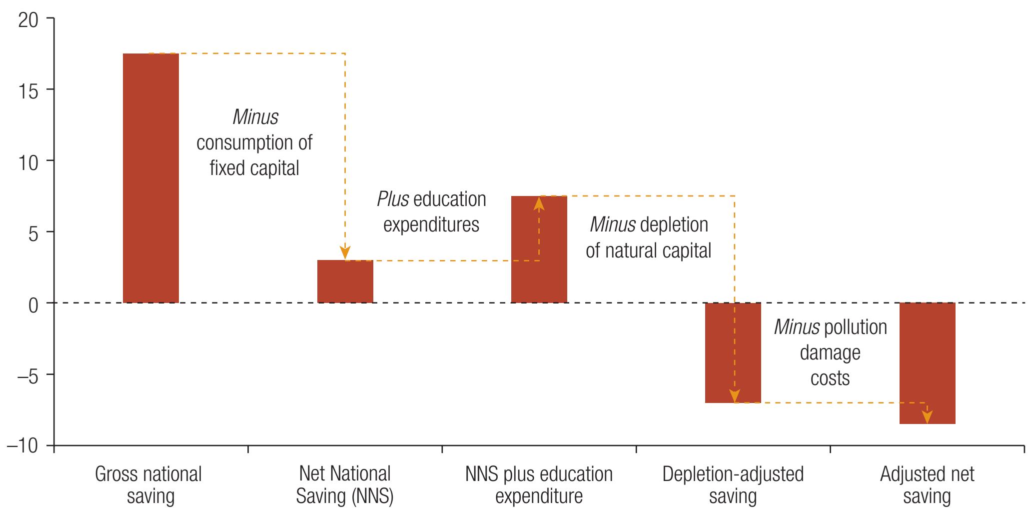
The key to increasing standards of living lies in building national wealth, which requires savings to finance this investment as well as good institutions and governance to make productive use of assets. The previous discussion looked at comprehensive wealth between 1995 and 2014; the chapter now examines some of the dynamics that drive changes in wealth from one period to the next. The most important dynamics, the endogenous or policy-induced dynamics, savings, and investment, are captured by adjusted net (or genuine) saving (ANS), defined as gross national saving adjusted for the many of the annual changes in the volume of all forms of capital.

Comprehensive wealth shows the value of each asset at a particular time and can be used to monitor whether per capita wealth is maintained over time, a criterion for sustainable, long-term growth. ANS does not show how *per capita* wealth is changing, but does provide a complementary indicator to help in a deeper examination of the process of building wealth and how policy might influence each part of the process.

ANS is measured as gross national saving minus depreciation of produced capital, depletion of subsoil assets and timber resources, the cost of air pollution damage to human health, as well as a credit for education expenditures (see figure 2.10). Conceptually, ANS differs from changes in wealth over time because it does not include exogenous impacts on wealth from (1) changes in prices, which can be substantial for natural resources; (2) new discoveries of energy and mineral resources; or (3) other exogenous impacts such as the impact on produced and human capital of natural disasters, civil unrest, or other factors. Because of a lack of data, the current measure of ANS is also missing changes in agricultural land, an important asset. Other missing sources of capital are common to both comprehensive wealth and ANS, notably, water and fisheries. Current measures of ANS are not based on

FIGURE 2.10 Procedure for Estimating Adjusted Net Saving

percentage of gross national income



Source: World Bank.

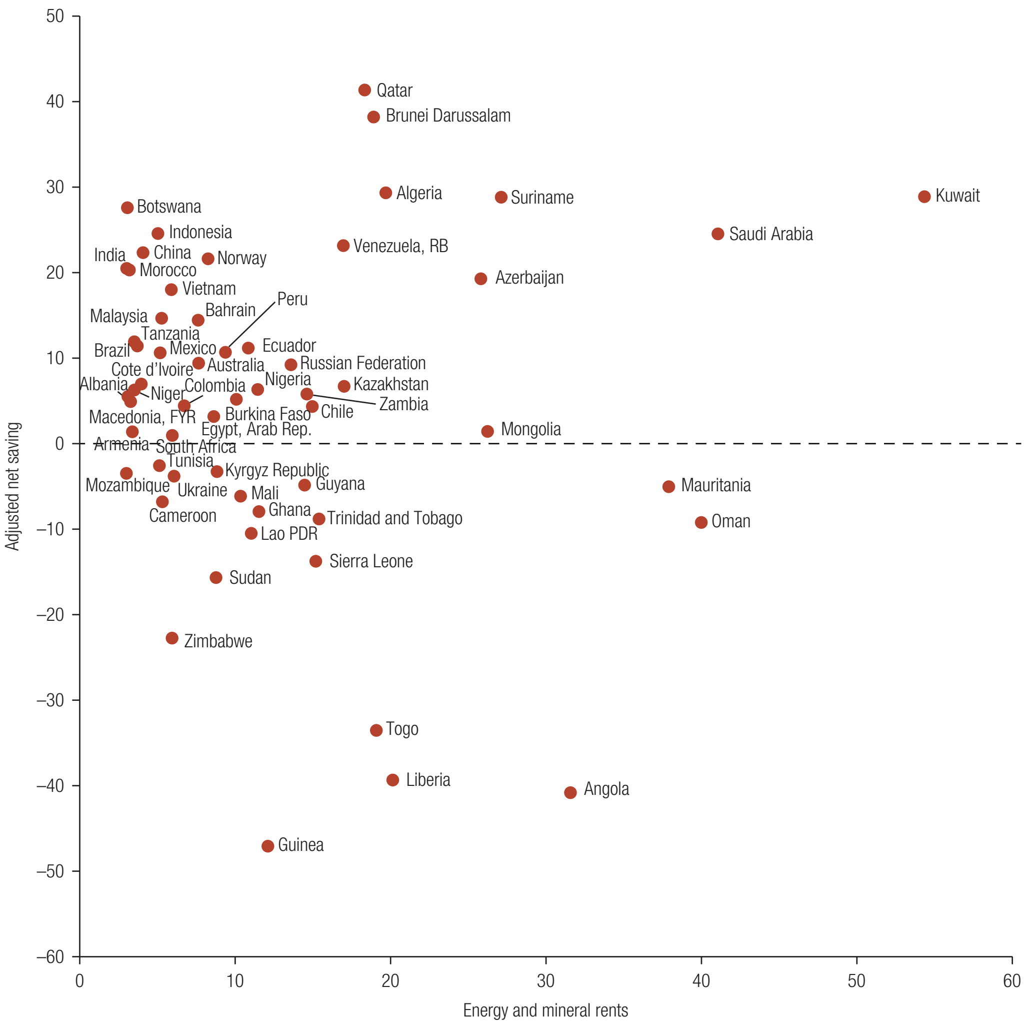
changes in the value of human capital as measured in this book; instead, they are based on expenditure data from public spending on education. Still, although ANS does not correspond completely to changes in wealth, it is a complementary indicator that enables a more detailed look at policies that influence future wealth.

ANS is measured annually. It provides policy makers with immediate feedback about the direction of the economy and possible action they may need to take to ensure long-term growth. ANS provides a lower-bound warning indicator showing whether a country is consuming more wealth than it is adding. The rule for interpreting ANS is simple: If ANS as a percentage of gross national income (GNI) is negative, then a country is running down its capital stocks and possibly reducing future social welfare. If ANS is positive, then it is adding to wealth and future well-being. Breaking down the components of ANS makes it is easier to discuss policy interventions that could improve a nation's ANS, such as increasing the level of gross saving, improving the quality and maintenance of built capital to achieve longer lifetimes and better resilience to reduce depreciation of fixed capital, increasing investment in education and innovation to increase human capital, optimizing the use of natural capital (sustainable use of renewables and efficient extraction of nonrenewables), or improving air quality to reduce pollution damage costs.

ANS can be a particularly useful indicator for resource-rich countries where, as mentioned earlier (box 2.1), transforming nonrenewable natural capital into other forms of wealth is a major development challenge. Figure 2.11 plots countries according to the importance of resource rents

FIGURE 2.11 Adjusted Net Saving in Resource-Rich Countries, Average 2011–15

percentage of gross national income



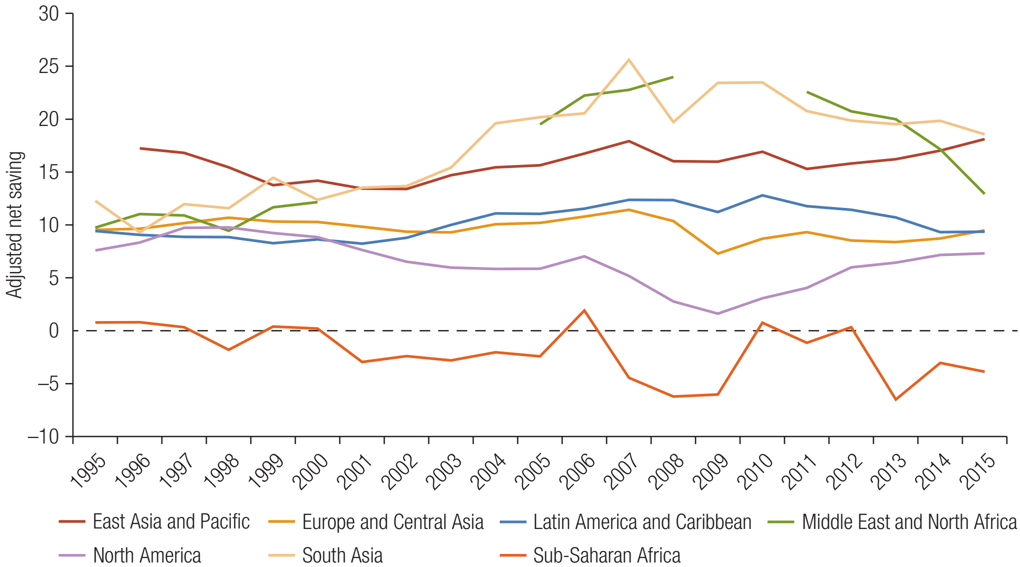
Source: World Bank calculations.

in GNI and ANS. In many countries, subsoil asset depletion is offset by investment in other types of capital. But in countries with negative ANS, such as Angola and Guinea, natural capital is being depleted without being replaced, suggesting that these countries may be becoming poorer over time.

Looking at regional trends in ANS over the past two decades in figure 2.12, divergence is evident starting in the early 2000s. Average ANS in East Asia and South Asia showed strong gains, while Europe and Central Asia, Latin America and the Caribbean, and North America

FIGURE 2.12 Adjusted Net Saving, by Region, 1995–2015

percentage of gross national income



Source: World Bank calculations.

Note: There is a break for Middle East and North Africa because of a lack of data for many countries in the region for those years.

remained relatively stagnant. Sub-Saharan Africa stands out, with its ANS at a consistently lower level. It is also the only region with periods of negative levels (averaging –3 percent of GNI over the past decade), suggesting that its development policies are not yet sufficiently promoting sustainable economic growth. Recall also that Sub-Saharan Africa was the only region with a decline in per capita wealth in the earlier analysis. A more detailed breakdown of trends in ANS for the various regions is provided in annex 2B.

Conclusion

This chapter provides a simple analysis of trends in the wealth of nations over the past two decades. Three main components of that wealth are identified: produced capital, natural capital, and human capital. Most countries have achieved substantial gains in wealth per capita, and there has been at least some level of convergence between middle-income and high-income countries, with countries with initially lower levels of wealth catching up with countries with higher initial endowments.

There are, however, important caveats to this promising story. Sub-Saharan Africa as a whole has been affected by a decline in total wealth per capita from losses in a few large countries, as well as high rates of population growth in most countries that dilute the benefits from growth in wealth. The challenge for Sub-Saharan Africa in the next decade will be to harness the benefits of the demographic dividend so that standards of living can rise more rapidly without depleting natural capital. Doing so will require substantial investments in all assets, especially in the human capital needed for growth.

This book is the first to provide measures of human capital wealth for 141 countries using data for individuals from a large number of household surveys. One of the lessons from the analysis carried out in this chapter is the rising importance of human capital wealth. Whereas human capital wealth in upper-middle- and high-income countries has decreased slightly as a share of total wealth, in part because of aging and stagnating wages, it has been rapidly rising as a share of total wealth in low- and lower-middle-income countries.

Annex 2A: Countries Classified by Income Group and Region

This edition of *The Changing Wealth of Nations* covers 141 countries for which data for all categories of assets could be estimated. Countries are classified by geographic region and income group. Per capita GNI is used to assign a country to an income group. The classification may change as GNI changes from year to year. For example, 52 countries were classified as low income in 1995, but only 28 were so classified in 2014. This book uses the country classifications for 2014 for the 141 countries in the data set; the distribution is shown in table 2A.1.

TABLE 2A.1 Number of Countries in the Wealth Accounting Database, by Region and Income Group

Region	Low-income countries	Lower-middle-income countries	Upper-middle-income countries	High-income non-OECD countries	High-income OECD countries	Total
East Asia and Pacific	1	6	4	1	3	**15**
Europe and Central Asia		6	10	4	23	**43**
Latin America and the Caribbean	1	6	12	3	1	**23**
Middle East and North Africa		5	4	7		**16**
North America					2	**2**
South Asia	1	4	1			**6**
Sub-Saharan Africa	21	10	5			**36**
Total	**24**	**37**	**36**	**15**	**29**	**141**

Source: World Bank.
Note: Countries are included in the wealth accounting database only if they have full data coverage for years 1995 to 2014.
OECD = Organisation for Economic Co-operation and Development.

Annex 2B: Regional Trends in Adjusted Net Saving

This annex provides a more detailed breakdown of the components underlying ANS calculations for selected regions over time. East Asia and Pacific as well as South Asia sustained consistently high levels of gross saving, averaging 37 and 34 percent of GNI, respectively. Among the components of ANS, East Asia had much higher depreciation of fixed capital (because of

FIGURE 2B.1 Adjusted Net Saving for East Asia and Pacific, 1995–2015
percentage of gross national income

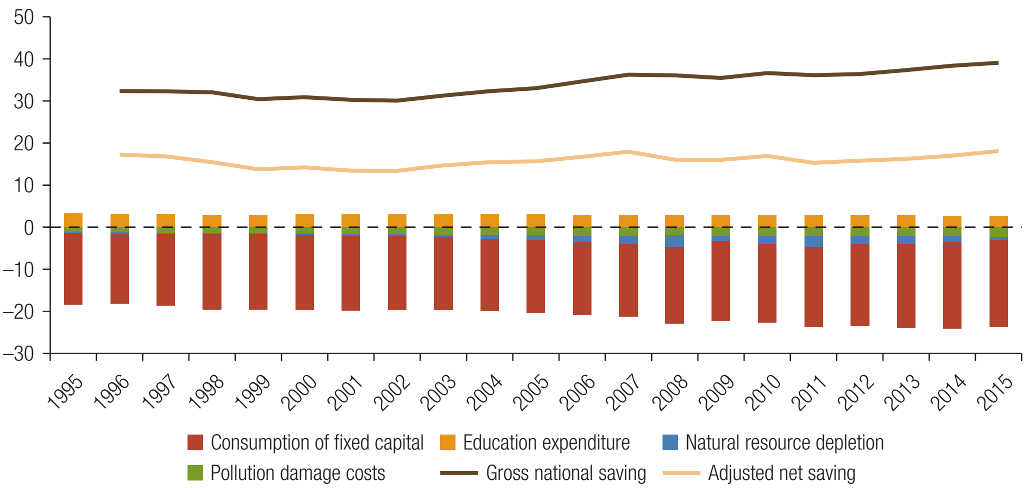
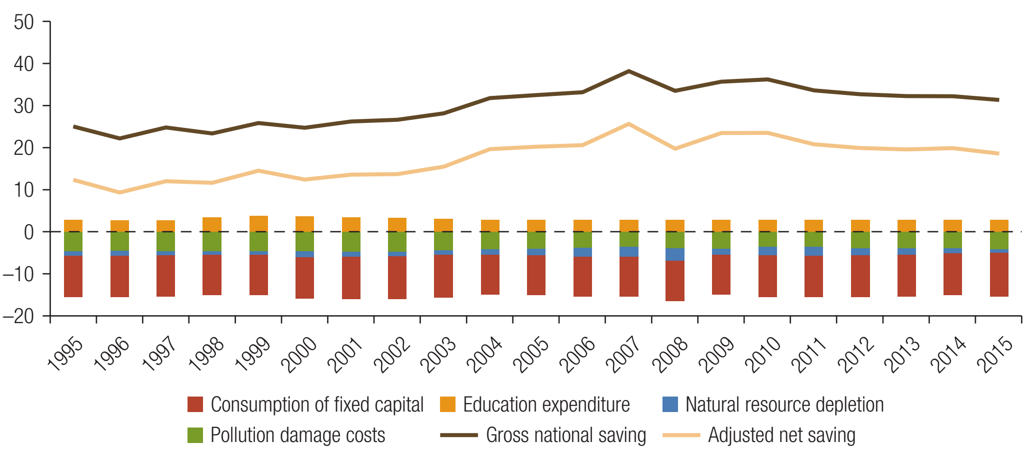


FIGURE 2B.2 Adjusted Net Saving for South Asia, 1995–2015
percentage of gross national income



its larger stock of produced capital), while South Asia had higher pollution damage costs. The net result is higher average ANS in South Asia (21 percent of GNI) compared with East Asia and Pacific (17 percent of GNI). In contrast, Sub-Saharan Africa's gross saving averaged a much lower 19 percent of GNI over the past 10 years. Because of its low starting point for savings, its ANS was below zero most of the time. With many resource-dependent countries, Sub-Saharan Africa's average gross saving and investment in

FIGURE 2B.3 Adjusted Net Saving for Sub-Saharan Africa, 1995–2015

percentage of gross national income

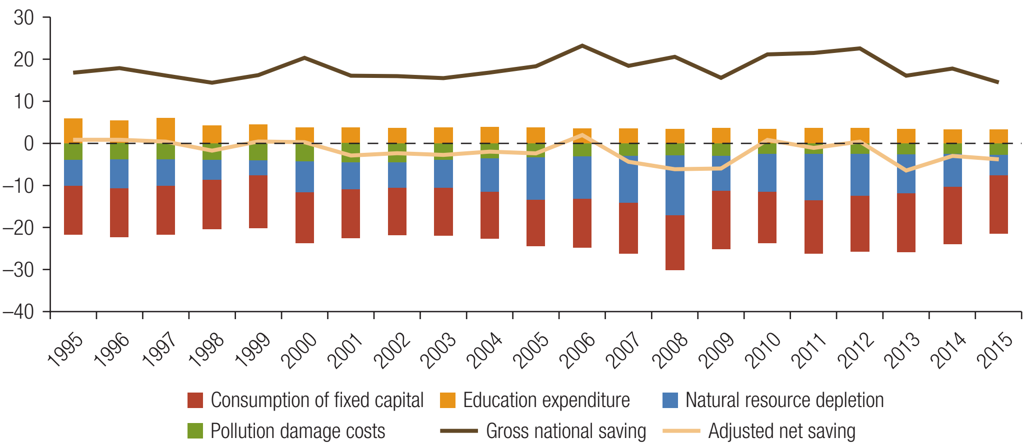


FIGURE 2B.4 Adjusted Net Saving for Latin America and the Caribbean, 1995–2015

percentage of gross national income

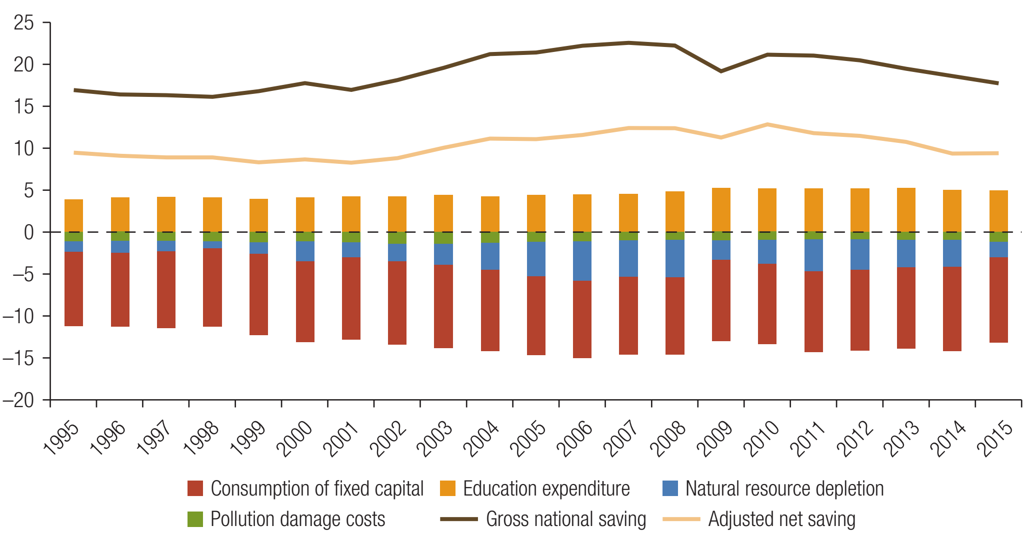


FIGURE 2B.5 Adjusted Net Saving for Europe and Central Asia, 1995–2015

percentage of gross national income

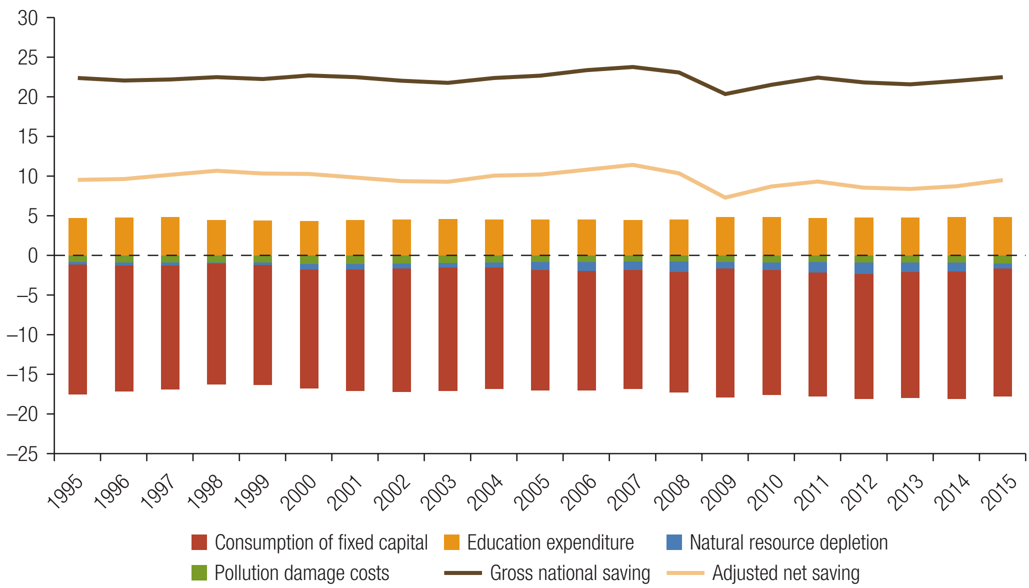
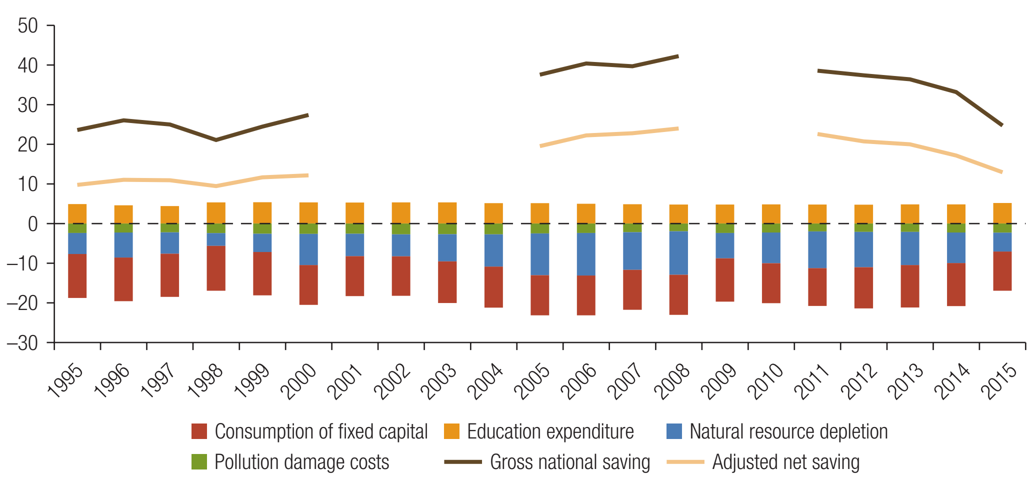


FIGURE 2B.6 Adjusted Net Saving for the Middle East and North Africa, 1995–2015

percentage of gross national income



education has not been enough to offset the depletion of its natural resources. On average, the region had the largest levels of net forest depletion, energy depletion (excluding the Middle East and North Africa region), and mineral depletion.

Note

1. The estimates of natural wealth, including oil and gas, are for 2014, when oil prices peaked. The estimates therefore do not reflect the reduction in commodity prices over the past three years and its impact on wealth

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3
Wealth Accounts, Adjusted Net Saving, and Diversified Development in Resource-Rich African Countries

Kevin Carey, Hania Sahnoun, and Quentin Wodon

Main Messages

- This chapter documents the performance over the past two decades of Sub-Saharan Africa countries, especially resource-rich countries, in using their natural resources to invest in creating wealth for sustainable development. Two different measures of wealth creation are used: (1) the changes provided in this volume on the wealth of nations, and (2) estimates of adjusted net saving (ANS), which provide a more detailed, but partial, indicator of changes in wealth.
- The data on ANS suggest that many countries in Africa are doing poorly in investing for the future. ANS is often low in comparison with levels observed in other regions. In resource-rich countries, the depletion of natural resources is often not compensated for by other investments.
- At the same time, negative ANS has not prevented many countries, including resource-rich countries, from accumulating more wealth and increasing their national income. This apparent paradox, introduced in chapter 2, is discussed in general terms, as well as with two brief illustrative case studies for Ghana and Niger.
- The conclusion from the analysis is that data on the wealth of nations do help enrich assessments of the development prospects of countries, thereby adding value compared with using ANS only.

Introduction

The new *Changing Wealth of Nations* data appear at a time of uncertainty for many low- and middle-income resource-rich countries. Oil producers are especially affected, as discussed in greater detail in chapter 5. After a period of elevated oil prices during 2010–14, commodity prices for fossil fuels have plummeted, and it is unclear how much time will be needed for prices to recover. Longer term, concerns about the impact of climate change have increased, culminating in the first global agreement containing specific targets set in the Paris agreement reached at the 21st Conference of the Parties. These concerns may contribute to a shift to renewable energy, thereby potentially moderating future oil prices.

For resource-rich low- and middle-income countries that have linked their development aspirations to natural resources, current market signals have been discouraging. The vulnerability of these countries to commodity price shocks underscores the need to diversify their asset base, and specifically to invest in human and produced capital beyond a traditional reliance on natural capital.

The underlying assumption of the *Changing Wealth of Nations* is that assessing countries' economic development through indicators such as GDP per capita is not sufficient. GDP measures a country's total annual production. By contrast, a country's wealth is a measure of the asset base that enables it to continue to produce income in the future. Resource-rich countries in particular run the risk that nonrenewable natural resources may be exploited for short-term gains in income without compensating investments in produced and human capital to generate income in the future. Whereas GDP per capita is an indicator of standards of living and development today, wealth is a better indicator of the ability of countries to sustain their development and standards of living in the future. Both indicators are needed for a comprehensive assessment of a country's level of development and prospects for future development.

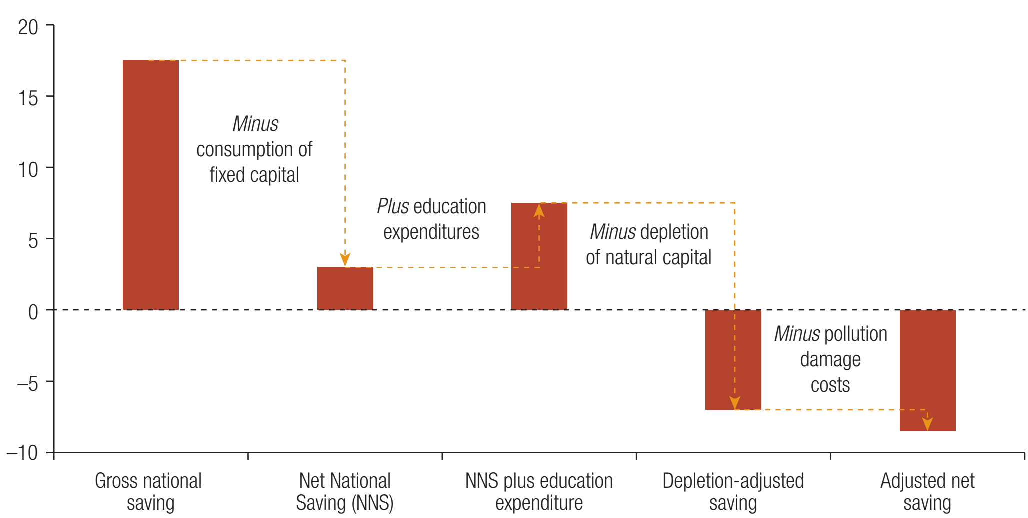
The importance of developing a balanced portfolio of assets for resource-rich countries is widely recognized (see, for example, Gill et al. [2014] for Eurasia), but doing so is not easy. Attaining a balanced portfolio of assets is linked to intangible, but measurable, institutional capabilities in at least three critical areas: fiscal policy that is adapted to the volatility of rent flows from natural assets; effective delivery of social services, especially for education and health; and a business environment conducive to competition, contestability, and investment. Faced with sharp declines in oil revenues and a lack of buffers, some countries may have little flexibility in the short term to reshape their development path. Still, some space is often available—whether through subsidy reform, domestic revenue mobilization, or prudent deficit financing—to take steps toward sustainability. In other words, countries can improve their policy frameworks to manage revenue volatility and embed the principle of converting resource rents into other productive assets so that strategic development paths are enabled, but not dominated, by natural resources.

This chapter documents the performance over the past two decades of Sub-Saharan Africa countries, especially resource-rich countries, in using their natural resources to create wealth for sustainable development. It compares recent estimates of country wealth and ANS. The differences between ANS and changes in wealth are briefly discussed in chapters 1 and 2 and are reviewed here. The discussion compares results from the two measures—wealth and ANS—to test whether the new data on the wealth of nations produced for this volume help enrich our understanding of the development path of countries and its sustainability. After a brief section on methodology, the chapter discusses trends in wealth and ANS for the region as a whole, then discusses in more detail the experiences of two countries in West Africa that have recently discovered new natural resources: Ghana and Niger.

Two Approaches to Measuring Investments and Sustainability

This book uses two approaches to assess whether countries are investing enough today for their future development. The first approach relies on ANS. ANS is a measure of gross national saving minus depreciation of produced capital, depletion of natural capital, plus public expenditures for education (for a graphic depiction, see figure 3.1). A negative ANS suggests that a country is running down its capital stocks and thereby possibly reducing future social welfare; a positive ANS suggests that a country is adding to its wealth and thereby its future well-being. ANS measures the portion of national income that is not consumed by the private and public sectors, adjusted to reflect

FIGURE 3.1 Procedure for Estimating Adjusted Net Saving
percentage of gross national income



Source: World Bank.

investment in human capital, depreciation of fixed capital, resource depletion, and pollution damage costs. ANS is measured annually. It provides policy makers with immediate feedback about the direction of the economy and possible action they may need to take to ensure long-term growth.

The alternative approach looks at changes in the wealth of nations as measured in this book by summing up estimates of natural, produced, human capital, and net foreign assets. The procedures for estimating the four types of capital are discussed extensively in chapters 1 and 2, and a summary of the methodologies for each type of capital is provided in appendix A to this volume. Compared with previous estimates in this series (World Bank 2006, 2011), estimates of human capital in this study were derived from household surveys for 141 countries. These estimates follow the approach suggested by Jorgensen and Fraumeni (1992a, 1992b), whereby human capital wealth is defined as the discounted value of future earnings for a country's labor force.

Each approach has strengths and weaknesses. The two measures are compared in detail in chapters 1 and 2 (see box 1.2). By definition, ANS excludes capital gains. It also follows the System of National Accounts (EC et al. 2009) treatment of resource discoveries and reclassification of resources as economically profitable resources—discoveries and reclassification of resources caused by changes in prices or technology are recorded in a country's balance sheet, but are not considered part of gross national saving. However, additions to subsoil assets increase the lifetime of the asset and reduce the depletion share of rent in ANS. Information gaps also cause ANS to diverge from the change in total wealth. One informational issue is that ANS does not address improvements to or degradation of agricultural land, in part because not all changes are considered saving, but also because of a lack of global data given the difficulties in valuing degradation. Finally, the measure of human capital formation in ANS is not fully aligned with the estimate of human capital in current wealth accounts. Current public expenditure on education (the proxy for investment in human capital in ANS) is likely underestimating the changes over time in human capital when compared with the human capital component of wealth measures. On the other hand, human capital wealth measures are estimated with standard errors using household surveys, which may lead to some bias in estimates from one year to the next, whereas the risk of bias in reporting public spending for education is likely to be much less severe.

Because these two different approaches—ANS and changes in total wealth—are used in this chapter to assess investments made by Sub-Saharan African countries over the past two decades to diversify their assets base, conclusions may differ depending on which approach is used for the assessment. This possibility is illustrated and discussed below, first considering the Sub-Saharan Africa region as a whole, and next considering Ghana and Niger as illustrative examples of development paths for countries considered both resource rich and stable.

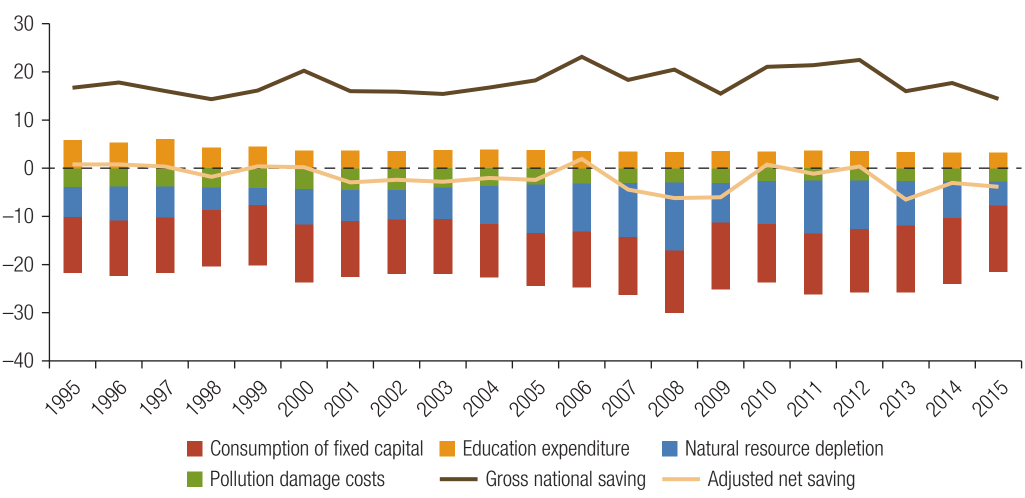
Trends in ANS in Sub-Saharan Africa

This section considers trends in ANS for Sub-Saharan Africa as a whole. Figure 3.2 illustrates the trend in ANS for the region over the past 20 years. In most years, ANS was negative, suggesting disinvestment. Gross national saving is estimated at slightly less than 20 percent of GNI in most years. About half of gross national saving is used for the consumption of fixed assets (depreciation), with a similar negative contribution (with some variation over the years) resulting from natural resource depletion. The losses from pollution are smaller, as is the positive contribution of spending for education. Clearly, natural resource depletion is one of the key drivers of negative ANS in the region.

How does Sub-Saharan Africa compare to other regions? Not favorably. For example, East Asia and Pacific, as well as South Asia, have achieved much higher levels of gross saving, at more than a third of GNI in both regions. After accounting for depreciation, natural resource depletion, pollution, and investments in education, both regions have positive ANS of about one-fifth of GNI. The fact that natural resource depletion is much lower in these regions helps in generating high positive ANS. In Latin America, ANS is smaller, but still substantial at about one-tenth of GNI over the years.

Within Sub-Saharan Africa, not all countries fare equally. Countries can be grouped according to whether they are resource rich, and according to whether resource-rich countries are fragile or affected by conflict (table 3.1). This classification may change with changes in the fragile or conflict status. For example, Côte d'Ivoire is no longer considered to be a fragile state, but it was affected by civil conflict for many

FIGURE 3.2 Trends in Adjusted Net Saving for Sub-Saharan Africa, 1995–2015
percentage of gross national income



Source: World Bank calculations.

TABLE 3.1 Typology of Countries and Average Adjusted Net Saving, 1990–2015

	Higher dissaving (less than –8%)	Some saving or dissaving (–8% to 8%)		Higher saving (greater than 8%)
Not resource-rich countries	Burundi (–30.3) The Gambia (–11.1) Malawi (–9.7)	Benin (1.4) Burkina Faso (2.1) Comoros (–2.1) Eritrea (4.0) Guinea-Bissau (–7.8) Kenya (–5.7) Lesotho (1.8)	Mauritius (6.9) Rwanda (–0.2) Senegal (3.3) Swaziland (3.8) Uganda (–5.8) South Africa (1.7) Zimbabwe (7.9)	Cabo Verde (18.8) Ethiopia (9.1) Namibia (10.3)
Resource-rich and stable countries	Angola (–67.8) Rep. of Congo (–49.3) Equatorial Guinea (–38.8) Guinea (–8.1)	Cameroon (–1.4) Ghana (0.8) Gabon (–4.3) Mauritania (4.8) Mozambique (0.5)	Niger (–0.8) Nigeria (–2.6) Tanzania (5.7) Zambia (5.3)	Botswana (28.5)
Resource-rich and fragile or conflict countries	Liberia (–8.2) Sierra Leone (–19.0) Sudan (–18.0) Togo (–11.0)	Central African Rep. (3.6) Chad (–3.8)	Madagascar (1.3) Mali (2.7)	Côte d'Ivoire (8.3)

Source: World Bank.
Note: Data are not available for a few countries, including for the Democratic Republic of Congo, São Tomé and Príncipe, Somalia, and South Sudan. For some countries, data are available only for selected years during the period 1990–2015.

years over the period in review. Mali is now considered fragile, but was not affected by conflict for quite a few years.

Table 3.1 provides a simple typology of countries according to the above categorization and their levels of ANS. Countries are considered to have higher dissaving (negative saving) if ANS is less than 8 percent and higher saving if ANS is greater than 8 percent. The threshold of 8 percent is somewhat arbitrary, but conclusions would not fundamentally change with a slightly higher or lower threshold, and using this type of threshold helps illustrate and categorize countries. The middle category includes countries with ANS between –8 percent and 8 percent. This is by no means good performance in comparison with countries in other regions, but it helps identify some of the outliers—the countries with higher saving or dissaving in comparison with the average level of saving for the region (which, again, is low overall).

Table 3.1 includes 43 countries, slightly more than half of which (23 countries) are considered resource rich. Clearly, among resource-rich countries, the proportion of countries falling into the category of higher dissaving is higher than the proportion among non-resource-rich countries. This is not surprising: resource-rich countries tend to have negative saving because they have the ability to exploit their natural resources to increase current income, but at a cost to future development.

One of the issues leading to low ANS faced by many countries, but especially resource-rich countries, is the pressure for public spending. Typically, greater resource revenue can create a deficit bias and reduce public savings. Examples of spending pressures are energy subsidies, unproductive public sector jobs, and higher public sector wages. Most energy subsidies are not only inefficient, but also regressive in countries where the less wealthy do not own cars or have access to electricity. Public sector employment is typically large in resource-rich countries in the region. Evidence shows that pay increases for government employees given during a boom are almost impossible to reverse. More generally, spending that leads to increases in consumption is hard to reverse because habits are formed and political resistance is high. By contrast, fluctuations in investment are easier to manage.

The "curse" affecting resource-rich countries is not destiny for all such countries. For example, Botswana is often mentioned as an example of a resource-rich economy that has been highly successful in promoting long-term growth and poverty reduction. It has successfully recovered and invested rents, including for building human capital. Although there have been challenges in diversifying the economy and building a business-friendly environment to promote investment, Botswana's sound macroeconomic policies have helped reduce short-term pressures to increase public spending inefficiently.

Comparing Adjusted Net Saving and Changes in Wealth

As measured by ANS, the region's performance in investing for the future is not encouraging. Many countries, especially resource-rich countries, have negative ANS. This does not necessarily mean that changes in wealth for those countries also are negative. As mentioned earlier, the two approaches rely on different sets of assumptions. In addition, a peculiar feature of the estimation of human capital can lead countries with negative ANS to exhibit substantial gains in wealth.

Consider a hypothetical scenario in a resource-rich country where the government uses natural resource revenue to increase wages in the public sector. The increase in public sector wages may lead to a higher wage bill. Because estimates of human capital wealth are anchored in a country's wage bill (as discussed in chapter 6), human capital wealth may appear to increase, even though in the long term the increase in public sector wages may not be sustainable. This could lead to a negative relationship between ANS and trends in wealth.

There are other scenarios in which negative ANS may be associated with positive changes in wealth. As highlighted in the example of Ghana below, structural changes in the economy may result in moving labor from low productivity agriculture to higher productivity services and manufacturing in urban areas. The result would be higher values of human capital combined with no apparent increases in human capital investment.

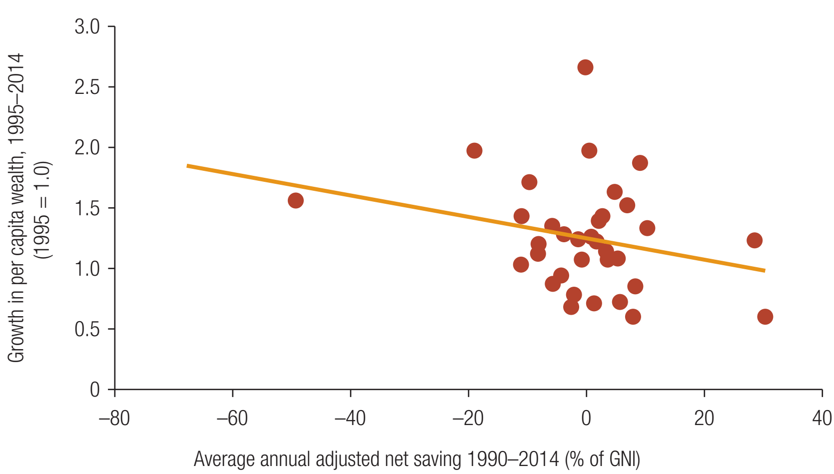
New discoveries of natural resources may also be more likely in countries that already have natural resources. These new discoveries are not fully accounted for in ANS, but they are reflected in wealth estimates. This situation could again lead countries with negative ANS to post gains in wealth.

Finally, a country's measure of wealth is best presented as wealth per capita. Countries with natural resources may be richer, and further along the demographic transition, than countries without large natural resource bases. In that case, when considering changes in wealth per capita, higher demographic growth may penalize countries with few natural resources, while resource-rich countries find it easier to post gains in wealth per capita thanks to lower population growth.

For the subset of countries in table 3.1 for which estimates of wealth are available, figure 3.3 displays the relationship between average ANS from 1990 to 2014 and the change in wealth observed between 1995 and 2014. The change in wealth is measured as wealth per capita in 2014 divided by wealth per capita in 1995, so that a value of 1 implies no change in wealth per capita. Two important findings emerge from figure 3.3. First, many—but not all—countries benefited from gains in wealth per capita over time, but the performance of the region as a whole is not stellar. Second, there is a negative relationship between ANS and changes in wealth so that, on average, countries that had higher ANS also had slightly smaller gains in wealth per capita.

Should this be considered a saving grace for resource-rich countries? It could, since some of the countries with negative ANS still scored gains in wealth. One also could argue that with more sustained investments, these countries could probably have achieved even higher gains in wealth. Implicitly, the counterfactual should be different for countries depending on whether they are resource rich. Given resource-rich countries' ability to invest more, the bar for gains in wealth that would be expected over time should probably be set higher. Still, figure 3.3 makes it clear that

FIGURE 3.3 Adjusted Net Saving and Change in Wealth



Source: World Bank calculations.
Note: GNI = gross national income.

negative ANS does not necessarily imply losses in wealth per capita over time. The two measures can be thought of as complementary, in that they provide different insights.

Case Studies: Ghana and Niger

The remainder of this chapter focuses on the changing wealth and ANS patterns of two nations: Ghana and Niger. The objective is to assess whether data on the wealth of nations can be used together with ANS to provide a richer picture of a country's investments and sustainability. Ghana and Niger were selected for brief case studies because they have fairly complete ANS and wealth data. They also present two very different contexts in level of economic development, natural resource base, constraints, and fiscal policy.

Ghana

Even before oil production began in 2011, and increasingly thereafter, Ghana found itself facing issues typical of middle- and low-income resource-rich countries. Between 2005 and 2014, Ghana saw its total wealth increase by 23.4 percent (or 2.4 percent annually). However, estimates of ANS suggest stresses on sustainability even in the midst of strong GDP growth (GDP tripled in real terms from 1995 to 2014). ANS in Ghana was barely positive over the 25-year period from 1990 to 2014. But ANS turned negative in 2007, the year preceding the elections. Dissaving increased quite dramatically in 2008, the election year, and all through the oil boom. By the end of the oil price boom in 2014, Ghana was under severe fiscal constraints and requested a bailout from the IMF. National saving had failed to offset consumption of fixed capital and resource depletion (related, in part, to land productivity) over the past decade.

As shown in table 3.2, ANS was already rather low in per capita terms between 1995 and 2005, but it shrank thereafter, turning to negative $189 in 2014. This is illustrated in the decline of ANS as a percentage of GNI from 5 percent in 2005 to negative 12 percent in 2014. Saving effort, measured in net terms, declined; when considering population growth, the decline is even more severe. The existing capital stock thus has to be shared with a new population cohort, a form of wealth dilution. This effect is captured in the measure of "population dilution/capita" in the table. Subtracting this dilution term from ANS per capita yields adjusted net saving with population adjustment (ANS-PA) per capita.[1] This is an indicator of potential future well-being. In Ghana, ANS-PA per capita has been consistently negative. The combined effects of insufficient saving (as measured by ANS) and a growing population lead to negative wealth creation per person using those measures. The data suggest that the negative ANS is mostly due to consumption of fixed capital without corresponding investments (before the discovery of oil, resource depletion, mostly gold, was quite low). Notwithstanding new oil revenues and a massive increase in debt, capital expenditure as a percentage of GDP

TABLE 3.2 Decomposition of Ghana's Adjusted Net Saving Per Capita with Population Adjustment, 2005–14

	1995	2000	2005	2010	2013	2014
Population growth rate (%)	2.6	2.4	2.6	2.5	2.4	2.4
ANS/capita ($)	39.5	42.3	55.6	–67.7	–164.3	–188.6
Population dilution/capita ($)	466.1	391.1	527.7	478.1	569.2	588.6
ANS-PA/capita ($)	–426.6	–348.8	–472.1	–545.8	–733.5	–777.2
ANS/GNI (%)	4.4	4.4	5.0	–5.1	–10.1	–11.6
(ANS-PA/capita)/(GNI/capita) (%)				–41.9	–45.9	–48.7
Total wealth/capita ($)	18,294.0	16,514.1	20,292.7	18,991.5	23,738.6	25,044.2
GDP (billions, in constant 2010 dollars)	14.9	18.4	23.5	32.2	43.0	44.8

Sources: World Bank calculations; World Bank 2017.
Note: Figures are in constant 2014 US dollars at market exchange rates. ANS = adjusted net saving; ANS-PA = adjusted net saving minus population adjustment; GDP = gross domestic product; GNI = gross national income.

declined from an average of 12 percent of GDP between 2004 and 2008 to 4.8 percent in 2011.

At the same time, Ghana until very recently achieved high and sustained growth and impressive poverty reduction. The nation's economic growth rate has consistently outperformed its African peers since the early 1990s, bringing the country into lower-middle-income status. Growth and job creation were accompanied by rapid urbanization and a gradual structural transformation of the economy from agriculture to services jobs, and to a lesser degree industry. The share of agriculture in value added fell from 36 percent in 1991 to 24 percent in 2012, while agricultural employment fell from 61 percent to 43 percent over the same period. The share of services expanded from 36 percent to 48 percent between 1991 and 2005, and then remained constant. Since 1991, the population of Ghana's two major cities, Accra and Kumasi, has more than doubled, for an additional 2.4 million inhabitants. Secondary cities also expanded significantly. More people now live in urban areas than rural areas, and the urban population is expected to increase from slightly more than 50 percent of the country's inhabitants to 70 percent by 2050, with benefits for development.

In short, despite bouts of fiscal turmoil, in some cases related to the election cycle (see box 3.1), Ghana has made remarkable progress in increasing living standards and reducing poverty and deprivation along many dimensions. Extreme poverty was halved in the past two decades and the first Millennium Development Goal was met. By 2012, just one in five Ghanaians (21 percent) lived in poverty, and one in 10 (10 percent) in extreme poverty (GSS 2014). Other social indicators—such as life expectancy, child mortality, and hunger—are now near those of countries with higher average levels of income. Educational attainment also has increased.

BOX 3.1 Oil Revenues, Electoral Cycles, and Adjusted Net Saving in Ghana

Election cycles are critical to understanding trends in adjusted net saving (ANS) in Ghana. The fiscal expansion in the run-up to the December 2000 presidential and parliamentary elections launched a cycle of high inflation and currency depreciation that coincided with a sharp deterioration in the commodity terms of trade. In the span of one year, ending December 2000, the currency (the cedi) lost 50 percent of its value relative to the US dollar. The country's gross international reserves were so depleted that they could only cover a month's imports, and external payments arrears started building up.

The new government's focus after the 2000 elections was to restore macroeconomic stability. The term of the "Kufor government" overlapped with adherence to an IMF program to obtain debt relief. Ghana operated under a quasi-fiscal rule during this period, introducing a major shift in macroeconomic policy away from expansionary fiscal policy and monetary accommodation and toward fiscal consolidation and monetary discipline. The central government budget was cast in a medium-term framework, and public finances were set on a fiscal consolidation course. These developments coincided with a period of mostly positive ANS.

The situation changed after 2007. The electoral races of 2008 and 2012, amid expected or newly available oil revenues, generated a situation in which the management of expectations was undermined by electoral promises. Higher expectations, in turn, generated spending pressures that could hardly be contained. Political consensus failed to materialize around sustainable fiscal management, weakening the nominal fiscal rules in place and the central bank's independence. Procedures for forecasting oil revenues were also not isolated from upward political pressure (unlike, for example, in Chile). In the 2007–08 election cycle, inflation increased from 11 percent at the end of 2006 to 18 percent at the end of 2008, and the exchange rate depreciated by 20 percent. A subsequent correction was, in turn, overtaken in the 2012 election year when the budget deficit reached 11.3 percent of GDP, which is also the period when ANS turned sharply negative.

These various shifts have had positive implications for wealth accumulation. As noted earlier, ANS excludes capital gains and new discoveries (oil was discovered in Ghana in 2007, with exploitation starting in 2011). ANS also may underestimate human capital formation, especially when economies benefit from positive structural changes that boost income levels. Table 3.2 shows that wealth per capita increased over the period. In large part, this increase stemmed from gains in human capital, which increased by almost 80 percent between 2005 and 2014. Natural and produced capital also increased. The gains in wealth per capita in Ghana have been smaller than one might have expected—given recent gains in poverty reduction, better educational attainment, and higher wages—but they have been positive.

These developments are encouraging, but some concerns remain for the future. The prospect of oil revenues may have led to a classic bias toward consumption rather than investment. Ghana's growth model may have become increasingly dependent on natural resources—and more so since 2011, with the start of commercial oil production. Because the prospect of a windfall led to higher spending for public sector wages and employment, public investment was squeezed, with negative ANS estimates being a source of caution. At the same time, the country has so far avoided the potentially more debilitating effects of a natural resource cycle, and past accumulation of human capital in high-growth years has provided a buffer of wealth accumulation and future prospects for development.

Niger

Despite its large endowment of renewable resources compared with subsoil assets, Niger has relied heavily on oil and uranium assets to generate growth and savings over the years. The country has a long history of oil exploration dating back to the 1970s, but much like Ghana, Niger's petroleum industry did not begin to develop substantially until 2011 with the opening of the Agadem oil field and the Soraz refinery near Zinder. With direct investment from China and France, new oil and uranium mining projects are being developed, transforming the country into a natural resources exporter. The new Azelik uranium mine, which is relatively small, began operating in 2011. An integrated oil project (including an oil field and a refinery) started in 2012. The new Imouraren uranium mine will begin production around 2019–20, when prices reach a level that would make the mine profitable (IMF 2015).

Natural resources contributed 12.3 percent of total GDP in 2013, and are projected to double their contribution to GDP by 2020, while total government revenue from natural resources is expected to increase by about 2 percent of GDP. In addition to its recent gains in minerals and mining endowments, Niger's share of renewables in total wealth (agricultural land, forest, and protected areas) is substantial as well and has grown over time. Both the area and value of protected areas have also gained significantly over the past two decades. These renewable assets are growing, but not as fast as nonrenewables.

Despite the pitfalls of newly available resource rents, ANS trended above zero from 2010 to 2014 (table 3.3). Niger has managed to shift its ANS from negative to positive territory in several years since 2005. ANS as a percentage of gross national income increased from −24 percent in 1995 to more than 7 percent in 2014. The combined efforts of saving, as measured by ANS, and fiscal restraint have improved the outlook in recent years, even if total consumption expenditure (the difference between GDP and gross domestic saving) has increased at a sustained pace since 2011.

A major issue in Niger is the high rate of population growth, currently 3.9 percent per year. As shown in table 3.3, population growth leads to negative wealth creation per capita because of population dilution. Fertility rates remain among the highest in the world, at

TABLE 3.3 Decomposition of Niger's Adjusted Net Saving Per Capita with Population Adjustment, 2005–14

	1995	2000	2005	2010	2013	2014
Population growth rate (%)	3.5	3.7	3.7	3.9	4.0	4.0
ANS/capita ($)	–84.5	–46.6	0.3	29.1	30.4	..
Dilution/capita ($)	363.1	389.7	419.4	474.9	467.9	468.3
ANS-PA/capita ($)	–447.6	–436.3	–419.1	–445.8	–437.5	..
ANS/GNI (%)	–24.3	–13.5	0.1	7.8	7.5	..
(ANS-PA/capita)/(GNI/capita) (%)				–128.0	–119.5	..
Total wealth/capita ($)	10,346.4	10,656.7	11,345.3	12,244.1	11,644.5	11,622.7
GDP (billions, in constant 2010 $)	3.2	3.7	4.4	5.7	6.9	7.4

Sources: World Bank calculations; World Bank 2017.
Note: Figures are in constant 2014 US dollars at market exchange rates. ANS = adjusted net saving; ANS-PA = adjusted net saving minus population adjustment; GDP = gross domestic product; GNI = gross national income.

7.6 children per woman, in part because women marry very early (three-quarters of women marry as children before age 18 years), and the use of modern contraception is very low. This population growth rate has also limited gains in total wealth, despite improvements in other areas such as educational attainment.

In Ghana fiscal volatility coexisted with a broader trend of wealth accumulation; in Niger, however, the fiscal story is a more dominant part of the overall picture. The ANS trend suggests that natural resource revenues have been largely invested or used to lower debt relative to the country's income level and related wealth accounts in the past decade. The data suggest a strengthening trend in ANS, mostly as a result of the government's commitment to fiscal consolidation.

However, similar to Ghana, the fiscal situation has deteriorated since 2013 owing to rapidly increasing public investment spending, while domestic arrears have accumulated. Windfall resource revenues were directed at general public services and spending related to economic affairs (including agriculture, transport, and infrastructure), and social spending also increased. The central government's fiscal deficit widened from 2.6 percent of GDP in 2013 to 9.1 percent of GDP in 2015, even though government revenue was rising. These widening deficits were accompanied by an accumulation of domestic arrears and rapid growth of domestic financing, notably through the issuance of bonds in the regional market.

As a result, Niger's public and publicly guaranteed debt stock has risen sharply in recent years, reaching an estimated 47 percent of GDP in 2016, up from 27.2 percent in 2013. The debt is 70 percent external and largely composed of concessional debt to multilateral creditors (54 percent). The good news is that this growth in debt reflects, in part, a scaling up of government borrowing to fund public investment in infrastructure (thereby expanding physical capital), including a

US$1 billion investment facility from the Export-Import Bank of China and the signing of a Chinese master facility agreement in 2013. Like Ghana, the overall picture for Niger is mixed, but for different reasons, including the role played by population growth in undermining the ability of the country to increase wealth per capita.

Conclusion

Resource-rich countries have an apparent advantage over other countries because they have a source of revenue with which to finance investment and development. Managing the windfall from resource rents poses well-known challenges for macroeconomic management, including the risk of "Dutch disease" and potentially volatile income streams. The development challenge for resource-rich countries is to capture and manage resource rents to the benefit of the domestic economy, with specific attention to investing in productive assets (produced and human capital) that will help generate income and jobs long after the natural resources are depleted. Energy and minerals are exhaustible natural resources. Eventually they will run out. But while the resources themselves are not sustainable, if the rents are captured and invested in other productive assets, they can help build an economy that will be sustainable. Resource-rich economies are often concerned with diversification to reduce long-term dependence on a single source of potentially volatile income that will eventually be depleted. Investment of natural resource rents in produced and human capital can be a solution to this dilemma.

To assess whether resource-rich countries are indeed investing in their long-term development potential, two different measures can be used. The traditional approach has been to measure investments using ANS. An alternative is to rely on data from the wealth of nations to measure changes in wealth over time. Both measures have strengths and weaknesses. The ANS data suggest that many countries in Africa are doing poorly in investing for the future. ANS is often low compared with levels observed in other regions. Especially for resource-rich countries, the depletion of natural resources is often not compensated for by other investments. And yet many (albeit not all) of the same countries have still been able to accumulate wealth, as measured by estimates of produced, natural, and human capital. This chapter describes some of the reasons for this apparent paradox, both in general terms and through brief case studies for Ghana and Niger. Clearly, data on the wealth of nations appear useful for providing better assessments of sustainability in comparison with the conclusions that can be reached when using ANS alone.

However, the warnings provided by negative ANS in many countries and in the region as a whole should not be ignored. Countries are better off in the long term with positive ANS. The measure remains very important, especially in resource-rich countries. It helps in advocating for investments toward diversification to promote exports and sectoral growth outside the resource sector. But beyond calls for diversification, investing in institutions and the conditions needed for an efficient private sector to flourish is important. These conditions include sound macroeconomic policies to create a stable economic environment for investment and business, investment in human capital, and building appropriate governance structures. As one example of such governance structures, box 3.2 provides a brief discussion of the role of sovereign funds in managing the windfall that natural resources provide.

BOX 3.2 Principles of Managing Natural Resource Revenues: Is a Fund Enough?

At a nontechnical level, two macroeconomic criteria can be used to evaluate governance structures in natural resource revenue management: First, is procyclicality avoided? That is, is a country able to prevent the volatility in resource rents from being transmitted to the rest of the economy? Second, is the increase in the level of government spending financed by natural resources beyond the sustainable income flow from these natural resources? Underlying these criteria is a deeper principle that natural resource revenues should be converted into capital that will provide the foundation to sustain per capita income at a higher level following the depletion of the resources.

Some countries have translated these principles into the idea of having a natural resource or sovereign wealth fund. However, resource funds do not place formal direct restrictions on fiscal policy in the same way that fiscal rules may be able to. Fiscal rules and resource funds only coincide in cases of "financing" funds, which are funds that are linked to the implementation of a fiscal rule. The fund receives all resource revenue and finances the budget's nonresource deficit by way of a reverse transfer. The objective is to finance the budget. The fund accumulates budget surpluses and finances budget deficits. Funds in Chile, Norway, and Timor-Leste are closest to this framework, as is Ghana's fund—at least on paper. For many resource-rich countries, resource funds have been accumulating financial assets even as the overall fiscal policy stance has depleted national assets.

It also is important to consider time consistency. If a fiscal rule or operational rule requires some specific corrective action in the future, will that action actually be carried out when the time arrives? The credibility of any rule depends on some meaningful space to adjust as the rule becomes binding. For instance, maintaining commitments to a fund deposit clearly implies the necessity for fiscal space in stressed scenarios. Governments often find this difficult, or else make unwise cuts in capital investment and maintenance. Much of the evidence on sustainable fiscal consolidations suggests that the space needed for rules to work has to come from public sector compensation and noncontributory transfers and subsidies. If these cannot be cut, no rule will be time consistent. These few examples illustrate how difficult the management of natural resources is, but good management of these resources is clearly essential for resource-rich countries to adopt sustainable development paths.

Note

1. In principle, the population adjustment factor could be positive or negative, depending on whether population is growing or declining.

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4

Expanding Measures of Productivity to Include Natural Capital

Kirk Hamilton

Main Messages

- Poverty reduction and increasing well-being are tied to gains in economic productivity—how efficiently a country produces goods and services for given inputs. Traditionally, economists measure productivity based on the contribution to gross domestic product (GDP) growth by only two factor inputs, stocks of labor and produced capital. After accounting for the growth in capital and labor, the unaccounted share of GDP growth is termed multifactor productivity (MFP) growth. However, the traditional approach to measuring MFP growth ignores the contribution that natural resources make to production.
- This chapter extends recent research to look at a broader range of assets, in particular natural capital assets (agricultural land, minerals, and fossil fuel energy) and their impact on the measurement of MFP. The chapter shows that, depending on the relative growth rates of fixed capital and a composite measure of natural capital, MFP growth rate calculations that include natural capital as a production factor may be higher or lower than the traditional measure that excludes natural capital. The analysis points to the potential for major improvements in measuring MFP growth rates in resource-dependent developing countries.

Introduction

A key issue in economic analysis is the relationship between the inputs to production, typically fixed capital and labor, and the quantity of output. At one level this is a question of measurement: Can the production process be decomposed to provide an understanding of the individual contributors to changes in output, particularly when the analysis is extended to include natural resources? At another level it raises fundamental questions about the efficiency of production: Does adding more labor and capital to production result in proportionate increases in output, or is production necessarily subject to diminishing marginal returns? As this chapter shows, excluding the contribution of natural resources to production has arguably biased the estimates of MFP growth to date.

Of course, no sensible economic model aims to maximize production. The general goal of economics is to maximize, or at least progressively increase, human well-being for the greatest number. But production provides the means to boost both well-being and investment in new productive factors. The rate at which this can happen is of fundamental importance to the world's poor, in particular the 767 million people (10.7 percent of the total) who live in extreme poverty, defined as income of less than US$1.90 a day.

Growth accounting—that is, decomposing growth in output into its constituent factors—is a key tool for assessing the efficiency of economic production. Until recently a two-factor approach to decomposing growth in output, counting only fixed capital and labor, has been the dominant approach, but the publication of wealth accounts by the World Bank—starting with *Where Is the Wealth of Nations? Measuring Capital in the 21st Century* (World Bank 2006)—has opened the door to a much more comprehensive approach to understanding the contributors to growth. In particular, an Organisation for Economic Co-operation and Development (OECD) study (Brandt, Schreyer, and Zipperer 2017) uses the Bank's data on the quantity and value of selected natural resource assets to explore the question of how a broader measurement of the factors of production influences the measures of the efficiency of economic production.

The goal of this chapter is to extend the work of the OECD to look at a broader range of assets, in particular the range of natural assets (agricultural land as well as subsoil minerals and fossil fuel energy) and their impact on the measurement of production efficiency. The chapter presents the first steps on a journey to more comprehensively assessing the factors underpinning growth in output.

In a world with fixed technology, the only way to increase production is to deploy more factor inputs to the production process. The Solow (1956) model of economic growth shows where this leads. Diminishing returns combined with fixed technology mean that the development path for the economy is one in which output per person approaches a long-term steady state. Growth stops. In an unequal world, this process could imply that millions of people become trapped in extreme poverty.

A careful accounting of the contributors to growth in economic production, whether with two factors of production or many, typically shows that the growth in individual factors of production does not sum to the quantity of production observed, as measured by gross domestic product (GDP). In most countries, growth in GDP exceeds aggregate growth in factors of production. This is good news because it means that other, unmeasured factors are contributing to production. The growth in these unmeasured factors tracks the increase in the efficiency of economic production. If economic policies can sustainably increase the efficiency of production, then diminishing returns to factor inputs can be overcome.

The missing factor is generally termed multifactor productivity (MFP) in the economics literature.[1] Although it is measured as a residual in growth accounting, we are not ignorant of its source. Intellectual property, or knowledge, must be a key component of the residual. Knowledge, in turn, leads to new technologies and better ways of managing the assets we have. Another component is almost certainly institutional quality. Increasing the efficiency and effectiveness of institutions—such as an independent judiciary that can enforce the rule of law—is fundamental to any incentive to invest in the future, not to mention the protection of the rights that underpin well-being. Changes in the quality of factor inputs, as Jorgensen (1995) investigated, are another potential contributor.

This chapter is fundamentally about measurement. It uses the latest comprehensive wealth accounts, updated to 2014, to assess the growth in MFP in selected resource-dependent economies. The next section reviews recent work by the OECD on the growth of MFP. This is followed by a simplified presentation of how measurement of the MFP growth rate is carried out in the chapter. Empirical results and some reflection on the determinants of the results obtained follow the section on methodology. Finally, the concluding section considers the lessons learned and potential next steps in productivity measurement building on comprehensive wealth accounts.

Recent Work on MFP Growth by the OECD

The OECD has an ongoing work program on productivity measurement (OECD 2001) focused primarily on OECD member countries. Brandt, Schreyer, and Zipperer (2017) introduce an important innovation in this work by attempting to measure MFP growth both in traditional terms, such that the only factors of production considered are produced capital and labor, and in an expanded model in which exhaustible natural resources are also treated as factors of production.

To estimate the growth rate of multifactor productivity, Brandt, Schreyer, and Zipperer (2017) assume constant returns to scale in production and zero economic profits (other than the resource rents that are used to bring resources into the MFP measurement framework).

TABLE 4.1 MFP Average Annual Growth with and without Accounting for Natural Resources, Selected Countries, 1996–2008
percent

	MFP growth rate excluding natural resources	MFP growth rate including natural resources	Capital and labor composite growth rate	Natural capital growth rate	Share of resource rent in GDP
Chile[a]	0.90	1.10	5.07	4.18	6.63
Mexico	0.97	1.09	2.81	0.84	3.73
Russian Federation	2.21	2.50	3.16	2.12	13.32
South Africa	1.62	1.70	2.01	0.65	2.35

Sources: Brandt, Schreyer, and Zipperer 2017; natural resource data from World Bank 2011.
Note: GDP = gross domestic product; MFP = multifactor productivity.
a. Data for Chile are for 1997–2008.

MFP growth rates are estimated for most OECD countries, but in two OECD countries—Chile and Mexico—the underlying data do not support detailed estimation of the rental value of produced capital. Therefore, in estimating MFP growth rates, Brandt, Schreyer, and Zipperer (2017) measure the rental value of produced capital as a residual, that is, the share of GDP left over after accounting for labor and natural resource rents. This approach is also applied to two non-OECD countries that are highly resource dependent: the Russian Federation and South Africa. Natural capital, based on World Bank data, is limited to minerals and fossil energy in their analysis. Their estimates of MFP growth rates with and without natural resources, averaged over 1996–2008, are shown in table 4.1.

Brandt, Schreyer, and Zipperer (2017) note that average MFP growth is higher in these four countries when natural resources are taken into account, a result they attribute to higher growth rates of the traditional factors measured in MFP—capital and labor—compared with the growth rates for a composite measure of natural capital.

This work is an important step forward in the measurement of MFP growth rates based on a more comprehensive measure of national wealth. The next sections of this chapter present new estimates of MFP growth rates for a selection of oil and gas producers, extending Brandt, Schreyer, and Zipperer (2017) by including the rents from agricultural land in the analysis in addition to oil and gas rents.

Growth Accounting for Measuring MFP Growth

In any attempt to measure MFP growth, the starting point is to decompose the factors that drive GDP growth. In common with the OECD work, we assume that the elasticity of output with respect to factor inputs equals the share of the factor in GDP, and that the sum of these factor shares equals 1.[2] We also assume that there are no economic profits in the economy, other than the rents on natural resources.

GDP Y equals the sum of the rental value of the different factors of production. For simplicity, assume that there are three factors: produced capital K, labor L, and natural resource N. The corresponding unit rents are denoted F_K, F_L, and F_N, while the factor shares are given by $\frac{F_K K}{Y}$ for produced capital and the corresponding measures for labor and natural resources. By assumption the factor shares sum to 1, and as a result we can write[3]

$$\frac{\dot{Y}}{Y} = \frac{F_K K}{Y} \times \frac{\dot{K}}{K} + \frac{F_L L}{Y} \times \frac{\dot{L}}{L} + \frac{F_N N}{Y} \times \frac{\dot{N}}{N}. \tag{4.1}$$

The rate of growth of GDP is equal to the average of the growth rates of the factors of production weighted by the corresponding factor shares.[4] In the calculations that follow, it is important to note that all growth rates are measured in real terms: for GDP and produced capital, constant prices are used; for labor, the number of people employed is used; and for natural resources, physical quantities are used, drawn from the underlying World Bank natural resource accounting data.

When the decomposition of growth is carried out in practice, there are generally differences between the growth rate of GDP and the factor-share-weighted sum of the growth in factor inputs. There are, in effect, missing factors that contribute to GDP and, as noted in the introduction, some obvious candidates include technological change and changes in institutional quality. These missing factors constitute MFP. If we denote these factors collectively as A, we can measure the growth rate of MFP as

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \frac{F_K K}{Y} \times \frac{\dot{K}}{K} - \frac{K_L L}{Y} \times \frac{\dot{L}}{L} - \frac{F_N N}{Y} \times \frac{\dot{N}}{N}. \tag{4.2}$$

Growth in MFP is measured as a residual in growth accounting. As such, it can be negative, which would signal a decline in the overall efficiency with which the economy uses factors of production.

The empirical estimates in the next section follow Brandt, Schreyer, and Zipperer (2017) in assuming that the rental value of produced capital equals the residual in GDP, after accounting for the rents of labor and natural resources. The assumption of constant returns to scale makes this straightforward to do in practice.

One important consequence of assuming that the rental value of produced capital is measured residually is that it becomes possible to determine whether introducing natural capital into MFP measurement will increase or decrease the estimates of the MFP growth rate compared with the traditional practice of treating only labor and produced capital as factors of production. As annex 4A shows, if the quantity of produced capital is growing faster than the weighted average of the quantities of natural capital, where the weights are derived from the individual factor shares, then adding natural capital to the analysis will increase measured MFP relative to its traditional value. If the inequality runs the other way—natural capital in aggregate grows faster than produced capital—then the revised measure of MFP growth, including natural capital, will be less than the traditional measure.

Empirical Applications to Selected Petroleum Producers

As a complement to the OECD work, this section compares the traditional measure of the MFP growth rate (excluding natural resources) to an analysis that includes oil and gas production as well as production from cropland and pastureland (table 4.2). These non-OECD countries were chosen on the basis of data availability and regional coverage. Whereas the area of agricultural land changes only very slowly, the quantities of oil and gas extracted vary widely over time in the selected countries.

Looking at the averages over time, the inclusion of natural resources as a factor of production increases the estimated rate of MFP growth for all countries except Bolivia and Kazakhstan. In Ecuador over 1996–2014 and Gabon over 1997–2014, a sign change can be seen between the two measures, with the inclusion of natural resources resulting in moderate to substantial increases in the measured growth rate of MFP.

For 2010 (when the oil price was still rising and economies had begun to recover from the recession of 2007–09), figure 4.1 plots the two estimates of MFP growth for the selected countries. MFP growth including natural resources exceeds the measure excluding natural resources in the Arab Republic of Egypt, while the opposite is true for Oman. In Oman, the growth rate of natural resource use in 2010 was 6.4 percent,

TABLE 4.2 MFP Growth Rates, Selected Petroleum Producers, 1996–2014
percent

	MFP growth rate excluding natural resources			MFP growth rate including natural resources		
	Average, 1996–2014	Average, 2004–2014	2010	Average, 1996–2014	Average, 2004–2014	2010
Bolivia	0.96	1.52	4.88	0.74	1.18	4.49
Ecuador	–0.30	0.30	0.80	0.02	0.79	1.40
Egypt, Arab Rep.	2.11	1.27	1.11	2.45	1.72	1.54
Gabon	–1.53	0.67	10.39	0.07	1.39	8.90
Kazakhstan	5.49	6.66	10.20	4.22	5.46	8.35
Oman	0.77	–0.77	8.02	0.88	–0.18	2.47

Source: World Bank data.
Note: Averages are unweighted. MFP = multifactor productivity.

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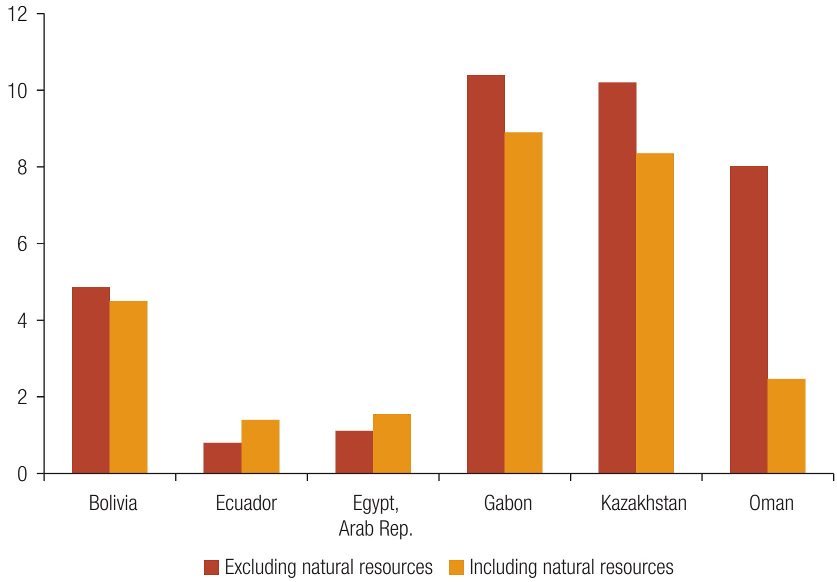
FIGURE 4.1 Comparing MFP Growth Measured Excluding and Including Natural Resources, Selected Petroleum Producers, 2010
percent



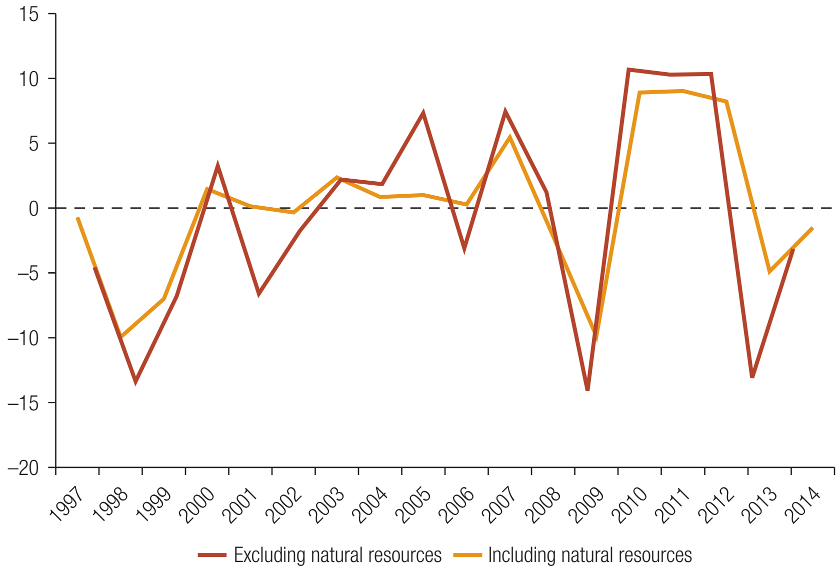
Source: World Bank calculations.
Note: MFP = multifactor productivity.

while the growth rate of produced capital was –8.4 percent; as shown in annex 4A, the result is that MFP growth excluding natural resources exceeds the MFP growth including natural resources. Conversely, in Egypt, the growth rate of natural resource use was 1.9 percent in 2010, compared with 4.3 percent growth for produced capital; as a consequence, the growth rate of MFP including natural resources exceeds MFP growth excluding natural resources.

Figure 4.2 shows the year-by-year evolution of the two measures of MFP growth for Gabon over the period 1997–2014. An obvious conclusion is that the measures are extremely volatile, not surprising perhaps for a petroleum producer. The figure suggests that the measured MFP growth rate including natural resources is less volatile than the traditional measure that is limited to produced capital and labor. However, much more comprehensive analysis of results across countries would be needed to confirm this empirical finding.

This analysis for petroleum producers obviously just scratches the surface of measuring the MFP growth rate using more comprehensive measures of wealth. Other natural resources can clearly be brought into the analysis, including timber production and, data permitting, fisheries.

FIGURE 4.2 Gabon, MFP Growth Rate with and without the Inclusion of Natural Resources, 1997–2014
percent



Source: World Bank calculations.

Conclusions

The analysis in this chapter points to progress in measuring MFP growth rates in developing countries that are highly dependent on natural resources. As the analysis shows, in these countries in particular there is a consistent relationship between the growth rate of produced capital, which is the product of public and private investment decisions, and the growth rate of natural resource extraction. As established in annex 4A, MFP growth measured comprehensively is given a boost when the growth rate of produced capital exceeds that of composite natural capital exploitation. This is arguably relevant to policy, because the Hartwick rule argues for investing natural resource rents in other types of capital, including produced assets, if well-being is to be preserved as the resource asset is depleted.

There is also an intriguing suggestion in the time series of MFP growth for Gabon that an inclusive measure of MFP growth that incorporates natural capital could be less volatile than the traditional measure of MFP growth. This finding points to a future research agenda, where these methods for estimating MFP growth would be applied to a much wider range of developing countries. It may also be that different types of developing countries will show consistent patterns in inclusively measured MFP growth—for example, agriculture-dependent low-income countries compared with extractive resource exporters, or lower-middle-income countries where growth in industrial output has begun.

As noted in the introduction, MFP growth is one of the key indicators used by economists to measure the efficiency with which the economy is using its factors of production. Increasing efficiency is critical if the goal of policy is to increase well-being over the long term. There is a parallel here with wealth accounting, in which the underlying theory tells us that increases in real wealth today lead to increases in future well-being. Underpinning the theory, however, is an assumption that wealth is measured comprehensively. Comprehensive measurement is a major challenge, however, particularly when it comes to such intangible factors as institutional quality and technological change.

Combining more comprehensive measurement of wealth—the subject matter of this book—with the estimation of MFP growth offers an expanded toolkit for measuring the determinants of increasing well-being for the long term. For too long the estimation of MFP growth has been limited to fixed capital and labor. Future work on bringing natural wealth into measures of economic efficiency offers the prospect of not just more comprehensive economic analysis but also more comprehensive policies to increase social welfare.

Annex 4A: Understanding How Including Natural Resources as Factors of Production Affects the MFP Calculation

Denote the factor shares of GDP for produced capital, labor, and natural resources as s_K, s_L, and s_N, and the corresponding growth rates as g_K, g_L, and g_N. Let g_Y be the growth rate of GDP, g_A^{NNR} be the growth rate of MFP calculated without taking natural resources into account, and g_A^{WNR} be the growth rate of MFP with natural resources taken into account.

Because the factor share of produced capital in GDP is calculated residually, in the case in which natural resources *are not* taken into account it follows that

$$s_k = (1 - s_L), \tag{4.3}$$

and if natural resources *are* taken into account we have

$$s_k = (1 - s_L - s_N). \tag{4.4}$$

The formulas for the growth rates of MFP with and without natural resources can therefore be written as

$$g_A^{NNR} = g_Y - [(1 - s_L)g_K + s_L g_L]. \tag{4.5}$$

$$g_A^{WNR} = g_Y - [(1 - s_L - s_N)g_K + s_L g_L + s_N g_N]. \tag{4.6}$$

Straightforward algebra therefore implies that

$$g_A^{WNR} > g_A^{NNR} \text{ if } g_K > g_N. \tag{4.7}$$

That is, the MFP growth rate including natural resources as a production factor exceeds the MFP growth rate excluding natural resources if produced capital is growing at a rate greater than natural capital. This makes intuitive sense: the weighted average growth rate of the factors of production will decrease if the growth rate of produced capital exceeds that of natural resources because the factor share of produced capital has been reduced by the introduction of natural resources as a factor of production.

This result extends easily to the case in which there are two natural resources N_1 and N_2 with factor shares s_{N_1} and s_{N_2}, and growth rates g_{N_1} and g_{N_2}. Then MFP growth including both natural resources exceeds MFP growth without natural resources if

$$g_K > \left[\frac{s_{N_1}}{s_{N_1} + s_{N_2}} \times g_{N_1} + \frac{s_{N_2}}{s_{N_1} + s_{N_2}} \times g_{N_2} \right]. \tag{4.8}$$

That is, adding the two natural resources as factors of production will increase the MFP growth rate (relative to the case without natural resources) if the growth rate of produced capital exceeds the weighted average growth rate of the two natural resources, where the weights are determined by the "within-class" factor shares of the two resources. The intuition for this result is exactly the same as for the case with one natural resource, and it is obvious that this result generalizes to more than two natural resources.

Notes

1. An older literature on this measure of economic efficiency termed it total factor productivity. The terms continue to be used interchangeably.
2. These characteristics would hold if the economy were based on a Cobb–Douglas production function with constant returns to scale.
3. A dot over a variable indicates an instantaneous change in the variable. As a result, $\frac{\dot{Y}}{Y}$ represents the rate of growth of GDP, in this case measured year over year.
4. For a more technical presentation of this result, see Brandt, Schreyer, and Zipperer (2017). We measure changes in quantities in the current period with reference to the quantity in the preceding period, so the decomposition is effectively a Laspeyres index.

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CHAPTER 4: EXPANDING MEASURES OF PRODUCTIVITY TO INCLUDE NATURAL CAPITAL 95

5

The Carbon Wealth of Nations: From Rents to Risks

James Cust and David Manley

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

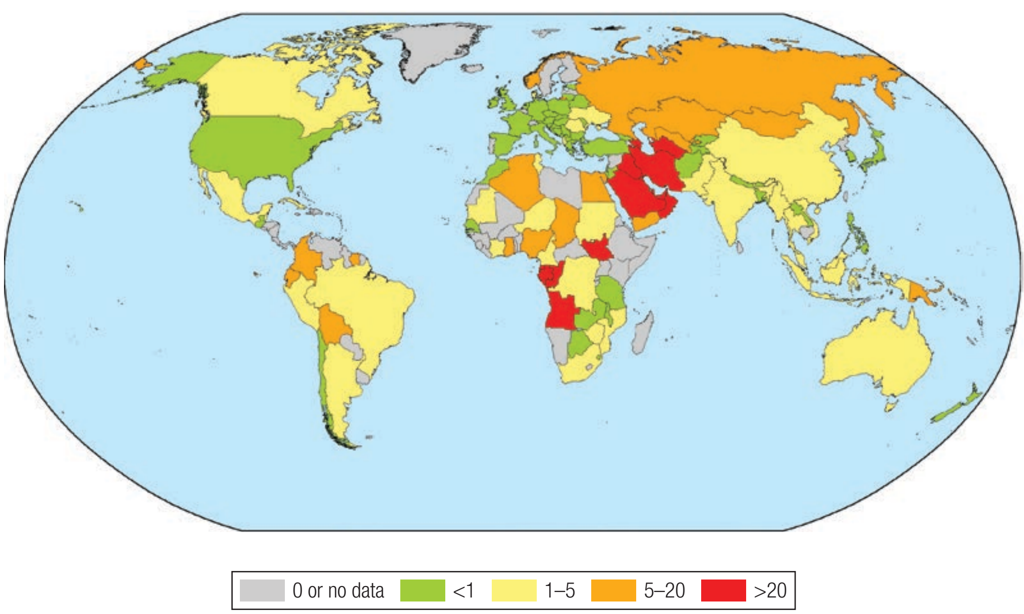
Calculating the carbon wealth of nations is not a straightforward process. This report provides values for three fossil fuels: petroleum, natural gas, and coal. The World Bank calculates these values as the present value of

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

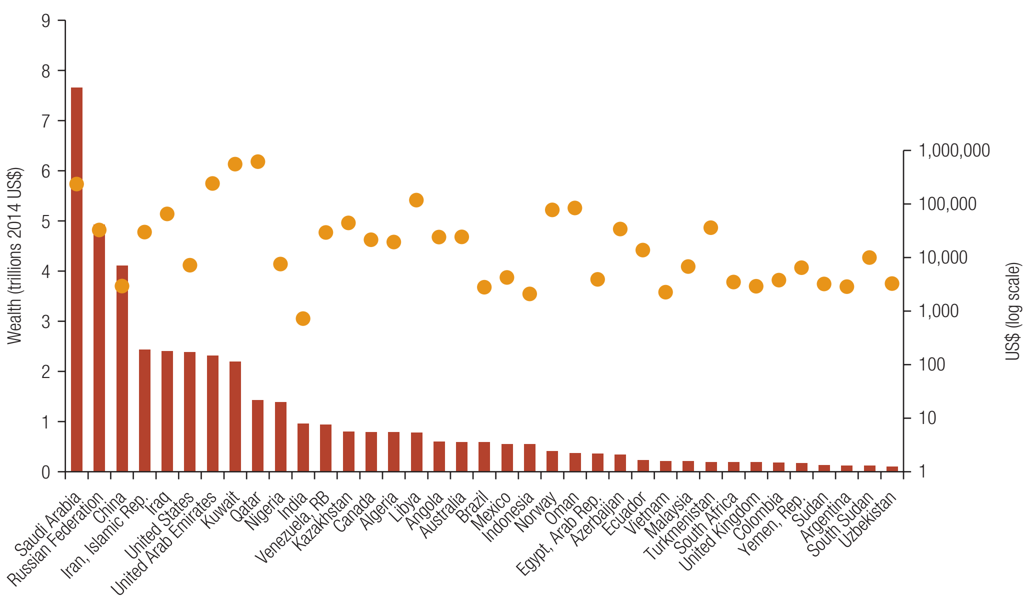
Carbon-rich nations face four special challenges. These challenges arise from the future uncertainty of the value of their carbon-based wealth as the world grapples with mitigating global climate change. They may have little control over the external factors affecting the value of carbon wealth, such 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.

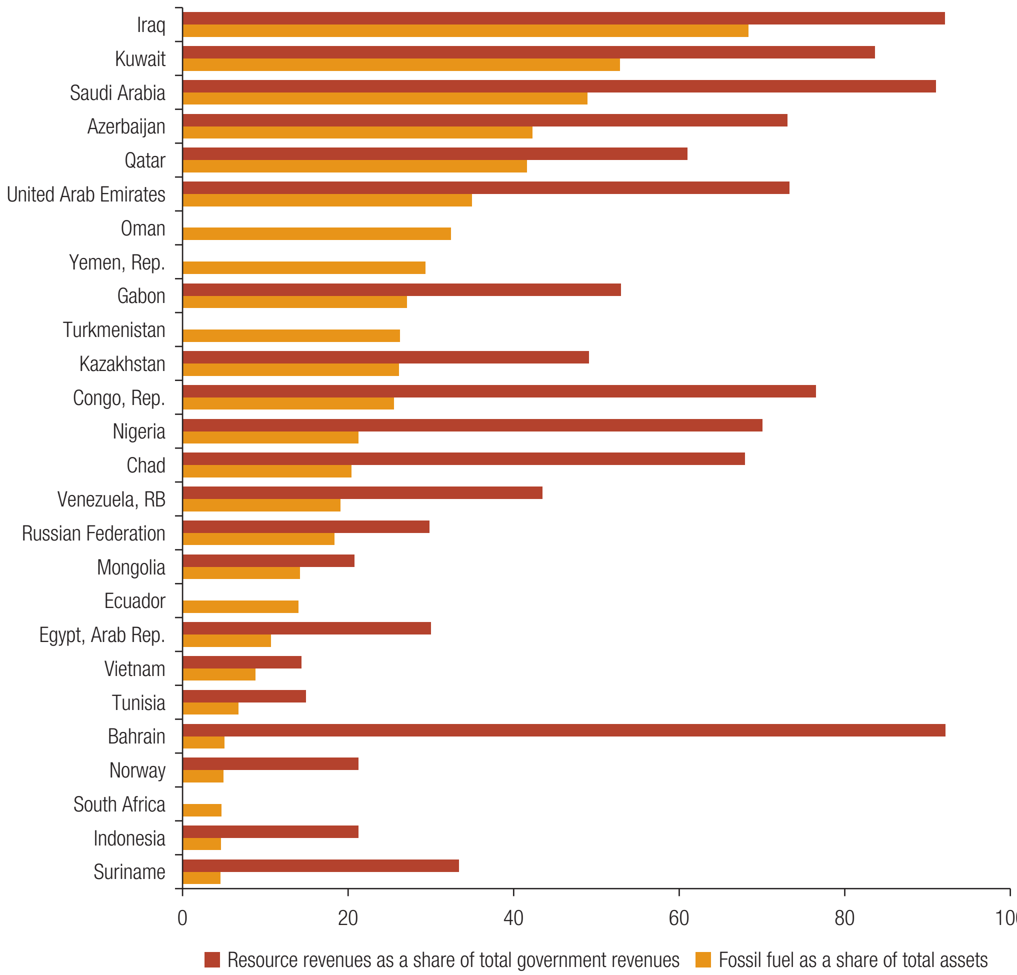
Of the 141 countries in the wealth database, 26 countries have at least 5 percent of their wealth in fossil fuels. The data show that the risk of a permanent drop in fossil fuel demand is worrisome for both poverty and geopolitical reasons. First, most of these countries are classified as low or middle 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.

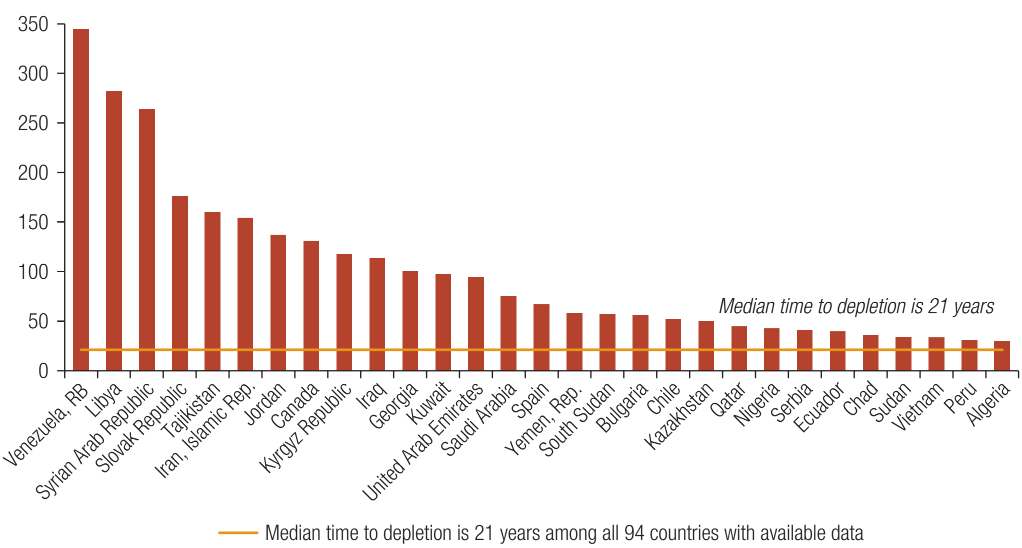
Challenge 2: Carbon-Rich Nations Cannot Easily Monetize Carbon Wealth

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; Sociѐté 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.

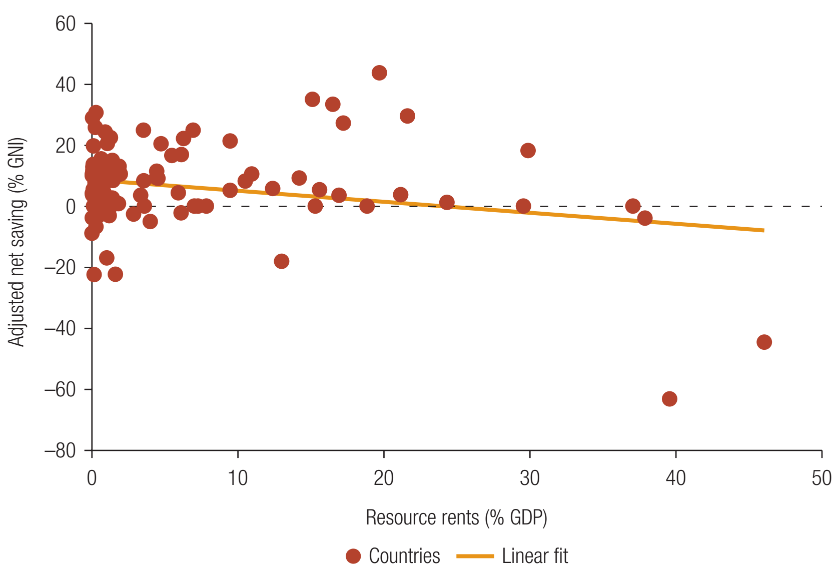
income generated from the depletion of fossil fuels, the depreciation of all forms of capital in the economy (including damage to natural capital), education and health expenditures (representing savings in the form of human capital), and the costs of air pollution damage. Relating to fossil fuel depletion, 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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6

Human Capital and the Wealth of Nations: Global Estimates and Trends

Kirk Hamilton, Quentin Wodon, Diego Barrot, and Ali Yedan

Main Messages

- Using for the first time a time series of household surveys, this chapter explains the motivations, concepts, and methods used in the measurement of human capital wealth and presents estimates for 141 countries.
- Human capital wealth is estimated as the present value of future earnings for the labor force. The estimates suggest that human capital accounts for the lion's share of a country's wealth, and typically a higher share in upper-middle-income and high-income countries than in poorer countries.
- Apart from country-wide estimates, the chapter includes estimates of human capital wealth by gender and type of employment. Globally, most human capital is associated with employed workers. But the human capital of the self-employed is a large share of the total in many of the poorest countries, where the agriculture sector and informal employment are significant.
- Gender shares of human capital wealth are significantly skewed toward men across most regions and income classes. North America had the highest female share in 2014, while South Asia had the lowest. Achieving gender parity in wage earnings and thereby human capital wealth could greatly enhance the wealth of nations.

Introduction

In the introduction to *An Inquiry into the Nature and Causes of the Wealth of Nations*, Adam Smith argued in 1776 that "the annual labour of every nation is the fund which originally supplies it with all the necessaries and conveniencies of life… [This fund] must … be regulated by the skill, dexterity, and judgment with which its labour is generally applied … whatever be the soil, climate, or extent of territory of any particular nation." What was true in 1776 remains true today. Human capital wealth is essentially defined in this report as the present value of the future flow of wages and other labor earnings of the population. As noted in chapter 2, human capital wealth—the result of a combination of skills, dexterity, judgment, and sheer labor as defined by Adam Smith—accounts for the lion's share of the total wealth of nations, as well as a growing share of wealth as countries achieve higher levels of economic development.

How large is human capital wealth and how is it measured? What do human capital wealth estimates tell us that other measures, such as GDP per capita or indicators of human development, do not? To what extent is human capital wealth growing, and what are some of the factors that affect human capital wealth? How is human capital wealth to be understood as a measure of human development, and what are the limits of this measure? These are some of the questions that this chapter considers to set the stage for more detailed analysis in subsequent chapters.

Although the recognition of the importance of human capital wealth is not new (Gu and Wong 2008; Hamilton and Liu 2014), this study is the first to provide measures of human capital wealth worldwide based on a time series of household surveys. This chapter explains the motivations, concepts, and methods used in the measurement of human capital wealth and presents estimates for 141 countries. In previous editions of the *Changing Wealth of Nations* reports (World Bank 2006, 2011), the focus was on produced and natural wealth. This left the largest component of the wealth of nations unexplained as "intangible wealth." The estimates provided here suggest that much of intangible wealth is actually human capital wealth. In this chapter, the focus is on broad trends. A more detailed discussion of human capital—together with illustrations of how to use the data for policy analysis—is provided in a companion volume to this study (Wodon forthcoming).

The chapter is organized in two main sections. First, it explains how the measures of human capital are estimated in this investigation. These measures of human capital deliberately rely on the economic benefits that a well-educated and healthy workforce generates. The emphasis on the role of human capital in generating income through wages and earnings does not imply in any way that this analysis is advocating for a "commodification" of human capacities that would overlook other essential benefits from investments in human development. For example, we are aware of the intrinsic value of a good education and good health. But for wealth accounting purposes, the focus is strictly on monetary estimates of wealth associated with human capital.

The next section provides summary results from the estimations. Both levels and trends in human capital wealth are discussed, as are some of the factors associated with higher levels of human capital wealth. A particular focus is placed on human capital wealth by gender, since the extent to which women participate in the labor force, are well educated, and benefit from earnings commensurate with their education has a large impact on these measures of human capital wealth. The chapter also briefly summarizes some of the other results presented in this part of the book to illustrate how the data can be used for simulations that can help make the case for specific programs and policies.

Measuring Human Capital Wealth

The concept of human capital wealth differs from that of human development or human capabilities. The term "capital" denotes a resource that can be used for economic production. A good education has an intrinsic value apart from the fact that it helps workers be better paid. Good health also is beneficial in itself, independent of its impact on production and wages. These important benefits are acknowledged, but they are not part of this research methodology. The emphasis is deliberately and solely on the economic benefits of a productive labor force. A more detailed explanation of the steps for the estimation of human capital wealth measures is provided by Barrot et al. (forthcoming).

Conceptual Approaches

Two basic approaches can be used to measure human capital wealth. The first approach is based on an analysis of investments in human development, typically with a focus on public spending for education. As an example, current figures on adjusted net saving published by the World Bank treat public sector expenditure on education as an investment. This method is technically correct from the point of view of wealth accounting, since these expenditures have the character of investment. But expenditures are measured on a gross basis, not net, since there is no netting out of human capital that retired or died in a given year. In addition, the measures do not include private expenditures on education. Finally, these measures are only loosely connected to the value of the human capital created, owing to inefficient expenditures, particularly in developing countries. Analyses of the relationship between investments by countries in their education (and health) systems and the performance of education (and health) systems often show that the links are not very strong—spending better is often more important than spending more.

The second approach looks at the valuation of the outcomes of investments in human development, not the investments themselves. This is the approach used here following Jorgensen and Fraumeni (1992a, 1992b). Human capital wealth is defined as the discounted value of future earnings for a country's labor force.[1] In other words, human capital wealth is considered to be an asset that generates a stream of future economic benefits (earnings). This approach fits well with the basic motivation for measuring a nation's wealth as distinct from its annual production or consumption. We seek a measure of wealth that informs us about likely future well-being. Note that this methodology essentially assumes that GDP is relatively stable, and in fact growing at a moderate rate, over the course of a working life (50 years). For most countries in most years, this is a reasonable assumption. But for countries that have recently experienced a natural disaster or a war, this assumption does not hold, and human capital estimates would need to build on an assumed recovery path for the economy.

Although this definition of human capital wealth as the present value of future labor earnings is conceptually simple, a number of steps must be undertaken for the estimations. Those steps and some of the choices involved in the empirical estimations are described below.

Earnings Profiles from Household Surveys

Since human capital wealth is defined here as the discounted value of future earnings for a country's labor force, the likelihood that various types of individuals will be working and how much they will earn when working need to be known. "Various types" of individuals means individuals categorized by age, sex, and level of education. Household surveys are used to construct a set of matrices that capture (1) the probability that individuals are working depending on their age, sex, and years of education; and (2) their likely earnings when working, again, by age, sex, and years of schooling. This is done separately for men and women.

The estimates of the likelihood of working are simply based on observed values in the available household and labor force surveys for the various countries. Following Montenegro and Patrinos (2016), the estimates of likely earnings are based on Mincerian wage regressions. The regressions enable us to compute expected earnings for workers throughout their working lives, taking into account sex, education, and assumed experience (computed on the basis of age and the number of years of education completed). Expected earnings are computed for all individuals in the surveys from age 15 to 65 years, noting that some individuals may go to school beyond age 15 years (for the purpose of these estimations until age 24 years). The analysis also takes into account the life expectancy of the labor force. In countries with high life expectancy, workers are expected to work until age 65 years, but in other countries they may not be able to.

Until recently, estimating wage regressions and the net discounted value of future wages for the labor force in many countries was not feasible because of a lack of standardized household survey data with which to conduct the estimations in a systematic way. Thanks to the availability of the World Bank's International Income Distribution Database of household and labor force surveys, the task can now be performed. The database provides access to surveys for 141 countries over more than 20 years (Montenegro and Hirn 2009). It is used to estimate both the likelihood of participation in the labor force by age, sex, and years of education and expected earnings, again by age, sex, and education level.

Adjustments to the National Accounts and Population Data

The household surveys used for the computation of the earnings profiles—as well as the probability of working—are nationally representative. The surveys are in most cases of good quality, but they may still generate estimates that are not consistent with either the System of National Accounts (EC et al. 2009) or population data for the countries. Therefore two adjustments are made.

First, to ensure consistency of the earnings profiles from the surveys with published data from the System of National Accounts, especially GDP figures, earnings estimates from the surveys are adjusted to reflect the share of labor earnings (including both the employed and the self-employed; see box 6.1) in GDP as available in the Penn World Table (Feenstra, Inklaar, and Timmer 2015). To explain why this adjustment is needed, consider a low-income country with many self-employed individuals in subsistence agriculture. Earnings as measured in a labor force or household survey may not adequately capture these workers,

BOX 6.1 Human Capital: Wealth, by Type of Employment

An innovation of this study is the estimation of human capital for the self-employed using new data from the Penn World Table (PWT) to supplement the World Bank's International Income Distribution Database. Self-employment is important in many countries, especially in the agricultural sector of developing countries. However, the earnings of the self-employed reported in national surveys typically combine profits plus returns to human capital, making it difficult to estimate the share of human capital attributed to self-employment in a systematic way across countries (given differences in survey design and questionnaires among countries).

Fortunately, as documented in Feenstra, Inklaar, and Timmer (2015), version 9.0 of the PWT provides estimates of the income of the self-employed in more than 130 countries. The PWT estimates draw on data on mixed income (i.e., total income earned by self-employed workers, including both capital and labor income) and make adjustments for returns to capital, persons employed as a share of total persons engaged from the International Labour Organization, and value added in agriculture in low-income countries with high agriculture shares of GDP. In countries where data on mixed income are available, the PWT distinguishes between the shares of returns to capital and those to labor in mixed income by using the observed shares for the employed. For poor countries where smallholder farming dominates the agricultural sector, the PWT treats all of the value added in agriculture as the return to self-employment. Although these estimations are by necessity relatively crude, potential errors with this approach in poor countries are limited by the fact that these countries often

(continued on next page)

BOX 6.1 Human Capital: Wealth by Type of Employment *(continued)*

have low capital inputs as well as by the relatively low land rents in agriculture-dependent economies.

Based on the PWT figures, and using regional averages to fill in gaps for countries not covered by the PWT, these estimates of human capital wealth augment the System of National Accounts' employee compensation figures to include compensation of the self-employed. This approach implicitly assumes that the age-sex-education structure of the self-employed is the same as that of the employed, which is likely not the case for the poorest countries where agriculture makes up the bulk of self-employment. This is again a limitation, but it is mitigated to the extent that the estimated earnings of the self-employed will tend to be quite low in these countries.

so that total earnings from the survey may be too low in comparison with the share of labor earnings in GDP. Version 9.0 of the Penn World Table provides estimates of the income of the self-employed 141 countries. In practice, the earnings profiles by age, sex, and years of education are adjusted up or down so that total earnings from the surveys match the labor share of labor earnings in the national accounts, considering both employed workers and the self-employed using Penn World Table data.

Second, and separately, the estimations also rely on two variables obtained from data compiled by the United Nations Population Division: population data by age and sex (so that the data in the household surveys can be better calibrated) and mortality rates by age and gender (so that the expected years of work can be adjusted, accounting for the fact that some workers will die before age 65 years). Again, data from the surveys are adjusted to population estimates from the United Nations to ensure that estimates are adequate (while nationally representative, and as a result of limited sample sizes, household surveys may not precisely estimate the exact distribution of the population by age and sex nor life expectancy). For those in the 15-to-24 years age group, the probability of being in school also has to be taken into account.

Choice of Discount Rate

Those familiar with present value computations recognize that the choice of discount rate can make a major difference in the estimates. A higher discount rate will generate lower values for human capital wealth, whereas a lower discount rate will lead to higher estimates of human capital wealth.

Human capital is calculated under the assumption that labor earnings grow at a constant rate g (owing to increases in efficiency) and are discounted at rate r. The discount factor used in the calculation of human capital is therefore $d = (1 + g)/(1 + r)$.

We assume that for all countries g and r are chosen such that this discount factor is $d = (1 + g)/(1 + r) = 1/(1.015)$. The effective discount rate used in calculating human capital is therefore 1.5 percent. This choice is somewhat arbitrary, but the resulting discount rate is not unrealistic. Simulations to test for the sensitivity of the results to these assumptions are provided in the more detailed analysis of human capital provided in the companion volume to this study (Wodon, forthcoming).

Coverage of Household Surveys and Gap Filling

Data from the System of National Accounts are available for all countries on a yearly basis, but data from household surveys are not. Although upper-middle-income and high-income countries may have annual surveys (or in some countries quarterly surveys), low-income and lower-middle-income countries often conduct labor or household surveys with detailed information on earnings only every few years. The latest household survey is used for estimates in subsequent years, until a new survey is available. This choice means that estimates from the latest available survey are carried forward in time, but still with adjustments based on data from the national accounts for the share of labor earnings in GDP.

In a handful of cases, estimates of labor earnings obtained from household surveys seemed to be off by a wide margin. In those few cases, interpolations were used instead. Finally, for countries from the Gulf Cooperation Council (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates), because no household survey data were publicly available, estimates of human capital wealth per capita were based instead on a simple estimation taking into account the countries' GDP per capita, labor share in GDP, and education level.

Estimates of Human Capital Wealth

This section provides estimates of human capital wealth across countries as well as trends over the 20-year period from 1995 to 2014. Data are provided for human capital wealth globally, as well as by groups of countries according to their income level. The objective of the section is not to conduct a detailed analysis, but rather to provide a few general facts about the observed patterns of growth in human capital wealth.

Global Estimates and Estimates by Income Group

As noted in chapter 2, global wealth stood at $1,143 trillion in 2014. This figure represents an increase in total wealth of 66 percent over 20 years—an average annual growth rate of 2.7 percent. Human capital wealth reached $737 trillion in 2014, an increase of 55 percent since 1995—an average annual growth rate of 2.3 percent. This chapter focuses on measures in per capita terms to control for population growth.

Total wealth stood at $168,580 per person in 2014 versus $128,929 in 1995. Human capital wealth stood at $108,654 per person in 2014 versus $88,874 in 1995. Thus, human capital accounts for slightly less than two-thirds of total global wealth. Note that the estimates depend on a number of assumptions described earlier, including the choice of discount factor. The share of human capital wealth in total wealth has declined slightly over time. With an average annual growth rate of 1.0 percent over the past two decades, human capital wealth per capita increased by 22 percent, versus 31 percent for total wealth per capita. This decline in the share of human capital wealth in global wealth has not occurred in all countries, only in comparatively richer countries.

In table 6.1, aggregate data are provided globally as well as for groups of countries according to their level of economic development. Five groups of countries are considered: low income, lower-middle income, upper-middle income, high-income non–Organisation for Economic Co-operation and Development (OECD), and high-income OECD. Inequality in human capital wealth as well as total wealth is high. In high-income OECD countries, total wealth per capita is greater than $700,000, and human capital wealth alone is at close to $500,000 per person. This is not far from 100 times more than the levels observed in low-income countries, where human capital wealth is an estimated $5,564 per person.

At the global level, the dynamics of human capital wealth accumulation are driven primarily by shifts taking place in OECD and upper-middle-income countries because those countries account for 87 percent of global wealth (65 percent for the OECD, and 22 percent for upper-middle-income countries). The proportions are even larger for human capital wealth. In these countries, the share of human capital wealth in total wealth is falling. Recall from the methodology section that the estimates of human capital wealth are anchored in the share of labor earnings in GDP. For some time, labor earnings as a share of GDP have declined in OECD countries because of technological change, stagnating wages, and in many countries a reduction in the share of the population in the labor force, due in part to aging.

By contrast, the share of human capital wealth in total wealth is rapidly increasing in low-income and lower-middle-income countries. This share increased from 34 percent to 41 percent over two decades in low-income countries, and from 45 percent to 51 percent in lower-middle-income countries. Many of these countries are experiencing a demographic transition and are reaping the benefits of the demographic dividend as population growth rates are declining and the population is becoming better educated. We thus have diverging trends for poorer and richer countries in the increasing or decreasing role played by human capital over time. However, overall it is clear that as countries achieve higher levels of economic development, human capital wealth clearly dominates, whereas at lower levels of economic development, produced and natural capital (not shown in table 6.1) tend to be larger.

Statistics provided in table 6.1 on growth rates in human capital wealth per capita are illustrated in figure 6.1. The statistics suggest that growth in human capital wealth tends to be higher in countries at lower or middle levels of economic development than it is in high-income countries. This would be akin to the convergence often observed in GDP per capita, but in this case the convergence is evident for human capital wealth per capita. The fact that growth rates are indeed higher at lower

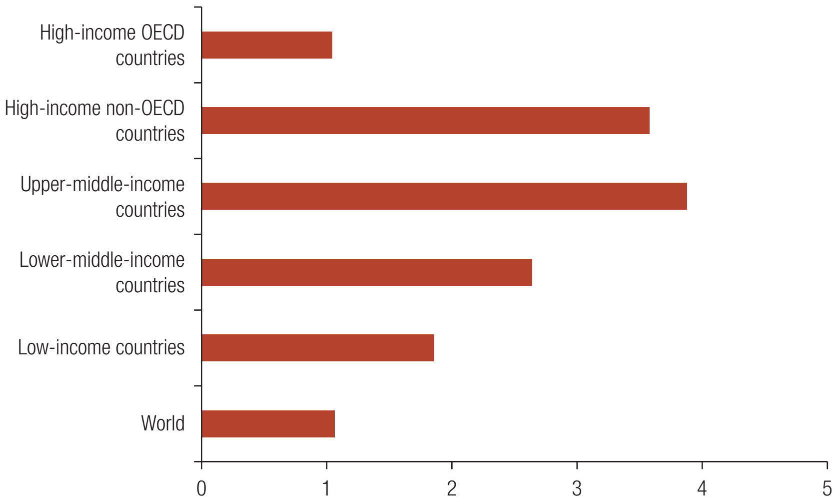
TABLE 6.1 Trends in Wealth Per Capita, by Level of Development, 1995–2014

	1995	2000	2005	2010	2014	Annual growth (%)
World						
Total wealth per capita (US$)	128,929	138,064	145,891	158,363	168,580	1.42
Human capital per capita (US$)	88,874	96,478	97,707	102,170	108,654	1.06
Human capital as share of total (%)	69	70	67	65	64	
Low-income countries						
Total wealth per capita (US$)	11,601	10,435	10,240	11,802	13,629	0.85
Human capital per capita (US$)	3,921	4,016	4,046	4,447	5,564	1.86
Human capital as share of total (%)	34	38	40	38	41	
Lower-middle-income countries						
Total wealth per capita (US$)	17,718	16,745	19,426	23,675	25,948	2.03
Human capital per capita (US$)	7,992	7,917	9,301	11,421	13,117	2.64
Human capital as share of total (%)	45	47	48	48	51	
Upper-middle-income countries						
Total wealth per capita (US$)	51,142	57,623	66,224	93,811	112,798	4.25
Human capital per capita (US$)	31,906	36,716	38,526	54,740	65,742	3.88
Human capital as share of total (%)	62	64	58	58	58	
High-income non-OECD countries						
Total wealth per capita (US$)	163,827	163,232	194,243	241,224	264,998	2.56
Human capital per capita (2014 $)	57,319	67,122	79,265	103,229	111,793	3.58
Human capital as share of total (%)	35	41	41	43	42	
High-income OECD countries						
Total wealth per capita (US$)	547,419	614,791	653,078	672,866	708,389	1.37
Human capital per capita (US$)	408,992	458,949	472,722	471,270	498,399	1.05
Human capital as share of total (%)	75	75	72	70	70	

Source: World Bank calculations.
Note: Figures are in constant 2014 US dollars at market exchange rates. OECD = Organisation for Economic Co-operation and Development.

levels of human capital wealth per capita appears even more clearly when looking at data for individual countries, as opposed to the aggregated data in table 6.1, which tends to give greater weight to larger countries. Chapter 7 provides a more detailed analysis of trends in human capital wealth by gender, suggesting that there is some level of convergence, both statistically (higher growth rates in human capital

FIGURE 6.1 Annual Growth Rates in Human Capital Wealth Per Capita, 1995–2014
percent



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

wealth per capita in countries with lower initial levels of wealth) and econometrically (the difference in growth rates persists in regression analysis after controlling for other factors likely to affect growth in human capital wealth per capita over time).

Regional Trends in Human Capital Wealth

Table 6.2 considers an alternative grouping for countries by geographic location. The highest growth rate in human capital per capita was observed in South Asia (4.0 percent), followed by the Middle East and North Africa and East Asia and Pacific (both at 2.3 percent), and Sub-Saharan Africa (1.6 percent). Sub-Saharan Africa has experienced a decrease in total wealth over time related, in part, to declining prices of commodities. In the three other regions (Europe and Central Asia, Latin America and the Caribbean, and North America), the average annual growth rate in human capital per capita was less than 1.5 percent. These three regions also have comparatively higher levels of development and more significant pressures from declining labor shares in GDP.

Components of Human Capital Wealth

Apart from estimates of total human capital wealth, the estimation procedure in this volume generates estimates of human capital wealth by gender and by type of employment (employed versus self-employed),

TABLE 6.2 Trends in Wealth Per Capita, by Region, 1995–2014

	1995	2000	2005	2010	2014	Annual growth (%)
East Asia and Pacific						
Total wealth per capita (US$)	76,102	83,618	89,773	117,983	140,042	3.26
Human capital per capita (US$)	54,919	57,894	56,454	71,643	84,334	2.28
Human capital as share of total (%)	72	69	63	61	60	
Europe and Central Asia						
Total wealth per capita (US$)	279,651	300,506	327,765	355,495	368,233	1.46
Human capital per capita (US$)	175,863	193,142	206,622	219,664	227,581	1.37
Human capital as share of total (%)	63	64	63	62	62	
Latin America and the Caribbean						
Total wealth per capita (US$)	108,351	109,692	117,115	130,960	138,294	1.29
Human capital per capita (US$)	66,961	70,415	71,791	79,225	82,750	1.12
Human capital as share of total (%)	62	64	61	60	60	
Middle East and North Africa						
Total wealth per capita (US$)	91,203	95,076	113,731	143,965	158,892	2.96
Human capital per capita (US$)	35,620	39,177	44,513	50,440	54,871	2.30
Human capital as share of total (%)	39	41	39	35	35	
North America						
Total wealth per capita (US$)	782,370	901,889	962,329	945,004	986,621	1.23
Human capital per capita (US$)	622,124	724,656	751,682	720,485	762,896	1.08
Human capital as share of total (%)	80	80	78	76	77	
South Asia						
Total wealth per capita (US$)	9,251	10,523	12,511	15,710	18,400	3.69
Human capital per capita (US$)	4,454	5,541	6,885	8,033	9,393	4.01
Human capital as share of total (%)	48	53	55	51	51	
Sub-Saharan Africa						
Total wealth per capita (US$)	26,403	21,964	22,669	25,362	25,562	–0.17
Human capital per capita (US$)	9,397	8,771	8,507	11,298	12,680	1.59
Human capital as share of total (%)	36	40	38	45	50	

Source: World Bank calculations.
Note: Figures are in constant 2014 US dollars at market exchange rates.

as well as for a combination of the two. The differences by gender and type of employment can be large. For example, in most countries, self-employed workers tend to fare worse in earnings than wage workers, simply because in low- and lower-middle-income countries, a large share of the self-employed are working in subsistence agriculture.[2] In addition, women also tend to fare worse than men in earnings, because of both lower education levels and a higher likelihood of being self-employed.

Globally, women account for just 39 percent of human capital wealth, versus 61 percent for men. The differences are even more striking for types of employment. Globally, self-employed workers account for only 12 percent of human capital wealth, while employed workers account for 88 percent. Global figures can be misleading for most countries, simply because most human capital wealth is concentrated in upper-middle- and high-income countries, so that these countries are more heavily weighted in global estimates.

When looking at country-specific patterns, a number of interesting findings emerge. Figures 6.2 and 6.3 show the relationship between the share of human capital wealth attributed to men (both employed and self-employed) and the share attributed to self-employed workers (both men and women) as a function of the level of human capital wealth achieved, which is itself highly correlated with GDP per capita.

Figure 6.2 shows a weak downward relationship between the share of human capital attributed to men and the level of human capital wealth. Countries with higher levels of human capital wealth have slightly higher shares of wealth attributed to women. But there is also a lot of variation around the central tendency. This variation suggests that apart from human capital wealth, or more generally, levels of economic

FIGURE 6.2 Male Share in Human Capital Wealth, 2014

Source: World Bank calculations.

FIGURE 6.3 Self-Employed Share in Human Capital Wealth, 2014

Source: World Bank calculations.

development (given that the two measures are closely correlated), other factors such as cultural norms may play an important role in differences in earnings between men and women. It is interesting to note that the variance around the central tendency is smaller at higher levels of human capital wealth per capita, suggesting more homogeneity at those levels in the gender shares of human capital wealth.

By contrast, the relationship between human capital wealth (or economic development) and the share of the wealth attributed to the self-employed is much stronger in figure 6.3. Even though there is again quite a bit of variation around the central tendency, it is clear that the importance of self-employment is much higher in countries with lower levels of human capital wealth, as well as lower levels of economic development. This finding was expected, given that in those countries many individuals are working in subsistence agriculture and in very small businesses in the informal sector rather than in wage employment.

Potential Benefits from Equity in Human Capital Wealth

The estimates of the shares of human capital wealth by gender or type of employment can be used to conduct simple simulations of the gains that could be achieved from more equity in earnings and thereby gains in human capital wealth by gender or by type of employment.

Consider the case of gender differences in human capital wealth. The drivers of these differences include differences in educational attainment and labor force participation between men and women. However, other factors also play a role, including (1) careers that are interrupted for childbearing; (2) penalties for child care, as women work part time to meet family needs, and as employers question the commitment of women to their careers; (3) preferences on the part of women for occupations that may be lower paid, an effect that is often reinforced by preferences for fields of study that lead to such occupations; and (4) a lack of women in leadership positions in the workforce. Gender discrimination fosters and reinforces many of these negative influences on women's earnings.

Despite a global trend toward greater gender parity in human capital wealth over time globally, not all country income groups have followed the trend, and progress has been fairly slow. Major gains in human capital wealth could still be achieved with gender equity. Globally, as shown in table 6.3, women account for less than 40 percent of human capital wealth. These are also essentially the proportions observed for upper-middle- and high-income OECD countries, which account for the bulk of total wealth, including human capital wealth. By contrast, in low-income and lower-middle-income countries, women account for only a third or less of human capital wealth.

Differences between regions are even more striking. The region with the largest difference in human capital wealth by gender is South Asia,

TABLE 6.3 Shares of Human Capital Wealth, by Gender, 1995–2014
percent

	Male share					Female share				
	1995	**2000**	**2005**	**2010**	**2014**	**1995**	**2000**	**2005**	**2010**	**2014**
World	63	63	62	61	61	37	37	38	39	39
Income group										
Low-income countries	66	66	66	68	67	34	34	34	32	33
Lower-middle-income countries	72	74	73	70	70	28	26	27	30	30
Upper-middle-income countries	60	58	61	60	60	40	42	39	40	40
High-income non-OECD countries	57	58	57	56	56	43	42	43	44	44
High-income OECD countries	64	64	62	61	61	36	36	38	39	39
Regions										
East Asia and Pacific	68	67	68	65	65	32	33	32	35	35
Europe and Central Asia	62	62	61	61	61	38	38	39	39	39
Latin America and the Caribbean	61	57	58	57	56	39	43	42	43	44
Middle East and North Africa	60	61	60	59	59	40	39	40	41	41
North America	62	62	60	59	59	38	38	40	41	41
South Asia	83	84	85	82	82	17	16	15	18	18
Sub-Saharan Africa	60	60	58	61	61	40	40	42	39	39

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

where 82 percent of human capital wealth is attributed to men in 2014. At the other extreme is North America, where 59 percent of human capital wealth is attributed to men. Europe and Central Asia and Sub-Saharan Africa are not far behind, with 61 percent of human capital wealth attributed to men.

Table 6.4 provides a simple measure of the gender gap in human capital wealth, defined as the ratio of the human capital wealth of women divided by that of men in a country. In low-income and lower-middle-income countries, the gender gap ratio is especially low, less than 0.50. In other words, women in those countries have, on average, levels of human capital wealth below half the levels observed for men. In countries with higher levels of economic development, the gender gap ratio is higher, but still well below parity.

Assume for simplicity that the working-age population is equally divided between men and women. Then, if the earnings of women were on par with those of men, the human capital wealth of women would rise considerably. Assuming no decrease in the human capital wealth of men, the resulting gains in human capital wealth (NG) can be estimated as NG = (100 − gender gap ratio) × 0.50/100. As shown in table 6.4, human capital wealth worldwide could increase by 18 percent with gender parity. In low-income and lower-middle-income countries where

TABLE 6.4 Potential Gains in Human Capital Wealth from Gender Equity, 1995–2014

	Gender gap ratio (×100) (ratio of human capital wealth by gender)					Potential gain from gender equity (percentage increase from base)				
	1995	2000	2005	2010	2014	1995	2000	2005	2010	2014
World	58	59	61	64	63	21	21	20	18	18
Income group										
Low-income countries	52	51	51	48	49	24	24	24	26	26
Lower-middle-income countries	39	36	37	43	42	31	32	31	29	29
Upper-middle-income countries	67	72	65	68	67	16	14	17	16	17
High-income non-OECD countries	74	72	75	79	77	13	14	12	11	11
High-income OECD countries	57	57	61	64	63	21	21	20	18	18
Region										
East Asia and Pacific	47	49	48	53	54	26	25	26	23	23
Europe and Central Asia	62	62	64	65	64	19	19	18	18	18
Latin America and the Caribbean	64	74	74	77	79	18	13	13	12	11
Middle East and North Africa	66	63	66	71	70	17	19	17	15	15
North America	627	61	65	70	70	19	20	17	15	15
South Asia	21	18	18	22	22	39	41	41	39	39
Sub-Saharan Africa	66	66	72	65	64	17	17	14	18	18

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

levels of wealth are lower, the gains would be larger. The differences between regions are especially striking. As mentioned earlier, South Asia has the largest differences in human capital wealth by gender. In that region, if gender parity were achieved, human capital wealth would increase nationally by almost 40 percent. These simple simulations do not account for the general equilibrium impact that an influx of women into the labor market might generate, and thereby tend to overestimate the benefits that could result from gender equity. Still, these simple estimates show that major gains in human capital wealth per capita could be achieved if women were able to work more and earn more.

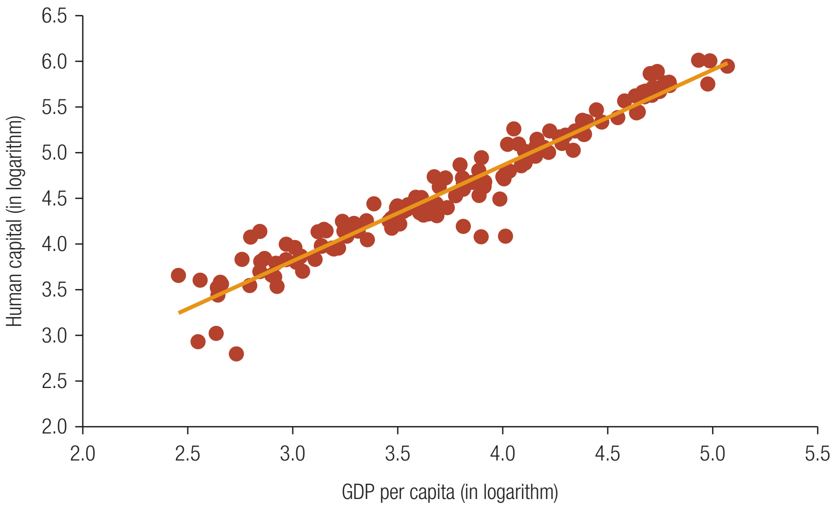
Finally, it is worth noting that the differences in human capital wealth by gender are not likely to be related to lower returns to education for women. A large body of evidence suggests that the returns to education are often higher for women than for men. Using data from 1970 to 2014, Montenegro and Patrinos (2016) find that globally the returns to education for women are 1.26 times those for men, with the highest ratio, 1.46, in South Asia and the lowest, 1.10, in East Asia and Pacific. Dougherty (2005) considers various explanations for the higher returns for women in the United States. Contributors to the gender pay gap can be grouped into discrimination, taste (preferences for certain occupations), and circumstances (related to child care needs). At least for the Unites States, higher educational attainment could enable women to overcome the handicaps associated with discrimination, tastes, and circumstances through, for example, better bargaining. Since men do not suffer such handicaps, the result would be higher female returns to education.

Human Capital Wealth and GDP Per Capita

The core findings from the estimates of human capital presented above are not really surprising. Overall, estimates of human capital wealth per capita are closely correlated with GDP per capita. Building on the underlying growth theory, previous issues of the *Changing Wealth of Nations* reports (World Bank 2006, 2011) measured total wealth as the present value of consumption in the national accounts. Since consumption typically accounts for 80 percent of GDP in many countries, this led to an almost perfect correlation between wealth estimates and GDP, whether in aggregate levels or per capita. Rankings of countries according to their total wealth per capita and their GDP per capita were therefore almost identical.

In this chapter, the large "intangible" wealth that was unaccounted for in previous estimates of the wealth of nations is now largely accounted for by the estimates of human capital wealth based on the present value of future earnings. But since labor earnings typically account for about 60 percent of GDP (with some differences depending on the country), estimates of human capital wealth per capita are again strongly correlated with GDP per capita. The orders of magnitude of the two estimates are different, with human capital wealth per capita typically seven to ten times larger than GDP per capita in most countries. Yet the two measures remain highly correlated. This relationship is shown in figure 6.4,

FIGURE 6.4 Human Capital Wealth Per Capita and GDP Per Capita



Source: World Bank calculations.

where both measures are provided in logarithm. A simple univariate regression of human capital wealth on GDP per capita generates an R^2 of 93 percent (results are similar for a regression in levels).

The fact that human capital wealth and GDP are correlated does not imply, however, that all countries perform similarly, or that similar policies to boost wealth would apply to all countries. The development challenge for a low-income country with heavy dependence on agricultural land and labor is very different from that of a middle-income country with substantial produced capital. The policy context is again different, for example, for resource-rich countries, or high-income countries where human capital wealth truly dominates. Because of limited space, the focus in this chapter is on describing broad patterns and trends in human capital wealth. The data can be used for a wide range of policy simulations that take into account the countries' specific circumstances, as shown in subsequent chapters.

Conclusion

This chapter provides the first-ever set of comparable estimates of human capital wealth based on a time series of household surveys for a large number of countries over two decades, from 1995 to 2014. The estimates suggest that human capital accounts for the lion's share of a country's wealth, and typically a higher share in upper-middle-income and high-income countries than in poorer countries. Essentially, the large "intangible capital residual" that was referred to in the previous edition of *The Changing Wealth of Nations* (World Bank 2011) turns out to be, for the most part, human capital wealth. These estimates suggest that investing in human capital can be the springboard for diversification of national wealth and the economy, reducing many countries' dependence on natural capital and the commodity-driven boom and bust cycles common to so many low- and middle-income countries.

This chapter focuses solely on human capital as a productive asset that produces a stream of benefits—future wages. This approach fits well with the notion of comprehensive wealth used in previous volumes of the *Changing Wealth of Nations*. This is not to deny that education, good health, and knowledge are not sources of well-being in and of themselves, or that doing a job well is one of the great human pleasures. It simply reflects a focus that is useful for assessing and guiding economic policy.

Apart from countrywide estimates, this chapter also provides estimates of human capital wealth by gender and type of employment. The human capital of the self-employed is a large share of the total in many of the poorest countries where the agriculture sector and informal employment are significant. Gender shares of human capital wealth are significantly skewed toward men across most regions and income classes. North America had the highest female share in 2014, while South Asia had the lowest. This also means that achieving gender parity in wage earnings, and thereby human capital wealth, could greatly enhance the wealth of nations.

The estimates provided in this chapter should be considered a first attempt at measuring human capital wealth within a coherent national accounts framework. In future work, a number of improvements to the methodology used here could be undertaken. But even with the data now available, additional analysis as well as simulations can be undertaken to inform policy, as illustrated in the companion volume to this study focusing on human capital (Wodon, forthcoming).

Notes

1. See also Fraumeni (2008) and Hamilton and Liu (2014) for a basic introduction to the literature on human capital measurement.
2. Note, however, that data are not available on the age-sex-education structure of the self-employed and this structure is assumed to be the same as for the wage employed. Although this assumption does not affect total estimates for self-employed earnings, it does affect estimates by age, sex, and education. This chapter does not consider estimates of self-employed earnings by age, sex, or education—only overall estimates are provided.

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7

Gains in Human Capital Wealth: What Growth Models Tell Us

Ada Nayihouba and Quentin Wodon

Main Messages

- This chapter describes an analysis, conducted separately for men and women, of some of the factors that may affect the growth in the human capital wealth of nations on a per capita basis. Higher rates of population growth tend to reduce the rate of growth in human capital wealth, while growth in the labor force has the opposite effect. Investments in human capital to increase the average years of schooling of the adult population (as a proxy for better education) as well as life expectancy (as a proxy for better health) have a positive effect on growth in human capital wealth per capita.
- The results underscore the importance of investments in education and health (for life expectancy) to achieve growth in human capital wealth. They also emphasize the large role that demographic and labor market factors play in enabling countries to achieve higher rates of human capital wealth per capita.

Introduction

Estimates provided in chapters 2 and 6 suggest that human capital wealth accounts for the largest share of the wealth of nations, and in most cases (with the exception of some high-income countries) a larger share of wealth as countries achieve higher levels of economic development. This finding broadly suggests that investing in human capital is a smart strategy for countries to use to improve the well-being of their populations in a sustainable way over long periods. Annual aggregate income, as measured, for example, by GDP per capita, can be broadly conceived of as the return to a country's wealth, including produced, natural, and human capital.

How can countries promote high levels of growth in human capital wealth, and thereby in total wealth? The objective of this chapter is to consider some of the factors that affect growth in human capital wealth using techniques from the literature on growth modeling. Special emphasis is placed on the role that changes in population growth—as well as changes in the growth of the labor force—may play in boosting human capital wealth per capita. The chapter also discusses the importance of investing in education and health as well as the need to maintain sound macroeconomic fundamentals. The analysis considers the human capital wealth of men and women separately.

The emphasis placed in this model and empirical analysis on population growth, as well as growth in the labor force, stems from the renewed attention policy makers are paying to the demographic structure of populations under the concept of the demographic dividend. At the World Bank, the 2015–16 *Global Monitoring Report* was devoted to the demographic dividend (World Bank 2016a), as was a major report completed for the Africa Region (Canning, Raja, and Yazbeck 2015). In January 2017, the Africa Union organized a key meeting in Addis Ababa on harnessing the demographic dividend for the realization of the Sustainable Development Goals. These are just a few examples of the recognition of the importance of demography for growth and development. Countries in the earlier stages of the demographic transition are well placed to take advantage of the demographic dividend. But to do so, a number of policies must be put in place.

Several cross-country analyses of economic growth have suggested a one-to-one negative relationship between population growth and growth in GDP per capita. This finding is not surprising, since growth in GDP per capita is mathematically the difference between GDP growth and population growth. When population growth is high, we expect growth in GDP per capita to be negatively affected. But it is an important empirical finding that this relationship holds not only as an accounting identity, but also when estimating the correlates of economic growth using cross-country panel data. For example, it has been suggested that demographic change has been a key factor contributing to the high economic growth rates observed in Asia often referred to as the Asian miracle (Bloom and Williamson 1998; Bloom and Finlay 2008). By contrast, high fertility and population growth rates have contributed to Africa lagging behind (Bloom and Sachs 1998; Bloom et al. 2007), but there are now opportunities for this to change (Canning, Raja, and Yazbeck 2015).

Taking inspiration from the literature on economic growth as measured by GDP per capita, this chapter considers the correlates of growth in the human capital wealth of nations. The chapter applies a standard growth model to uncover some of the factors that may affect growth in human capital wealth per capita. The chapter outlines the methodology for estimating human capital wealth per capita, provides basic data on human capital wealth by gender, presents the theoretical model for some of the factors likely to affect growth in human capital wealth per capita provides a brief description of the data used in the estimation of the growth model, and describes the estimation results.

Measures of Human Capital Wealth

This chapter relies on the data provided in chapter 6 to model factors that may affect changes in human capital wealth over time. The main variable of interest—the dependent variable in these regressions—is the growth rate in human capital wealth per capita. The estimation of human capital wealth follows the procedure suggested by Jorgensen and Fraumeni (1992a, 1992b) and is discussed within the context of the broader literature on human capital by Fraumeni (2008) and Hamilton and Liu (2014), among others. Details on the construction of the estimates are provided in Barrot et al. (forthcoming).

The estimation of the human capital wealth of countries is based on wage regressions used to compute expected earnings for individuals over their lifetimes by gender, age, and education level (see Barrot et al. [forthcoming] for details). Labor force and household surveys are used to measure the number of workers according to age, sex, and education level, as well as their earnings. The procedure for the estimation of the wage regressions follows Montenegro and Patrinos (2016). Mincerian regressions provide estimates of the returns to schooling and experience. Estimations are conducted using a large number of surveys from the World Bank's International Income Distribution Database (Montenegro and Hirn 2009).

Total earnings observed in the labor force surveys at the country level are adjusted to match estimates of the wage share in the national accounts for both employed workers and the self-employed (Feenstra, Inklaar, and Timmer 2015). This adjustment is based on data from the Penn World Table. The adjustment is used to ensure compatibility between estimates of human capital wealth and other estimates of wealth for countries that are not used here. To construct estimates of the discounted lifetime earnings of workers, population data as well as mortality rates by age and gender from the United Nations Population Division are used. The discount factor for calculating the present value of future earnings estimates from the surveys is set at 1/1.015 per year.

The analysis in this chapter is carried out for two different periods: 1995 to 2010 and 1995 to 2014. The main reason for considering two different periods in the estimations is that doing so provides a simple robustness test. But in addition, for some countries, although recent household surveys may have been implemented, they may not yet have been made publicly available for analysis. In that case, estimates of human capital wealth in 2014 must be based on older surveys, which could generate a small bias in the estimates of wealth and thereby possibly for the analysis. Broadly speaking, many of the empirical results turn out to be similar for both periods, but the results obtained for the period 1995–2010 are slightly better at yielding the results that the theoretical model suggests.

Table 7.1 provides summary statistics on the levels of human capital wealth globally and by income group. Differences between countries are massive. Whereas human capital wealth per capita is close to $500,000 in high-income Organisation for Economic Co-operation and Development (OECD) countries, the corresponding value for low-income countries is only slightly more than $5,500.

Apart from estimates of total human capital wealth, the estimation procedure generates estimates of human capital wealth by gender. Globally, as shown in table 7.1, women account for nearly 40 percent of human capital wealth. This is also the proportion observed for upper-middle- and high-income OECD countries, which account for the bulk of human capital wealth and thereby have a higher weight in global estimates. By contrast, in low-income and lower-middle-income countries, women

TABLE 7.1 Levels and Gender Shares in Human Capital Wealth, by Income Group, 1995–2014

	1995	2000	2005	2010	2014
World					
Human capital wealth per capita (US$)	88,874	96,478	97,707	102,170	108,654
Men's share (%)	63	63	62	61	61
Women's share (%)	37	37	38	39	39
Low-income countries					
Human capital wealth per capita (US$)	3,921	4,016	4,046	4,447	5,564
Men's share (%)	66	66	66	68	67
Women's share (%)	34	34	34	32	33
Lower-middle-income countries					
Human capital wealth per capita (US$)	7,992	7,917	9,301	11,421	13,117
Men's share (%)	72	74	73	70	70
Women's share (%)	28	26	27	30	30
Upper-middle-income countries					
Human capital wealth per capita (US$)	31,906	36,716	38,526	54,740	65,742
Men's share (%)	60	58	61	60	60
Women's share (%)	40	42	39	40	40
High-income OECD countries					
Human capital wealth per capita (US$)	408,992	458,949	472,722	471,270	498,399
Men's share (%)	64	64	62	61	61
Women's share (%)	36	36	38	39	39

Source: World Bank calculations.
Note: Income categories are skewed by lack of data by gender for China and the Gulf Cooperation Council countries. Figures are in constant 2014 US dollars at market exchange rates. OECD = Organisation for Economic Co-operation and Development.

account for only a third or less of human capital wealth. Many countries, but not all, have made progress toward greater gender parity in human capital wealth, but only slowly.

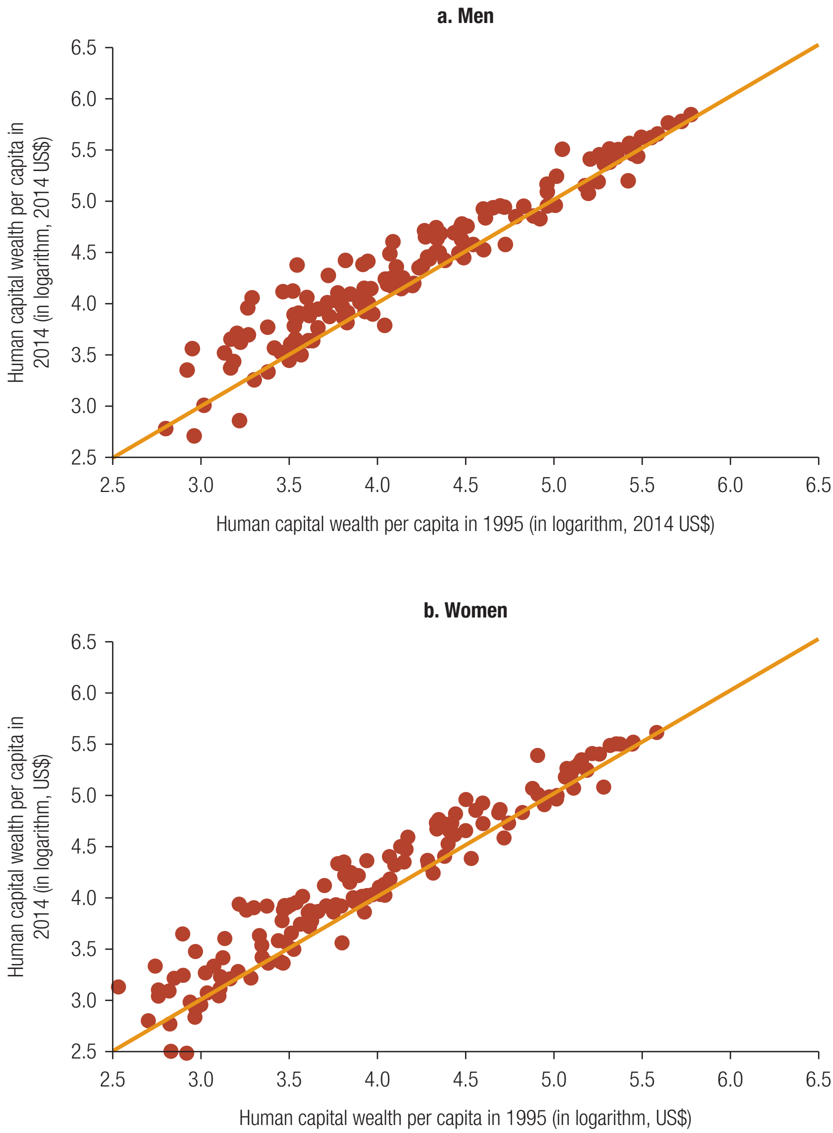
Why are there differences between men and women in human capital wealth? The reasons are multiple, but two factors stand out. First, men have higher labor force participation rates than women in many countries, and they often work more hours in "productive work." Women tend to work, on average, more hours than men overall, but a much larger share of this work is dedicated to "domestic work," so they tend to have lower earnings. In addition, men tend to earn more than women when they are working. Part of the wage gap by gender is due to differences in educational attainment between men and women, which itself is often due to deeply entrenched social norms, but other factors also play a role, including various forms of gender discrimination. The reasons leading to a gender wage gap in both earnings and labor force participation are not discussed in this chapter. But it should be noted that the growth in human capital wealth per capita attributed to women is slightly higher than that attributed to men, suggesting that women may be very slowly catching up with men.[1]

Convergence in Human Capital Wealth?

To set the stage for the analysis of the drivers of growth in human capital, figure 7.1 displays scatterplots for the levels of human capital wealth per capita estimated in 1995 and in 2014. This estimation is made separately for men and women. Since estimates are in logarithms, the difference between values for 2014 and the diagonal for a country approximately represents (when estimates are not too large) the cumulative growth in human capital per capita observed over two decades for that country. The same scales are used for both figures to facilitate comparisons by gender.

Several insights emerge from the figure. First, for both men and women, most countries lie above the diagonal, suggesting that an overwhelming majority of countries benefited from an increase in human capital wealth per capita between 1995 and 2014. However, a few countries have lost ground, often because of a conflict or other shock. Second, as already mentioned, the levels of human capital wealth tend to be lower for women than for men—the values on the horizontal axis of the scatter plot for men tend to be slightly to the right of the values on the scatter plot for women. Third, and important for the topic of this chapter, growth rates in human capital tend to be higher for lower-income countries, that is, the observations in the scatter plots for lower-income countries tend to be located farther away from the diagonal than the observations for higher-income countries. In other words, there appears to be some level of convergence in human capital wealth, with poorer countries catching up. This is evident for both men and women.

FIGURE 7.1 Convergence in Human Capital Wealth Per Capita, by Gender



Source: World Bank calculations.
Note: Figures are in constant 2014 US dollars at market exchange rates.

That there appears to be some level of convergence in human capital wealth, with higher growth rates for lower-income countries, should not be too surprising given major investments made in the past two decades to improve education levels and to improve the health of populations. In many countries, the benefits from the demographic transition also are starting to make a difference, generating higher estimates of human capital wealth, in part because a larger share of the population is of working age.

Finally, economic growth rates have also been higher in much of the developing world than in high-income countries in the past two decades. However, the apparent convergence does not mean that poorer countries are catching up quickly—the differences in estimates of human capital wealth between countries remain massive, as shown in table 7.1.

Modeling Human Capital Wealth Per Capita

This chapter's objective is to assess some of the factors that may lead to faster growth in human capital wealth per capita. As discussed in chapter 6, the measure of human capital wealth per capita is based on estimates of the discounted value of future wages for the working population. Therefore, when looking at the correlates of growth in human capital wealth per capita, it makes sense to explicitly factor in not only general conditions that make the labor force productive, such as macroeconomic characteristics of the economy and aggregate measures of human capital such as the level of education and health status of workers, but also growth of the population and of the labor force.

The model is inspired by the growth literature, but instead of looking at growth in GDP per capita, it looks at growth in human capital wealth per capita. H is the human capital wealth of a nation, P is its population size, and L is the size of the actual labor force. Human capital wealth per capita can be expressed as H/P = (H/L) × (L/P). In logarithm, this is expressed as $\log(H/P) = \log(H/L) + \log(L/P)$. To simplify notations, denote the logarithm of human capital per capita by h and the logarithm of human capital per worker by z, so that $z = h - \log(L/P)$. The growth in human capital per capita (g_h) is equal to growth in human capital per worker (g_z) plus growth in the labor force (g_L) minus growth in the population (g_P), so $g_h = g_z + (g_L - g_P)$.

In growth models, it is common to consider the variable of interest (GDP per capita growth) as a function of the steady-state level of the variable under consideration and current conditions represented by the initial value of that variable. The same approach is used here for human capital wealth per capita. To introduce directly into the model the role of the labor force, denote by z^* the steady-state level of the logarithm of human capital per worker and by z_0 the initial value. The growth rate in human capital wealth per worker can be expressed as $g_z = \lambda(z^* - z_0)$. If a matrix of variables affecting steady-state growth is denoted by X, so $z^* = X\beta$, a regression model specified as follows would be estimated:

$$g_z = \lambda\left(X\beta - z_0\right) + \varepsilon, \tag{7.1}$$

where ε is a random error term and X is a set of exogenous variables that may affect growth. Given the identities outlined earlier, equation (7.1) can be rewritten as follows to estimate the correlates of the growth in human capital per capita while factoring in population growth:

$$g_h = \lambda X\beta - \lambda h_0 + \lambda \log\left(\frac{L}{P}\right)_0 + \left(g_L - g_P\right) + \varepsilon. \tag{7.2}$$

TABLE 7.2 Summary Statistics for the Variables, 1995–2010 and 1995–2014

		1995–2010				1995–2014			
		Men		Women		Men		Women	
	Variable	Mean	Median	Mean	Median	Mean	Median	Mean	Median
g_h	Five-year growth rate of human capital wealth per capita (%)	9.67	9.15	11.34	10.25	9.78	9.07	10.73	9.49
H	Human capital wealth per capita (2014 US$)	83,576	20,218	53,309	15,010	86,384	22,475	55,669	15,493
L/P	Share of labor force in total population (%)	25.38	25.78	18.82	19.8	25.54	26.03	19.15	20.17
WA/P	Share of working-age population in total population (%)	30.97	31.96	31.39	32.27	31.1	32.09	31.51	32.35
g_P	Five-year growth rate of population (%)	6.33	6.39	6.33	6.39	6.27	6.32	6.27	6.32
g_L	Five-year growth of labor force (%)	11.1	10.52	7.71	7.15	10.56	10.52	7.55	7.34
g_{WA}	Five-year growth of working-age population (%)	8.17	8.5	8.04	8.79	7.74	8.3	7.64	8.27
X	Average years of schooling	7.9	8.26	7.14	7.92	8.11	8.34	7.4	8.11
	Life expectancy	66.58	68.71	71.69	75.32	67.46	69.14	72.52	75.86
	Public investment (% of GDP)	21.86	21.42	21.86	21.42	22.05	21.44	22.05	21.44
	Government spending (% of GDP)	15.59	15.64	15.59	15.64	15.79	15.95	15.79	15.95
	Trade (% of GDP)	88.34	74.1	88.34	74.1	88.89	74.27	88.89	74.27
	Inflation (%)	21.86	21.42	21.86	21.42	22.05	21.44	22.05	21.44

Source: World Bank calculations.

Simple predictions can be made from this specification about some of the correlates of the growth in human capital per capita. First, the model suggests that the regression coefficient for growth in the labor force should be equal to 1, so that every percentage point increase in the labor force should generate a corresponding increase in human capital per capita. By contrast, the coefficient for growth of the population should be −1, so that higher population growth should reduce the growth in human capital wealth per capita. Moreover, the coefficients for the logarithm of the initial value of human capital per capita and the logarithm of the proportion of workers should be the same, but with opposite signs. Much of the literature indicates convergence in economic growth, which is typically interpreted in part by having a positive sign for the coefficient λ, so that countries with lower levels of GDP per capita grow faster, on average. The same is expected here, with a higher rate of growth in human capital expected for countries with initially lower levels of human capital per capita.

As an additional decomposition, we can also look at growth in the working-age population, in which case the labor force needs to be decomposed into the product of the working-age population and the share of the working-age population that is actually working. Denote by *WA* the working-age population. This can be expressed as $\log(H/P) = \log(H/L) + \log(L/WA) + \log(WA/P)$. Using the same notation as before, this leads to $g_h = g_z + (g_L - g_{WA}) + (g_{WA} - g_P)$. The model that incorporates this additional decomposition is specified as

$$g_h = \lambda X\beta - \lambda h_0 + \lambda \log\left(\frac{L}{WA}\right)_0 + \lambda \log\left(\frac{WA}{P}\right)_0 + \left(g_L - g_{WA}\right) + \left(g_{WA} - g_p\right) + \varepsilon. \tag{7.3}$$

As mentioned earlier, the data on human capital wealth per capita is available for both men and women. Therefore, the model suggested in equation (7.3) can be estimated separately for men and women. In so doing, some variables are specific to each sex, while other variables are at the national level. Specifically, the population size *P* in the model is the same for both sexes since the measures of human capital are per capita (taking into account the entire population). By contrast, the analysis uses data on the size of the labor force and the working-age population by gender. Similarly, while macroeconomic controls (inflation, investment, trade, and government spending) in the regressions are specified at the national level, variables related to the education and life expectancy of the labor force are disaggregated by gender.

Summary Statistics

The dependent variables in the models are the growth rates in human capital wealth per capita attributable to women and men separately over five-year intervals. As independent variables, apart from the initial level of human capital wealth, the regressors include two measures of human capital: (1) the average years of schooling of the adult population (a proxy for education-related human capital) and (2) life expectancy at birth (a proxy for health-related human capital). Given that macroeconomic conditions may affect wages and thereby estimates of human capital wealth, a number of variables related to trade, government spending, investment, and inflation are included in the covariates. These variables are typically those used in models for economic growth (DeLong and Summers 1991; Mankiw, Romer, and Weil 1992). All variables are from the World Bank's World Development Indicators (World Bank 2016b), with two exceptions: the average years of schooling in the adult population are obtained from the Barro and Lee data set (Barro and Lee 2016), and the measures of human capital wealth are those reported in chapter 6 (see also Barrot et al. [forthcoming] for more details on the estimation procedure).

Summary statistics for the variables are presented in table 7.2 for the countries included in the regression (some correlates are not available for some countries, which reduces the sample size for the regression analysis). The statistics are provided for two periods: 1995 to 2010 and 1995 to 2014. Consider first the growth in human capital wealth per capita, using the statistics for 1995 to 2014. The average five-year growth rate in the sample for human capital wealth per capita attributed to men is 9.67 percent, while the median is 9.15 percent. For women, the growth rates are slightly higher: 11.34 percent for the mean and 10.25 percent for the median. This suggests that in real terms, the average annual growth rate in human capital wealth per capita is about 2 percent, with the present value of women's future earnings slowly catching up to that of men. "Slowly" is the right term, and there is a lot of catching up to do. Indeed, the mean level of human capital wealth per capita attributed to men across all countries and years is slightly greater than $83,500, but the median is much lower at just over $20,000. By contrast, the human capital wealth attributed to women is lower (mean value just above $53,300 and median about $15,000).

The model predicts that the growth rates of the population, of the working-age population, and of the labor force may be important factors affecting human capital wealth per capita. In terms of basic statistics for the estimations, as shown in table 7.2, the average share of the labor force in the total population is lower than the average share of the working-age population in the total population, as one would expect. For men, the growth rates in the labor force are higher than the growth rates in the working-age population, whereas the reverse is observed for women. Note also that because growth in the labor force appears to be higher for men than for women, the slight catching up observed for women in human capital wealth is likely due to gains in earnings, and perhaps not as much to gains in labor force participation in comparison with men. Overall, growth rates in the working-age population and the labor force tend to be higher than the population growth rates, suggesting that many countries are reaping the benefits of the demographic dividend.

Other factors that could affect growth in human capital per capita include proxies for human development. Two factors are used here. The average years of schooling for the adult population is about eight years in the sample as a whole. As expected, it is higher for men than for women. Life expectancy is close to 70 years, and is higher for women than men, again as expected. Macroeconomic variables suggest that, on average, more than a fifth of GDP is invested every year. Government expenditure accounts for about 16 percent of GDP, on average. Trade accounts for about four-fifths of GDP, depending on whether the mean or median value is used. Finally, inflation is, on average, slightly above 20 percent over a five-year period.

Estimation Results

The predictions suggested by the model can be tested by estimating the model using a cross-country panel data set. Two periods are used for the analysis: 1995 to 2010, and 1995 to 2014, for the reasons mentioned earlier. Detailed results from six different specifications of the model are available from the authors. The discussion here focuses on the main results. These results are provided in table 7.3 for the most parsimonious

TABLE 7.3 Correlates of the Growth in Human Capital Wealth of Nations Per Capita: Key Results

	Parsimonious model: Equation (7.2) without macroeconomic variables				Extended model: Equation (7.3) with macroeconomic variables			
	1995–2010		1995–2014		1995–2010		1995–2014	
	Men	Women	Men	Women	Men	Women	Men	Women
Lagged human capital wealth per capita	–0.076***	–0.065***	–0.071***	–0.058***	–0.074***	–0.058***	–0.068***	–0.053***
Schooling	0.021***	NS	0.020***	NS	0.017**	NS	0.018***	NS
Life expectancy	0.607***	0.574***	0.470***	0.475***	0.362**	0.332**	0.260***	NS
Labor share	NS	0.076*	NS	0.082**				
Population Growth	NS	0.878*	NS	NS				
Labor force growth	NS	NS	NS	NS				
Public investment (%)					0.092**	NS	NS	0.101***
Government spending (%)					NS	NS	NS	NS
Trade (%)					NS	NS	0.103***	NS
Inflation					–0.213*	NS	–0.231**	NS
Log(L/WA)					–0.254*	NS	NS	0.395***
Log(WA)					NS	NS	NS	NS
$g_L - g_{WA}$					NS	NS	1.077**	NS
$g_{WA} - g_p$					NS	NS	NS	NS
Constant	–1.203**	–2.040***	–0.990	–1.714	NS	NS	NS	NS

Source: World Bank calculations.

Note: L = labor force; WA = working-age population.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$; NS = not significant.

and the most comprehensive specifications estimated in chapter 6. The most parsimonious specification does not include controls for macroeconomic variables, nor does it provide decompositions for the demographic variables. The most comprehensive specification includes macroeconomic variables as controls and also decomposes the demographic variables as in equation (7.3).

A number of results are fairly stable across specifications as well as samples. As expected, the coefficient for the initial level of human capital per capita is statistically significant and negative, which can be related loosely to conditional convergence in human capital wealth growth, as is often observed with GDP per capita growth. The results are robust to alternative specifications. There are limits to the interpretation of the coefficient suggesting convergence, but these need not be discussed here. As shown in figures 7.1 and 7.2, there does appear to be convergence statistically; furthermore, growth rates in human capital wealth per capita are higher at lower initial levels.

The proxies for human development tend to have positive and statistically significant impacts on growth in human capital wealth. For both men and women, the impact of life expectancy is positive, which could denote gains in productivity as well as gains in the number of years that workers are able to work. For men, the impact of average years of education is also positive, but it is not statistically significant for women.

In principle, according to the theoretical model presented earlier, the coefficients for the logarithm of the initial value of human capital per capita and for the logarithm of the proportion of workers in the population should be the same, but with opposite signs. That prediction is respected in the models for women. For men, the coefficient is not statistically significant, but the standard error is such that equality of the two coefficients in absolute value cannot be rejected.

The regression coefficient for growth in the labor force is predicted to be equal to 1, while the coefficient for growth of the population is predicted to be −1. The two coefficients are predicted to be of equal value, but opposite sign. In the basic model, those predictions often cannot be rejected, but at the same time most coefficients are not statistically significant. In the sole case in which the coefficient is statistically significant, the coefficient for growth of the labor force for women is indeed close to 1, as predicted by the model.

In the more extensive specification of the model, two main changes are made. First, additional controls are included to account for macroeconomic conditions. Second, the demographic and labor force participation variables are decomposed to take into account two terms: the differential in growth rates between the labor force and the working-age population, and the differential in growth rates between the working-age population and the overall population. The model predicts coefficients for both variables to be equal to 1.

The results for men tend to fairly closely replicate the predictions of the model. For women, a smaller number of coefficients are statistically significant. This outcome could reflect the fact that other factors, such as cultural norms, not included in the model may play an important role in driving growth in human capital wealth. In addition, it could also be that these measures of human capital wealth are more subject to measurement error for women. Indeed, in many countries fewer women work, especially in the formal sector, and formal sector work is used as a basis for the estimation of wage regressions that are, in turn, used for estimating human capital wealth.

Still, overall the results suggest that—at least for men—an increase in the labor force as a share of the working-age population is associated with a corresponding increase in human capital per capita. Similarly, an increase in the working-age population as a share of the overall population has the same effect. In other words, holding other variables constant, a higher rate of population growth is associated with a reduction in human capital per capita, at least within the time frame of the model (five-year intervals). By contrast, having more workers is beneficial, whether because a larger share of working-age individuals is in the population or a higher share of those individuals are actually in the labor force. Longer term, lower population growth may lead to a reduction in human capital wealth, as is observed with aging in several high-income countries. But for many countries at lower levels of development today, in the short to medium term there are clear benefits to be reaped from lower population growth and, even more important, from the demographic dividend that has been associated in many countries with a larger share of the population working, and from rising education levels.

Finally, results for the macroeconomic variables suggest that more-open economies tend to have a higher growth rate of human capital wealth per capita. By contrast, a higher rate of inflation is associated with lower growth rates in human capital wealth per capita. The coefficients for investment and government spending, both expressed as shares of GDP, are not statistically significant. In the economic growth literature, various variables turn out to be statistically significant depending on the specifications used. The results here align with the literature, in that for coefficients that are statistically significant, the directions of the effects are as expected. Indeed, open economies tend to reward workers who have higher levels of education, which could generate higher values of human capital wealth per capita. By contrast, inflation may erode growth as well as workers' wages, thereby affecting human capital wealth negatively.

Conclusion

This chapter analyzes some of the factors that may affect growth in the human capital wealth of nations on a per capita basis. Because the human capital wealth measures can be disaggregated by gender, the analysis is conducted separately for men and women. The modeling approach follows similar work conducted for economic growth, with an emphasis on demographic factors that may affect growth rates.

The results of the analysis conform for the most part to the predictions of the model, at least for men. Higher rates of population growth tend to reduce the rate of growth of human capital wealth, whereas growth in the labor force has the opposite effect. Investments in human capital to increase average years of schooling of the adult population (as a proxy for education) as well as life expectancy (as a proxy for health) have a positive effect on growth in human capital wealth per capita. The effect of life expectancy is also positive and statistically significant. When a set of macroeconomic variables is added to the estimation, familiar results are obtained, in that inflation is associated with slower rates of growth of human capital wealth, while open economies are associated with higher growth rates when effects are statistically significant.

None of those results are especially surprising, and the estimations mimic, to some extent, what is observed for economic growth. This outcome is to be expected, since in a reduced form model, it could be shown that growth in human capital wealth per capita is itself strongly correlated with economic growth. Recall that human capital wealth is estimated as the future value of discounted earnings, with earnings clearly driven in good part by how the economy is doing as a whole.

Still, although none of the results are too surprising, they do help draw attention to the importance of investments in education and health (for life expectancy) for achieving growth in human capital wealth, and just as important, they also underscore the large role that demographic and labor market factors play in enabling countries to achieve higher rates of human capital wealth per capita. Some of the results obtained are stronger for men than for women in terms of their conformity with the model being tested. This is not too surprising given that for women, other factors not included in the models, such as social and cultural norms, may play a large role in enabling or curtailing their earnings potential.

Note

1. A more detailed discussion of gender parity and other issues related to human capital wealth is provided in the companion volume to this study on human capital (Wodon, forthcoming).

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8

Intangible Capital as the Engine for Development in Morocco

Kirk Hamilton, Jean-Pierre Chauffour, and Quentin Wodon

Main Messages

- The gap in wealth between Morocco and selected other countries of the Middle East and North Africa region (MENA) of similar levels of economic development is primarily the result of relatively lower levels of human capital per capita. Increasing human capital in Morocco requires reforms in the education sector and labor markets, plus a greater emphasis on early childhood development.
- From 2005 to 2014, Morocco achieved strong growth in per capita wealth, a rise of 45 percent. However, this growth masks weaknesses. When population growth is taken into account, the net change in real wealth per capita—as measured through adjusted net saving (ANS)—fell from roughly US$400 in 2005 to less than US$100 in 2014.
- Women account for only about a fifth of total human capital in Morocco. If gender parity in human capital wealth were achieved, levels of human capital wealth in Morocco could increase by more than a third. In addition, the country should invest more in early childhood development as well as in improving the quality of its education system.
- Equally important will be institutional reforms to create a modern administration, improve public investment and financial management, and increase voice and accountability and access to information.

Introduction

In an important speech given in July 2014, King Mohammed VI called for an assessment of Morocco's development that would include the "country's historical and cultural heritage, social and human capital, … the quality of institutions, innovation and scientific research, cultural and artistic creativity, the quality of the environment…. The objective of the study is not only to highlight the value of our country's intangible capital, but also to make sure intangible capital is used as a key standard in the development of public policies, so that all Moroccans may benefit from their country's wealth."

The context for the king's speech was that Morocco had made significant economic progress since 2000 but that the rate of convergence with high-income countries, including Mediterranean peers, was too low to meet the aspirations of Moroccan citizens, particularly its youth. Although intangible assets are usually defined somewhat narrowly in the System of National Accounts (EC et al. 2009) as consisting primarily of intellectual property, the king had in mind a broader concept, closer to that developed by the World Bank and encompassing human, social, and institutional capital (World Bank 2006, 2011). In the aftermath of the king's speech, the World Bank prepared a Country Economic Memorandum—*Morocco 2040: Emerging by Investing in Intangible Capital*—that focuses on the role that intangible capital could play in accelerating Morocco's transition to upper-middle-income status (World Bank 2017a).

Morocco 2040 highlights the challenges faced by the country in its quest for convergence with higher-income countries. Macroeconomic reforms, trade and competitiveness, and institutional reforms are high on the country's development agenda. From the perspective of building wealth for the future, three key issues stand out. First, the report notes that growth in the first decade of the 2000s was driven by investment in fixed capital, especially in the public sector. Second, and by contrast, although Morocco could benefit from a demographic dividend thanks to a large cohort of workers ages 15 to 35 years, gains in human capital have not kept pace. Investments in education have led to universal primary enrollment as well as higher enrollment rates in secondary and postsecondary education. But educational quality remains low, as do labor force participation rates, especially for women. Third, total factor productivity has not taken off, and productivity gains have remained too modest to sustain a rapid economic catch-up.

Building on the impetus provided by the king's speech and the preparation of the *Morocco 2040* economic memorandum (World Bank 2017a), this chapter presents an analysis of the growth and changing composition of the wealth of Morocco and its peers in the region, with particular emphasis on human capital. It then turns to the government's priorities across a broad range of contributors to intangible wealth and economic development. These priorities include creating a modern administration, governance reforms, support for the rule of law, increasing the scope of competitive markets, integrating with global markets, reforming labor laws, implementing education and health sector reforms, boosting early childhood development, increasing gender equality, and fostering social trust. The reforms are briefly discussed; for some of them, estimates are provided of the gains in wealth per capita that could result.

The structure of the chapter is as follows. The next section provides a brief description of trends in Morocco's wealth, together with analysis of the main components of this wealth. Then some of the reforms under consideration by the government are described. Estimates are provided of the potential gains that could be achieved from some of the reforms. The analysis is only meant to be illustrative of the magnitude of the gains that could be achieved, but it is hoped that it is instructive. A brief conclusion follows.

Trends in Morocco's Wealth

A key finding from previous World Bank studies on the wealth of nations (World Bank 2006, 2011) was that intangible wealth constitutes the lion's share of total wealth, especially for high-income countries. This finding is confirmed in this study for the world as a whole (chapters 2 and 6) as well as for Morocco. The country has enjoyed strong growth in wealth since 2005, as seen in table 8.1 and figure 8.1. Total wealth per capita grew by 45 percent in 10 years. Produced capital grew proportionately. Natural capital grew strongly, more than doubling owing to rising agricultural productivity and the development of mineral reserves, while the net foreign asset position of the country declined slightly. The lagging wealth component was human capital, which grew by only 22 percent.

Comparator Countries

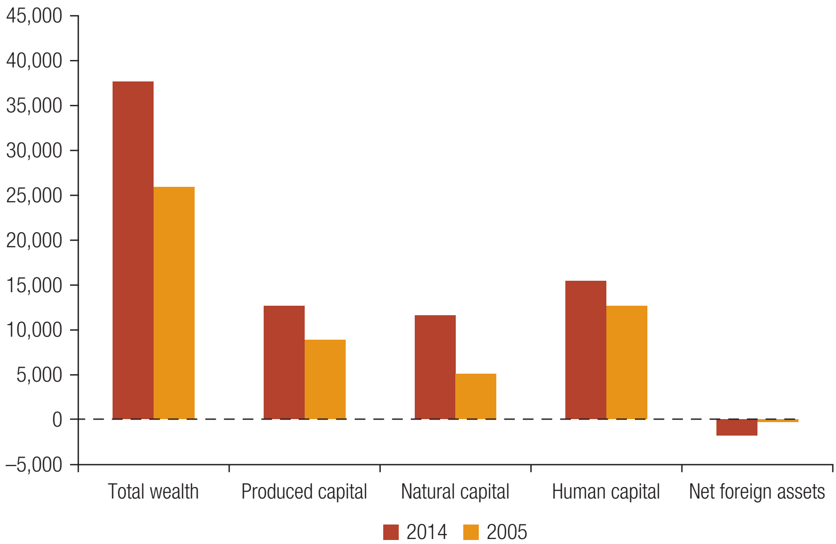
How does Morocco compare with selected competitor countries? Table 8.2 compares wealth levels in Morocco with those in the Arab Republic of Egypt, Jordan, Lebanon, Spain, and Tunisia, as well as the average of all upper-middle-income countries. The other countries from the region were selected because they tend to have levels of economic development similar to those observed in Morocco.

TABLE 8.1 Morocco's Wealth Per Capita, 2005–14

	Total wealth	Produced capital	Land[a]	Energy	Minerals	Total natural capital	Human capital	Net foreign assets
2005	27,956	9,469	5,266	2	165	5,433	13,527	–472
2010	34,756	11,634	7,227	3	1,979	9,209	15,239	–1,325
2014	40,488	13,616	10,037	3	2,332	12,372	16,490	–1,990
% change 2005–14	44.8	43.8	90.6	95.0	1313.3	127.7	21.9	321.2

Source: World Bank calculations.
Note: Figures for wealth are in constant 2014 US dollars at market exchange rates.
a. Land comprises primarily agricultural land, with small values of forestland and protected areas.

FIGURE 8.1 Components of Morocco's Wealth Per Capita, 2005 and 2014
US$



Source: World Bank calculations.
Note: Figures for wealth are in constant 2014 US dollars at market exchange rates.

Total wealth per capita in Morocco stood at just about US$40,000 in 2014, a level similar to that observed in Egypt but less than the levels observed in Jordan, Lebanon, and Tunisia. Spain is also included in the table, with wealth per capita that is 8.5 times higher than in Morocco, even though wealth per capita declined in Spain over the past decade because of the 2008–09 financial crisis. Table 8.2 suggests that much of the gap between Morocco and other MENA countries is the result of lower levels of human capital per capita. Note that in the MENA-3—Jordan, Lebanon, and Tunisia—the average level of wealth per capita is slightly greater than US$53,000. The main difference between the MENA-3 countries and Morocco is human capital wealth. If Morocco's level of human capital wealth was equal to that of the average of the MENA-3—a gain of close to US$15,000, or almost double Morocco's current human capital wealth—the country's total wealth per capita would be greater than the MENA-3 average.

This is illustrated in a different way in figure 8.2, which decomposes wealth in Morocco and comparator countries by source. The composition of the wealth of Morocco and its peers shows distinct differences. Morocco stands out with a relatively low share of human capital, at roughly 40 percent of the total, compared with roughly 60 percent of the total in the other countries. Spain shows a pattern typical of high-income countries, with a high level of produced and human capital and an insignificant contribution from natural capital (in absolute terms, the value of Spain's natural capital per person is on par with other countries).

TABLE 8.2 Wealth Per Capita in Morocco and Comparator Countries

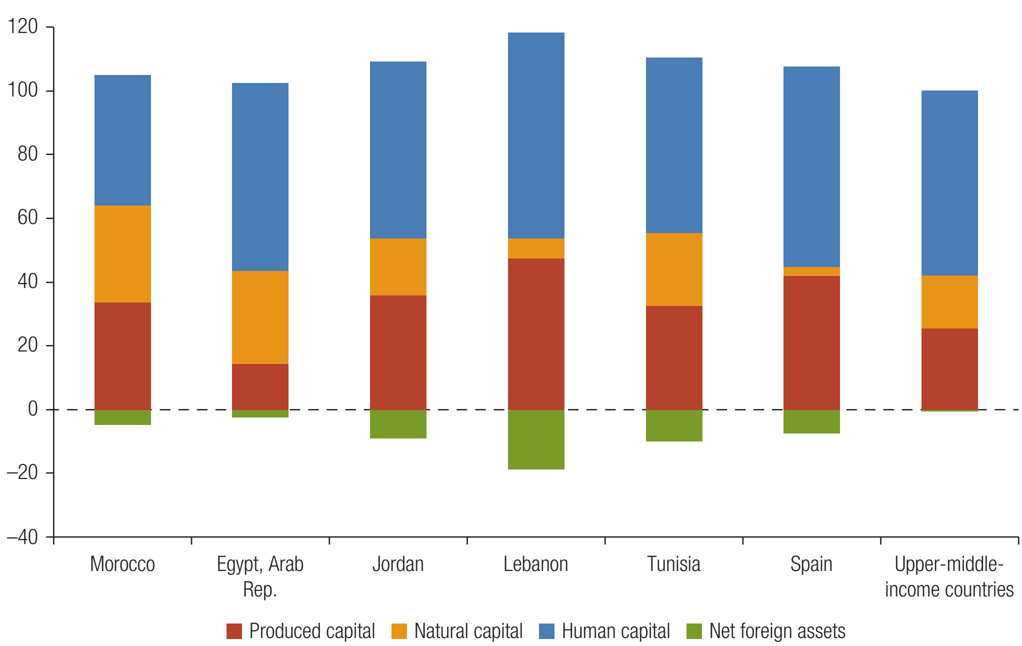
US$

	Total wealth	Produced capital	Natural capital	Human capital	Net foreign assets
Individual countries					
Morocco (1)	40,488	13,616	12,372	16,490	–1,990
Egypt, Arab Rep.	38,470	5,605	11,229	22,591	–955
Jordan	49,287	17,577	8,876	27,312	–4,478
Lebanon	65,148	31,015	4,131	42,153	–12,151
Tunisia	45,150	14,838	10,178	24,796	–4,662
Spain	342,470	142,821	10,298	215,593	–26,241
Upper-middle-income country average	112,798	28,527	18,960	65,742	–432
MENA-3 (Jordan, Lebanon, Tunisia)					
Average for MENA-3 (2)	53,195	21,143	7,728	31,420	–7,097
Morocco versus MENA-3					
Difference (2) – (1)	12,707	7,527	–4,643	14,930	–5,107

Source: World Bank calculations.
Note: Figures are in constant 2014 US dollars at market exchange rates. MENA = Middle East and North Africa.

FIGURE 8.2 Sources of Wealth in Morocco and Comparator Countries, 2014

percent



Source: World Bank calculations.

Adjusted Net Saving

Another way to look at wealth accumulation is to use data on adjusted net saving (ANS). As discussed in chapter 2, ANS is measured as gross national saving minus depreciation of produced capital and depletion of natural capital, plus public expenditures for education. Although the measure has a number of limitations, it is easy to interpret. A negative ANS suggests that a country is running down its capital stocks and thereby possibly reducing future social welfare. By contrast, a positive ANS suggests that a country is adding to its wealth and thereby its future well-being. In other words, ANS measures the portion of national income that is not consumed by the private and public sectors, adjusted to reflect investment in human capital, depreciation of fixed capital, resource depletion, and the costs of pollution damage.

Table 8.3 suggests that Morocco is experiencing a reduction in ANS per capita. ANS per capita was a healthy US$688 in 2005, but it decreased to US$631 in 2014. This was mirrored in the decline of ANS as a percentage of gross national income from roughly 28 percent in 2005 to 20 percent in 2014. Saving effort, measured in net terms, has declined, and when considering population growth the decline is even more severe, as described in chapter 3.[1] The existing capital stock has to be shared with the new population cohort, which is a type of wealth dilution. This effect is captured in the measure of "population dilution per capita" in table 8.3.

Subtracting the adjustment for population dilution from ANS per capita yields adjusted net saving – population adjustment (ANS-PA) which is a key indicator of likely future well-being per capita. In Morocco, ANS-PA dropped from slightly more than US$400 per person in 2005 to well under US$100 per person in 2014. In other words, the combined effects of a declining saving effort, as measured by ANS, and rising population growth reveals a marked deceleration in

TABLE 8.3 Decomposing Morocco's Net Wealth Creation Per Capita, 2005–14
US$

	2005	2010	2014
Population growth rate (%)	1.0	1.2	1.4
ANS per capita	688	676	631
Population dilution per capita	270	428	563
ANS-PA	418	248	68
ANS as a percentage of GNI	28.4	23.3	20.0
ANS-PA as a percentage of GNI per capita	17.2	8.5	2.1
Total wealth per capita	27,956	34,756	40,488

Sources: World Bank calculations; and World Bank 2017b.
Note: Figures are in constant 2014 US dollars at market exchange rates. ANS = adjusted net saving; ANS-PA = adjusted net saving minus adjustment for population dilution; GNI = gross national income.

net wealth creation per person, from 17 percent of total wealth per capita in 2005 to 2 percent in 2014. This drop has consequences for the speed with which Morocco can hope to reach high-income-country status. Reversing the recent trend requires a renewed focus on increasing saving effort and associated investments.

Morocco 2040: Building Human Capital

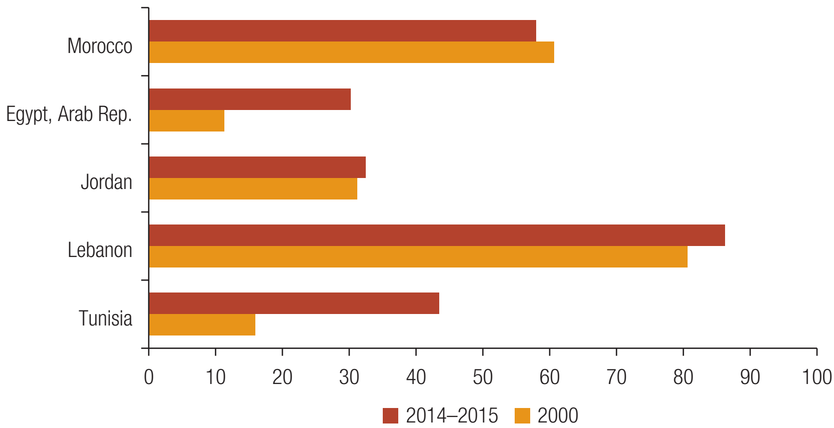
As mentioned earlier, Morocco's produced capital grew at a rate similar to that of its total wealth. Natural capital grew faster, but human capital lagged, with a growth rate of only half that of total wealth. Given that human capital is the largest source of wealth in most advanced economies, building Morocco's human capital is *the* development challenge. The gap in wealth observed between Morocco and other MENA countries in table 8.2 is primarily the result of low levels of human capital per capita. Increasing the quantity and quality of human capital in Morocco requires reforms in the education sector as well as in labor markets. In addition, a greater emphasis on early childhood development is needed to better prepare children for entry into the school system.

Early Childhood Development

As noted in (Wodon forthcoming), putting resources into early childhood development (ECD) is considered one of the smartest investments that countries can make. Children entering school suffering from deprivation face important handicaps that can have lifelong consequences. Children's physical, socioemotional, and cognitive development are closely linked (Shonkoff et al. 2012). Neurological studies show that synapses develop rapidly in the first 1,000 days of a child's life (Nelson 2000). These synapses form the basis of cognitive and emotional functioning later in life. Poor nutrition or lack of stimulation may therefore not only lead to poor physical growth but also impede brain development, with negative impacts later in life on academic achievement as a student and future productivity in adulthood. The implication is that young children require nurturing care—defined by Black et al. (2017) as health, nutrition, security and safety, responsive caregiving, and early learning.

Investments in ECD have high economic rates of returns (Carneiro and Heckman 2003; Heckman and Masterov 2007; Engle et al. 2011; Denboba et al. 2014), particularly when compared with investments made later in life. This matters for human capital wealth because this wealth is essentially measured as the net present value of the population's future earnings. Interventions to provide psychosocial stimulation to growth-stunted toddlers have been shown to have the potential to increase earnings in adulthood by a fourth (Gertler et al. 2014). Similar results have been observed for interventions to avoid stunting, with gains in per capita consumption in adulthood of 21 percent (Hoddinott, Maluccio, et al. 2008; Hoddinott, Alderman, et al. 2013). Enrollment in preschool also has been shown to have high returns (Engle et al. 2011).

FIGURE 8.3 Enrollment Rates in Preprimary Education
percent



Source: World Bank 2017b.

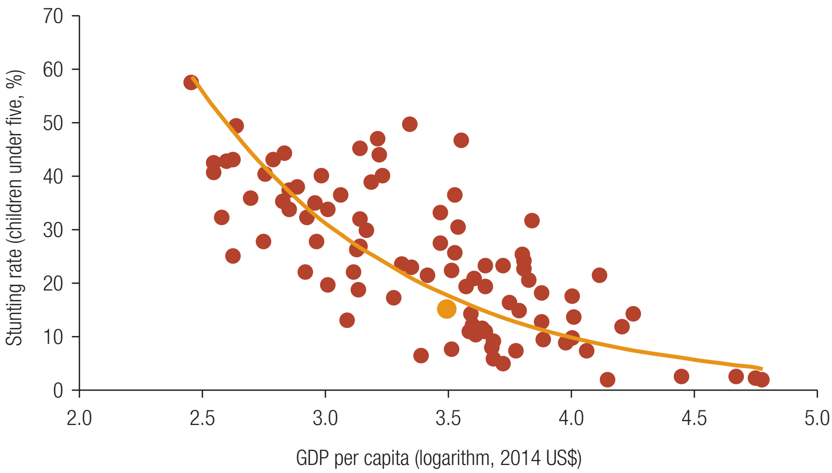
How is Morocco doing in this area? Figure 8.3 provides rates of enrollment of children in at least one year of preschool for Morocco and the comparator countries. Morocco's performance is respectable, lagging behind only Lebanon. But Morocco appears to have lost ground between 2000 and 2014–15, whereas all the other countries have made gains.

Another widely used indicator of ECD is the stunting rate. A child is considered stunted if his or her height is more than two standard deviations below the median reference height for that age. As noted in Wodon (forthcoming), stunting often results from persistent insufficient nutrient intake and infections. It may lead to delayed motor development and poor cognitive skills that can affect school performance as well as productivity and earnings later in life. How is Morocco doing in this area? Almost one in six children (14.9 percent) was stunted in Morocco in 2011. As shown in figure 8.4, where Morocco is represented by the orange dot, the country's stunting rate is in line with expectations given the country's level of economic development (represented in the horizontal axis by the logarithm of gross domestic product [GDP] per capita). Yet, according to the literature, reducing stunting to the level in comparator countries would result in a gain in earnings of about 25 percent for one-sixth of the population, and thereby a gain in human capital wealth nationally of about 4 percent, which is far from negligible.

Primary and Secondary Education

Morocco has high enrollment rates but also well-known weaknesses in education outcomes, both in poor student performance on international tests and persistently high levels of adult illiteracy. Reform needs

FIGURE 8.4 Under-Five Stunting Rate and GDP Per Capita



Source: World Bank 2017b.
Note: GDP = gross domestic product.

to begin in the school system with revisions to curriculum and teaching methods. An emphasis on basic skills is a starting point, as is upgrading vocational training to prepare students for the needs of enterprises. Teaching performance is another weak point and will require reforms in teacher training, recruitment, evaluation, coaching, and ongoing professional development. Greater use of information and communication technologies can play a role in the teaching process, including testing and training; but, to be successful, information and communication technologies need to be closely related to the curriculum. Beyond the classroom, greater engagement of parents in their children's education will be an important complement. More broadly, review and reform of education sector governance will be needed, focused on the roles of different players, including officials, administrators, teachers, students, and families. This reform can be combined with new ways of financing and governing schools, including charter schools, school vouchers, and similar approaches that have been proven to yield results internationally.

The potential gains from such reforms are difficult to assess because gains in wages depend on both the supply of skills, which can be improved through better education systems, and the demand for skills in the labor market. But it is important to note that any gain in the returns to education brought about by better quality in the education system could translate into an equivalent gain in human capital wealth because human capital wealth is estimated as the net present value of the population's future earnings.

Gender Gap in Human Capital

Gender equality is first and foremost a matter of fundamental human rights. In addition, increasing autonomy and freedom of choice for women is at the heart of economic development. Female participation in education and employment creates economic assets, and can be catalytic in increasing not only the size but also the efficiency of the economy. The resulting economic growth can, in turn, create positive spillovers for family incomes and the welfare of children.

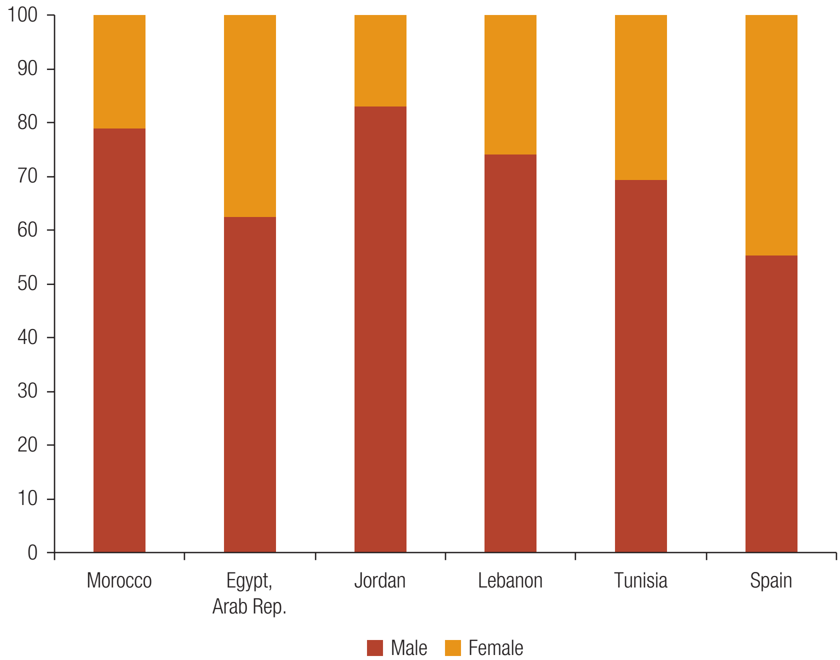
Morocco's constitution and laws regarding women's rights are among the most progressive in the MENA region. The 2011 constitution embodies the central tenets of the United Nations Convention on the Elimination of all Forms of Discrimination against Women. It protects the political, economic, social, cultural, and environmental rights of all citizens. The Family Code, revised in 2004, extended the rights of women regarding guardianship, marriage, and divorce. Gender equality is enshrined in the 2003 Labor Code and the Nationality Law of 2008. Elections to the House of Representatives and regional bodies are subject to quotas for the representation of women.

Although these protections create a solid foundation in law for gender equality, in practice there are limits on the economic and political rights of women. Within the family, it is men who have a say over the educational and employment activities of women. The consequences are visible in the large disparity in labor force participation between men and women. But these results are also a consequence of Morocco's development model, which has not engendered strong growth in sectors such as manufacturing and high-value services, where female employment opportunities are large. In addition, limits on women's rights to property and inheritance (and the consequent access to credit) are built into important laws such as the Family Code. Women are still subject to physical, psychological, and sexual violence at unacceptable rates. Finally, child marriage has decreased over time but still affects one in six girls, with consequences for girls, including for their contribution to human capital (Wodon, forthcoming).

Figure 8.5 breaks down total human capital into its gender shares. Morocco and Jordan stand out for distinctly low female shares of human capital, at slightly more than 20 percent of the total. This low share is due to both low labor force participation rates for women and lower educational achievement, both of which lead to lower earnings when women are working in the labor market. These results compare with stronger figures for Tunisia and particularly Egypt, which falls only 7 percentage points below Spain. Increasing women's labor force participation and earnings could lead to major gains in wealth, as well as in income generation and poverty reduction more generally.

To achieve the goals of *Morocco 2040*, further progress on gender equality will be essential, requiring increased economic opportunities for women. Export-oriented manufacturing and a growing services sector, particularly in information and communication technologies and financial services, can provide a greater source of jobs for women.

FIGURE 8.5 Shares of Human Capital, by Gender, 2014
percent



Source: World Bank calculations.

Better access to child care can also increase the supply of female labor. Equally important, the remaining barriers to women's participation in the economy need to be eliminated. The necessary steps include enhancing women's control over economic assets, strengthening the property rights of women, ensuring rights to job-related benefits (including pensions), and improving access to credit. Greater rights for women in marriage and divorce can complement these actions. Finally, effective implementation of the existing protections for women in the 2011 constitution and legal code would go a long way toward leveling the playing field. This recognition gives added impetus to the need to reform Morocco's institutions.

What could be the magnitude of the gains in human capital wealth for Morocco from gender equity? To answer this question, assume for simplicity (following chapter 6 in this volume) that the working-age population is equally divided between men and women, each with a 50 percent share. If there is no decrease in the human capital wealth of men with women working more and for better pay, the gains in human capital wealth (denoted by NG) can be estimated as NG = (100 − GGR) × 0.50/100, where GGR is the gender gap ratio in human capital wealth defined as the human capital wealth of women divided by that

TABLE 8.4 Potential Gains in Human Capital Wealth from Gender Equity, 2014

	Gender gap ratio (×100) (ratio of human capital wealth by gender)	Potential gain from gender equity (percentage increase from base)
Morocco	27.4	36.3
Egypt, Arab Rep.	60.1	20.0
Jordan	20.5	39.8
Lebanon	35.4	32.3
Tunisia	43.7	28.2
Spain	81.0	9.5
Upper-middle-income countries	66.6	16.7

Source: World Bank calculations.

of men. As shown in table 8.4, human capital wealth in Morocco could increase by 36 percent with gender parity under this simple simulation. In many other countries in the MENA region, gains would be similar. By contrast, in upper-middle-income countries and in Spain, the gains are much lower.

Public policies can be designed to both combat gender inequalities and promote economic growth. Economic and legal inequalities between the sexes and social norms and gender biases tend to reinforce each other in explaining women's low access to economic opportunities as well as women's low bargaining power. Modeling these interactions could help quantify the impact on growth of an integrated approach aimed at reducing gender bias in the labor market, reallocating the time that mothers devote to their daughters, and increasing the bargaining power of women within the family (Agénor, Berahab, and El Mokri 2017). In Morocco, the combined effects of these policies on economic growth could reach up to 2 percentage points on an annual basis (box 8.1).

Gap in Human Capital, by Type of Employment

Building human capital involves not only schooling but also the functioning of labor markets. Figure 8.6 compares the human capital of the employed with the self-employed in 2014.[2] In both Morocco and Egypt, the self-employed constitute roughly 30 percent of total human capital, a much higher share than in the other countries. Both countries are characterized by a significant share of smallholder agriculture in the economy, resulting in high levels of self-employment combined with low earnings because smallholdings are often inefficient. In addition, apart from self-employment in agriculture, many workers are often involved in self-employed, low-productivity occupations. To improve labor market outcomes, current programs for training and skills promotion need to be

BOX 8.1 Evaluation of the Impact of Public Policies on Gender Inequality and Growth in Morocco

The impact of public decisions on gender equality and economic growth could be quantified by an overlapping generations and gender-differentiated model (Agénor 2012, 2017). Such a model was developed and calibrated for Morocco on the basis of the 2014 General Population Census, employment surveys, and the 2012 national survey on the time budget by the High Commission for Planning (Agénor, Berahab, and El Mokri 2017). The model is designed to capture the dynamics among social norms, gender inequalities within the family and the labor market, women's bargaining power in family decisions, spousal time allocation, and economic growth. The variables used for the analysis are families, domestic production, commercial production, human capital accumulation, government activity, women's bargaining power, social norms, and gender inequalities.

In a first simulation, the government implements measures to combat discrimination against women in the labor market (hiring parity and awareness campaigns, for example). The consequences are numerous: an increase in family income, which leads to higher private savings and investment, and then higher economic growth and tax revenues. The second simulation focuses on the reallocation of mothers' time with their daughters, for example, as the result of an awareness campaign. In this case, economic growth is positively affected by women's human capital increases. Finally, a third simulation examines the effects of the improved bargaining power of women within the household. This leads to three changes: (1) women allocate less time to domestic tasks; (2) because of women's lower preference for current consumption, the savings rate increases, leading to an increase in investment and physical capital; and (3) given the preference of mothers for the education of children, the time spent by women in raising children increases to the detriment of their participation in the labor market and their own accumulation of human capital, but to the benefit of their children's accumulation of human capital.

Overall, the positive impact of pro-gender measures on the economic growth rate would be on the order of 0.2 to 1.95 percentage points on an annual basis, depending on the scenarios (table B8.1.1).

TABLE B8.1.1 Effect of Reducing Gender Inequality on the Rate of Economic Growth

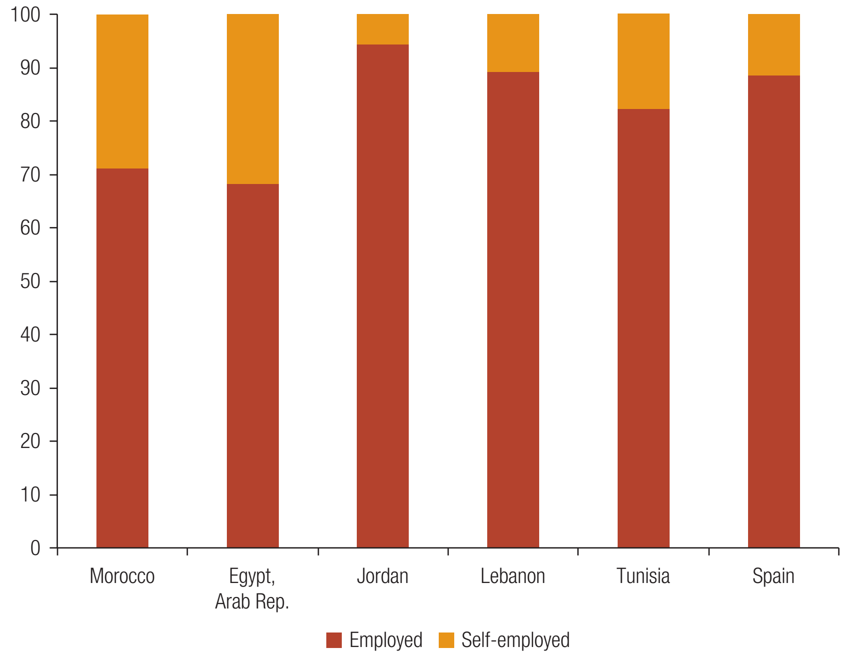
percent

	Reduced gender bias in the labor market	Increased time dedicated by mothers to girls	Increased women's bargaining power in the family	Integrated program
Allocation of women's time with endogenous leisure	0.2	0.6	1.0	1.95

Sources: Agénor 2012, 2017; Agénor, Berahab, and El Mokri 2017.

upgraded, as do programs aimed specifically at unskilled labor. Active labor market policies need to facilitate the matching of the supply of and demand for labor. Longer-term actions in the labor market will need to reform existing labor law with the aim of increasing flexibility. Targets for action include regulations dealing with hiring and firing, working hours, and overtime. To support those at risk as economic conditions vary over time, unemployment benefits will need to be made universal while maintaining fiscal sustainability.

FIGURE 8.6 Shares of Human Capital, by Type of Employment, 2014
percent



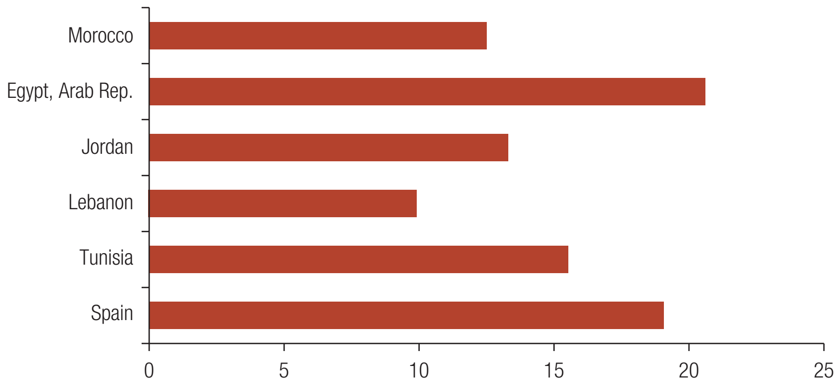
Source: World Bank calculations.

Morocco 2040: Institutions and Governance

In his 2014 speech, King Mohammed VI emphasized not only the need for investments in human capital but also the importance of institutions for development and wealth creation. Although this volume does not provide measures of wealth associated with institutions, other indicators can be used to compare Morocco with other countries.

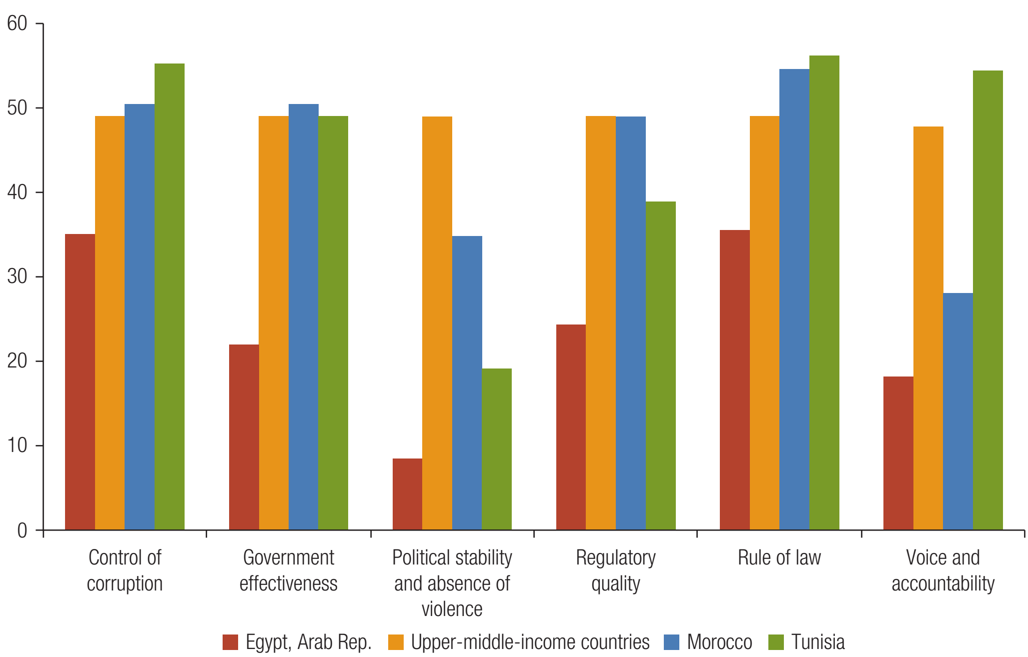
Social trust is the most common indicator of social capital. It can be defined as "networks together with shared norms, values and understandings that facilitate cooperation within or among groups" (OECD 2001, 41). Figure 8.7 reports the degree of social trust in Morocco and its comparator countries using data from the World Values Survey (2015). Levels of social trust are relatively low, with only 12 percent of respondents in Morocco saying that most people can be trusted. Although trust is not much higher in comparator countries, Morocco tends to do less well than the average. Figure 8.8 compares governance indicators for Morocco and comparators countries in 2015 using the Worldwide Governance Indicators. Here, Morocco's performance is relatively strong when compared with selected countries in North Africa and the aggregate score for upper-middle-income countries. On political stability, it leads its regional comparators but lags the average

FIGURE 8.7 Degree of Social Trust, Morocco and Comparators, 2014
percent



Source: World Values Survey 2015.
Note: The figure shows the percentage of the population responding positively to the statement, "Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?"

FIGURE 8.8 Governance Indicators, Morocco and Comparators, 2015
percent



Source: Worldwide Governance Indicators, from World Bank 2017b.
Note: For each indicator, the percentile scores are relative to the distribution of scores for all countries.

for upper-middle-income countries. The main potential source of weakness for Morocco appears to be voice and accountability.

As a program for growth, *Morocco 2040* targets a wide spectrum of reforms, from macroeconomic policy to labor markets to the social sector. However, underpinning these reforms is the need for transformation of public institutions and governance. The public sector enforces the rule of law, redistributes income, regulates economic activity, and provides essential social services, including health and education. Failure in this dimension of the program would put all other outcomes at risk. Creating a modern public sector is no small task, because it requires a commitment to building a public service based on merit rather than political affiliation. The proposed public sector reforms in *Morocco 2040* start with human resource management in the public service, aimed at merit-based hiring and promotion and dealing with absenteeism. Results-based management and a formal system for employee training aim to increase public service effectiveness.

Reforms to two key management functions also will be critical for success. First, enhanced public financial management can ensure more effective use of scarce financial resources, starting from the planning and budgeting cycle, to ensuring cost control measures and accountability for budget execution at the level of ministries. The second priority reform is to public investment management. As noted in the introduction to this chapter, the majority of investments in Morocco are made by the public sector, notably state-owned enterprises, and returns have often been low. Basic processes of project design, project appraisal, cost–benefit analysis, and independent evaluation of both project design and postimplementation outcomes need to be built and strengthened.

Decentralization of public administration can provide an important boost to governance. It holds the promise of bringing government closer to the governed as well as providing an opportunity to implement best civil service practices in the creation of new regional government structures. Decentralization also can give impetus to increasing voice and accountability in Morocco. Modern structures of governance ensure participatory processes in policy and project planning and implementation. Citizens will require increased access to information about government programs and better data on both government expenditures and indicators of service delivery. More broadly, users of government services need a stronger voice in expressing their satisfaction with the quality and equity of provision of these services. This is a long list of reforms, underpinned by surveys of the satisfaction of citizens with the Moroccan public administration, but the success of *Morocco 2040* will depend on successful implementation.

Conclusion

Morocco achieved strong growth in per capita wealth from 2005 to 2014, at 45 percent over 10 years, with notable gains in produced capital and the values of agricultural land and minerals. However, this growth masks weaknesses.

When population growth is taken into account, the net change in real wealth per capita as measured through ANS fell from over US$400 per person in 2005 to less than US$100 per person in 2014. Much of this weakness is due to low levels of human capital wealth. In 2014, 41 percent of Morocco's total wealth was human capital, compared with 59 percent in Egypt and 65 percent in Lebanon. The gap in human capital—compared with countries such as Jordan, Lebanon, and Tunisia—fully explains why total wealth per capita in Morocco is well below the average for those three countries.

One of the primary factors leading to insufficient levels of wealth per capita in Morocco is the gap in earnings—and thereby in wealth—by gender. Women account for only about a fifth of total human capital in Morocco. If gender parity in human capital wealth were achieved, levels of human capital wealth in Morocco could increase by more than a third. In addition, the country should invest more in early childhood development, as well as in improving the quality of its education system. As one example of potential gains, ending stunting could, according to estimates from the literature, lead to gains in human capital wealth of about 4 percent. On governance, Morocco leads its North African peers on rule of law, but the weak point is voice and accountability. Levels of trust also tend to be low. The good news is that reforms outlined in *Morocco 2040* could make a significant difference.

In 2014, the King of Morocco highlighted the role of intangible capital in powering the country's development. The *Morocco 2040* economic memorandum emphasizes not only macroeconomic reforms but also human capital growth through education and labor market reforms, as well as efforts to increase gender equality. Equally important will be institutional reforms to create a modern administration, improve public investment and financial management, and increase voice and accountability and access to information.

Progress to date in implementing the goals of *Morocco 2040* has been rooted in the new constitution adopted in 2011. To strengthen citizen voice and engagement, the organic law on petitions was adopted in 2016. More laws have been adopted to enhance citizen engagement, including the organic law of the right of citizens to submit legislative proposals (2016), the organic law of the right to strike (not yet adopted), and the right of access to information (not yet adopted), which is considered essential to enhancing democracy and achieving societal development. Regarding public finances, the organic law relative to budget law (2016) foresees ministerial performance objectives and indicators aimed at improving the effectiveness and efficiency of public policies and programs and the quality of public services. The organic laws of the judiciary system were approved by the Council of Ministers in 2015. They aim to organize the functioning of the Supreme Judiciary Council and establish the composition of the judicial system, the rights and obligations of magistrates, and their disciplinary regime.

In addition, far-reaching constitutional amendments have been made to enhance the accountability and transparency of local and regional councils as well as to increase citizen participation in the management of local affairs and public services. These amendments led to the consolidation of the current 16 regions into 12 larger regions to increase their economic and social attractiveness and maximize synergies. In this context, three organic laws were adopted in 2015, the main purpose of which is to provide local authorities with management autonomy, to broaden their prerogatives, and to establish the principles of mutual assistance and solidarity between them through a gradual approach. Accordingly, regional and local councils have been granted expanded powers and the corresponding resources on the basis of the principle of subsidiarity.

Notes

1. If the population grows by 1 percent, as it did in 2005, then, other things equal, a 1 percent decline in wealth per capita will occur.
2. Note, however, that there are no separate estimates of the age-sex-education structure of the self-employed cohort, which introduces a level of inaccuracy to the estimates of the human capital of the self-employed.

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9

Air Pollution: Impact on Human Health and Wealth

Christopher Sall and Urvashi Narain

Main Messages

- This chapter presents estimates of monetary losses of human capital in 172 countries from fatal health conditions caused by exposure to air pollution.
- Exposure to air pollution—including ambient particulate matter with a diameter of less than 2.5 microns ($PM_{2.5}$), household $PM_{2.5}$ from cooking with solid fuels, and ambient ozone—caused nearly 6.5 million premature deaths in 2015, accounting for more than 1 in 10 deaths worldwide. A combination of declining air quality, increasing rates of urbanization, and population aging has contributed to a rise in the number of deaths from ambient $PM_{2.5}$ each year.
- Pollution is particularly damaging to the elderly. Individuals age 65 years and older make up about 8 percent of the world's population but account for 61 percent of fatalities from illnesses attributed to air pollution.
- Globally, annual labor income losses from premature mortality caused by air pollution exposure totaled nearly US$179 billion in 2015, an increase of about US$47 billion or 36 percent in real terms since 1995.

Introduction

Air pollution damages human health, affecting the value of human capital by reducing labor force participation and productivity, which undercuts the global economy and the lives of the people who constitute it.

This chapter provides a measure of the loss, or depreciation, of human capital associated with premature deaths from air pollution, both ambient and indoor. The work seeks to guide the treatment of air pollution–related damage in the measurement of adjusted net saving (ANS).

It is important to understand how these figures relate to the broader wealth accounts published in this book. The first important point, as presented in the executive summary, is that the World Bank wealth accounts have been expanded to include the value of human capital. Although human capital is not included in the national balance sheet defined by the System of National Accounts (SNA) (EC et al. 2009), it arguably fits the SNA's definition of economic assets—that is, assets have an owner, and they provide a stream of benefits to their owner. The focus in this chapter is therefore on valuing the depreciation of human capital inherent in premature mortality from air pollution exposure. This measurement is distinct from valuing the welfare losses associated with this excess mortality, which World Bank and IHME (2016) show to be, for example, 25 times higher than human capital losses in the United States and 35 times higher in China.

The methods presented in chapter 6 for estimating human capital wealth implicitly incorporate the impacts of air pollution exposure described in this chapter. Every year, mortality and survival rates are applied to each worker for the estimation of human capital wealth. Survival from one year to the next is based on all causes of mortality, including pollution exposure. Similarly, workers' earnings that are used in the estimation of human capital wealth reflect their productivity and all factors that affect it, either positive or negative. At this time, it is not possible to separately estimate the impact on human capital wealth of air pollution, but it may be addressed in future work.

It is equally important to understand how the SNA deals with damage to assets. If the damage is not related to production or consumption, such as losses from a natural disaster, the SNA treats it as a change in total asset value ("other changes in volume") in the balance sheet. The SNA does not adjust measures of saving to reflect these losses, precisely because the losses are not linked to production or consumption. Because air pollution damage is directly related to production or consumption (emissions from factories, private automobiles, or fuel burned in the home), the treatment of human capital losses from air pollution should parallel the treatment of consumption of fixed capital. In the SNA, consumption of fixed capital is reflected both as a deduction in the balance sheet and as a deduction from saving, yielding the standard measure of net saving. The reason for this treatment is that wear and tear and loss of economic value for fixed capital are byproducts of production and consumption. The parallel with air pollution damage to human capital is direct, which motivates both this chapter and the proposed treatment of the cost of air pollution damage in ANS.

The chapter presents estimates of monetary losses in 172 countries from fatal health conditions caused by exposure to air pollution.

The analysis draws from findings on the health effects of air pollution published for the *Global Burden of Disease Study 2015* or GBD 2015 (IHME 2016), an international scientific collaboration led by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, Seattle (see Forouzanfar et al. 2016). The methodology for valuing the monetary cost of fatality risks from pollution comes from a study published jointly by the World Bank and the IHME in 2016 entitled *The Cost of Air Pollution: Strengthening the Economic Case for Action* (World Bank and IHME 2016). This chapter discusses the evolution of this methodology and its results. It closes with a discussion of how to improve the valuation of the reductions in human capital because of pollution.

Air Pollution Incidence and Impact across the Globe

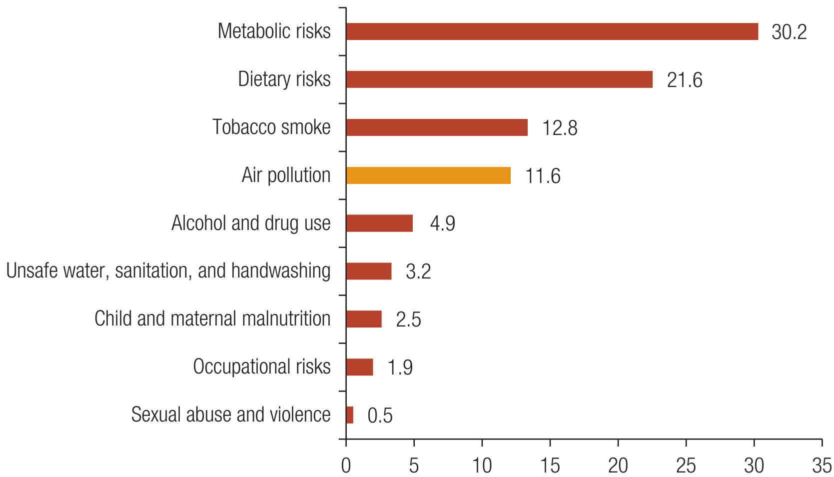
Air pollution comes in many forms, contaminating the air we breathe both indoors and outdoors. Some of the most pernicious constituents of air pollution are tiny particles measuring less than 2.5 microns in diameter, capable of penetrating deep into the lungs. Collectively referred to as $PM_{2.5}$, these particles may contain a mix of dust, dirt, smoke, vapors, gases, microscopic liquid droplets, and even heavy metals. Depending on their composition, they may come from a variety of sources. Direct sources of ambient $PM_{2.5}$ commonly include emissions from motor vehicles and power plants. Indoor sources of $PM_{2.5}$ include smoke from burning solid fuels such as coal, wood, charcoal, or dung for cooking and heating. Secondary $PM_{2.5}$ may occur when primary pollutants such as ammonia from agricultural fertilizers react with sunlight, water, oxygen, and other pollutants.

Though the composition and sources of air pollution can vary greatly from place to place, pollution is truly a global challenge. The results of the GBD 2015 show that exposure to air pollution—including ambient $PM_{2.5}$, household $PM_{2.5}$ from cooking with solid fuels, and ambient ozone—caused nearly 6.5 million premature deaths in 2015, accounting for more than one in ten deaths worldwide (figure 9.1). The number of fatalities from illnesses caused by pollution exposure is about 5.4 times the number of deaths each year from HIV/AIDS and 8.8 times that from malaria (IHME 2016), making air pollution the fourth-leading fatal health risk, just after tobacco smoke.

These estimates of the disease burden attributable to air pollution in the GBD 2015 are derived by first measuring the severity of air pollution and the extent to which people are exposed (Brauer et al. 2016; Cohen et al., forthcoming; Forouzanfar et al. 2016). Estimates of exposure to ambient $PM_{2.5}$ combine information from satellite observations of aerosols, numerical models of atmospheric chemistry, and ground monitoring of PM (van Donkelaar et al. 2016; Shaddick et al. 2017). Exposure to household $PM_{2.5}$ is estimated using data on the proportion of people reliant on solid fuels, the resulting concentrations of

FIGURE 9.1 Leading Fatal Risk Factors Globally, 2015

percentage of total deaths globally



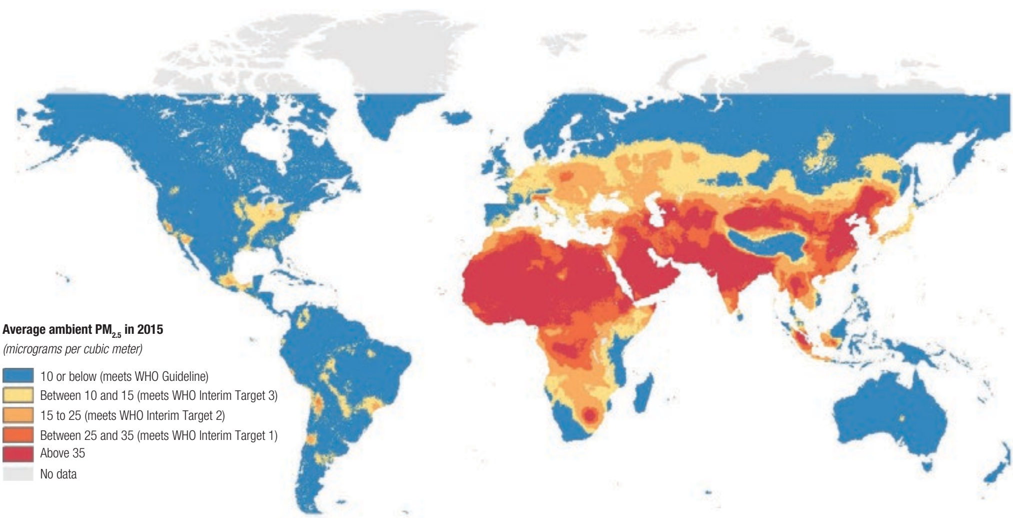
Source: IHME 2016.

$PM_{2.5}$ in the kitchen from cooking with those fuels, and the level of personal exposure of men, women, and children in the household to those kitchen concentrations. The GBD 2015 then evaluates how exposure raises people's relative risk of contracting illnesses associated with air pollution, including lower respiratory infections, lung cancer, ischemic heart disease, stroke, chronic obstructive cardiopulmonary disease, and pneumonia (see Burnett et al. 2014). Cause-specific models of relative risk combine information from epidemiological studies of the effects of exposure to widely varying levels of $PM_{2.5}$ from ambient air pollution, household air pollution, active cigarette smoking, and second-hand smoke. These models then allow researchers to estimate what portion of recorded deaths from these illnesses can be statistically attributed to pollution exposure.

Estimates of exposure to ambient $PM_{2.5}$ for the GBD 2015 reveal that 92 percent of the world's population in 2015 lived in areas with average annual concentrations in excess of World Health Organization guidelines (map 9.1). Air quality is deteriorating in many fast-growing, fast-urbanizing regions, particularly South Asia and East Asia and Pacific, whereas air quality has improved on the whole in other regions such as Europe and North America.

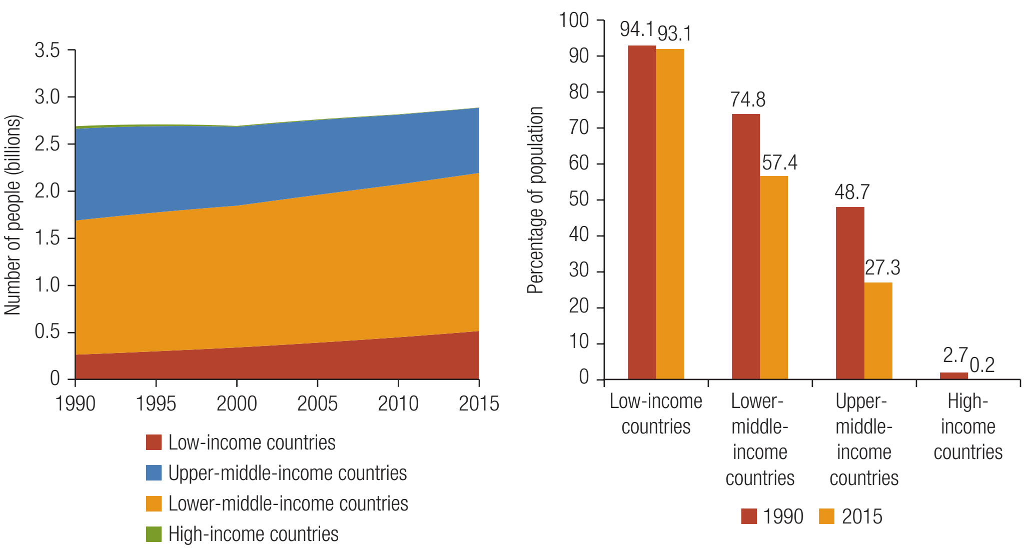
Trends in exposure to household air pollution, by comparison, show signs of mixed progress. The share of the world's population reliant on solid fuels dropped from about 52 percent in 1990 to 40 percent in 2015 (figure 9.2). Rates of solid fuel use dropped the fastest in middle-income countries such as China. Yet, because the

MAP 9.1 Mean Annual Concentrations of Ambient $PM_{2.5}$ Pollution, 2015



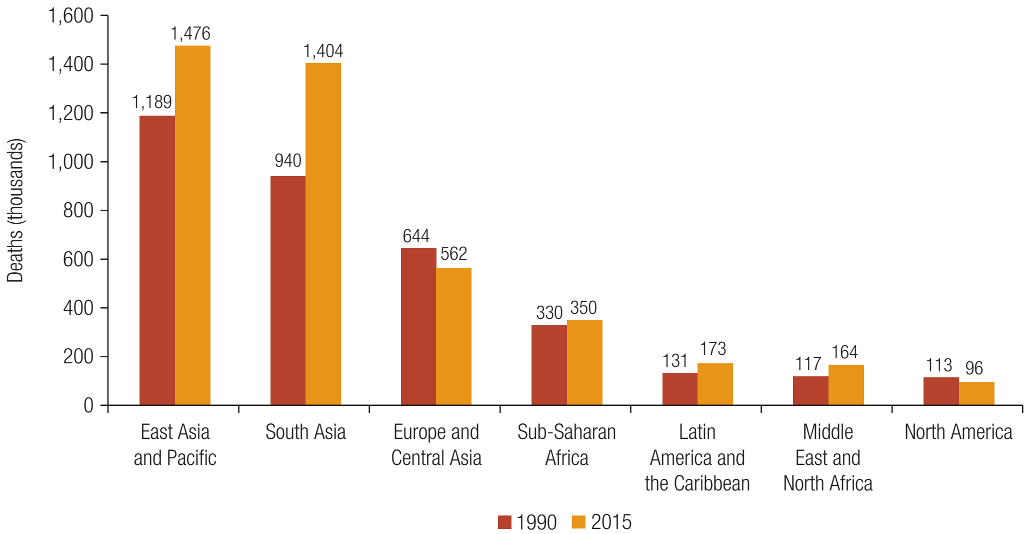
Source: World Bank, using data from van Donkelaar et al. 2016 (http://fizz.phys.dal.ca/~atmos/martin/?page_id=140).
Note: The map includes concentrations of natural windblown dust and sea salt. $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns; WHO = World Health Organization.

FIGURE 9.2 Population Reliant on Solid Fuels, 1990–2015



Source: World Bank data (http://data.worldbank.org/indicator/EG.CFT.ACCS.ZS).
Note: Data for missing years were extrapolated linearly according to year-over-year trends in percentage of population.

FIGURE 9.3 Premature Deaths from Ambient $PM_{2.5}$ Pollution, by Region, 1990 and 2015



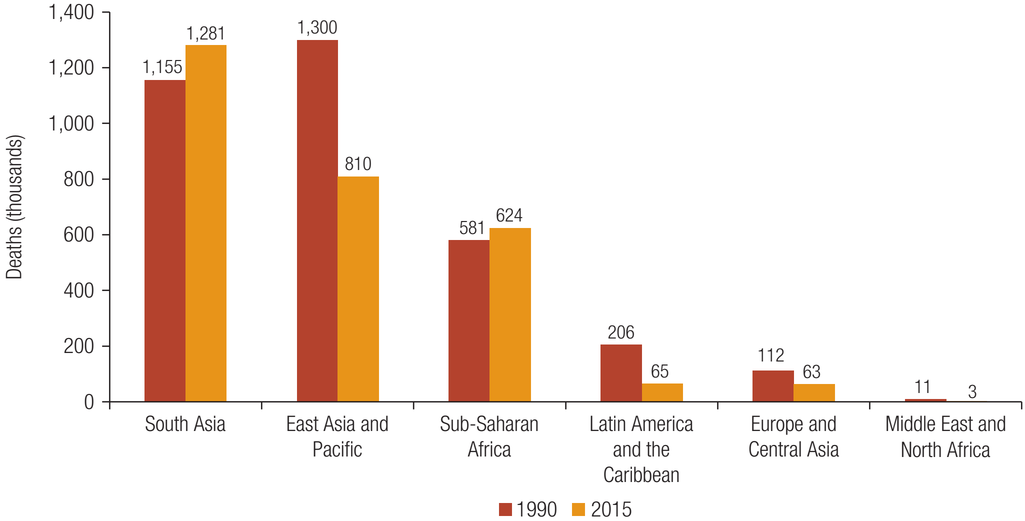
Source: IHME 2016 (http://ghdx.healthdata.org/gbd-results-tool).
Note: $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

total population using solid fuel grew at an even faster rate, the number of people exposed to household air pollution increased, from 2.69 billion in 1990 to 2.89 billion in 2015. In low-income countries, more than 90 percent of people continued to rely on solid fuels in 2015, as they did in 1990.

A combination of declining air quality, increasing rates of urbanization, and population aging has contributed to a rise in the number of deaths from ambient $PM_{2.5}$ each year, as a greater number of people who are more susceptible to pollution-related illness are exposed. In 2015, ambient $PM_{2.5}$ caused more than 4.2 million fatalities, up from slightly less than 3.5 million in 1990 (figure 9.3). The greatest increase in premature mortality as a result of ambient $PM_{2.5}$ occurred in South Asia, which accounted for 1.4 million deaths in 2015. Death rates continue to be highest in middle-income countries.

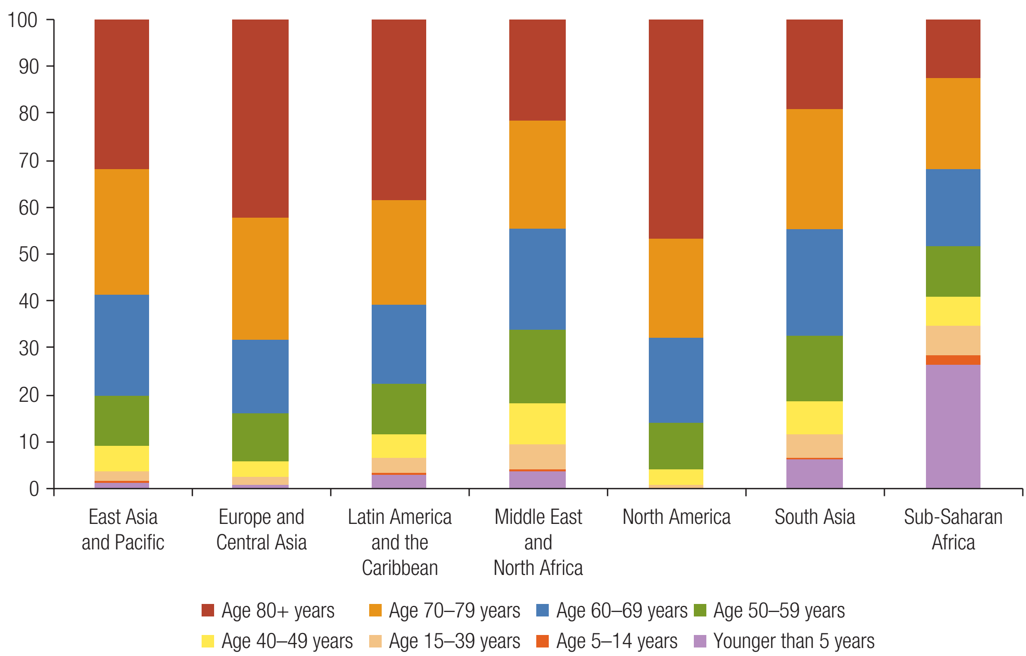
In contrast with ambient $PM_{2.5}$, the number of premature deaths annually from household air pollution has declined, from slightly less than 3.4 million in 1990 to about 2.8 million in 2015 (figure 9.4). These declines reflect not only significant improvement in household access to modern forms of energy in regions such as East Asia and Pacific, Europe and Central Asia, and Latin America and the Caribbean, but also baseline declines in mortality from pollution-associated illness, independent of exposure, aging, and other factors. Still, the number of deaths each year from household air pollution continues to increase in South Asia and Sub-Saharan Africa.

FIGURE 9.4 Premature Deaths from Household Air Pollution, by Region, 1990 and 2015



Source: IHME 2015 (http://ghdx.healthdata.org/gbd-results-tool).

FIGURE 9.5 Age Profile of Premature Mortality from Air Pollution, by Region, 2015
percent



Source: IHME 2015 (http://ghdx.healthdata.org/gbd-results-tool).

When the health impacts of air pollution are broken down by age, it becomes clear that pollution is particularly damaging to the elderly (figure 9.5). Individuals age 65 years and older make up about 8 percent of the world's population but account for 61 percent of fatalities due from illnesses attributed to air pollution. In Sub-Saharan Africa, in particular, a high portion of fatal health effects due to air pollution also are suffered by children younger than age 5 years. Children represented 16 percent of the region's population in 2015 and 26 percent of pollution-attributed deaths.

The Economic Costs of Air Pollution

The number of early deaths attributed to air pollution is staggering. From the perspective of wealth accounting, the tragic human toll of air pollution also causes loss of a nation's stock of human capital. The value of this loss is captured explicitly within the framework of the ANS indicator, which is published annually as part of the World Bank's World Development Indicators.

Under the present methodology for ANS, losses due to premature mortality from air pollution exposure are equated with the discounted value of the forgone labor income that sufferers of fatal illness would have earned over their remaining working lives had they not died. The income-based approach for measuring the reduction of human capital due to air pollution draws parallels with how the degradation of other forms of productive capital is measured under ANS. Annex 9A briefly explains the valuing methodology; a more detailed discussion of the methodology can be found in Narain and Sall (2016).

This approach does have its limitations, however. First, measuring the costs of nonfatal illness is not possible. Second, the income-based

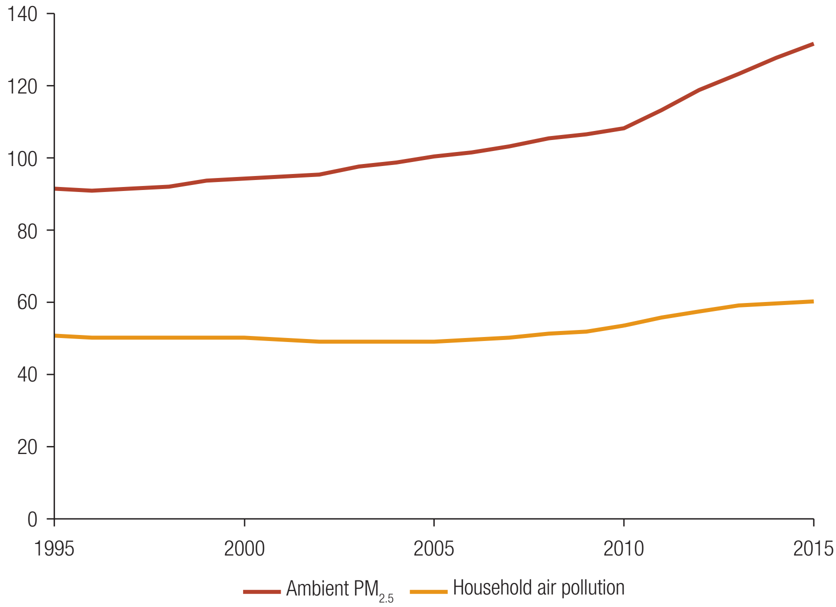
TABLE 9.1 Labor Income Losses from Air Pollution, by Region, 1995–2015
billion US$

Region	1995	2000	2005	2010	2015
East Asia and Pacific	29.9	35.3	40.3	47.9	62.0
Europe and Central Asia	31.0	26.2	26.7	25.4	26.3
Latin America and the Caribbean	15.0	12.4	10.1	9.1	9.2
Middle East and North Africa	4.6	4.5	4.4	5.3	6.5
North America	15.9	17.8	20.8	19.0	20.7
South Asia	19.6	21.1	21.1	25.3	32.7
Sub-Saharan Africa	15.4	15.4	15.8	18.2	21.3
Total	**131.4**	**132.6**	**139.0**	**150.2**	**178.7**

Source: Data from World Development Indicators database (http://data.worldbank.org/indicator/NY.ADJ.DPEM.CD).
Note: Data are for a balanced set of 157 countries with data for all years, deflated to constant 2014 US dollars at market rates.

FIGURE 9.6 Global Labor Income Losses from Ambient $PM_{2.5}$ and Household Air Pollution, 1995–2015

billion US$



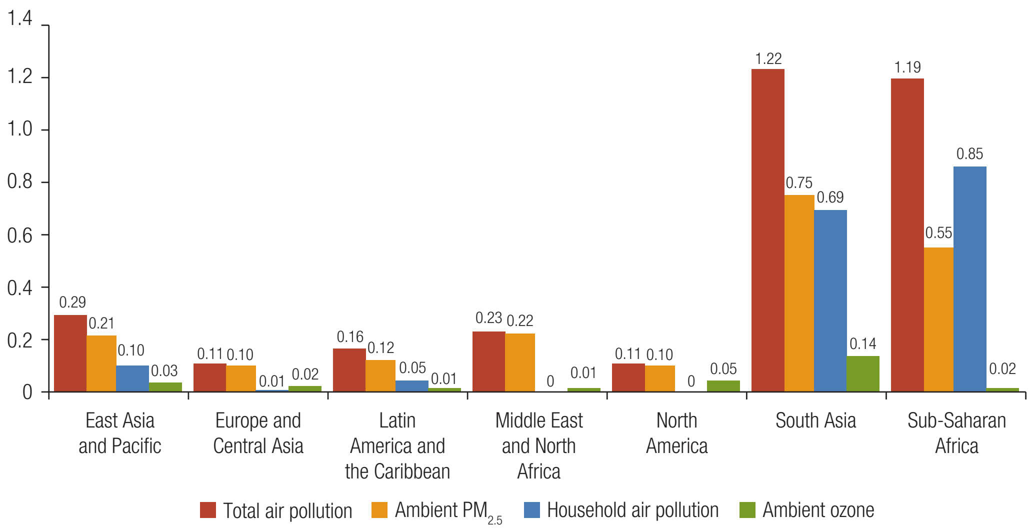
Source: Data from IHME 2016.

Note: Figures are constant 2014 billion US$ at market rates. $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

approach to valuing increased mortality risks does not reflect the cost of pain and suffering or the loss of the many intangible parts of life that people value beyond their paychecks. Third, beyond human health, air pollution affects the economy in a myriad of other ways, for example, by reducing crop yields and depressing real estate prices.[1] Thus, labor income losses as presented here should be interpreted within the confines of ANS and not as a full accounting of the economic costs of pollution.

Globally, annual labor income losses from premature mortality due to air pollution exposure totaled nearly US$179 billion in 2015,[2] an increase of about US$47 billion, or 36 percent in real terms, since 1995 (table 9.1).[3] Losses from ambient $PM_{2.5}$ exposure increased most rapidly over this time (figure 9.6), owing to deteriorating air quality in many fast-growing, fast-urbanizing, and fast-aging regions. By 2015, global losses from ambient $PM_{2.5}$ had reached about US$133 billion. Though losses from ambient $PM_{2.5}$ have grown more quickly, the deadly effects of household air pollution from cooking with solid fuels continue to be a drag on the world economy, resulting in US$60 billion in forgone labor output in 2015.

FIGURE 9.7 Annual Labor Income Losses from Air Pollution, by Region, 2015
percentage of GDP

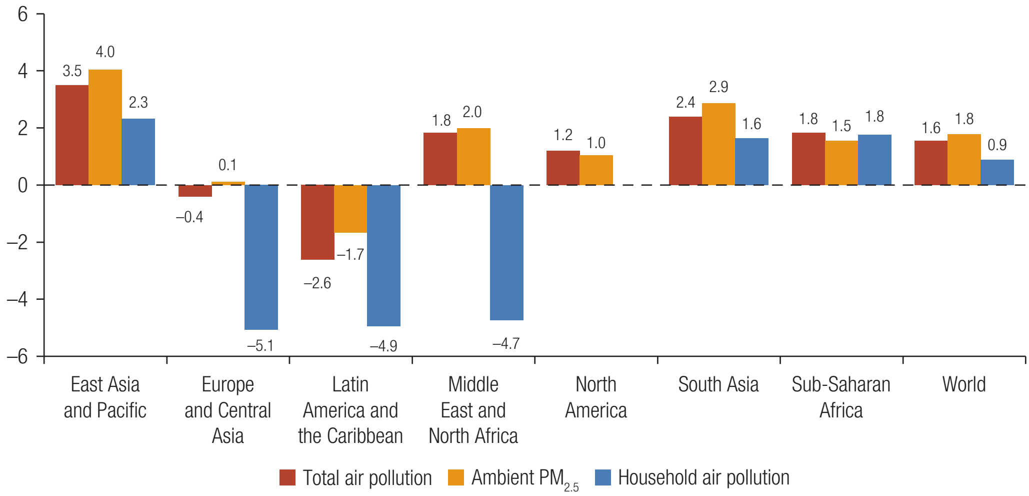


Source: Data from IHME 2016.
Note: GDP = gross domestic product; $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

Though labor income losses due to air pollution are increasing at an accelerating rate overall, when viewed on a regional basis, some divergent trends emerge. Losses have consistently risen in three regions: East Asia and Pacific, South Asia, and Sub-Saharan Africa. Among these three regions, East Asia and Pacific experienced the most rapid increase—losses more than doubled between 1995 and 2015, reaching US$62 billion or the equivalent of 0.3 percent of regional gross domestic product (GDP).[4] Sub-Saharan Africa, which experienced US$21 billion in labor income losses in 2015, continues to be the only region in which the majority of losses are due to household air pollution (figure 9.7). Meanwhile, two regions significantly reduced losses since 1995: Europe and Central Asia and Latin America and the Caribbean. The declines in these regions were mainly the product of improved access to nonsolid fuels and reduced mortality from household air pollution, as shown by figure 9.8. The Middle East and North Africa region also experienced significant improvements in household air pollution, though these advancements were canceled out by worsening exposure to outdoor air pollution, including windblown dust.[5] Despite the longer-term improvements seen in some regions, in the most recent years these improvements have begun to slow and even reverse—all the world's regions have experienced an increase in mortality-related losses since 2010.

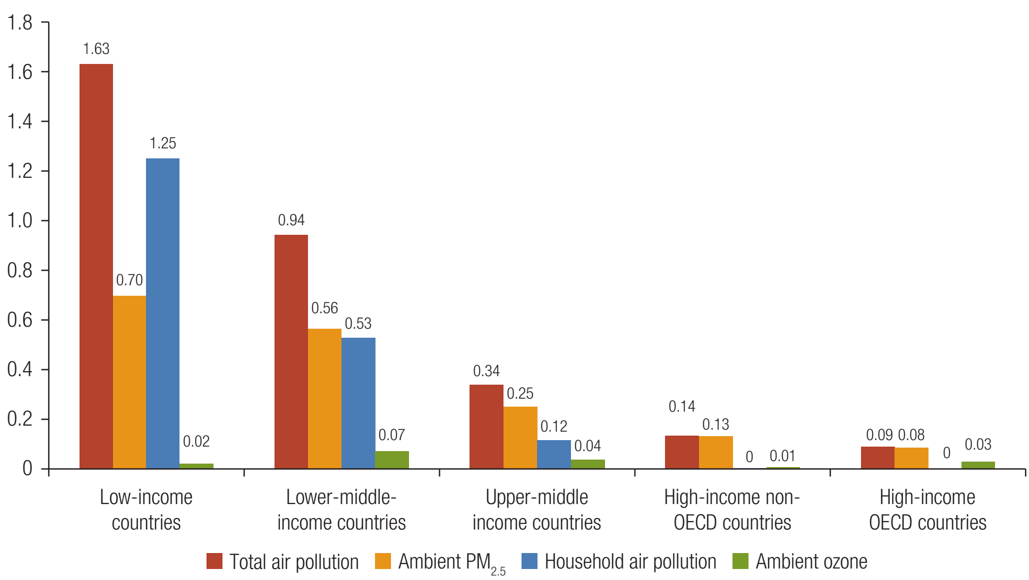
When trends in pollution losses are viewed instead by income level, the heavy burden of air pollution on the world's poorer countries becomes apparent. Forgone labor output in low- and lower-middle-income countries averaged the equivalent of 1.63 percent of GDP and 0.94 percent of GDP, respectively, in 2015 (figure 9.9). These relatively

FIGURE 9.8 Average Annual Change in Labor Income Losses from Air Pollution, by Region, 1995–2015
average annual percent change



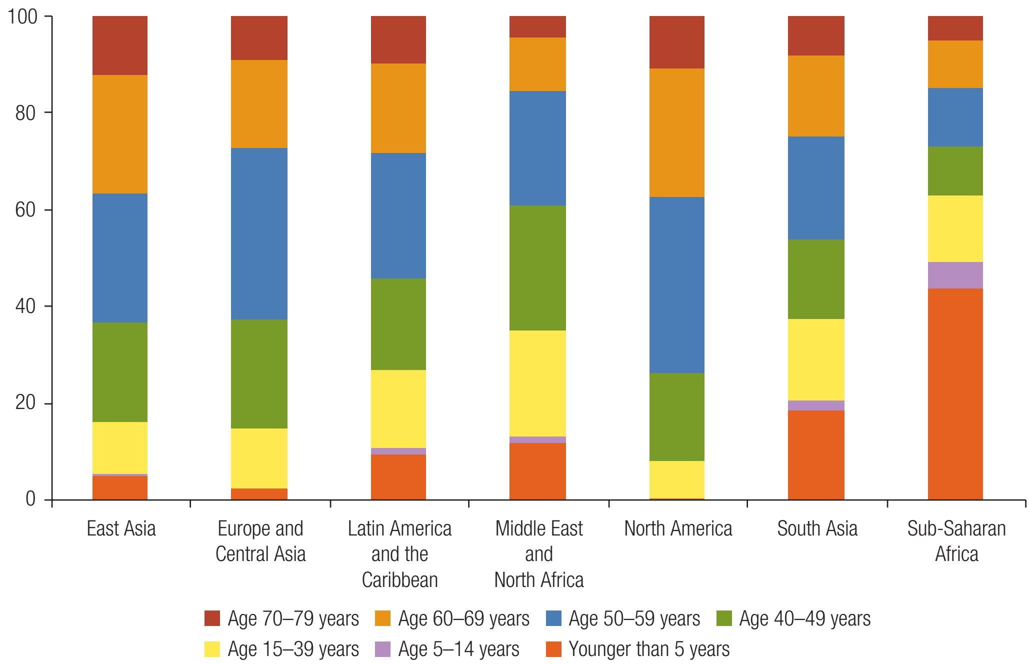
Source: Data from IHME 2016.
Note: Average annual percent change in losses, as measured in constant 2014 US dollars at market exchange rates. $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

FIGURE 9.9 Labor Income Losses from Air Pollution, by Income Group, 2015
percentage of GDP



Source: Data from IHME 2016.
Note: GDP = gross domestic product; OECD = Organisation for Economic Co-operation and Development; $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

FIGURE 9.10 Age Profile of Labor Income Losses from Air Pollution, by Region, 2015
percent



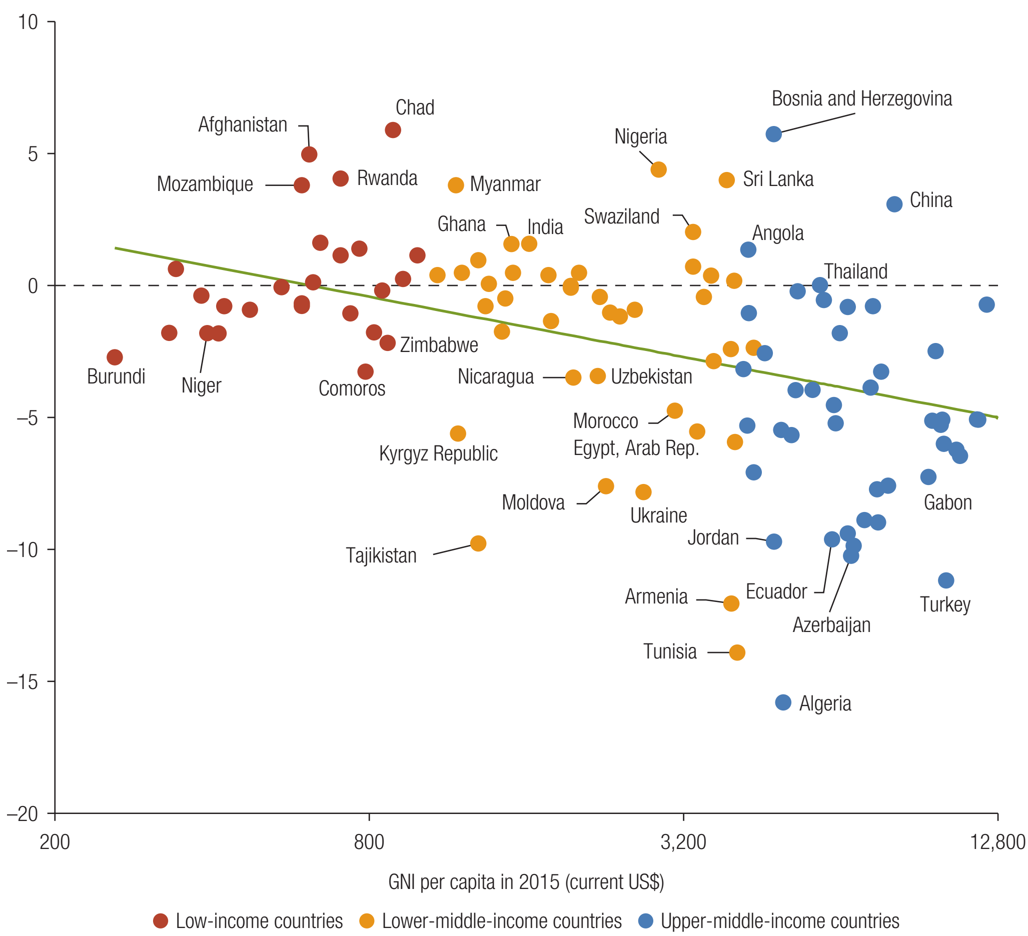
Source: Data from IHME 2016.
Note: $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

high losses are caused by the continuing high rates of exposure to both ambient and household air pollution in these countries. Higher losses are also influenced by demographic and economic factors. In these lower-income countries, the workforce tends to be younger, and a higher portion of overall losses come from premature mortality in children. In Sub-Saharan Africa, which represents about half of the world's low- and lower-middle-income countries, 49 percent of total forgone labor output was due to fatal illnesses among children younger than age 14 (figure 9.10). Expected losses of labor income are greater among these younger age groups. This effect is gradually being weakened, however, as the age profile of people affected by pollution continues to shift and a higher proportion of deaths occurs among people later in their working lives.

Losses from household air pollution have largely followed improvements in access to nonsolid fuels and show a clear relationship with income. Year-over-year decreases in losses were seen in 71 percent of all low- and middle-income countries, including 89 percent of upper-middle-income countries (figure 9.11). The greatest reductions in household air pollution losses were achieved by Algeria, Armenia, Azerbaijan, Tunisia, and Turkey. The greatest increases occurred in Afghanistan,

FIGURE 9.11 Average Annual Change in Losses from Household Air Pollution in Low- and Middle-Income Countries, 1995–2015, versus Income Level in 2015

percent change



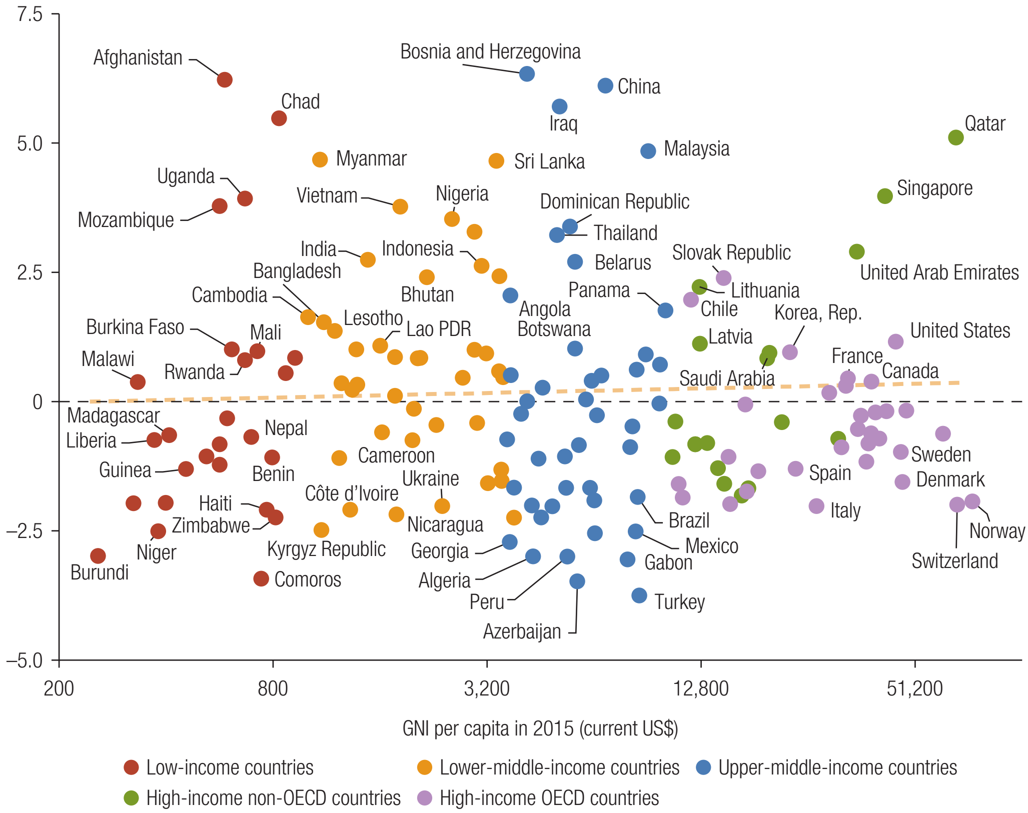
Source: Data from IHME 2016.

Note: Equatorial Guinea is not shown. Household air pollution exposure and losses in high-income countries are negligible, so they are not included. GNI = gross national income.

Bosnia and Herzegovina, Chad, Nigeria, and Uganda.[6] Reductions in losses from household air pollution tended to be deeper for higher-income countries. For ambient $PM_{2.5}$, trends were less clear (figure 9.12). Year-over-year increases in annual losses occurred in 38 percent of low-income countries, 63 percent of lower-middle-income countries, 44 percent of upper-middle-income countries, and 32 percent of high-income countries. The countries with the highest rates of annual growth in ambient $PM_{2.5}$ losses included Afghanistan, Bosnia and Herzegovina, China, Iraq, and Kuwait.[7] The countries with the largest annual decreases were Azerbaijan, Comoros, Gabon, Tajikistan, and Turkey.

FIGURE 9.12 Average Annual Change in Losses from Ambient $PM_{2.5}$, 1995–2015, versus Income Level in 2015

percent change



Source: Data from IHME 2016.

Note: Kuwait and Equatorial Guinea are not shown. GNI = gross national income; OECD = Organisation for Economic Co-operation and Development; $PM_{2.5}$ = particulate matter with a diameter of less than 2.5 microns.

Recommendations for the Way Forward: Improving the Measure of Pollution Losses for Human Capital

Currently, pollution losses are valued by assuming that annual labor income is the same for all adult workers (ages 15–79 years), regardless of skills, experience, or education. Using the more granular data from the International Income Distribution Database used for the human capital estimates in chapter 6 would improve the existing estimates of expected lifetime labor income. Estimates of forgone labor output might be incorporated into the wealth accounts to measure the reduction in human capital due to risk factors such as air pollution, though with some caveats. As currently estimated, human capital includes only the working population ages 15 to 65, but 69 percent of premature deaths in 2015 due to air pollution exposure were suffered by children younger than age 15 and adults older than age 65. And, of the 30 percent of premature deaths in the population ages 15 to 65, not all occurred among workers.

Beyond air pollution, the ANS indicator and wealth accounts could be further expanded to incorporate other fatal health risks, many of which are already covered in the GBD.

The valuation of air pollution losses for ANS would also be improved by continuing to explore how nonfatal health outcomes associated with pollution exposure—such as chronic bronchitis, low birth weight, and the impairment of cognitive development in early childhood—may be valued.

Annex 9A: Valuing the Cost of Air Pollution in the Adjusted Net Saving Indicator

The approach to estimating the disease burden from air pollution exposure is described in the introduction to this chapter. A summary of the general approach to valuation is provided here, and a full discussion of the methodology and data sources is provided in Narain and Sall (2016). The World Bank uses an income-based approach to monetizing premature mortality for ANS. Under the present methodology for ANS, losses due to premature mortality from air pollution exposure are equated to the present value of the forgone labor income that sufferers of fatal illness would have earned over their remaining working lives had they not died. The income-based approach for measuring the reduction of human capital due to air pollution draws parallels with how the degradation of other forms of productive capital are measured under ANS. It does not include the costs of nonfatal illness, pain and suffering, or losses due to impacts on economic assets such as productivity of cropland.

Losses from premature mortality are estimated per five-year cohort for ages 15–79 as years as follows:

$$PV(I) = \sum_{i=0}^{T} I(1+g)^i / (1+r)^i \tag{9A.1}$$

where $PV(I)$ is the present value of expected lifetime labor earnings for people in that age group; I is average labor income per worker in the present year; T is the expected number of working years for the average person in that age group, conditional on survival probabilities and rates of labor force participation; g is the annual rate of income growth, assumed to be 2.5 percent for all countries and years; and r is the discount rate, assumed to be 4 percent for all countries and years. Valuing forgone labor output for children 14 and younger represents a special case. Working life expectancy is estimated by accounting for survival probabilities up to the age of 15, and then is adjusted for labor force participation rates thereafter.

Average labor income per worker is derived from the labor share of GDP for each country as

$$I = (GDP \times s) / w \tag{9A.2}$$

where s is the labor share, $GDP \times s$ is total labor income in the economy, and w is the total number of employed workers.

Working life expectancy, T, is calculated by weighting life expectancy to maximum working age by the probability that an individual will survive and be active in the labor force. It is expressed as

$$T_j = \sum_{t=j}^{79} s_{j,t} \times l_t \tag{9A.3}$$

where $s_{j,t}$ is the probability that a person of age j will survive to the end of age t, and l is the labor force participation rate. This assumes that life expectancy increases monotonically with age, which is not the case for countries with high rates of infant mortality and where life expectancy at birth is lower than it is for children who survive to age 1. Data used are from the International Labour Organization by five-year age group for ages 15–64 and for the open-ended 65-and-up age group.[8] It is assumed that no person older than age 79 works. Valuing forgone labor output for children 14 and younger is a special case. Working life expectancy is estimated by accounting for survival probabilities up to age 15, and then is adjusted for labor force participation rates thereafter, as for adults in equation (9A.2). In equation (9A.1), the present value of labor income is discounted further into the future, assuming working age begins at 15.

Notes

1. See Wang and Mauzerall (2004); Avnery et al. (2011); and Zheng et al. (2014) for evidence from China.
2. All dollar figures reported in this chapter are 2014 US dollars at market exchange rates.
3. Here, total losses are for the 157 countries for which data are available for all years from 1995 to 2015. Estimates of forgone labor output in 2015 exist for another eight countries that are missing data for some earlier years. Including these countries, labor income losses in 2015 were US$179.8 billion.
4. Forgone labor income does not represent a deduction from GDP because GDP produced in a given year reflects the lower labor inputs resulting from air pollution. Losses are compared with GDP merely to provide a sense of relative magnitude.
5. The current position of the U.S. Environmental Protection Agency, the World Health Organization, and the International Agency for Research on Cancer is that there is still insufficient evidence to differentiate the health impacts from exposure to specific sources or components of $PM_{2.5}$. With the GBD data that underlie the cost estimates, it is not possible to "net out" the effects of dust exposure.
6. Equatorial Guinea, for which losses due to household air pollution increased by 17.6 percent annually even though deaths declined, is excluded as an outlier. The apparent increase in losses for Equatorial Guinea is due entirely to income growth.
7. As in the case for household air pollution, Equatorial Guinea is excluded from this list of countries with the highest rates of growth in ambient $PM_{2.5}$ losses as an outlier.
8. The International Labour Organization's definition of the labor force encompasses anyone who is actively working or seeking work. This includes the

unemployed as well as the employed. The self-employed, underemployed, and those working informally (such as family workers) are counted as employed. In practice, however, definitions of employment vary among countries, and countries with high levels of informality in the labor market may underreport the size of the economically active population (see ILO 2015).

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10

Subsidies Reduce Marine Fisheries Wealth

Charlotte de Fontaubert, U. Rashid Sumaila, and Glenn-Marie Lange

Main Messages

- After steadily increasing over decades, annual global production of capture fisheries has plateaued just above 80 million metric tons. From a peak of 86 million tons in 1996, global marine catches have shown a small downward trend of about 0.2 million ton per year.
- Globally, the proportion of fully fished stocks and overfished, depleted, or recovering fish stocks has increased from slightly more than 50 percent of all assessed fish stocks in the mid-1970s to about 75 percent in 2005, and to almost 90 percent in 2013.
- As global marine catches have stagnated and even declined, fishing effort has greatly expanded over the past 70 years. Over the same period the level of global marine catches has not even doubled, suggesting a steep decline in the catch per unit effort, often considered a measure of fishing productivity.
- At the global level, the data show that, overall, global fisheries have foregone US$83 billion of rent in 2012. Fisheries are heavily subsidized and in many countries resource rents from fisheries are negative—meaning that revenues do not fully cover the costs of fishing.

Introduction

One of the primary motivations for the early natural capital accounting efforts in the mid-1980s was a concern that rapid economic growth in some countries was achieved through liquidation of natural capital—a temporary strategy that creates no basis for sustained advances in wealth and human well-being, unless this natural capital is converted efficiently into other forms of wealth. Sound management of natural capital is a critical step in the development process for many countries. Aquatic resources, including marine fish stocks, are an important component of natural capital, especially in coastal nations or small island developing states. According to FAO, approximately one in ten people relies on fisheries and aquaculture for their livelihood (FAO 2016). Commercial capture fisheries, including postharvest activities, were estimated to contribute at least US$274 billion to global GDP in 2007 (de Graaf and Garibaldi 2014) while generating tens of millions of jobs worldwide (Teh and Sumaila 2013).

Despite their global importance, fisheries are measured and assessed on the basis of data that are frequently incomplete, limited, or even inaccurate. Lack of quality data prevents countries from effectively evaluating the importance of the sector as a path for sustainable development and hinders effective management of this important natural resource. Accounting for fish and other aquatic resources, however, has lagged behind the accounting efforts for other natural capital assets such as forests and subsoil assets. The System of Environmental-Economic Accounting (SEEA) (UN et al. 2014) provides the framework for accounts, further elaborated for fisheries in SEEA for agriculture (UN, FAO, and OECD 2015) and SEEA for fisheries (FAO 2006). But fisheries resources are still poorly represented in most national environmental accounting efforts, largely because of a lack of data.

The *Changing Wealth of Nations* does not include fish assets because available data do not meet the criteria for inclusion. Assets are included when the necessary data are available for a large number of countries (at least 100), updated regularly to provide a time series, and publicly available. The general approach to asset valuation—as described in chapter 1 and following UN et al. (2014)—is to estimate the discounted stream of rents an asset like fisheries is expected to generate over its lifetime. If managed sustainably, the lifetime and stream of rents are infinite; if not, then the lifetime is limited, as it is for minerals. Data requirements include catch volume, price and costs of fishing to calculate rents, discount rate to estimate the present value of future rents, and information about the size and condition of the underlying stock to assess the potential lifetime of the stock and rents generated. Although some country studies and one-off studies at regional or global level are available (see box 10.1), the available data with global coverage have largely been limited to catch volume and value.

Despite these data challenges, recent initiatives have improved the understanding of what is really at stake and of the need to take steps

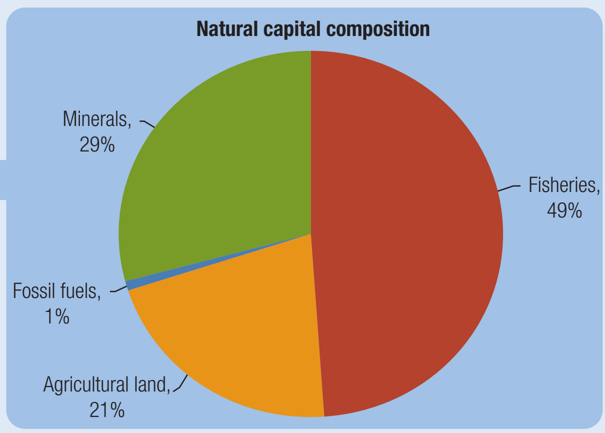
BOX 10.1 Mauritania: Where Fisheries Capital Really Counts

Mauritania is a resource-rich country with total per capita wealth of US$46,463. Natural capital accounts for 74 percent of wealth, and fisheries are the largest component (49 percent); the rest is evenly divided between agricultural land (mainly pastureland) and minerals (figure B10.1.1). These wealth accounts, including fisheries, were compiled for the *Changing Wealth of Nations* data set on the basis of a case study of national wealth by Mele (2014), who used country data to estimate fisheries assets.

Commercial fishing, mainly by foreign operators, accounts for approximately 90 percent of the sector, with artisanal fishing making up the remainder. The revenues generated by international fishing agreements accounted for roughly 20 percent of public sector income. Domestic (mainly artisanal) fishing represents just 3 percent of annual gross domestic product (GDP), but the prospects for growth are high. This situation underscores the importance of optimizing rents from commercial fisheries and using a share of these resources to ensure that the sector is properly managed. Without effective monitoring and enforcement, overfishing of the highest-value species (for example, octopus) may seriously jeopardize the regenerating mechanisms of the country's fisheries. Overall, however, the fact that more than 50 percent of national wealth is in renewable resources gives the country an advantage and the incentive to manage these resources sustainably, so that they can provide a permanent source of income.

FIGURE B10.1.1 Where Is the Wealth of Mauritania?

US$ per capita (2014)	
Total wealth	**46,463**
Produced capital	4,891
Natural capital	34,657
Human capital	9,368
Net foreign assets	–2,454



Sources: Mele 2014; World Bank calculations.

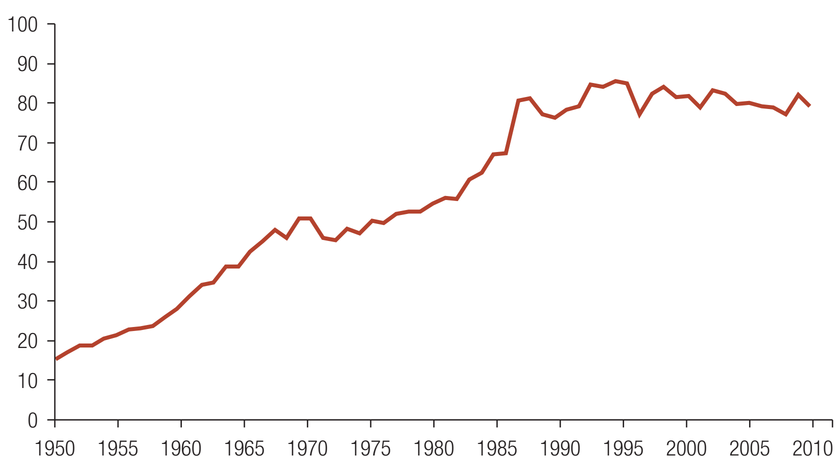
toward including fisheries wealth in future versions of the *Changing Wealth of Nations*. Resource rent is a key concept both to wealth accounting and more broadly to fisheries management. It represents the value that the asset—in this case, fisheries—contributes to fishing revenue. The revenue generated by fishing must cover all the costs—fuel, vessel costs (including a reasonable return on fixed capital invested in fishing), labor, and other inputs. Any revenue above payments needed for other inputs is rent attributable to fisheries.

The Sunken Billions (World Bank and FAO 2009) made a first attempt at measuring global rents from marine fisheries and found that massive overfishing, supported by subsidies, resulted in forgone rents of US$51 billion in 2004. An independent study (Sumaila et al. 2012) confirms that the forgone rents are considerable; it estimated dissipated rents of US$67 billion. A more recent update of *The Sunken Billions* report found that forgone rents reached US$83 billion in 2012 (World Bank 2017), and implies that in many countries rent was actually negative. A negative rent means that the revenue from fishing is not able to cover all of the costs of fishing—fuel, vessel costs, labor, and others—and requires subsidies. In such cases, the fish stock itself has a zero value in pure economic terms, contributing nothing to global wealth. These estimates were carried out at the global level and do not identify highly variable rents generated for each country. However, data on global fisheries point to widespread overfishing, declining fish stocks, and likely negative rents in many countries.

State of Global Marine Fisheries

According to the United Nations Food and Agriculture Organization (FAO 2016), after steadily increasing for decades, annual global production of capture fisheries has plateaued at slightly more than 80 million metric tons. It is fueled by sustained demand from developed and, increasingly, developing countries, with China accounting for the most in the latter group. Figure 10.1 illustrates the evolution of global marine catches from 1950 to 2012, showing a steady increase (about 1.4 million tons each year) until the early 1990s, followed by a period of stagnation, fluctuating between 79 million and 86 million tons per year. From the

FIGURE 10.1 Trends in Global Marine Catch, 1950–2012
million metric tons



Source: FAO Fishstat Plus database.

peak of 86 million tons in 1996, global marine catches have shown a small downward trend of about 0.2 million ton per year, a shift from a regime of a growing catch to a regime of stagnation in the early 1990s.

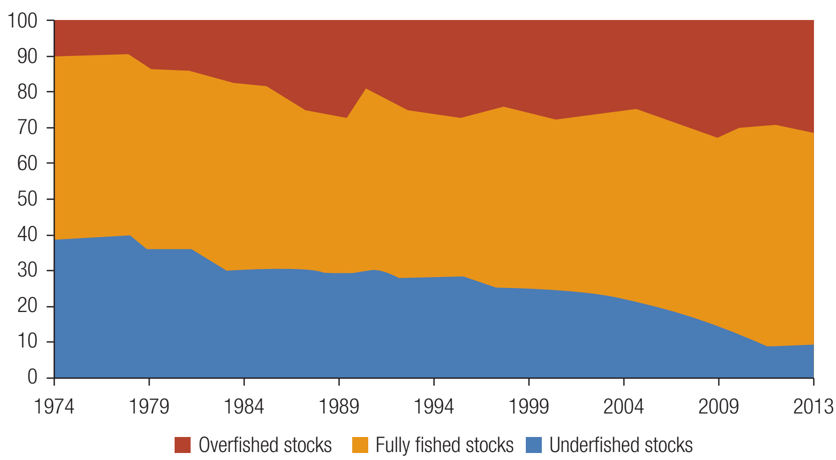
In biological terms, the crisis in marine fisheries has been well documented. Globally, the proportion of fully fished stocks and overfished, depleted, or recovering fish stocks has increased from slightly more than 50 percent of all assessed fish stocks in the mid-1970s to about 75 percent in 2005, and to almost 90 percent in 2013, as illustrated in figure 10.2.

In FAO statistics, fish stocks are defined as fully or overfished if their biomass is at or below the level that supports maximum sustainable yield (MSY). Maximum economic yield (MEY), which maximizes the sustainable net benefits flowing from the stocks, occurs at a level of effort that is lower than that at the MSY level (figure 10A.1 in annex 10A). Therefore, the FAO assessment of the biological state of fish stocks indicates that approximately 90 percent of the world's fisheries likely were subject to economic overfishing in 2011.

Just as global marine catches stagnated and even declined, fishing effort[1] appears to have increased. Although the available global data on fishery inputs, both quantitative and qualitative, are limited and not always reliable, they all point in the same direction of greatly expanded fishing effort over the past 70 years (FAO 1999, 2014a, 2014b). It is clear that there has been a substantial increase in the global fishing effort over the past four decades, but over the same period the level of global marine catches has not even doubled, suggesting a steep decline in the catch per unit effort, often considered a measure of fishing productivity.

Recent work at the University of British Columbia—under the Sea Around Us and the Fisheries Economics research unit of the Institute

FIGURE 10.2 State of Global Marine Fish Stocks, 1974–2013
percent



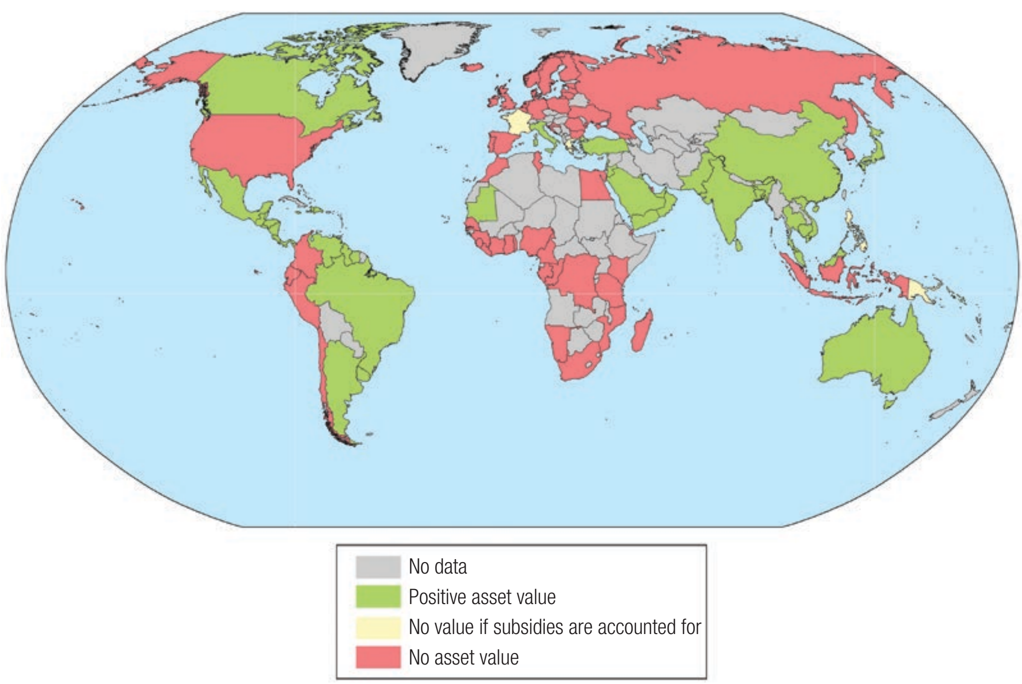
Source: FAO 2016.

for the Oceans and Fisheries—helps in the estimation of the asset value of fisheries at the country level. Their database covers landed value based on reconstructed catch data, costs of fishing, and subsidies in 2014 for 139 maritime countries, which collectively represented approximately 98 percent of global landings in 2014.[2]

The first step in estimating fisheries asset value is to determine whether rent, net of subsidies, as currently managed is positive for a country. If negative, as mentioned for the global study, the productive value of the fish stock itself is zero. At the global level, these new data show that, overall, global fisheries do not generate positive rent. Landed value in 2014 was US$164 billion, with rent of –US$24 billion. Subtracting subsidies yields net rent of –US$44 billion. These findings cannot be strictly compared with the estimates of the *Sunken Billions* reports, mostly because of major differences in how subsidies are accounted for and even how landing values are measured. But the message is similar, and a worrisome one.

Of course, global figures do not reflect what is going on in every country. Map 10.1 shows that fisheries in 64 of 139 countries generate positive rents, even after accounting for subsidies. In these 64 countries, fisheries contribute to national wealth; but in 75 countries they do not. For 6 countries with negative net rents, the subsidies make the difference, pushing net rent into negative territory. Fisheries in the remaining

MAP 10.1 Where Fisheries Contribute to the Wealth of Nations



Source: World Bank calculations based on Pauly and Zeller 2016; Sumaila et al. 2012; and Tai et al. 2017.

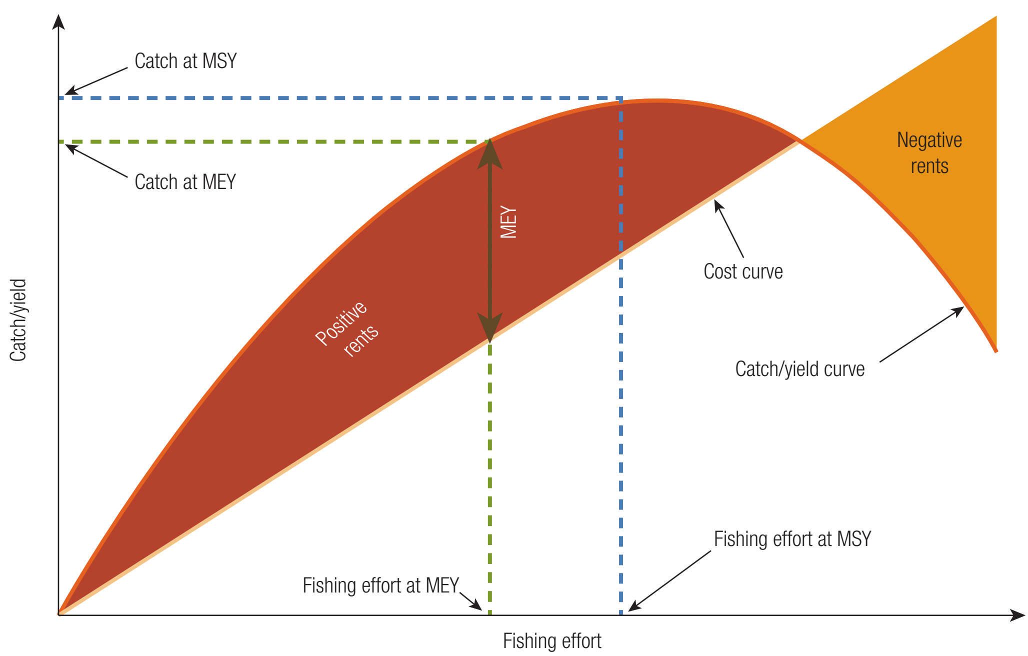
69 countries generate negative net rents and do not contribute to national wealth.

The next step in estimating fisheries wealth, for those countries with positive rents, is to assess the biophysical sustainability of fisheries. A fishery might generate positive rents but still be managed unsustainably, resulting in a limited time horizon for generating rents, much like exhaustible mineral resources. The potentially devastating impacts of climate change (increased ocean temperatures, acidification, and changes in oceanic currents) should also be taken into account (for example, Sumaila et al. 2011; Cheung, Reygondeau, and Frölicher 2016). These data will be developed and used to fully incorporate fisheries in future versions of the *Changing Wealth of Nations*.

Annex 10A: Maximum Sustainable Yield, Maximum Economic Yield, and How Subsidies Can Create Negative Rents

Figure 10A.1 illustrates how, in the absence of incentives (subsidies or taxes), the natural equilibrium point for the level of effort is at the intersection of the catch (or revenue) and cost curves (where positive rents are

FIGURE 10A.1 Catch, Fishing Effort, and Rents



Source: World Bank and FAO 2009.
Note: MEY = maximum economic yield; MSY= maximum sustainable yield.

no longer generated and negative rents begin). This point exceeds both the MEY point—where the distance between these two curves is the greatest—and the MSY point, beyond which the level of effort starts to have a negative impact on the stock's ability to replenish itself. MEY is thus an ideal economic level, whereas MSY is the biological level beyond which fishing is no longer sustainable.

The only case in which a negative rent can be generated is the shaded area on the right, where fishing continues even though it should not because, theoretically at least, the cost of fishing has now exceeded the revenues generated. This occurrence is possible only because of the input of distorting subsidies—the incentives of rational economic operators have become distorted by support that artificially lowers their operating costs.

This explains why, in the database used for the elaboration of map 10.1, the rent generated in so many of the countries (almost half) is actually negative once the cost of subsidies is incorporated.

Notes

1. Fishing effort is a composite indicator of fishing activity, including the number, type, and power of fishing vessels; the type and amount of fishing gear; the contribution of navigation and fish-finding equipment; and the skill of the skipper and fishing crew.
2. The data focus on measuring the value realized through marine capture fisheries, the predominant mode of economic use of the resources, although it is also recognized that societies derive other values from fish, notably recreational, ecological, and cultural values. In addition, the study focuses on the value of fish resources rather than the value of fisheries or the seafood industry.

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11

Remote Sensing and Modeling to Fill the Gap in "Missing" Natural Capital

Kenneth J. Bagstad, Simon Willcock, and Glenn-Marie Lange

Main Messages

- This chapter reviews recent advances in remote sensing and environmental modeling that address the first step in ecosystem accounting: biophysical quantification of ecosystem services. The chapter focuses on those ecosystem services in which the most rapid advances are likely, including crop pollination, sediment regulation, carbon sequestration and storage, and coastal flood regulation.
- The discussion highlights data sources and modeling approaches that can support wealth accounting, next steps for mapping and biophysical modeling of ecosystem services, and considerations for integrating biophysical modeling and monetary valuation. These approaches could make the inclusion of some ecosystem services increasingly feasible in future versions of wealth accounts.

Introduction

The natural capital component of wealth accounts currently includes agricultural land, protected areas, forests, minerals, and fossil fuel energy resources. However, further progress is needed for the natural capital component of wealth to be comprehensively measured and its value properly attributed. Some important assets are missing, such as fisheries (discussed in chapter 10), as well as the value of renewable energy resources from wind, solar, and geothermal power. One of the characteristics of natural capital, except for minerals and fossil fuel energy resources, is that it often provides multiple goods and services. Although some goods can be measured reasonably well, such as timber produced by forests, mainly because they are valued in markets, the value of many services—such as the protection of coastal assets from natural hazards by mangroves and coral reefs, or the soil retention services provided by forests—are not included because of lack of information and markets for these services. In addition, the value of some ecosystem services, such as natural pollination services provided by wild habitats near agricultural land, is implicitly part of the value of agricultural land and not attributed to its source. As a consequence, national wealth may be underestimated or the value of some services misattributed. Correcting for incomplete representation or omission of natural capital is not simply an issue of a nation being "more wealthy than we thought," but is essential for supporting decision making that makes the best use of a nation's assets.

Filling these data gaps for missing ecosystem services to more fully reflect nature's contribution to national wealth poses conceptual, methodological, and measurement challenges. The natural capital accounts follow the concepts and methodology of the *System of Environmental-Economic Accounting Central Framework* (SEEA-CF) (UN et al. 2014a). The SEEA-CF was adopted as an international statistical standard by the UN Statistical Commission in 2012, and provides a framework that all countries can be expected to follow. But the SEEA-CF covers only material natural resources, pollution emissions, and related monetary transactions, not the more complex issue of ecosystems and their services. More recently, the international community has started to address accounting for ecosystems in a separate volume, *SEEA Experimental Ecosystem Accounting* (SEEA-EEA) (UN et al. 2014b). As its title implies, ecosystem accounting is still at an early stage; agreed-upon guidelines have not yet been developed, and many issues remain unresolved. However, progress is being made through the piloting of ecosystem accounting across a range of countries, such as Australia, the Netherlands, the Philippines, Mexico, and Rwanda.

In addition to some conceptual issues, ecosystem services are more challenging to measure than other types of assets. Natural capital asset values in the *Changing Wealth of Nations* (World Bank 2011) are estimated as the discounted sum of the stream of benefits they are expected to provide over their lifetimes. Asset values are derived from a combination of physical data to quantify the volume of goods and services delivered and monetary data used for their valuation. The volume and value of many of the assets can be directly observed or reasonably derived from observable information, including official statistics and administrative data, sometimes in combination with modeling. To quantify ecosystem services within wealth accounts or the SEEA-EEA, this analysis essentially follows the same methodology, but relies much more heavily on modeling.

The construction of ecosystem accounts begins with the quantification of ecosystem services biophysically, then the conversion of these quantities into monetary values. Finally, a projection is made about the delivery of future bundles of services. For the first step in measuring ecosystem services, biophysical data often come from remote sensing and field observations combined with modeling (Schröter et al. 2015). Once biophysical estimates of ecosystem service supply and use have been generated and valued, ecosystem asset values can be estimated. Monetary values are first assigned, typically on an annual basis. Similar to other assets, natural capital asset values are then calculated as the net present value of ecosystem services—their discounted flow over the asset's lifetime.

Assets are included in the *Changing Wealth of Nations* data set when the necessary data are available for a large number of countries (at least 100), are updated regularly to provide a time series, and are publicly available. This sets a rather high bar for some ecosystem services, for which such data are not readily available. Many one-off studies of specific ecosystem services and attempts to value ecosystems have been conducted, but there is no reliable set of data that meets these three criteria at this time.

Nevertheless, in recent years remarkable growth in the availability of biophysical information about ecosystems and the services they provide is rapidly advancing ecosystem accounting. This progress is due to an increase in the availability of remote sensing data, improvements in data processing, and advances in the understanding of how to model and interpret these data. Although valuation challenges remain, new data sources and modeling approaches make biophysical assessment of natural capital increasingly possible for a large number of countries, moving natural capital a step closer toward fuller inclusion in wealth accounts.

This chapter reviews recent advances in remote sensing and environmental modeling that address the first step in ecosystem accounting: biophysical quantification of ecosystem services. It focuses on those ecosystem services for which the most rapid advances are likely, including crop pollination, sediment regulation, carbon sequestration and storage, and coastal flood regulation. Other services are not addressed here. The chapter highlights data sources and modeling approaches that can support wealth accounting, next steps for mapping and biophysical modeling of ecosystem services, and considerations for integrating biophysical modeling and monetary valuation. Although global natural capital asset values do not yet exist, the approaches described here could make the inclusion of some ecosystem services increasingly feasible in future versions of wealth accounts, for example, within a five-year time frame.

Biophysical Quantification of Ecosystem Services

Biophysical modeling of ecosystem services often begins with Earth observations, including satellite images, which are typically validated with ground-based field data. Remote sensing uses satellites and other technology to measure how the Earth's surface reflects visible and nonvisible light. Remote sensing provides an increasingly complete view of the global land and sea surface, including frequent, high-resolution measurements of weather and climate, primary productivity in vegetation, and other surface characteristics. Once raw satellite images are collected, they are first cleaned—for example, by stitching together cloud-free images or correcting for other atmospheric interference and flattening naturally curved Earth-surface images. Next, data are interpreted and classified into thematic data sets such as land cover, vegetation condition, or population density using manual approaches or algorithms. Finally, images are typically validated against data from ground-based observations, as described later in this chapter. Satellite images are increasingly stored in public data archives—for example, the Landsat program of the U.S. Geological Service and National Aeronautics and Space Administration or the Copernicus program of the European Space Agency. When combined with supercomputing and cloud computing resources such as Google Earth Engine,[1] remote sensing supplies increasing volumes of data. These data can be used as inputs to ecosystem service models (Schröter et al. 2015), supporting ecosystem service assessment and wealth accounts.

U.S. Landsat satellites and the European Space Agency's Copernicus program are two major remote sensing platforms. Landsat has collected global data continuously since 1972 using various sensor instruments. The European Space Agency's Sentinel satellites began service in 2014 and collect a wide variety of data. Different sensors collect different types of information, which have various uses for Earth observation. For example, optical remote sensing uses visible and infrared light to measure land and ocean temperature, estimate vegetation condition, classify land cover, and identify fires, among other applications. Radar remote sensing can help quantify vegetation structure and other attributes, and is not affected by cloud cover, allowing greater flexibility in humid regions. Data from both the Landsat and Sentinel programs are available to the public at no cost. A growing number of other public and commercial Earth observation satellites can provide data for ecosystem services and natural capital assessments; a full review is beyond the scope of this chapter (see Alcaraz-Segura, di Bella, and Straschnoy 2013; Araujo Barbosa, Atkinson, and Dearing 2015).

As mentioned, to inform wealth accounts, biophysical measures of ecosystem services should cover most (at least more than 100) and ideally all countries; be regularly updated, to retrospectively show changes in wealth over time (that is, they should not be one-off studies); and be publicly available. Although no studies appear to meet all of these criteria, a series of studies have spatially quantified ecosystem services in biophysical terms at the global scale. With global ecosystem service data, national estimates could be compiled, allowing comparisons within and between nations over time.

A subset of global ecosystem service studies is summarized in table 11.1. Studies such as these could be used in future wealth accounts if they were estimated over time and connected to beneficiaries to allow ecosystem service flows to be estimated. Although not a comprehensive list, table 11.1 includes ecosystem services that address

TABLE 11.1 Environmental Modeling and Mapping Approaches for Ecosystem Services in Support of Wealth Accounting

Ecosystem service	Examples of modeling and mapping approaches	Key data inputs	Representative examples	Comments
Crop pollination	Global mapping of pollination-dependent crops and pollinator habitat	Cropland extent and type,[a] pollinator habitat,[a] pollination dependency ratios, agricultural values	Lautenbach et al. 2012	High social relevance given rapid agricultural intensification and pollinator declines
Sediment regulation	Global erosion models paired with dams or other beneficiary data	Soils,[a] elevation,[a] vegetation,[a] rainfall,[a] dams[a]	Naipal et al. 2015	Could pair global erosion models with dams data (for example, Lehner et al. 2011) and water routing algorithms to roughly quantify sediment transport and its impacts and values
Carbon sequestration and storage	Global mapping of biomass and net primary productivity mapping (terrestrial); modeled mangrove biomass using climate as predictor (blue carbon)	Primary productivity,[a] biomass,[a] soils,[a] rainfall,[a] land and tree cover[a] (terrestrial), climate,[a] seagrass extent, mangrove extent[a] (blue carbon)	Scharlemann et al. 2014; Avitable et al. 2016; Spalding, Brumbaugh, and Landis 2016; Globbiomass 2017	Methods frequently used to track carbon stocks and flows for reducing emissions from deforestation and forest degradation (REDD+) and other programs
Coastal flood regulation	Statistical models of coastal ecosystems' ability to reduce wave energy	Elevation and bathymetry,[a] coastal ecosystems (coral reefs, mangroves, seagrass, coastal wetlands),[a] population distribution,[a] property value	Halpern et al. 2015; Spalding, Brumbaugh, and Landis 2016	For coastal and marine ecosystem services, Halpern et al. (2015) provide rankings (0–100) with annual change and by country; Halpern et al. have encountered some criticism related to construction of the index (Branch, Hively, and Hilborn 2013; Visbeck et al. 2013). Spalding, Brumbaugh, and Landis (2016) provide some monetary values but do not yet include changes over time.

Note: REDD+ = Reducing Emissions from Deforestation and Forest Degradation (REDD), and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.
a. Data derived from remote sensing.

wealth accounts' "attribution problem"—ecosystem services included in economic production measures but not accurately attributed to ecosystems; and their "production boundary problem"—services whose values are not currently included in wealth accounts. Examples of the first group include crop pollination and aspects of sediment regulation; examples of the second group include carbon sequestration and storage, coastal flood regulation, and aspects of sediment regulation. Four types of studies are excluded. First are global studies that use land-cover-based value transfer, which are not informative for wealth accounts because of conceptual and methodological limitations (Costanza et al. 2014). Second are modeling tools that have not yet been applied at global scales—such as Artificial Intelligence for Ecosystem Services

(ARIES), Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST), and others (Bagstad et al. 2013; Sharp et al. 2016; Villa et al. 2014). Third are services with serious data or conceptual challenges that currently limit the ability to map at global scales, such as riverine flood regulation (Stürck, Poortinga, and Verburg 2014; Ward et al. 2015). Fourth are studies of ecosystem goods (for example, fisheries) and recreation whose values are already included in wealth accounts. Advancements in Earth observation and environmental modeling will likely make it possible to model more ecosystem services in the future using methods such as those shown in table 11.1.

Two recent studies have mapped multiple ecosystem services globally, demonstrating the feasibility of global mapping; but each has limitations for use in wealth accounting. First, Karp et al. (2015) explore the immediate feasibility of global ecosystem service monitoring, combining models with national statistics. However, eight of the nine services they report are provisioning services already included in the wealth accounts, estimated using country-reported data published by the Food and Agriculture Organization of the United Nations (FAO). These limitations make the study unsuitable for wealth accounts, but it does provide one example of how provisioning services can be tracked globally using existing data. Second, the Integrated Model to Assess the Global Environment (IMAGE) quantified 11 ecosystem services globally at spatial resolution ranging from 10 kilometers to 0.5 degree (Stehfest et al. 2014). IMAGE estimates five regulating services that could be incorporated into wealth accounts; however, all but carbon sequestration are reported as ranked indexes rather than biophysical units that are more amenable to monetary valuation. This makes its estimates largely inappropriate for wealth accounting.

An important step in biophysical ecosystem service assessment is to distinguish the potential supply of ecosystem services from the flows of services that are used by people. Ecosystem service flows can be valued, but their potential supply should not be. This means separating out, for example, watersheds that provide sediment regulation upstream of hydroelectric dams from those that regulate sediment but have no downstream dams, or distinguishing coastal ecosystems providing flood protection to human settlements from those with no nearby human settlements or other valuable assets (Hein et al. 2016). To make this distinction, better data are needed about the location, demand, and vulnerability of beneficiaries for different ecosystem services. Spatial data on population density (WorldPop 2017), market access (Verburg, Ellis, and Letourneau 2011), and other sources derived from both remote sensing and census data may be useful for this effort. As human populations grow, the quantity and value of ecosystem service flows are likely to increase, though their potential supply may be degraded (Hein et al. 2016; Zank et al. 2016). Tracking changes in potential supply and ecosystem service flows can thus aid our understanding of the sustainability of service supply and use.

Guidelines for Data and Models in Supporting Wealth Accounting for Natural Capital

Before being used, studies such as those mentioned above should first be screened for their suitability for use in wealth accounting. Mapped ecosystem service data should ideally meet seven criteria to be acceptable for use in wealth accounts. The first section notes that data should cover most or all nations, be amenable to repeated measure, and be publicly available. The third criterion means that the authors of each study would need to be willing to share their data. Fourth, studies should be quantitative, with metrics amenable to monetary valuation (making rankings or semiquantitative studies unsuitable, such as Dickson et al. [2014], or several services quantified using IMAGE, such as Stehfest et al. [2014]). Fifth, studies should be of adequate spatial and temporal resolution so that changes over time at the national level can be detected, but not at such high resolution as to be computationally intractable. Given today's data and computational resources, and depending on the ecosystem services of interest and the complexity of models used to quantify them, annual outputs produced at 1 kilometer resolution may be a "sweet spot" for computationally complex global ecosystem service models (Willcock et al. 2016), whereas simpler models may be feasible at higher spatial resolution. Sixth, modeling studies should be calibrated wherever possible to field-collected observations. Similarly, where possible, remote sensing data should be verified on the ground and include an accuracy assessment. Although there are differences of opinion on what constitutes an acceptable level of ground verification, best practices generally suggest that uncertainties in remote sensing data should be understood and communicated during the biophysical modeling process (Hamel and Bryant 2017). Finally (seventh), the limitations of each study should be carefully reviewed to avoid using studies in unintended ways. Discussions may be needed with the authors of key studies to understand their limits and proper use.

A key requirement for wealth accounts is their repeated measurement over time. Time trend estimates of ecosystem services are not yet common at broad geographic scales (Willcock et al. 2016), though this limitation is changing (see Stehfest et al. 2014; Karp et al. 2015) with studies from Europe (Maes et al. 2015) and China (Ouyang et al. 2016). Despite the drawbacks of land cover as a proxy for ecosystem services, land cover data remain a key input to most ecosystem service models (Eigenbrod et al. 2010), and their consistent measurement over time is important. Land cover data are increasingly available on an annual basis. For example, in 2017 the European Space Agency Climate Change Initiative released a 300 meter global land cover data set available annually from 1992 to 2015 (ESA-CCI 2017).

Other spatial data also will be needed for terrestrial and coastal or marine environments. Various data integration challenges will need to be overcome, including how to handle data sets of varying spatiotemporal resolution and quality, which introduce uncertainty into model results.

The Earth Observation for Ecosystem Accounting initiative within the Group on Earth Observations is working to identify data needs that support applications of the SEEA-EEA. Many of its findings will also be highly relevant to wealth accounting.

In future wealth accounts, ecosystem service models themselves will need to be periodically updated. This effort will be a challenge because global models have tended to be either systems dynamics models that lack a spatial component or one-off studies (as described earlier). However, with steady data and computing improvements, such studies are increasingly feasible. A key decision for future wealth accountants will be whether (1) to work with multiple groups of scientists who have produced individual modeling studies, updating studies using common input data, or (2) to integrate a series of models into a common spatial modeling system. The first approach would require that multiple research groups be available for such work and that their data and model code remain up to date. The second approach would require more up-front coordination, but could make the generation of future estimates simpler and more routine (see Villa et al. 2014). Either approach requires substantial investment. Wealth accountants might also consider supporting the independent development of rival models, which would allow model ensembles to be used to quantify uncertainties, such as those used for modeling climate change and its impacts (Pachauri et al. 2014).

As newer models become available, natural capital accountants will face the choice of keeping past modeling approaches or using new, potentially improved approaches that require updating for the entire time series. Updating past time series with new data and models is considered best practice because failing to do so can compromise the analysis of temporal trends. This approach is currently undertaken in other forms of environmental assessments, such as the FAO Forest Resource Assessments (FAO 2015). As spatial data improve, estimates could be generated on a more regular basis—eventually moving, perhaps, from every five years to annually. Finally, beneficiary data will need to be better incorporated into the models to estimate ecosystem service flows, and valuation data will be needed to generate natural capital asset values.

Economic Valuation for Wealth Accounting

As a final step in bringing natural capital into wealth accounting, ecosystem service flows are valued monetarily as assets—typically first on an annualized basis, then as asset values (that is, net present value). Monetary valuation is likely to be at least as challenging as biophysical modeling of ecosystem services, and its full treatment is beyond the scope of this chapter. Although value transfer has been widely used to provide faster monetary values for ecosystem services, it is fraught with problems if done incorrectly (Plummer 2009). Benefit transfer functions, especially those that incorporate spatially explicit data, may provide estimates of value that are considered acceptable by some analysts and for some services, while maintaining the capacity to provide global-scale estimates (Siikamäki, Santiago-Ávila, and Vail 2015). Recent studies to value groundwater (Fenichel et al. 2016) and fisheries (Yun et al. 2016) also provide useful examples of valuation within a wealth accounting framework. Although prices are likely to shift as the quantity of ecosystem services changes, this chapter makes the common simplifying assumption that prices remain constant over time. Using this assumption reduces the uncertainty surrounding price changes and prevents the mixing of signals of changing prices and quantities. As mentioned, proper natural capital accounting reattributes value to specific services and the ecosystems that provide them. For example, the value of cropland will be partly attributed to the water supply, soil fertility, and pollination services provided to that cropland. To avoid double counting, the value of services reattributed to natural capital should be deducted from the rental value estimates for cropland as estimated, for instance, in the *Changing Wealth of Nations*. The same holds true for estimates of the value of pasture, forests, and other ecosystem types.

Challenges remain for comprehensively bringing the value of natural capital into wealth accounts—particularly regarding valuation of natural capital assets and modeling some of the more technically challenging ecosystem services (for example, riverine flood regulation) at a global scale. However, advances in data and environmental models should make the inclusion of certain ecosystem services in wealth accounts increasingly possible over, for example, a 5-to-10-year time frame. Such information can play an important role in building better wealth accounts and ecosystem accounts that can guide decision making regarding national and global development, including the Sustainable Development Goals.

Note

1. Any use of trade, firm, or product names is only for descriptive purposes and does not imply endorsement by the U.S. government.

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Appendix A
Summary of Methodology and Data Sources

This appendix summarizes the data and methods behind the comprehensive wealth and adjusted net saving (ANS) estimates. The methodology builds on the foundation laid in previous works by the World Bank, including *Expanding the Measure of Wealth* (World Bank 1997), *Where Is the Wealth of Nations?* (World Bank 2006), and *The Changing Wealth of Nations* (World Bank 2011), with the primary innovation in this edition being the direct calculation of human capital and the bottom-up approach to estimating total wealth.

The following sections provide an overview of the methodological details and data sources for estimating each wealth component. Detailed documentation of the data and methodology, and the scoping studies and background papers that underlie the revised methodology, are available on the wealth accounting page of the World Bank website.

Data are reported in constant 2014 U.S. dollars, at market exchange rates. A country-specific gross domestic product (GDP) deflator (base year 2014) is used to bring all figures to real terms.

Total Wealth

A nation's wealth consists of a diverse portfolio of assets, which together form the productive base of the national economy. These assets include

- *Natural capital*—including energy (oil, natural gas, and coal), minerals, agricultural land (cropland and pastureland), protected areas, and forests (timber and some nontimber forest products);
- *Produced capital*—including machinery, structures, equipment, and urban land;
- *Human capital*—including the knowledge, skills, and experience embodied in the workforce; and
- *Net foreign assets* (NFAs)—including portfolio equity, debt securities, foreign direct investment, and other financial capital held in other countries.

Total wealth is calculated by summing up each component of wealth ("bottom-up approach"):

Total wealth = *Natural capital* + *Produced capital* + *Human capital* + *Net foreign assets*

This represents a significant departure from past estimates, in which total wealth was estimated by assuming that consumption is the return on total wealth, and then calculating back to total wealth from current sustainable consumption ("top-down approach"). In previous estimates, produced capital, natural capital, and net foreign assets were calculated directly, then subtracted from total wealth to obtain a residual. The unexplained residual, called "intangible capital," was largely attributed to human capital as well as to missing or mismeasured assets. Now with a direct measurement of human capital, total wealth can be estimated as the sum of all categories of assets.

Natural Capital

A few assumptions are applied to the valuation of natural resources that should be highlighted up front. First, in calculating the net present value, a discount rate of 4 percent[1] is used across all resources and years (as in the previous *Changing Wealth of Nations* report [World Bank 2011]). Additionally, resource rents are assumed to remain constant in future years unless otherwise specified. This approach is supported by the System of Environmental-Economic Accounting (SEEA) in the absence of the ability to project future prices and extraction paths.

Second, a country-specific GDP deflator is used for all wealth components to bring the values to constant 2014 U.S. dollars. The GDP deflator is a broad deflator that reduces price effects but may not eliminate all capital gains (or losses) that would be captured if a commodity-specific price deflator were to be applied.

Finally, the comprehensive wealth database draws on publicly available, global data sets. Although this approach has its limitations compared with country-specific assessments, it allows for consistency in cross-country analyses. Also, to maximize country coverage and gap-fill missing data, regional averages are often applied (specified below).

Energy and Mineral Resources

Nonrenewable resources valued in the World Bank wealth accounts include fossil fuel energy and mineral resources. As described in World Bank (2011), the value of a nation's stock of a nonrenewable resource is measured as the present value of the stream of expected rents that may be extracted from the resource until it is exhausted. This value, V_t, is given as follows:

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

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), and T is the lifetime of the resource. Note that, unlike in previous *Changing Wealth of Nations* reports, there is no cap on T. Rents in the current year are calculated as follows:

$$R_t = \pi_t q_t \tag{A.2}$$

where π_t denotes unit rents, equal to revenues less production costs including a "normal" rate of return on fixed capital and the consumption of fixed capital; and q_t denotes the quantity of the resource extracted. Rents are converted into constant U.S. dollars at market rates using country-specific GDP deflators before averaging to obtain $\overline{R_t}$. The present value of rents from energy and mineral resources is estimated under the restrictive assumption that rents remain constant in future years.

The fossil energy resources valued in the World Bank wealth accounts are petroleum, natural gas, and coal. Metals and minerals valued in the wealth accounts comprise bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin, and zinc.

Data Sources

As noted, the value of a nation's stock of energy resources is calculated as the present value of expected rents that could be obtained over the lifetime of the resource. Calculating the present value of future rents requires data for annual production, prices, production costs, and proven reserves. From existing reserves and current rates of production, the time to exhaustion of the resource is assumed. Data sources for implementing and estimating each of these elements are listed in table A.1, and users should refer to the technical documentation for more detailed information.

Forest Resources: Timber

The predominant economic use of forests has been as a source of timber. Timber resources are valued according to the present discounted value of rents from the production of roundwood over the expected lifetime of standing timber resources. This value, V_t, is given by the following equation:

$$V_t = \sum_{i=t}^{t+T-1} \frac{\overline{R_t}}{(1+r)^{i-t}} \tag{A.3}$$

where $\overline{R_t}$ is a lagged, five-year moving average of rents from timber in years t (the present year) to $t - 4$; r is the discount rate (assumed to be equal to 4 percent), and T is the lifetime of timber resources. Unlike metals and minerals, timber is a renewable resource, so the concept of sustainable use of forest resources is introduced through the choice of T. The lifetime of timber resources is determined by the rate of timber extraction (Q) relative to the rate of natural growth (N). If $Q > N$, then current rates

TABLE A.1 Data Sources for Energy and Mineral Resources

Resource	Indicator	Data sources	Notes
Oil and natural gas	Production	Rystad Energy, UCube (upstream database) IEA, "World Energy Statistics," IEA World Energy Statistics and Balances database IEA, "World Conversion Factors," IEA World Energy Statistics and Balances database BP, Statistical Review of World Energy U.S. Energy Information Administration, International Energy Statistics UN Statistics Division, UN Monthly Bulletin of Statistics	Production data from different sources are selected following a few decision rules, such as best coverage over time and median values among estimates.
Oil and natural gas	Unit rent	Rystad Energy, UCube (upstream database)	The country data from Rystad Energy on unit revenues and costs for oil and natural gas are used to calculate average rental rates by region. Average rental rates are weighted by production.
Oil and natural gas	Proven reserves	BP, Statistical Review of World Energy U.S. Energy Information Administration, International Energy Statistics	
Coal	Production	IEA, World Energy Statistics U.S. Energy Information Administration, International Energy Statistics UN Statistics Division, UN Monthly Bulletin of Statistics	Coal production is standardized on the basis of heat content and is broken down into two general categories: hard coal and brown coal.
Coal	Unit cost	Wood Mackenzie, Global Economic Model database Case studies from various sources World Bank, Manufactures Unit Value Index, Global Economic Monitor Commodities database	
Coal	Unit price	World Bank, Global Economic Monitor Commodities database Government of Australia, Office of the Chief Economist, Department of Industry, Innovation and Science, "Resources and Energy Quarterly" IEA, *Coal Information* (Paris, OECD: various years)	Country-level estimates of unit production costs and prices are used to calculate average rental rates by region for thermal and metallurgical (coking) coal. Average rental rates are weighted by production.
Coal	Proven reserves	U.S. Energy Information Administration, International Energy Statistics BGR (German Federal Institute for Geosciences and Natural Resources), "Reserves, Resources, and Availability of Energy Resources" 2015	
Metals and minerals	Production	U.S. Geological Survey, *Minerals Yearbook, Vol. I: Metals and Minerals*, various years USGS, Mineral Commodity Summaries, various years British Geological Survey, World Mineral Statistics	
Metals and minerals	Unit cost	Country-specific case studies from various sources; assumed to be representative for the region World Bank, Manufactures Unit Value Index, Global Economic Monitor Commodities database	
Metals and minerals	Unit price	World Bank, Global Economic Monitor Commodities database	Unit rents are calculated directly per country.
Metals and minerals	Proved reserves	USGS, Mineral Commodity Summaries and Minerals Yearbooks, various years	

Note: IEA = International Energy Agency; OECD = Organisation for Economic Co-operation and Development; UN = United Nations.

of extraction are unsustainable, and the lifetime of the resource is limited. If $Q \leq N$, then extraction is assumed to be sustainable, and the lifetime of the resource is taken as infinite. As with other assets, T is no longer capped at 25 years. Rents from timber in year i are calculated as follows:

$$R_i = \pi_i Q_i \tag{A.4}$$

where π_i denotes unit rents, equal to revenues less production costs, and Q_i denotes the quantity of roundwood extracted. Data and methods for estimating timber wealth are described in table A.2. Rents are converted into units of constant U.S. dollars at market rates using country-specific GDP deflators before averaging to obtain $\overline{R}$.

Forest Resources: Nontimber

Timber revenues are not the only contribution forests make. Nontimber forest benefits such as minor forest products, hunting, recreation, and watershed protection are significant benefits not usually accounted for, which leads to the undervaluation of forest resources. This edition of the *Changing Wealth of Nations* features new estimates of nontimber forest wealth, based on a meta-analysis study that predicts annual, per hectare values for each service category per country using a spatially explicit meta-regression model (Siikamäki, Santiago-Ávila, and Vail 2015).

The annual value of nontimber forest ecosystem services is estimated by multiplying total forest area in a given year by the sum of the per hectare monetary values for the three benefit categories (nonwood forest products; recreation, hunting, and fishing; and watershed protection). The capitalized value of nonwood services is equal to the present value of annual services, discounted into the future. The present value, PV, of nontimber services is given by the following equation:

$$\mathrm{PV}(S) = S + \frac{S}{r} \tag{A.5}$$

where S is the sum of per hectare service values for the three benefit categories and r is the discount rate of 4 percent. Services received during the present year are not discounted. No distinction is made between natural and planted forest. Per hectare monetary values estimated for 2013 are assumed to be constant over time and are adjusted for inflation using country-specific GDP deflators. Also, values are estimated for the given year's forest area, assuming no change in forest cover in the future. See table A.3.

Agricultural Land

Agricultural land constitutes a considerable portion of total wealth in developing countries, particularly in the low-income group. For the purposes of the World Bank wealth accounts, agricultural land is conceptually divided into cropland and pastureland. There are potentially two alternative

TABLE A.2 Data Sources for Forest Timber Resources

Indicator	Data sources	Notes
Production	UN Food and Agricultural Organization (FAO), FAOSTAT database	Timber production is the sum of coniferous industrial roundwood, nonconiferous industrial roundwood, and woodfuel.
Unit price	FAOSTAT database	Unit price is proxied by export unit value. Regional averages are then used to help correct the observed volatility in prices at the country level.
Rental rate	Estimates by Applied Geosolutions 2015	A regional rental rate is applied to total revenues in the absence of country-specific production cost data. This rental rate additionally accounts for the price differential between export prices and domestic stumpage prices.
Life of resource	FAO, *Global Forest Resources Assessment*	Data on total forest area and its breakdown, net annual increment, and growing stock of timber

TABLE A.3 Data Sources for Forest Nontimber Resources

Indicator	Data sources	Notes
Total forest area	UN Food and Agricultural Organization, *Global Forest Resources Assessment*	
Annual service values per hectare of forest	Unit values are as estimated by Siikamäki, Santiago-Ávila, and Vail 2015	Annual values equal the sum of recreation, hunting, and fishing; nonwood forest products; and watershed protection.

methods for estimating land wealth. The first method uses information from sales of land. The second method uses information on the annual flow of rents the land generates and takes the present value of such rents in the future. Given that information on land transactions is often missing, the second method is used. The value of cropland and pastureland, V_t, is calculated as the present value of returns to land using the following equation:

$$V_t = \overline{R_t} + \frac{\overline{R_t}}{(r-g)} \tag{A.6}$$

where $\overline{R_t}$ refers to the lagged, five-year moving average of the total value of rents from crop and livestock products in the present year t to year $t-4$; r is the annual discount rate of 4 percent, assumed for all countries and years; and g is the annual rate of growth in agricultural productivity. For crops, a rate of 1.94 percent is assumed for g for all low- and middle-income countries, and a rate of 0.97 percent is assumed for g for all high-income countries. For livestock products, 2.95 percent is assumed for low- and middle-income countries and 0.89 percent for high-income countries (Rosengrant, Agcaoili-Sombilla, and Perez 1995). Total rents R are converted into units of constant U.S. dollars at market rates using country-specific GDP deflators before averaging to obtain $\overline{R_t}$. The area of agricultural land is assumed to be constant; that is, wealth is estimated for the current area of land, not taking into account changes in the area of land (or land degradation) that may affect rents in the future. See table A.4.

TABLE A.4 Data Sources for Cropland and Pastureland

Item	Indicator	Data sources	Notes
Primary crop and livestock	Production	FAO, FAOSTAT database	Crop products span the categories of cereals, fibers, fruits, nuts, oil crops, pulses, roots, spices, stimulants, sugar, and vegetables. Livestock products span the categories of meats, milks, and other (for example, hides).
Primary crop and livestock	Prices	FAO, Value of Agricultural Production, Production, FAOSTAT database FAO, Producer Prices – Annual, Prices, FAOSTAT database	Unit prices as reported in the FAO's estimates of the value of agricultural production are given priority, followed by the FAO estimates of producer prices. If country-specific data on prices are unavailable for a certain product, then regional or world averages are applied. Regional and world averages are weighted by production.

Note: FAO = United Nations Food and Agricultural Organization.

Rental Rates

Rents are estimated for crops as follows:

$$R_{c,k,t} = q_{c,k,t} \times p_{c,k,t} \times a_g \tag{A.7}$$

where $R_{c,k,t}$ represents rents in country c from crop k harvested in year t; $q_{c,k,t}$ denotes production for that individual country, crop, and year; $p_{c,k,t}$ denotes the unit price; and a_g is the average rental rate assumed for all countries and crops grown in region g. The rental rate a is equal to the ratio of (price – cost)/price. The rental rate is not given a t subscript because it is assumed to be constant over time. Estimates of rental rates are provided by Evenson and Fuglie (2010).

Rents from livestock products are different for livestock raised in extensive versus intensive production systems. Intensive systems are characterized by high output of animal products per unit surface area, and extensive systems use land areas of low production and under conditions of moderate grazing. Livestock rents are calculated as follows:

$$R_{c,k,t} = (q_{c,k,t} \times p_{c,k,t} \times 2a_g)\, e_c + (q_{c,k,t} \times p_{c,k,t} \times a_g)(1 - e_c) \tag{A.8}$$

where R, q, p, and a are as defined above for crops; e_c is the share of livestock production in extensive systems for livestock products in country c; and $(1 - e_c)$ is the share of livestock production in intensive systems. For livestock raised in extensive production systems, the rental rate is assumed to be twice that for intensive systems.[2] The same regional rental rates assumed for crop products are assumed for livestock products in intensive systems.

The share of livestock produced in extensive versus intensive systems is apportioned according to the percentage of ruminant meat produced in grazing systems, as estimated by the Food and Agricultural Organization of the United Nations (FAO) for its Global Livestock Environmental Assessment Model.[3] The FAO estimates the percentage of meat produced in grazing systems for 228 countries and other administrative regions. Where country-level estimates of meat production in grazing systems by the FAO are not available, regional averages of e are applied (weighted by the total area of pastureland).

Once rents are estimated for each crop and livestock product *k* produced by country *c* in year *t*, total rents from agricultural land are estimated by summing rents for all products *k*.

Protected Areas

Areas protected for conservation and preservation of ecosystems provide a range of services to the country. For example, wildlife reserves can generate significant revenues for developing countries, in particular from international tourism activities. And about one-third of the world's big cities get their drinking water from sources in or downstream of protected areas, saving billions of dollars in supply and treatment costs thanks to forests and wetlands that regulate the flow of water and remove contaminants (Dudley et al. 2010). Valuing such ecosystem services on a global basis, however, is difficult. For this reason, protected areas are valued in the World Bank wealth accounts using a simplified approach. Under this approach, the quasi-opportunity cost of protection per unit area of land contained in terrestrial protected areas is estimated as the lower of returns to cropland and pastureland. This is likely to be a lower bound on the true value of protected areas. Returns are capitalized over an infinite time horizon as follows:

$$V_t = \left(\overline{R_t} + \frac{\overline{R_t}}{r} \right) A_t \tag{A.9}$$

where V_t is the value of protected areas in year t; $\overline{R_t}$ is the minimum of total rents per square kilometer of cropland and total rents per square kilometer of pastureland, averaged over a five-year period from year t to year t–4; r is the discount rate of 4 percent; and A_t is the area of land under protection in year t.

Data sources for the area of cropland, pastureland, and protected areas are listed in table A.5.

TABLE A.5 Data Sources for Agricultural Land and Terrestrial Protected Land Area

Element	Data sources and notes
Area of cropland and pastureland	• World Bank, "Land area (square kilometer)" (AG.LND.TOTL.K2), WDI database • World Bank, "Agricultural land (% of land area)" (AG.LND.AGRI.ZS), WDI database • World Bank, "Arable land (% of land area)" (AG.LND.ARBL.ZS), WDI database • World Bank, "Permanent cropland (% of land area)" (AG.LND.CROP.ZS), WDI database
Terrestrial protected area	• World Bank, "Terrestrial protected areas (% of land area)" (ER.LND.PTLD.ZS), WDI database

Note: WDI = World Development Indicators.

Produced Capital

Produced capital consists of manufactured or built assets such as machinery, equipment, and physical structures. Estimates of produced capital stocks in the World Bank wealth accounts also include the value of built-up urban land, which is valued as a mark-up on other produced assets.

Several estimation procedures can be considered for the calculation of physical capital stocks. Some of them, such as the derivation of capital stocks from insurance values or accounting values or from direct surveys, entail enormous expenditures and face problems of limited availability and adequacy of data. Other estimation procedures, such as accumulation methods and, in particular, the perpetual inventory method, are cheaper and more easily implemented because they require only investment data and information on the assets' service lives and depreciation patterns. These methods derive capital series from the accumulation of investment series and are the most popular. The perpetual inventory method is, indeed, the method adopted by most Organisation for Economic Co-operation and Development (OECD) countries that estimate capital stocks (Bohm et al. 2002; Mas, Perez, and Uriel 2000; Ward 1976). This method is also used in the estimates of capital stock.

For most countries, estimates of physical capital are obtained directly from the Penn World Table 9.0 database[4] (Feenstra, Inklaar, and Timmer 2015). The Penn World Table authors use the perpetual inventory method to estimate produced capital stocks for 172 countries from 1970 to 2014.

The physical capital estimates include the value of structures, machinery, and equipment, because the value of the stocks is derived (using the perpetual inventory method) from gross capital formation data that account for these elements. In the investment figures, however, only land improvements are captured. Thus, the final capital estimates do not entirely reflect the value of urban land.

Drawing on Kunte et al. (1998), urban land is valued as a fixed proportion of the value of physical capital. Ideally, this proportion would be country specific. In practice, detailed national balance sheet information with which to compute these ratios was not available. Thus, as in Kunte et al. (1998), a constant proportion equal to 24 percent is assumed:

$$U_t = 0.24K_t \quad \text{(A.10)}$$

where U is the value of urban land and K is the produced capital stock (machinery, equipment, and structures) in year t.

Net Foreign Assets

Net foreign assets (NFAs) are a measure of the cross-border assets and liabilities held by a country's residents. A country's external asset position, or NFA, is calculated as follows:

$$NFA = FA - FL \quad \text{(A.11)}$$

where FA are total foreign assets and FL are total foreign liabilities. Total foreign assets are calculated as follows;

$$FA = equity_a + FDI_a + debt_a + derivatives_a + forex \qquad \text{(A.12)}$$

where $equity_a$ is portfolio equity assets, FDI_a is foreign direct investment assets, $debt_a$ is debt assets, $derivatives_a$ is financial derivatives assets, and $forex$ is foreign exchange reserves (excluding gold). Similarly, total foreign liabilities are calculated as follows:

$$FL = equity_l + FDI_l + debt_l + derivatives_l \qquad \text{(A.13)}$$

where $equity_l$ is portfolio equity liabilities, FDI_l is foreign direct investment liabilities, $debt_l$ is debt liabilities, and $derivatives_l$ is derivatives liabilities.

The primary data source for NFA is the updated and extended version of the External Wealth of Nations Mark II database developed by Lane and Milesi-Ferretti (2007). The Lane and Milesi-Ferretti database, last updated in early 2016, provides estimates of NFA for 1970–2014 for 211 economies. Where estimates of NFA and its components are not available in the Lane and Milesi-Ferretti database, additional data are obtained from various sources to extend the country coverage.

Human Capital

The approach used for measuring human capital is outlined in this volume in chapter 6, and in more detail in a companion piece by Barrot et al. (forthcoming). Our measures of human capital wealth rely on estimations conducted using household surveys; calibration of the results is based on the share of labor earnings in GDP in the national accounts. The first step in the analysis consists in estimating earnings regressions. Denote an individual's age by a (from age 15 to 64) and years of schooling by e (from 0 to 24). Years of experience are approximated as $x = \max(0, a - e - 6)$. Mincerian wage regressions are estimated as follows:

$$\text{In}\,(y_i) = \alpha + \beta_1 e_i + \beta_2 x_i + \beta_3 x_i^2 + \varepsilon_i. \qquad \text{(A.14)}$$

On the basis of these regressions, a matrix of expected earnings, H, is constructed. Each cell in the matrix accounts for wages earned by the population of age a and education level e. If n_{ae} is the number of workers of age a and years of schooling e, each cell in the matrix is defined as follows:

$$H_{ae} = n_{ae} \exp\,(\beta_1 e + (\beta_2 + \beta_3 x_{ae})\, x_{ae}). \qquad \text{(A.15)}$$

Total expected earnings, T, from the survey are estimated as $T = \sum_a \sum_e H_{ae}$. For consistency with the national accounts, all cells in the matrix of expected earnings from the survey are scaled up or down by the ratio of labor earnings in the national accounts, W, to expected labor earnings in the survey, T. This generates a set of wages by age group and education level $W_{ae} = (W/T)H_{ae}$. The data are disaggregated by sex as well as by type of employment.

For notation purposes, we consider only the disaggregation into self-employed workers and wage earners here. Denote by w_{ae}^{m} a cell in the remuneration matrix for employed workers, and by w_{ae}^{s} the corresponding cell in the matrix for the self-employed. Similarly denote the number of workers of both groups as n_{ae}^{m} and n_{ae}^{s} and the population of age a and education level e by pop_{ae}. Probabilities of being employed or in self-employment are estimated as $p_{ae}^{m} = n_{ae}^{m}/pop_{ae}$ and $p_{ae}^{s} = n_{ae}^{s}/pop_{ae}$.

Two additional parameters are used in the estimations. First, because estimates are provided for the adult population ages 15–64, we compute a probability, denoted by r_{ae}^{e+1}, that a person of age a and education e will undertake an extra year of education (and thereby not work during that year). Second, we compute age cohort survival rates from life tables, denoted as $V_{a,a+1}$.

Total human capital is calculated as the discounted value of lifetime earnings of two population subgroups, those ages 25–65 years (assumed to have finished schooling), and those ages 15–24 years who have some probability of still being in school. Denote the discount factor by d. For an individual with age a and education e randomly drawn from the subpopulation ages 25–65, the discounted lifetime income h_{ae} is estimated according to the following recursion:

$$h_{ae} = p_{ae}^{m} w_{ae}^{m} + p_{ae}^{s} w_{ae}^{s} + d \times v_{a,a+1} \times h_{a+1,e}. \tag{A.16}$$

This expression states that the lifetime income of a representative individual age 25–65 is the sum of two parts: current labor income taking into account the probabilities of being either employed or self-employed, plus lifetime income in the next year, adjusted by a discount factor and the corresponding survival rate.

For an individual between ages 15 and 24 years, the expression is slightly more complex to allow for the possibility of continuing one's education. In the next year, the individual must choose between two courses of action: the first is to continue to work (holding the same education level as before) and earn income of $d \times V_{a,a+1} \times h_{a+1,e}$ with the probability $\left(1 - r_{ae}^{e+1}\right)$; the second is to undertake one more year of education and (after finishing) to receive income $d \times V_{a,a+1} \times h_{a+1,e+1}$, with the probability of r_{ae}^{e+1}. In each case a proportion $V_{a,a+1}$ is assumed to survive. The recursive relationship is therefore the following:

$$h_{ae} = p_{ae}^{m} w_{ae}^{m} + p_{ae}^{s} w_{ae}^{s} + (1 - r_{ae}^{e+1}) \times d \times v_{a,a+1} \times h_{a+1,e} + r_{ae}^{e+1} \times d \times v_{a,a+1} \times h_{a+1,e+1}. \tag{A.17}$$

When adding disaggregation by sex, the approach results in a measure of human capital wealth with four components, namely the present values of future earnings by sex and by type of employment (wage earners versus self-employed).

Table A.6 provides the data sources used for the analysis.

Adjusted Net Saving

Table A.7 provides a brief overview of the underlying components of the adjusted net saving (ANS) indicator and their primary data sources.

TABLE A.6 Data Sources for the Estimation of Human Capital

Indicator	Data sources
Annual earnings (by age, gender, educational attainment)	International Income Distribution Database (I2D2)
Returns to schooling (Mincer equation)	Updated estimates, based on Montenegro and Patrinos (2016) derived from I2D2
Educational attainment (by age, gender)	I2D2
Population (by age, gender)	United Nations Population Division
Mortality rates (by age, gender)	United Nations Population Division
Labor share of GDP (employed and self-employed)	United Nations National Accounts, Penn World Table

Note: GDP = gross domestic product.

TABLE A.7 Adjusted Net Saving's Components and Primary Data Sources

Component	Description	Primary data sources
Gross national saving (GNS)	Calculated as gross national income less total consumption, plus net transfers, a standard item in the System of National Accounts.	World Bank, World Development Indicators
Consumption of fixed capital (CFC)	Calculated as the replacement value of capital used up in the process of production, also a standard item in the System of National Accounts.	United Nations, OECD, and Penn World Table (Feenstra, Inklaar, and Timmer 2015), with missing data estimated by World Bank staff
Current public expenditure on education (EDU)	Standard savings measures only count as an investment that portion of total expenditure on education (usually less than 10 percent) that goes toward fixed capital such as school buildings; the rest is considered consumption. Within the ANS framework, which considers human capital to be a valuable asset, expenditures on its formation cannot be labeled as simple consumption. As a lower-bound first approximation, the calculation thus includes current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment.	UNESCO; data are extrapolated to 2015 from the most recent year available
Net forest depletion (NFD)	Calculated as the product of unit resource rents and the excess of roundwood harvest over natural growth. If growth exceeds harvest, this figure is zero.	See section on "Forest Resources: Timber"

(continued on next page)

TABLE A.7 Adjusted Net Saving's Components and Primary Data Sources *(continued)*

Component	Description	Primary data sources
Depletion of fossil energy resources (END)	Calculated as the ratio of the value of the stock of energy resources to the remaining reserve lifetime. It covers coal, crude oil, and natural gas.	See section on "Energy and Mineral Resources"
Depletion of metals and minerals (MID)	Calculated as the ratio of the value of the stock of mineral resources to the remaining reserve lifetime. It covers bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin, and zinc.	See section on "Energy and Mineral Resources"
Carbon dioxide damage (CO_2)	Cost of damage as a result of carbon dioxide emissions from fossil fuel use and the manufacture of cement, estimated to be US$30 per ton of CO_2 (the unit damage in 2014 U.S. dollars for CO_2 emitted in 2015) times the number of tons of CO_2 emitted.	World Bank, *World Development Indicators*
Air pollution damage (POL)	Cost of damage as a result of exposure of a country's population to air pollution, including ambient concentrations of particulate matter measuring less than 2.5 microns in diameter ($PM_{2.5}$), indoor concentrations of air pollution in households cooking with solid fuels, and ambient ozone pollution. Damage costs are calculated as forgone labor output caused by premature death from pollution exposure.	Data on health impacts from pollution exposure are from the Institute for Health Metrics and Evaluation's Global Burden of Disease Study 2015
Adjusted net saving (ANS)	ANS = GNS – CFC + EDU – NFD – END – MID – CO_2 – POL	

Note: OECD = Organisation for Economic Co-operation and Development; UNESCO = United Nations Educational, Cultural, and Scientific Organization.

Notes

1. The 4 percent discount rate is the long-term (100 years or more) real return on financial assets globally, derived from Credit Suisse data.
2. As recommended by Pierre Gerber, Senior Livestock Specialist, World Bank, April 2016.
3. See FAO, Global Livestock Environmental Assessment Model (GLEAM), http://www.fao.org/gleam/en/.
4. Data available for download at http://www.ggdc.net/pwt.

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Appendix B
Per Capita Wealth for 2014

The following table shows estimates of total wealth and its subcomponents by economy and aggregate averages (income group, geographic region, region with only low- and middle-income economies). Estimates are in 2014 U.S. dollars per capita at market exchange rates.

Economy	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
Albania	**53,107**	18,808	13,375	*180*	*406*	*170*	*3,570*	*6,958*	*2,091*	22,818	–1,894	2,893,654
Argentina	**126,516**	37,869	16,185	*320*	*2,200*	*581*	*5,762*	*3,390*	*3,931*	71,429	1,033	42,980,026
Armenia	**52,894**	15,451	12,702	*183*	*81*	*2,635*	*3,257*	*4,397*	*2,150*	27,329	–2,588	3,006,154
Australia	**1,046,785**	311,442	180,792	*1,626*	*50,190*	*2,035*	*5,401*	*6,498*	*115,043*	585,737	–31,187	23,460,694
Austria	**694,616**	256,744	16,266	*946*	*4,701*	*3,704*	*2,244*	*3,663*	*1,007*	421,846	–239	8,541,575
Azerbaijan	**85,341**	20,061	45,935	*8*	*150*	*1,905*	*3,629*	*4,305*	*35,938*	11,961	7,384	9,535,079
Bahrain	**270,311**	76,788	14,027	*0*	*0*	*12*	*206*	*356*	*13,451*	157,679	21,816	1,361,930
Bangladesh	**12,714**	3,434	2,234	*4*	*6*	*29*	*1,501*	*609*	*85*	7,170	–124	159,077,513
Belarus	**99,685**	33,388	21,882	*1,112*	*2,245*	*1,410*	*5,371*	*10,576*	*1,167*	49,004	–4,588	9,474,511
Belgium	**645,969**	211,873	5,013	*233*	*689*	*474*	*2,158*	*1,460*	*0*	404,997	24,086	11,231,213
Belize	**58,872**	12,303	29,835	*527*	*7,720*	*13,651*	*5,256*	*816*	*1,865*	23,989	–7,254	351,706
Bolivia	**49,235**	6,626	17,527	*19*	*3,100*	*3,483*	*3,329*	*4,274*	*3,322*	24,805	277	10,561,887
Bosnia and Herzegovina	**40,486**	13,842	8,992	*672*	*1,102*	*122*	*2,841*	*1,952*	*2,302*	20,243	–2,592	3,817,554
Botswana	**95,797**	19,908	26,140	*585*	*5,550*	*6,004*	*699*	*9,304*	*3,998*	47,087	2,662	2,219,937
Brazil	**188,883**	32,067	36,978	*1,437*	*7,187*	*7,251*	*6,313*	*5,979*	*8,811*	123,696	–3,859	206,077,898
Bulgaria	**81,878**	23,186	16,683	*502*	*1,447*	*4,923*	*4,043*	*2,309*	*3,459*	47,593	–5,584	7,223,938
Burkina Faso	**12,323**	1,754	5,755	*598*	*25*	*1,036*	*1,893*	*1,469*	*734*	4,970	–155	17,589,198
Burundi	**7,579**	486	2,704	*103*	*11*	*71*	*2,309*	*195*	*15*	4,496	–107	10,816,860
Cambodia	**16,933**	2,212	7,700	*592*	*113*	*2,139*	*4,156*	*700*	*0*	7,337	–317	15,328,136
Cameroon	**31,398**	3,768	13,557	*1,086*	*256*	*3,587*	*5,414*	*2,682*	*532*	14,414	–342	22,773,014

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Economy	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
Canada	**1,016,593**	229,999	52,438	*919*	*7,000*	*8,574*	*5,092*	*2,938*	*27,915*	730,832	3,324	35,544,564
Central African Republic	**21,055**	2,433	17,978	*1,261*	*347*	*7,101*	*2,369*	*6,896*	*5*	846	–202	4,804,316
Chad	**20,077**	1,619	9,973	*434*	*39*	*954*	*2,672*	*1,918*	*3,956*	9,099	–614	13,587,053
Chile	**237,713**	45,096	55,113	*2,025*	*3,628*	*992*	*3,170*	*1,019*	*44,279*	139,512	–2,008	17,762,647
China	**108,172**	28,566	15,133	*258*	*289*	*850*	*7,093*	*2,088*	*4,556*	63,369	1,104	1,364,270,000
Colombia	**129,289**	27,857	15,932	*278*	*2,640*	*2,060*	*2,984*	*3,331*	*4,640*	87,674	–2,175	47,791,393
Comoros	**8,836**	2,585	2,898	*269*	*28*	*301*	*1,876*	*424*	*0*	3,402	–50	769,991
Congo, Dem. Rep.	**12,256**	2,369	6,705	*1,525*	*299*	*1,292*	*1,245*	*858*	*1,486*	3,301	–119	74,877,030
Congo, Rep.	**68,779**	15,401	32,843	*2,188*	*334*	*5,875*	*2,013*	*4,882*	*17,551*	25,906	–5,371	4,504,962
Costa Rica	**166,985**	24,681	24,160	*1,709*	*3,006*	*3,850*	*9,440*	*6,124*	*32*	122,640	–4,496	4,757,606
Côte d'Ivoire	**24,485**	4,391	11,016	*1,006*	*156*	*1,661*	*4,545*	*3,011*	*636*	8,986	92	22,157,107
Croatia	**147,545**	58,766	9,399	*974*	*1,830*	*2,759*	*1,872*	*807*	*1,156*	90,549	–11,169	4,238,389
Denmark	**854,331**	273,019	16,261	*246*	*1,183*	*1,055*	*3,517*	*3,342*	*6,918*	538,947	26,103	5,643,475
Djibouti	**22,914**	6,036	5,437	*7*	*7*	*34*	*591*	*4,798*	*0*	12,097	–656	876,174
Dominican Republic	**97,257**	21,808	6,219	*42*	*654*	*1,055*	*2,148*	*1,139*	*1,180*	73,055	–3,824	10,405,943
Ecuador	**102,451**	20,469	30,007	*557*	*1,481*	*6,823*	*3,255*	*3,332*	*14,560*	52,696	–721	15,902,916
Egypt, Arab Rep.	**38,470**	5,605	11,229	*2*	*1*	*959*	*2,631*	*3,257*	*4,378*	22,591	–955	89,579,670
El Salvador	**44,131**	10,216	4,554	*223*	*253*	*397*	*2,191*	*1,490*	*0*	31,951	–2,591	6,107,706
Estonia	**258,903**	91,646	20,093	*3,960*	*8,223*	*2,713*	*2,027*	*2,579*	*591*	155,041	–7,876	1,314,545

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Economy	Total wealth	Produced capital	Natural capital	*Forest* Timber	*Forest* Nontimber	*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
Ethiopia	**13,125**	1,347	5,284	*170*	*6*	*1,514*	*1,897*	*1,646*	*50*	6,723	–229	96,958,732
Finland	**726,422**	248,986	18,037	*4,086*	*3,178*	*2,964*	*1,471*	*3,455*	*2,883*	460,082	–683	5,461,512
France	**641,707**	223,830	11,109	*405*	*2,329*	*2,515*	*3,505*	*2,274*	*81*	415,851	–9,082	66,268,972
Gabon	**199,901**	34,697	95,461	*5,065*	*18,657*	*8,842*	*3,486*	*7,813*	*51,598*	62,233	7,511	1,687,673
Gambia, The	**5,208**	1,545	1,413	*30*	*77*	*72*	*760*	*474*	*0*	2,745	–496	1,928,201
Georgia	**44,327**	20,415	7,344	*94*	*567*	*920*	*1,765*	*3,081*	*917*	21,251	–4,682	3,727,000
Germany	**729,064**	236,891	7,701	*362*	*1,568*	*1,238*	*1,698*	*2,097*	*738*	467,668	16,804	80,982,500
Ghana	**25,044**	3,768	8,418	*122*	*105*	*496*	*4,821*	*1,202*	*1,673*	13,853	–995	26,786,598
Greece	**227,925**	134,895	12,546	*59*	*2,126*	*2,009*	*4,945*	*1,990*	*1,417*	105,663	–25,179	10,892,413
Guatemala	**43,140**	9,555	8,997	*201*	*773*	*1,956*	*4,296*	*1,034*	*738*	25,450	–862	16,015,494
Guinea	**8,943**	1,307	7,294	*238*	*134*	*962*	*3,502*	*1,435*	*1,022*	621	–279	12,275,527
Guyana	**69,971**	12,353	39,620	*9,506*	*12,513*	*2,302*	*6,785*	*1,655*	*6,857*	21,801	–3,803	763,893
Haiti	**15,040**	5,989	3,018	*14*	*29*	*10*	*2,432*	*534*	*0*	6,135	–101	10,572,029
Honduras	**44,778**	8,427	10,599	*486*	*1,496*	*2,875*	*3,424*	*2,095*	*223*	27,372	–1,620	7,961,680
Hungary	**165,519**	65,561	6,623	*414*	*850*	*1,335*	*2,998*	*612*	*413*	102,557	–9,222	9,866,468
Iceland	**825,857**	270,983	8,980	*4*	*196*	*3,190*	*194*	*5,397*	*0*	733,612	–187,717	327,386
India	**18,211**	5,161	4,739	*37*	*38*	*94*	*2,036*	*1,429*	*1,105*	8,755	–444	1,295,291,543
Indonesia	**46,919**	15,299	9,443	*375*	*312*	*1,027*	*4,182*	*426*	*3,122*	23,701	–1,524	254,454,778
Iraq	**101,705**	14,510	71,520	*7*	*25*	*34*	*2,138*	*819*	*68,498*	15,473	201	35,273,293
Ireland	**627,256**	189,309	15,912	*241*	*1,223*	*1,191*	*1,272*	*11,618*	*367*	473,656	–51,620	4,617,225

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Economy	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
Italy	**427,466**	188,055	8,619	*56*	*1,364*	*1,856*	*3,628*	*1,188*	*527*	241,350	–10,558	60,789,140
Jamaica	**71,766**	30,313	6,804	*77*	*467*	*657*	*3,430*	*874*	*1,300*	41,884	–7,235	2,783,301
Japan	**571,927**	179,277	3,741	*105*	*1,714*	*426*	*946*	*507*	*43*	365,157	23,751	127,131,800
Jordan	**49,287**	17,577	8,876	*12*	*15*	*193*	*1,441*	*4,881*	*2,334*	27,312	–4,478	7,416,083
Kazakhstan	**180,911**	40,150	66,606	*10*	*35*	*426*	*3,713*	*8,981*	*53,440*	76,617	–2,461	17,289,224
Kenya	**19,412**	3,356	6,771	*43*	*32*	*1,133*	*2,109*	*3,429*	*25*	9,556	–271	44,863,583
Korea, Rep.	**424,052**	126,650	4,013	*112*	*864*	*113*	*2,249*	*595*	*79*	291,748	1,641	50,423,955
Kuwait	**1,123,144**	74,879	591,229	*1*	*2*	*1,142*	*451*	*771*	*588,862*	271,628	185,408	3,753,121
Kyrgyz Republic	**24,429**	6,159	12,570	*5*	*2*	*1,087*	*2,473*	*7,514*	*1,490*	6,729	–1,029	5,835,500
Lao PDR	**39,307**	5,279	22,590	*926*	*952*	*9,034*	*6,368*	*1,586*	*3,724*	13,762	–2,324	6,689,300
Latvia	**236,906**	113,746	18,738	*4,476*	*7,085*	*2,387*	*2,560*	*2,230*	*0*	113,472	–9,049	1,993,782
Lebanon	**65,148**	31,015	4,131	*3*	*57*	*63*	*2,711*	*1,296*	*0*	42,153	–12,151	5,612,096
Liberia	**10,227**	1,219	7,037	*1,807*	*208*	*86*	*1,799*	*710*	*2,427*	3,636	–1,665	4,396,554
Lithuania	**169,046**	63,254	12,758	*1,629*	*3,273*	*1,585*	*3,593*	*2,503*	*174*	100,081	–7,047	2,932,367
Luxembourg	**1,288,607**	359,386	8,938	*329*	*1,542*	*1,152*	*825*	*3,103*	*1,989*	881,629	38,654	556,319
Macedonia, FYR	**52,210**	18,969	11,416	*177*	*858*	*796*	*3,841*	*2,639*	*3,106*	24,770	–2,945	2,075,625
Madagascar	**9,237**	919	4,964	*782*	*69*	*133*	*2,133*	*1,710*	*138*	3,784	–430	23,571,713
Malawi	**10,442**	939	5,642	*390*	*34*	*431*	*4,279*	*503*	*4*	4,003	–142	16,695,253
Malaysia	**239,203**	29,989	28,657	*6,339*	*2,586*	*3,453*	*8,223*	*163*	*7,894*	180,729	–173	29,901,997
Maldives	**44,991**	16,862	401	*2*	*2*	*0*	*397*	*0*	*0*	33,905	–6,177	401,000

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Economy	Total wealth	Produced capital	Natural capital	Forest: Timber	Forest: Nontimber	Protected areas	Cropland	Pastureland	Subsoil assets	Human capital	Net foreign assets	Population
Mali	**17,165**	1,999	11,041	*57*	*20*	*1,742*	*2,366*	*5,900*	*956*	4,334	–208	17,086,022
Malta	**303,804**	75,153	1,655	*0*	*1*	*133*	*1,036*	*485*	*0*	218,865	8,131	427,364
Mauritania	**29,380**	4,891	17,574	*38*	*17*	*165*	*518*	*6,542*	*10,293*	9,368	–2,454	3,969,625
Mauritius	**97,018**	32,173	2,980	*9*	*73*	*56*	*2,450*	*392*	*0*	51,520	10,346	1,260,934
Mexico	**110,471**	39,918	14,629	*220*	*1,941*	*1,008*	*2,411*	*3,252*	*5,797*	59,334	–3,410	125,385,833
Moldova	**35,380**	14,213	4,898	*65*	*172*	*178*	*2,983*	*1,500*	*0*	17,852	–1,582	3,556,397
Mongolia	**79,004**	16,487	50,047	*243*	*121*	*5,043*	*1,128*	*21,192*	*22,320*	20,635	–8,165	2,909,871
Morocco	**40,488**	13,616	12,372	*100*	*72*	*2,799*	*3,150*	*3,915*	*2,335*	16,490	–1,990	33,921,203
Mozambique	**7,718**	1,212	4,136	*1,096*	*236*	*86*	*2,104*	*280*	*333*	3,486	–1,117	27,216,276
Namibia	**84,398**	12,696	18,501	*677*	*2,997*	*5,268*	*1,604*	*6,423*	*1,532*	52,458	744	2,402,858
Nepal	**14,368**	2,334	5,545	*128*	*42*	*897*	*2,438*	*2,039*	*1*	6,402	89	28,174,724
Netherlands	**792,396**	234,415	9,528	*33*	*278*	*177*	*2,189*	*2,626*	*4,224*	516,543	31,910	16,865,008
Nicaragua	**37,084**	9,075	13,505	*496*	*455*	*5,330*	*2,833*	*3,909*	*482*	16,698	–2,193	6,013,913
Niger	**11,623**	2,369	8,490	*30*	*20*	*2,421*	*2,660*	*3,124*	*235*	1,041	–278	19,113,728
Nigeria	**37,408**	3,851	12,963	*122*	*33*	*350*	*3,766*	*822*	*7,870*	20,934	–341	177,475,986
Norway	**1,671,756**	423,905	103,184	*889*	*4,160*	*10,081*	*766*	*4,037*	*83,251*	1,004,649	140,018	5,137,232
Oman	**277,574**	49,045	95,238	*1*	*1*	*3,370*	*1,342*	*1,425*	*89,101*	125,278	8,013	4,236,057
Pakistan	**22,182**	3,029	5,982	*10*	*2*	*345*	*1,572*	*3,759*	*294*	13,587	–416	185,044,286
Panama	**136,125**	30,378	13,136	*370*	*4,492*	*3,172*	*1,804*	*3,130*	*167*	102,886	–10,275	3,867,535
Papua New Guinea	**50,489**	4,626	37,467	*2,098*	*665*	*1,455*	*6,205*	*18,178*	*8,867*	11,071	–2,674	7,463,577

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Economy	Total wealth	Produced capital	Natural capital	Forest: Timber	Forest: Nontimber	Protected areas	Cropland	Pastureland	Subsoil assets	Human capital	Net foreign assets	Population
Paraguay	85,575	11,868	21,358	119	2,332	1,179	9,967	7,761	0	54,026	–1,678	6,552,518
Peru	81,931	19,522	24,914	298	3,667	4,191	3,064	1,958	11,737	39,502	–2,007	30,973,148
Philippines	30,823	7,860	5,644	211	76	926	3,413	425	592	17,790	–471	99,138,690
Poland	154,932	40,085	10,353	623	1,085	1,582	1,946	1,222	3,894	113,406	–8,912	38,011,735
Portugal	274,453	117,409	9,189	707	1,972	1,566	2,705	1,406	833	172,163	–24,308	10,401,062
Qatar	1,597,125	217,846	660,305	2	0	312	246	419	659,327	562,650	156,323	2,172,065
Romania	107,022	41,163	17,265	540	1,050	3,248	5,459	5,070	1,899	54,014	–5,420	19,908,979
Russian Federation	188,715	48,807	46,921	910	1,587	2,773	1,859	1,544	38,247	90,812	2,175	143,819,666
Rwanda	21,619	1,538	6,650	386	37	268	5,007	892	60	13,649	–217	11,341,544
Saudi Arabia	512,869	66,347	252,186	7	34	401	1,625	1,014	249,105	156,869	37,467	30,886,545
Senegal	13,085	3,736	3,784	713	63	709	1,141	818	340	6,260	–695	14,672,557
Sierra Leone	14,742	1,166	9,351	90	119	164	5,541	457	2,980	4,529	–304	6,315,627
Singapore	775,196	186,017	56	6	11	6	33	0	0	466,119	123,004	5,469,724
Slovak Republic	213,211	70,364	7,381	1,206	1,967	1,808	1,451	725	224	147,386	–11,919	5,418,649
Slovenia	351,776	121,679	14,686	1,072	4,208	5,457	1,200	2,169	580	225,046	–9,634	2,061,980
Solomon Islands	31,245	1,835	14,438	4,560	1,033	1,728	5,755	223	1,138	15,327	–356	572,171
South Africa	77,348	19,263	13,743	898	320	370	2,115	2,892	7,149	44,921	–579	54,146,735
Spain	342,470	142,821	10,298	200	2,858	1,780	3,939	1,195	326	215,593	–26,241	46,480,882
Sri Lanka	44,970	11,352	3,247	34	194	737	2,053	223	6	32,410	–2,040	20,771,000
Suriname	161,690	46,402	86,572	1,649	32,526	16,393	3,421	1,187	31,395	30,782	–2,066	538,248

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Economy	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
Swaziland	**52,670**	17,889	7,125	*209*	*403*	*143*	*3,859*	*2,131*	*380*	26,811	846	1,269,112
Sweden	**886,129**	285,792	27,890	*3,218*	*8,698*	*2,875*	*1,240*	*2,848*	*9,010*	576,521	–4,073	9,696,110
Switzerland	**1,466,757**	356,075	8,531	*263*	*2,118*	*985*	*1,068*	*4,096*	*0*	1,022,950	79,200	8,188,649
Tajikistan	**42,286**	30,397	7,431	*1*	*62*	*2,134*	*2,286*	*2,719*	*229*	5,015	–557	8,295,840
Tanzania	**17,451**	3,199	8,039	*813*	*173*	*1,789*	*3,389*	*1,514*	*361*	6,706	–494	51,822,621
Thailand	**62,599**	20,380	10,144	*241*	*448*	*1,088*	*7,053*	*652*	*662*	33,573	–1,498	67,725,979
Togo	**18,924**	1,963	5,295	*145*	*6*	*811*	*2,443*	*596*	*1,294*	11,869	–204	7,115,163
Tunisia	**45,150**	14,838	10,178	*43*	*71*	*479*	*2,966*	*3,081*	*3,538*	24,796	–4,662	11,130,154
Turkey	**45,998**	26,984	12,854	*177*	*484*	*50*	*6,760*	*4,450*	*933*	12,081	–5,921	77,523,788
Turkmenistan	**146,831**	39,740	59,062	*0*	*962*	*776*	*2,785*	*16,695*	*37,843*	47,510	519	5,307,188
Uganda	**13,732**	1,872	5,269	*27*	*11*	*671*	*3,449*	*1,111*	*1*	6,889	–299	37,782,971
Ukraine	**56,053**	25,171	13,345	*193*	*242*	*327*	*4,664*	*2,710*	*5,210*	18,952	–1,414	45,271,947
United Arab Emirates	**738,270**	125,657	259,428	*2*	*39*	*1,312*	*669*	*1,149*	*256,257*	278,205	74,981	9,086,139
United Kingdom	**647,694**	193,456	7,592	*72*	*403*	*1,145*	*1,143*	*1,824*	*3,005*	457,223	–10,577	64,613,160
United States	**983,280**	216,186	23,624	*626*	*6,158*	*1,302*	*4,311*	*2,575*	*8,651*	766,470	–23,000	318,907,401
Uruguay	**254,601**	64,249	22,001	*1,829*	*2,279*	*426*	*6,342*	*10,903*	*222*	171,310	–2,959	3,419,516
Venezuela, RB	**162,560**	70,151	38,151	*131*	*2,833*	*1,376*	*1,258*	*527*	*32,026*	49,332	4,926	30,693,827
Vietnam	**27,368**	5,530	9,381	*430*	*102*	*171*	*5,658*	*487*	*2,533*	13,740	–1,284	90,728,900
West Bank and Gaza	**30,567**	11,533	4,256	*0*	*2*	*0*	*2,032*	*2,222*	*0*	14,778	0	4,294,682
Yemen, Rep.	**22,909**	3,630	10,491	*18*	*25*	*51*	*963*	*2,736*	*6,699*	9,002	–215	26,183,676
Zambia	**40,965**	7,139	16,305	*1,084*	*860*	*4,714*	*1,962*	*3,351*	*4,335*	17,549	–27	15,721,343
Zimbabwe	**18,958**	2,704	7,387	*853*	*175*	*2,017*	*1,212*	*2,371*	*759*	9,877	–1,012	15,245,855

Income Group	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
Low-income countries	**13,629**	1,967	6,421	565	103	1,195	2,472	1,518	568	5,564	–322	525,385,124
Lower-middle-income countries	**25,948**	6,531	6,949	138	105	500	2,646	1,616	1,944	13,117	–650	2,725,398,461
Upper-middle-income countries	**112,798**	28,527	18,960	469	1,248	1,635	6,176	2,810	6,623	65,742	–432	2,196,796,195
High-income non-OECD countries	**264,998**	59,096	80,104	602	1,567	1,851	2,310	1,700	72,074	111,793	14,005	287,470,518
High-income OECD countries	**708,389**	195,929	19,525	500	4,366	1,600	3,017	2,031	8,011	498,399	–5,464	1,046,598,271
World	**168,580**	44,760	15,841	353	1,195	1,149	3,819	2,063	7,262	108,654	–676	6,781,648,569

Geographic Region	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
East Asia and Pacific	**140,042**	39,185	14,739	375	956	900	5,982	1,658	4,868	84,334	1,784	2,145,669,572
Europe and Central Asia	**368,233**	122,870	19,377	468	1,447	1,704	3,059	2,670	10,029	227,581	–1,595	851,093,792
Latin America and the Caribbean	**138,294**	32,569	25,347	733	3,926	3,676	4,278	3,872	8,861	82,750	–2,372	608,240,663
Middle East and North Africa	**158,892**	23,984	70,137	19	25	880	2,165	2,513	64,535	54,871	9,900	266,210,252
North America	**986,621**	217,571	26,514	656	6,243	2,032	4,389	2,611	10,583	762,896	–20,360	354,451,965
South Asia	**18,400**	4,797	4,633	32	33	137	1,941	1,602	888	9,393	–423	1,688,760,066
Sub-Saharan Africa	**25,562**	4,017	9,225	525	179	1,138	2,824	1,735	2,822	12,680	–360	867,222,259

Geographic Region, Only Low- and Middle-Income Countries	Total wealth	Produced capital	Natural capital	*Forest*		*Protected areas*	*Cropland*	*Pastureland*	*Subsoil assets*	Human capital	Net foreign assets	Population
				Timber	*Nontimber*							
East Asia and Pacific	**91,581**	24,018	13,772	386	316	941	6,433	1,707	3,989	53,387	404	1,939,183,399
Europe and Central Asia	**70,530**	27,760	19,978	233	529	892	5,015	4,894	8,415	26,116	–3,325	224,742,378
Latin America and the Caribbean	**133,614**	29,234	24,341	752	4,157	4,187	4,359	4,164	6,721	83,142	–3,103	513,384,647
Middle East and North Africa	**48,495**	9,777	20,759	23	25	889	2,386	2,878	14,558	19,384	–1,425	214,287,031
South Asia	**18,400**	4,797	4,633	32	33	137	1,941	1,602	888	9,393	–423	1,688,760,066
Sub-Saharan Africa	**25,562**	4,017	9,225	525	179	1,138	2,824	1,735	2,822	12,680	–360	867,222,259

Note: Columns in italics indicate that they comprise the larger category of natural capital. OECD = Organisation for Economic Co-operation and Development.

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Countries regularly track gross domestic product (GDP) as an indicator of their economic progress, but not wealth—the assets such as infrastructure, forests, minerals, and human capital that produce GDP. In contrast, corporations routinely report on both their income and assets to assess their economic health and prospects for the future. Wealth accounts allow countries to take stock of their assets to monitor the sustainability of development, an urgent concern today for all countries.

The Changing Wealth of Nations 2018: Building a Sustainable Future covers national wealth for 141 countries over 20 years (1995–2014) as the sum of produced capital, 19 types of natural capital, net foreign assets, and human capital overall as well as by gender and type of employment. Great progress has been made in estimating wealth since the first volume, *Where Is the Wealth of Nations? Measuring Capital for the 21st Century*, was published in 2006. New data substantially improve estimates of natural capital, and, for the first time, human capital is measured by using household surveys to estimate lifetime earnings.

The Changing Wealth of Nations 2018 begins with a review of global and regional trends in wealth over the past two decades and provides examples of how wealth accounts can be used for the analysis of development patterns. Several chapters discuss the new work on human capital and its application in development policy. The book then tackles elements of natural capital that are not yet fully incorporated in the wealth accounts: air pollution, marine fisheries, and ecosystems.

This book targets policy makers but will engage anyone committed to building a sustainable future for the planet.

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