The Changing Wealth of Nations 2017

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Chapter 1: The Wealth of Nations: Introduction to the Approach

Why should we measure wealth?

National income is underpinned by a country's wealth--measured comprehensively to include all assets, produced capital, natural capital, human capital and net financial assets--and sustained economic growth over the long term requires investment in this broad portfolio of assets. While a macroeconomic indicator like GDP provides an important measure of economic progress, it does not reflect changes in the underlying asset base, and hence, used alone, may provide misleading signals about the health of the economy. GDP does not reflect depreciation and depletion of assets, whether investment and accumulation of wealth keep pace with population growth, or whether the mix of different 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 balance sheet[1] (assets and liabilities, or wealth). Similarly, a household can only obtain a mortgage by demonstrating both its income and its net assets. That's because income in a given year can always 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 on the basis of national income; wealth has been ignored.

Our goal in this book is to broaden the measures economists and policy-makers use to assess economic progress. Without a forward-looking indicator it is hard to conclude that we are actually capable of measuring 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. GDP indicates whether a country's income is growing; wealth indicates the prospects for maintaining that income over the long term. They are complementary indicators. Economic performance is best evaluated by monitoring the growth of both GDP and wealth.

How we measure wealth

Measuring national wealth and changes in wealth is part of an on-going effort by the World Bank to monitor long-term economic well-being of nations. *The Changing Wealth of Nations 2017* builds upon two previous reports, *Where is the Wealth of Nations? Measuring Capital for the 21st Century* (2006) and T*he Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* (2011), as well as work on Adjusted Net Savings that was

[1] 'Balance sheet' generally refers to a presentation of informant about assets, liabilities and net worth in a specific format defined by a formal accounting framework like the System of National Accounts or business accounting frameworks. We generally use the term wealth or assets interchangeably as equivalents to the information, but without following the same presentation structure.

started in the late 1990s and is published annually in the World Development Indicators. In this report, significant changes in methodology and data have been introduced to improve the quality of wealth estimates. The overall 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; Annex 1 to the report provides a more detailed technical explanation of methodology and data sources.

In a major departure from the earlier approach, Comprehensive wealth in this report is calculated by summing up estimates of each component of wealth: produced capital, natural capital, human capital and net foreign assets. This represents a shift from a 'top-down' approach to a 'bottom-up' approach. This is possible because human capital, for the first time, is measured as an explicit component of the wealth accounts for each country. The availability in the World Bank of a unique global database of more than 1500 household surveys has made it possible to implement the well-known Jorgenson-Fraumeni lifetime earnings approach for human capital. Drawing on work from the Penn World Table, we are able to estimate human capital for both employed and self-employed workers.

Wealth accounts are an integral part of the *System of National Accounts 2008* (European Commission et al., 2008), which provides the basis for the measurement of economic progress used by governments, the private sector and many others around the world. However, wealth accounts are not nearly as widely implemented as the measures of production and income. [2] The 2009 global economic crisis, related to housing and financial assets, and the work by Thomas Piketty (2013), *Capital in the Twenty-First Century* has sparked renewed interest in at least some aspects of wealth accounting.

The SNA measure of wealth is much narrower than what is presented here, because the SNA asset boundary includes only produced assets, natural resource assets and net foreign asset. Although there has been experimentation with human capital it is not yet part of the SNA national balance sheet. In this book we report wealth for 141 countries for the years 1995 to 2014 (due to space constraints tables report data at 5 year intervals only; the full dataset is available online). The distribution of countries by region and income group is given in the annex to this chapter. Comprehensive wealth accounts include the following categories of assets:

- Produced capital: machinery, buildings, equipment and urban land
- Natural capital: energy (4 categories) and minerals (10 categories), agricultural land (crop and pastureland), forests (timber and some non-timber forest products), protected areas

[2] The focus on production and income is largely the result of historical conditions. The idea of national economic accounts was around for several centuries, but only came to be widely implemented after World War II, in response to a combination of i) serious social and political crises arising from the Great Depression and then the financing of WWII, and ii) development of Keynes' macroeconomic theory that explained what needed to be done to counteract a depression. The theory addressed itself to essentially the short term challenges of macroeconomic management, not long term sustainability. National economic accounts developed as a tool for measuring the economy and informing macroeconomic policy, guided by the information needs of this short term perspective. For more information on this, see Coyle (2015).

- Human capital: human capital disaggregated by gender and employment status (employed, self-employed)
- Net foreign assets: the sum of a country's external assets and liabilities[3], for example, foreign direct investment and reserve assets (for further explanation see Lane and Milesi-Ferretti, 2007)

Not all countries or assets are included in the CWON database. Assets are included in CWON when the necessary data are i) available for a large number of countries (at least 100), ii) are updated regularly to provide a times series, and iii) are publicly available. This sets a rather high bar for some assets, for which such data are not readily available. Countries are included when such data are available or can be reasonably estimated for a country. For some assets, like produced capital and net foreign assets, asset values are directly available; for other assets, we estimate their value using data collected from a wide range of global sources as described in Annex 1. Naturally, our wealth account for each country is unlikely to be as accurate as one a country might construct itself using its own data.

The construction of the wealth accounts is guided by the concepts and methods of the System of National Accounts. While values for produced capital and net foreign assets are generally derived from widely used methods based on observed transactions in 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.

For natural capital, the United Nations Statistical Commission adopted as an international statistical standard the *System of Environmental Economic Accounting* (SEEA) in 2012 (European Commission et al., 2012). The SEEA is an extension of the System of National Accounts, using consistent concepts and structure, and provides the basis for our estimates of the value of natural capital. No such standard yet exists for human capital, but there has been a great deal of experimental work on this topic based on the Jorgenson-Fraumeni approach, including some work by national statistical offices.

Comprehensive wealth presently is measured at market exchange rates in constant 2014 US dollars. It has also been suggested that wealth accounts be compiled using purchasing power parities (PPP), which provide a better measure of the wellbeing derived from assets, just as we measure GDP using both market-exchange rates and PPP. This is a topic of great importance for future work and is explored further in Box 1.

[3] Domestic financial assets do not add to national wealth because 'assets + liabilities' sum to zero. Nevertheless, it would be quite useful to have such information but data are not readily available for many countries.

Box 1 Measuring wealth in Purchasing Power Parity terms

The wealth accounts presented in this book are all valued at market exchange rates. To arrive at the value of cropland in a given country in 2014, for example, land rents are measured as the value of crops and livestock produce 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 values of all the rents associated with agricultural production in local prices. To convert this value to US dollars, we use the market exchange rate (averaged over the year) between the local currency and US dollars. While this is a practical way to put all of the asset values for different countries on a common basis, the values are subject to the enormous volatility observed in currency markets, and may or may not have a sound link to the amount of wellbeing that citizens derive from their assets.

The first problem could be solved by using an average exchange rate over say a 5-year period, adjusted for relative inflation. To deal with the issues of comparing wellbeing citizens derive from their assets, however, a better solution would be to rely on economic aggregates measured in 'international dollars' at Purchasing Power Parity (PPP). PPP adjusted aggregate national accounting takes into accounts the purchasing power that a dollar would have in a given economy. To give a concrete example, Table.1 compares GDP per capita for China in 2014 using three different valuations.

Table.1 Alternative measures of GDP per capita in China in 2014

Local currency (Yuan Renminbi)	47,203
US dollars at market exchange rates	7,684
International dollars at PPP	13,440

Source: *World Development Indicators*

Comparing local currency to US dollars, the average exchange rate of the Yuan against the US dollar was 6.14 in 2014. Taking the ratio of GDP per capita at market exchange rates with the equivalent PPP value, we see that the price level of the elements of GDP (aggregate final demand) in China is 57.2% of that in the US – that is, a dollar in China will purchase about 1.75 times (or 1/0.572) the quantity of goods and services that the same dollar would purchase in the US. This has obvious implications for wellbeing per dollar spent in the two countries.

Under the International Comparison Program, a joint effort by the World Bank and its partners, regular surveys (the most recent being 2011) measure the purchasing value of a dollar across countries at a highly detailed level of aggregation. These PPP values for individual products and services are then used to arrive at weighted aggregate PPP values for aggregate final demand, for example, and therefore for GDP.

It would clearly add value to the wealth accounts presented here if we reported the PPP values of the assets making up national wealth. For fixed capital, the Penn World Tables already have the PPPs conversion factors for structures as well as machinery and equipment, since they publish fixed capital in PPP terms. Subsoil assets are mostly traded at world prices, so the PPP conversion factor is 1, although in many countries the domestic price of oil and gas, for example, can be heavily subsidized and differ substantially from world market prices. Since we value resource assets as the present value of resource rents, it is reasonable to assume a PPP conversion factor of 1 for most of these assets as well.

For agricultural produce the situation is more complex, because local prices can diverge from world prices in poor countries where transport costs within the country are very high. These local prices are currently used to value agricultural land in the wealth accounts; as a result, deriving the PPP conversion factor for the agricultural production of the country, broken down between crops and livestock, would permit conversion of the agricultural land asset values into PPP international dollars. Finally, wages represent the rental values for human capital. Since the wage in turn has a characteristic purchasing power when spent by households, the logical approach to measuring human capital in PPP terms would be to use the household consumption PPP conversion factor.

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.

Savings and changes in National Wealth

The key to increasing economic wellbeing 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. From the 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 assets.

The wealth accounting approach provides two related sets of information: the comprehensive wealth accounts (a stock measure) and Adjusted net (genuine) savings (a flow measure). ANS is measured as gross national saving minus depreciation of produced capital, depletion of subsoil assets and deforestation, air pollution damages to human health; and credited for education expenditures. The rule for interpreting ANS is simple: if ANS as a percent of Gross National Income (GNI) is negative, it indicates that the country is consuming more than it is saving, which will undermine long term sustainability; if ANS is positive then it is adding to wealth and future wellbeing.

For countries with growing populations or aspirations for higher standards of living, it is not sufficient to maintain wealth; *per capita* wealth must be growing, or at least not declining. Comprehensive wealth shows the value of each asset at a point in time and can be used to monitor whether per capita wealth is maintained over time, a 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 endogenous or policy-induced dynamics.

Measured annually, ANS 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. By breaking down the components of ANS, it is 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 longer lifetime and improved resilience to reduce depreciation of fixed capital, increasing investment in education and innovation to increase human capital, optimize use of natural capital (sustainable use of renewables and efficient extraction of non-renewables), or improving air quality to reduce pollution damage costs.

ANS does not correspond completely to changes in wealth for reasons explained in Box 2. Many of the factors affecting wealth which are not included in ANS, due to SNA conventions regarding saving/investment, are exogenous changes; other differences result from the impact of institutions or measurement challenges. The result of this gap is that it is possible to observe negative ANS and no associated declines in future consumption. There are two responses to this conundrum. First, 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 still warranted; relying on unmeasured and uncertain sources of future wealth to provide for a better future cannot be considered prudent. The second is to note that squandering existing wealth, and this point applies particularly to exhaustible resources that can finance investment, can never be prudent. Declines in wealth, as measured by ANS, represent opportunities not taken to increase future wellbeing.

Box 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 we have faced in measuring ANS, as well as SNA accounting definitions for saving/investment, this is not the case for our wealth accounts. Some of the important factors can change national wealth but are not part of ANS include:

Factors affecting wealth that are omitted from ANS due to a lack of data:

- changes in agricultural land, an important asset.
- Current measures of changes in human capital in ANS are not yet fully aligned with measurement of the value of human capital in the wealth accounts and in most cases may underestimate these changes. Future work will do so.

Effects on wealth that are not included in saving/investment according to SNA conventions:

- New discoveries of subsoil assets. These are only added to the balance sheet, not ANS
- Some capital gains/losses due to commodity price changes are included in wealth accounts when the GDP deflator is used to value an asset in constant prices
- Changes in technological, world prices, and/or management that affect 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 feasible extraction of previously uneconomic resources, increasing the volume of resources and adding to wealth. But changes in technology may reduce the demand for other resources (e.g., shale gas reducing the demand for and value of coal resources)
    - 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/losses)
    - Agricultural land will increase in value if a farmer switches to higher value crops or changes technology that results in higher yields
- Policy changes may affect asset value, e.g., trade policy, transport infrastructure, or environmental regulation may impact a country's costs; education, labor market 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

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 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, hence the value of an asset. These factors vary 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 previous CWON, for example, showed a very rapid increase in urban human capital from the mid-1990s, in part due to the transition to a market-oriented economy that provided opportunities for much higher returns. A wide range of indicators are available to assess institutions, governance and policy such as the World Governance Indicators or the Ease of Doing business indicators. This issue is explored in greater detail in several chapters where sustainable development is shown to depend on a combination of both accumulation of capital, as well as sound political economy and macroeconomic policy.

Social capital is based on the idea that more cooperative behavior can facilitate economic activity and increase wellbeing. 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). A broad literature has coalesced around 'social trust' as a key indicator of social capital. Social trust in turn 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 our analyses, as we have started to do for institutions and governance. A longer discussion of social trust and how it relates to wealth is provided in the annex to this chapter.

Organization of the Report

The book is divided into three parts. The first part presents overall trends in wealth accounts over the past two decades and examples of how wealth accounting is used in policy assessments and analytical work. Part two describes the new work on human capital and its uses for policy analysis (A companion volume goes into much greater detail about human capital and development). The last part of the book discusses new developments to increase the coverage of natural capital accounting to important assets that are currently not measured.

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

We begin with the big picture showing broad trends in wealth at the global level over the past two decades. The trends explore how the volume and composition of wealth has developed over time for different income groups and then takes a closer look at wealth in low and middle income countries by geographic region (Chapter 2). In the next four chapters we then provide examples of how the wealth account approach can be used for policy analysis.

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 an essentially 'free' revenue for financing development and moving a country onto a higher growth trajectory; but this can only be achieved with the right institutions and governance. Drawing on previous work, such as *From Mines and Wells to Well-Built Minds: Turning Sub-Saharan Africa's Natural Resource Wealth into Human Capital* (de la Briere et al., 2017) and *Diversified Development: Making the Most of Natural Resources in Eurasia* (Gill et al., 2014), Chapter 3 explores the relative success of several resource rich African countries, combining the wealth accounting approach with an assessment of political economy and fiscal policies.

Total Factor Productivity (TFP) of Multi Factor Productivity (MFP)[4] is a staple tool used by macroeconomists to assess long tem economic performance based on the contribution to GDP growth by labor and fixed capital. But the role of natural capital has been ignored. Based on a new methodology proposed by OECD (Brandt et a., 2017) that used the World Bank's data on natural capital to expand MFP, we show how use of a broader set of assets, including natural capital, changes the estimates of countries' MFP, and how economists may be mismeasuring MFP by omitting natural capital (Chapter 4).

In a 2014 speech from the throne, the King of Morocco highlighted the role of intangible capital in the powering the country's development. In an assessment that combined the wealth accounting approach with institutional assessment (Chapter 5), the Morocco 2040 growth initiative prioritized macroeconomic reforms, but also education and labor market reforms to promote human capital growth, as well as efforts to increase gender equality. Equally important are institutional reforms to create a modern administration, improve public investment and financial management, and to increase voice and accountability and access to information.

In Chapter 6, we use the wealth accounts to explore the specific challenges faced by carbon-intensive nations. Countries highly dependent on carbon wealth- oil, gas and coal—may face increasing risk in the future. Technological advancement in alternative energy technologies and wider adoption of climate policies may diminish the value of carbon assets and undermine development pathways for carbon-rich nations.

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

Previous work (World Bank, 2011) showed that the accumulation of human capital has been a key factor in economic growth, sustainable development, and reducing poverty. Providing an explicit measure of human capital contributes greatly to making wealth accounts more useful for monitoring progress and policy analysis. In part two of the book we look in detail at human capital accounts and their policy applications. As a result, investing in human capital can be the

[4] The terms have been used interchangeably.

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.

Chapter 7 provides the first ever set of comparable estimates of human capital wealth for a large number of countries over two decades, from 1995 to 2014. The measures of human capital wealth are essentially estimates of the net present value of future wages and earnings. In addition to country-wide estimates, estimates of human capital wealth are also provided 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.

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 made. But even with the data now available, additional analysis as well as simulations can be undertaken to inform policy. The companion volume to CWON presents any of these analyses and their policy implications for development

Chapter 8 provides an analysis of some of the factors that may affect the growth in the human capital wealth of nations on a per capita basis. Because human capital wealth measures can be disaggregated by gender, the analysis has been conducted separately for men and women. The modeling approach follows similar work conducted for economic growth, with an emphasis placed on demographic and labor market factors that may affect growth rates.

In the third part of the book we report 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 (Chapter 9), marine fisheries (Chapter 10), and ecosystems and their services (Chapter 11).

Summing Up and Future Research

Our goal in this book is to broaden the measures used to assess economic progress by complementing indicators of current outcomes (GDP, GNI) with a forward-looking indicator, wealth and changes in wealth. To achieve this objective, we demonstrate that comprehensive wealth accounts can be constructed, and also demonstrate how wealth accounts can be used to provide information useful for policy both as an indicator of long term sustainability to complement GDP and other conventional macroeconomic indicators, but also in analytical applications.

Great progress has been made since the first version of the wealth of nations was published in 2005. Asset and country coverage has increased and deepened. 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 the 10-year time series in the last version of CWON. The introduction of human capital accounts has opened up a new avenue for understanding human development. More analytical work has been undertaken using wealth accounts, some of which is presented here. These chapters present insights to development issues that may not be new, but ground them in the perspective of wealth and long term sustainability that is quantifiable.

But much work remains to be done. The measure of energy and mineral assets is reasonably sound[5] and their role in development has been studied a great deal. Renewable natural capital, however, is still not adequately represented in wealth accounts. Some important ecosystem services may be 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. Renewable natural capital is a unique asset. If managed sustainably, it can produce benefits in perpetuity. At present data are largely limited to extent; for example, we have information about the extent of forest cover, but not about its condition, and degradation of forests has potentially serious impacts on the future wellbeing of countries and the plane. Natural capital is also subject to thresholds, irreversibilites in natural systems and may precipitate catastrophic events, but great uncertainties surround these factors. None of the uncertainty, including potential climate change impacts, is incorporated in the value of renewable natural capital at this time.

Given these limitations, interpreting wealth accounts as a measure of sustainability must be approached with some (sensible) caution. Change in total wealth provides us only with a measure of weak sustainability that assumes a high degree of substitution possibilities among different kinds of assets. Our intention is to provide online all the underlying physical and price data used to calculate the wealth accounts so that the underlying data can be used to monitor individual capital stocks, particularly natural capital.

New conceptual work is also needed and some of the priorities have already been hinted at in this chapter: further work to develop measures of human capital, aligning the measures of human capital in the wealth accounts and ANS, integrating accumulation of productive wealth with the role of institutions and governance, and the use of purchasing power parities in addition to market exchange rates in constructing comparable wealth accounts across countries. Additional issues are identified in each chapter, and more will certainly emerge as the wealth accounts are used.

This book reports the main findings, but the ‘wealth’ of data raises 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 depends not only on productive wealth, but also the strength of our institutions and governance, and the integrity of

[5] Although some important resources are still not included due to lack of data, notable platinum group minerals, diamonds and others.

our natural capital. This new volume sets the stage for addressing these issues in an integrated manner.

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Annex. Changes in Methodology and Data Sources for the Wealth Accounts

The new wealth accounts data base covers the period 1995-2014 for 141 countries accounts for

- produced capital: 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 crop land, pastureland, forest (timber, non-timber forest resources), protected areas
- human capital
- net foreign assets

CWON 2017 builds substantially on previous reports with significant changes in methodology and data. These changes are the result of sector studies conducted over the recent years, and 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 the annex to the report.

Major changes to wealth estimates:

i) **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, where total wealth was estimated by i) assuming that consumption is the return on total wealth and then ii) calculating back to total wealth from current sustainable consumption (previous *Changing Wealth of Nations* reports in supplemental materials). 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 the *Changing Wealth of Nations* (World Bank, 2011)), as well as missing or mismeasured assets and possible effects of social capital. But the unexplained residual accounted for 50-85% of the total wealth indicator, making this indicator 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 category of asset.

   The advantage of the earlier approach was that the residual included human capital, (mis- or) unmeasured assets, and the influence of institutions and governance on wealth. The disadvantage was that the residual i) could not disentangle the various components of the residual and ii) was calculated assuming the same return on assets in all countries.

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

Penn World Tables follow 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 from 5 to 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.

iii) **Natural capital**: Scoping studies to improve the benchmark data were conducted for subsoil assets, forest assets and agricultural land (see attached supplemental materials for these reports). Some of the key recommendations that will be implemented include

- **Subsoil assets**: We use actual lifetime of reserves 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**: Use producer price to value output (rather than export unit values, used in earlier estimates) and new regional land rental rates for both crops and pastureland. The agricultural land values will indirectly affect the value of **Protected areas,** which are estimated as the opportunity cost of lowest value agricultural land in a country.
- **Forest:** Given the continued reliance on FAO's export unit value for timber prices, the regional rental rates have been revised in order to account for the price differential between domestically consumed versus exported timber. For **Non-Timber Forest products and services** we replaced the 1995 estimate of $10/hectare with updated values derived from a meta data analysis that include non-timber forest products, hunting & fishing, recreation and water services.

iv) **Human capital:** Human capital in the past was not measured explicitly but included as part of the 'residual', accounting from 50-85% of total wealth in past estimates. Providing an explicit measure of human capital will contribute greatly to making wealth accounts more useful for and policy analysis and monitoring progress. We apply the well-known Jorgenson-Fraumeni approach to measuring human capital globally. In the past, application of J-F was limited to a few countries because of the substantial data requirements. We utilize a unique database developed by the World Bank, the International Income Distribution Database, which contains more than 1500 household surveys.

v) **Net Foreign Assets:** This dataset is compiled by the Research Department of the IMF and is used for the wealth accounts without any changes.

Annex. Social Capital

The idea that more cooperative behavior can facilitate economic activity and increase wellbeing has a long history, with Putnam et al's (1993) study of civic traditions in Italy being a well-known contribution. Building on this work, 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).

A broad literature has coalesced around 'social trust' as a key indicator of social capital. Social trust in turn 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?"

While trust and cooperative behavior have social benefits, to merit the term 'social capital' we need to conceive of trust as an asset. Given that trust is not consumed (or 'used up') in a given period, and that its continued existence provides a stream of benefits over time, this provides a close match to the SNA concept of an asset – what is missing is the notion that an asset provides benefits to its owner. If we conceive of society at large as the owner of social trust, the match becomes better.

Social trust as an asset can affect wellbeing through at least two main channels. As an input to production, social trust can foster faster economic growth. This could work through the financial system, for example, where trust is a key facilitator. In addition, social trust can be a direct contributor to wellbeing, as confirmed by a wide literature on measuring subjective wellbeing.

On social capital and economic growth, there is an older literature built on cross-sectional analyses, including Helliwell (1996) for Asia, Helliwell and Putnam (1995) for Italy, and Knack and Keefer (1997) for a global analysis. More recently there has been an emphasis on using panel data, for example a study for Europe by Neira *et al.* (2009), which controls for unchanging country characteristics ('fixed effects' in the jargon) which can bias cross-country studies. The general conclusion from this literature is that there is indeed a significant link between social capital and GDP growth.

On social capital as a direct source of wellbeing, Hamilton et al. (2016) exploit recent rounds of the Gallup World Poll, the European Social Survey and the World Values Survey in order to derive the asset value of social trust. By using the range of questions on values from these surveys, as well as control variables such as income, it is possible to derive the amount of additional income a respondent would require to compensate them for a single unit change in the level of social trust. This compensating differential is used to measure the implicit dollar-valued flow of wellbeing that countries receive from their characteristic level of social trust. This annual flow is then capitalized by taking present values.

Hamilton et al. (2016) are careful to describe the capitalized value of social trust as a 'wealth-equivalent' quantity. This is because other forms of productive capital, including produced assets, natural resources and human capital, can be purchased or at least rented through market transactions. This does not apply for the capitalized flows of wellbeing derived in the study. But measuring wealth-equivalent values of social trust does permit comparisons of this asset value with the more familiar constituents of the national balance sheet. Table XXX.1 shows selected results from this analysis.

Table XXX.1 Selected high and low values of social trust wealth equivalents for 2010

	Trust score (1-10)	Percent of total wealth
Lebanon	0.67	4.5%
Turkey	0.84	5.4%
Kenya	0.96	6.4%
Macedonia, FYR	1.06	6.4%
Cambodia	1.05	7.0%
Honduras	1.28	7.5%
Bangladesh	1.15	8.4%
Hungary	1.33	9.4%
Uruguay	2.78	21.4%
Thailand	2.36	22.1%
Mali	4.48	34.7%
Sweden	5.63	51.1%
Denmark	6.30	54.3%

Source: Hamilton et al. (2016); total wealth figures are from World Bank (2011)

As a comparator, produced capital makes up roughly 25% of total wealth in middle and high income countries in 2014 (the shares in low income countries are considerably smaller - see Appendix XXX). Social trust asset values in the 'high trust' countries in Table XXX.1 are certainly comparable to, or higher than, this value.

In summary, there is ample evidence that social capital is a contributor to production and a direct source of wellbeing. From a wealth accounting perspective, where the World Bank's emphasis is on productive capital, the challenge will be to arrive at robust ways to estimate the asset value of social capital as an input to production. More work will be required.

Another bottom line, however, is that development agencies need to be able to invest in assets that will increase social welfare in developing countries. Social capital is problematic from this perspective. Putnam et al. (1993) point to institutions with deep historical roots, going back centuries, as the potential explanation for the geographic variation in social capital in Italy. Some means to build social capital today will be required as part of the development process. Options could include greater voice for citizens, more accountable governments, creating participatory processes for decision-making, and encouraging participation in civil society institutions. But there are no easy answers.

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Part 1. Global, Regional, and Country Perspectives

Chapter 2: The Changing Wealth of Nations: Global and Regional Trends from 1995 to 2014
Glenn-Marie Lange, Esther Naikal, and Quentin Wodon

Chapter 3: From Adjusted Net Savings to the Underpinnings of Development: A Snapshot of Resource Rich Economies in Africa
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Chapter 2: The Changing Wealth of Nations: Global and Regional Trends from 1995 to 2014

Glenn-Marie Lange, Esther Naikal, and Quentin Wodon

Introduction

How can countries and governments create wealth in a sustainable way order to improve their population's future income streams and standards of living, thereby reducing poverty? In simple terms, a country's production (GDP) can be seen as representing the annual income or return generated by a country's wealth. In this update in the World Bank series of reports on the Changing Wealth of Nations (see World Bank, 2006, 2011 on the previous two reports), three main types of wealth are distinguished: produced capital, natural capital, and human capital. As noted in chapter 1, the addition of estimates of human capital wealth represents a major improvement versus pervious reports in which human capital wealth was not estimated separately, and was thereby simply considered as part of intangible wealth. This chapter sets the stage for the report by telling the story of how the Wealth of Nations has changed over the last two decades, from 1995 to 2014. The chapter consists of two main parts. The first part discusses trends in wealth accumulation, while the second considers adjusted net savings, a concept that helps in understanding changes in wealth over time.

We begin in Section 2 with the global picture and assess how wealth has evolved for the world as a whole as well as across income groups and geographic regions. Section 3 discusses the contribution of the various sources of wealth to total wealth, showing how gains achieved over time were not necessarily the same in terms of asset classes for counties at various levels of economic development. Within natural capital, the role played by both renewables and non-renewables is also discussed. Section 4 assesses whether there is convergence across countries in wealth generation. 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 this is the case, which component of wealth – produced, natural, or human capital, accounts for this apparent convergence? Section 5 briefly discusses trends in wealth in the various regions of the world. Finally, section 6 considers adjusted net savings. While exogenous factors including the discovery of new mineral resources, commodity price swings, civil unrest, and natural disasters such as droughts and floods all matter for the Wealth of nations, the accumulation of wealth is nevertheless primarily driven by endogenous factors—the policies and decisions that influence savings and investment, as well as depreciation and depletion of capita. Adjusted net savings captures much of the endogenous, policy-induced change in wealth, so we use this indicator for the various regions of the world to better understand the dynamics of building national wealth.

Trends in Global Wealth

Global wealth grew 65 percent from 1995 to reach $1,148 trillion by 2014 (Table 1). On a per capita basis, wealth levels grew from $130,032 to $169,349 per capita. This represents a real rate of growth of 1.3 percent per year. This is good news since as mentioned in the introduction, a country's wealth is the assets base from which annual incomes (GDP) are generated. At the same time, in terms of distribution, while some trends observed over the last two decades are encouraging, others are not. While wealth is starting to be spread among a larger set of countries in the middle and at the top, low income countries are still lagging behind (Figure 1).

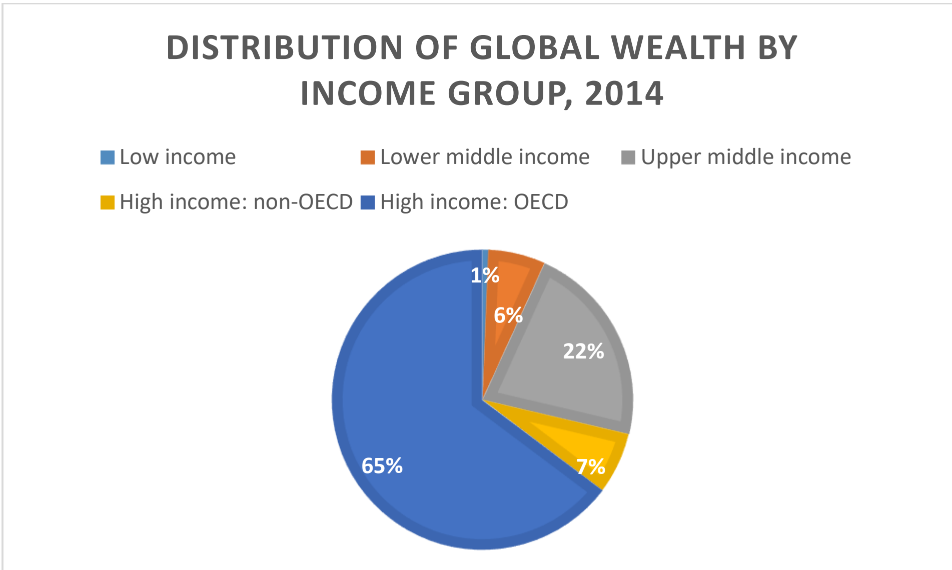
Indeed, the growth in wealth observed over the last 20 years was accompanied by a significant reduction in the concentration of wealth among high income countries. The wealth of middle income countries, especially upper middle income countries, surged from 19 percent to 28 percent of global wealth, while the share of high-income OECD countries came down from 75 percent in 1995 to 64 percent in 2014. However, wealth is still quite unevenly divided. Low income countries had only one percent of global wealth in 2014, about the same share as in 1995, despite the fact that 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 close to $710,000 in wealth at birth in 2014. For an individual born in a low income country, the estimate was at just $13,629. The ratio of per capita wealth between high-income OECD and low income countries was 47 in 1995. It increased further to 52 by 2014.

Table 1: Wealth and Population by Income Groups, 1995 and 2014

	Wealth (US$)					Population (millions)	
Aggregate (billions)	**1995**	**2000**	**2005**	**2010**	**2014**	**1995**	**2014**
Low income	3,616	3,731	4,194	5,552	7,161	311,706	525,385
Lower middle income	35,249	36,511	46,075	60,724	70,718	1,989,505	2,725,398
Upper middle income	96,952	115,283	139,736	203,638	251,412	1,859,615	2,196,796
High income: non-OECD	41,399	42,390	52,491	68,006	76,179	249,567	287,471
High income: OECD	518,629	598,493	653,969	693,481	742,997	940,935	1,046,598
World	695,845	796,408	896,464	1,031,400	1,148,466	5,351,327	6,781,649
Percentage shares	**1995**	**2000**	**2005**	**2010**	**2014**	**1995**	**2014**
Low income	1%	0%	0%	1%	1%	6%	8%
Lower middle income	5%	5%	5%	6%	6%	37%	40%
Upper middle income	14%	14%	16%	20%	22%	35%	32%
High income: non-OECD	6%	5%	6%	7%	7%	5%	4%
High income: OECD	75%	75%	73%	67%	65%	18%	15%
World	100%	100%	100%	100%	100%	100%	100%

Per capita wealth	1995	2000	2005	2010	2014
Low income	11,601	10,435	10,240	11,802	13,629
Lower middle income	17,718	16,745	19,426	23,675	25,948
Upper middle income	52,135	58,652	68,118	95,607	114,445
High income: non-OECD	165,884	165,561	199,485	245,513	264,998
High income: OECD	551,184	617,801	655,228	674,542	709,916
World	130,032	139,031	147,107	159,404	169,349

Source: Authors' estimations.



Source: Authors' estimations.

Components of Wealth

In previous issues of the Changing Wealth of Nations reports, intangible wealth – the wealth of countries not accounted for by produced, natural, or physical capital, represented most of the countries' wealth. This report 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 earnings. Human capital turns out to be the most important component of wealth, even though its share in total wealth decreased between 1995 and 2014 from 69 percent to 65 percent (Table 2). This decline in the share of human capital wealth, starting after 2000, is entirely due to upper middle and high income OECD countries, which together account for more than 80 percent of global wealth as well as 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 China which dominates upper middle income country group, and declining wages shares in GDP, again particularly in many high-income OECD countries (ILO, 2015). By contrast, in low and lower middle income countries which account for the majority of the population, the share of human capital wealth in total wealth is rising.

Trends in human capital wealth are explored in more detail in Chapter 6, not only overall, but also by gender and by type of employment. The data suggest among others that the share of human capital wealth accounted for by women is rising, albeit slowly and not in all countries. In terms of type of employment, wage workers account for the bulk of human capital wealth worldwide, but in low income counties, self-employment accounts for the largest share.

The other two major components of the Wealth of Nations are produced capital and natural capital. Both grew rapidly, increasing their shares of global wealth to 26 percent and 9 percent, respectively. Natural capital increased its share from 8 percent to 9 percent, largely due to an increase in subsoil assets. Among subsoil assets, fossil fuels are the largest component, but metal and mineral resources, starting at a low base, increased very rapidly accounting. Note however that our estimates of natural wealth, including fossil fuels, are for 2014, when oil prices peaked. The estimates thereby do not reflect the reduction in commodity prices over the last three years and its impact on wealth. The value of renewable assets--agricultural land, forests, and protected areas—increased, but not fast enough to maintain their share 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 our accounting framework - in theory should balance to zero because every financial must have a matching liability. However, reporting is not complete, so that there is a slight negative balance at the global level estimated at less than one percent of total wealth.

Table 2: Global Wealth by Type of Asset, 1995 and 2014 (billion US$, 2014 value)

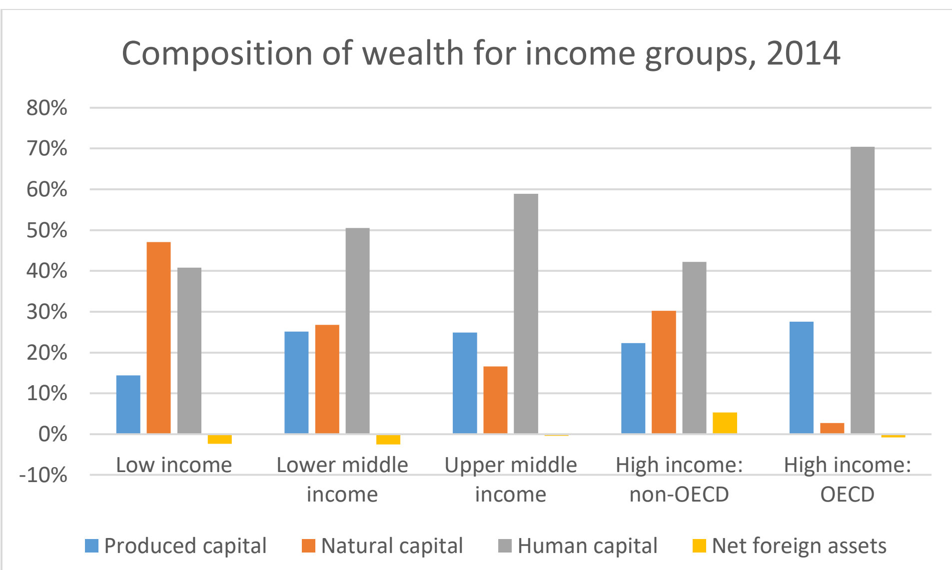
	1995		2014	
Total wealth	695,845	100%	1,148,466	100%
Produced capital	164,781	24%	303,548	26%
Natural capital	52,457	8%	107,427	9%
Forests and protected areas	14,515	2%	18,290	2%
Agr. land	25,859	4%	39,890	3%
Fossil energy resources	11,087	2%	39,094	3%
Metals and minerals	997	0%	10,154	1%
Human capital	481,497	69%	742,072	65%
Net foreign assets	-2,890	0%	-4,581	0%

Notes: 1. Shares are calculated from the sum of reported male and female human capital, not the global total. Female and male human capital do not sum to total human capital because a gender breakdown was not available for many of the high-income non-OECD. 2. Shares are calculated from the sum of reported employed and self-employed human capital, not the global total. Employed and self-employed human capital do not sum to total human capital because the breakdown was not available for China and many high-income non-OECD countries.

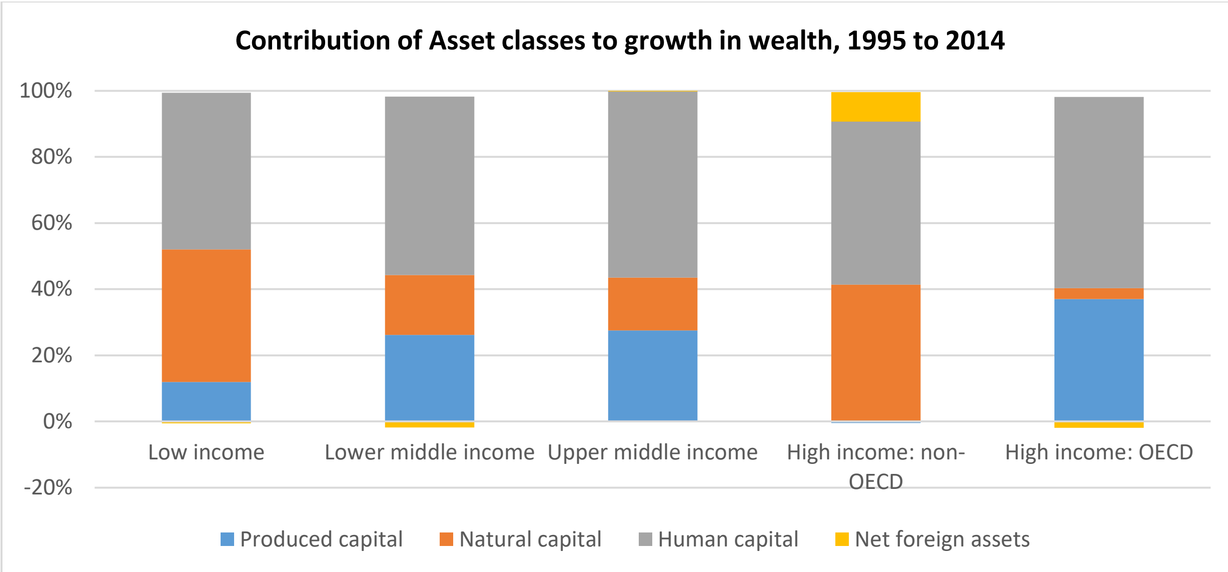
Source: Authors' estimations

There are important differences in the composition of wealth by income groups (Figure 2). Low income countries' greatest source of wealth remains natural capital, at 47 percent of total wealth in 2014 versus 14 percent for produced capital and 41 percent for human capital. As countries develop, they often leverage their natural capital to gradually increase produced capital and especially human capital. In high-income OECD countries, human capital accounts for 70 percent of total wealth, produced capital for 28 percent and natural capital only three percent. Natural capital clearly accounts for only a small share of total wealth in comparatively richer countries, but this does not mean that in absolute terms, this is not an important source of wealth. Per capita natural capital in high income countries, $19,525, was more than three times per capita wealth in low income countries, $6,421, in 2014. 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 process of capital accumulation between 1995 and 2014 suggests that, except for high-income non-OECD countries, human capital was the asset class comprising the largest investments (Figure 3). These gains are discussed further in chapter 6. As expected, in part due to differences in natural endowments, there is considerable variation in the accumulation of natural capital between countries. In high income non-OECD countries, gains in natural capital wealth, mostly energy resources, accounted for a very large share of total gains. But this was also observed in low income countries, mainly due to gains in the capital associated with agricultural land.

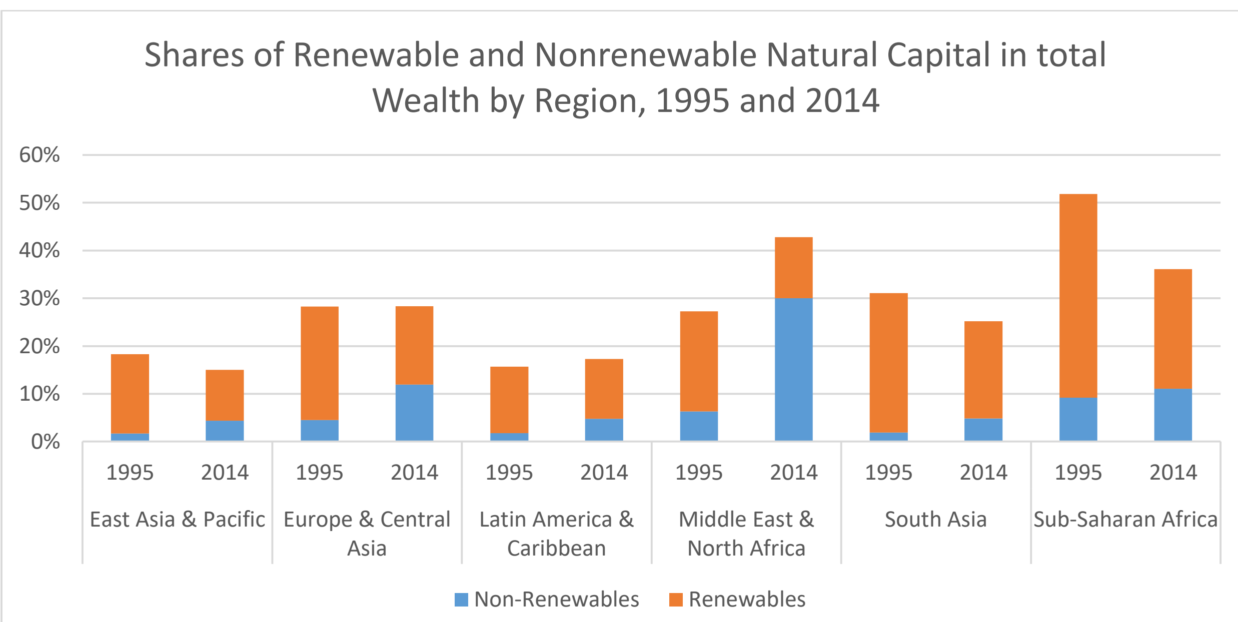


Source: Authors' estimations.



Source: Authors' estimations.

Natural capital can itself be decomposed into non-renewables (energy and minerals) and renewables (agricultural land, forest and protected areas), which pose quite different challenges for development (Box 1). Looking more closely at natural capital in low and middle income countries (Figure 4), we see that as a share of wealth, natural capital increased in three of six regions—Latin America and the Caribbean, Europe and Central Asia, and the Middle East and North Africa. Non-renewables accounted for most of the increase and the share of renewables declined in all regions, posing challenges for sustainability.



Source: Authors' estimations

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 – much of which is agricultural land, accounted for 50 percent of total wealth. Natural capital remains today the largest source of wealth in Nepal. However, while agricultural land value increased over time in most regions, energy and mineral wealth grew much faster and now account for most of natural capital worldwide. In addition, in several sub-Saharan African countries, agricultural land capital declined notably in Nigeria, the Democratic Republic of Congo, Tanzania and Zimbabwe.

Box 1: Renewables, Non-renewables and the Challenge of Diversification

For countries dependent on non-renewables, the development challenge is to recover rents from usually private (often foreign) operations and invest rents to build other assets. Non-renewables by definition are unsustainable and will eventually be exhausted, but the income from these assets can be sustainable if rents are ploughed back into other assets, especially infrastructure and human capital. One example of a country managing this transition is the United Arab Emirates where major gains have been achieved thanks to investments in education over the last two decades – both in terms of higher educational attainment and better learning as witnessed by substantial progress in rankings on international assessments. Botswana is another country often cited as a prudent manager of its mineral wealth.

Non-renewables also pose difficult management challenges for many countries. These assets typically do not generate many jobs or support livelihoods, and can result in factors that hinder development associated with the ‘resource curse.’ Revenue from non-renewables can finance investments for sustainable wealth, but this requires careful macroeconomic management and strong institutions, both of which are lacking in some countries. Of 24 countries that have remained low-income since 1995, 12 are classified as resource rich, and of those, eight are also classified as fragile-conflict states.

For countries highly dependent on the renewable assets, long term growth requires maintaining or improving productivity of these natural resources and managing them sustainably. Substantial investments may be needed to improve agricultural yields, or a 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.

In most regions the land area under crops and pasture increased, especially in Latin America and Sub-Saharan Africa, but the gains in agricultural land were matched by a decrease in forest land in those regions, Latin America (-7.4%) and sub-Saharan Africa (-9.4%). There was, however, over the last two decades a gain in both the area and value of protected areas in all regions. These areas now account for 17 percent of total land area, up from 10 percent in 1995. But this was not sufficient to fully compensate for a broader loss in forest asset value.

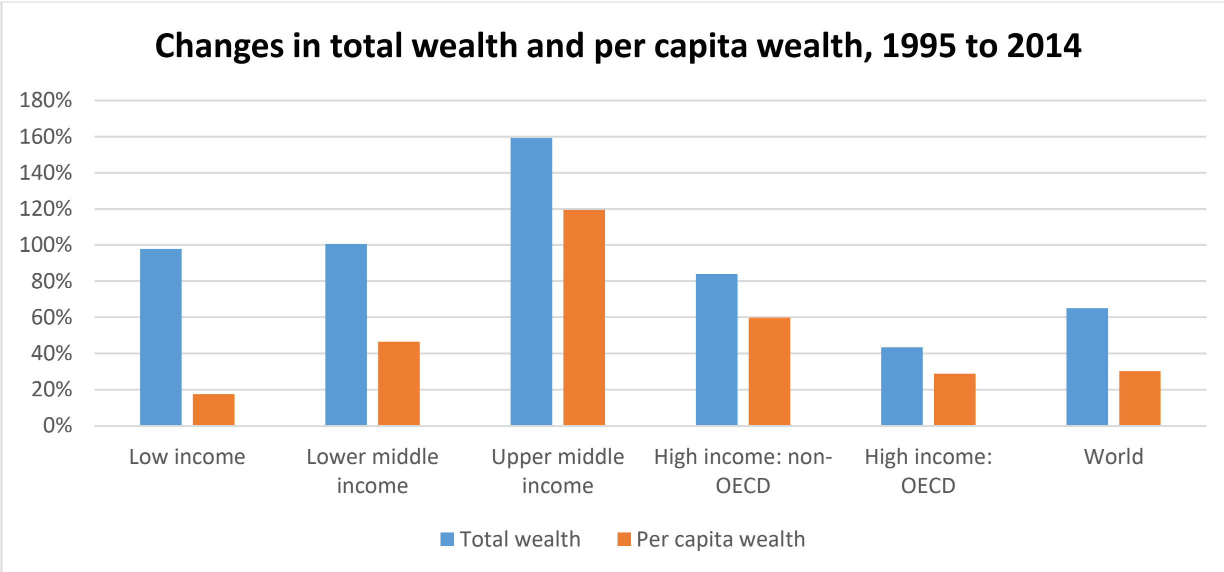
Table Land cover for forest, crops, pasture and protected area in low and middle income countries from 1995 to 2014

	Forest, total area (thousand sq km)			Cropland area (thousand sq km)			Pasture land area (thousand sq km)			Protected areas (thousand sq km)		
	1995	2014	Percent change	1995	2014	Percent change	1995	2014	Percent change	1995	2014	Percent change
East Asia & Pacific	4,082	4,360	6.8%	2,117	2,251	6.3%	5,262	5,218	-0.8%	1,944	2,440	25.5%
Europe & Central Asia	540	576	6.6%	1,290	1,174	-9.0%	2,663	2,721	2.2%	165	318	92.3%
Latin America & Caribbean	8,978	8,313	-7.4%	1,190	1,443	21.2%	3,981	4,038	1.4%	1,628	3,829	135.2%
Middle East & North Africa	74	84	13.6%	259	266	2.9%	539	543	0.8%	30	279	830.6%
South Asia	751	792	5.5%	2,140	2,137	-0.1%	189	181	-4.2%	259	296	14.3%
Sub-Saharan Africa	5,703	5,166	-9.4%	1,690	2,076	22.9%	5,833	6,005	3.0%	2,289	3,261	42.4%
All low and middle income contries	20,131	19,292	-4.2%	8,688	9,350	7.6%	18,468	18,708	1.3%	6,317	10,424	65.0%

Source: authors' estimation

Convergence in the Wealth of Nations

Is there convergence in the growth of the Wealth of Nations on a per capita basis? Said differently, are comparatively poorer countries catching up with comparatively richer ones over time? The answer depends a little bit on how we look at the data. If one considers averages that factor in population sizes as was done in table 1, so that large countries such as Nigeria, India, or China are driving the estimates, the data suggest that low income countries and to some extent even lower middle income countries are falling behind, in part due to differences in population growth. Between 1995 and 2014, global wealth grew by two thirds (65 percent), but population grew by a third, so that the net increase in per capita wealth was only 30 percent. Per capita wealth grew fastest in middle-income countries, producing their rising share of global wealth, but the largest growth in absolute terms was observed in upper-middle-income countries (at nearly 120 percent), in part due to China. Low income countries increased their total wealth by nearly 80 percent--more than high-income OECD countries or the global average--but only by eight percent on a per capita basis because population growth was highest in these countries (population increased by 69 percent from 1995 to 2014 in those countries). These trends are visualized in Figure 5, considering both total and per capita wealth.

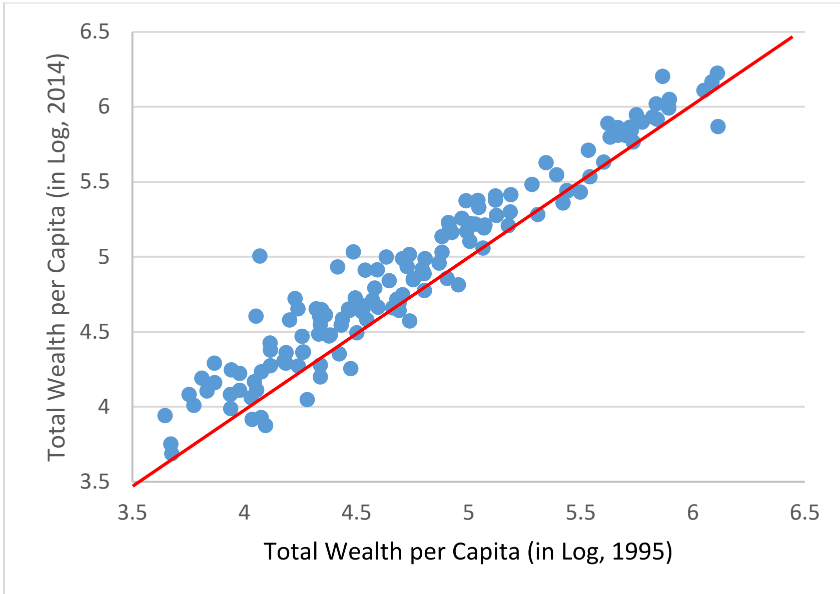


Source: Authors' estimations

However, if one weights equally all counties, the diagnostic is a bit different. considers Figure 6 displays for more than 140 countries levels of wealth per capita estimated in 1995 (on the horizontal axis) and in 2014 (on the vertical axis). Since estimates are in logarithms, the difference in 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 scatter plots provides for a simple visualization of the countries that have achieved gains in total wealth over time (above the diagonal) and those that have not (below the diagonal).

Two stylized facts emerge from Figure 6. 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 is not surprising, given that levels of wealth per capita are closely related to GDP per capita, and most countries experienced substantial economic growth over the last two decades. The second interesting fact is that the cumulative growth rates in human capital tends to be slightly higher for countries with lower levels of wealth initially. Observations for countries with lower initial levels of wealth tend to be located further away from the diagonal than for countries with higher levels of initial wealth. In other words, there appears to be some level of convergence in wealth with poorer countries catching up. Note that there is one clear outlier in the Figure with a level of wealth of per capita of about five in logarithm in 2015, versus four in 2015. This is actually not China (which also has a value of wealth per capita at about five in logarithm). That country is Iraq, with dramatic increase in natural capital wealth over the period thanks especially to fossil fuels.

Figure 6: Convergence in the Wealth of Nations per Capita, 1995 and 2014

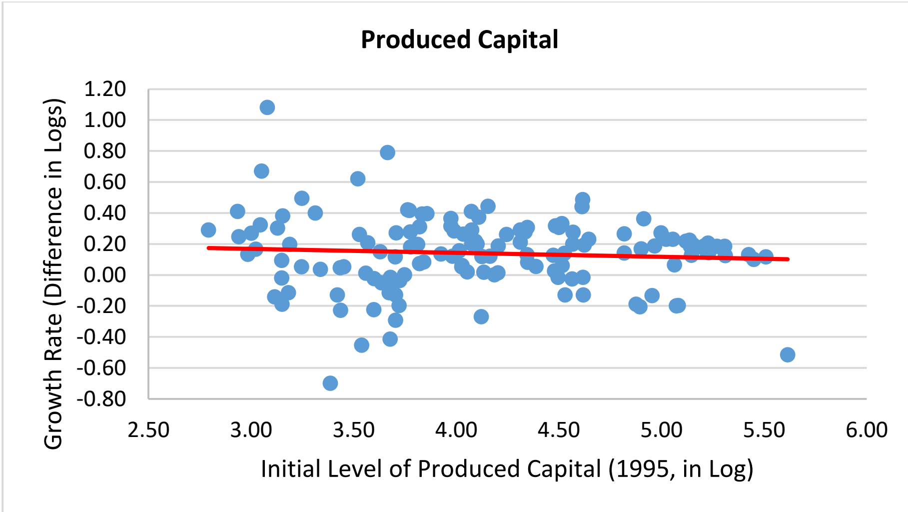


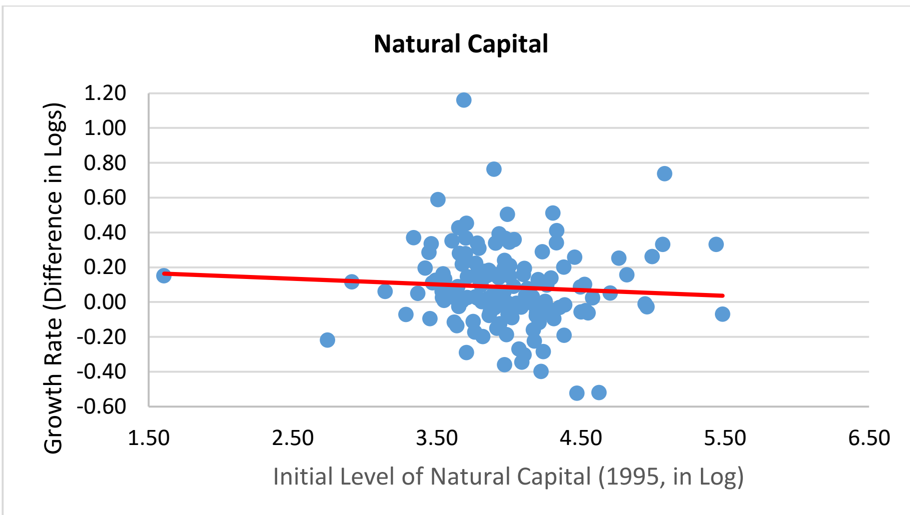
Source: Authors' estimations

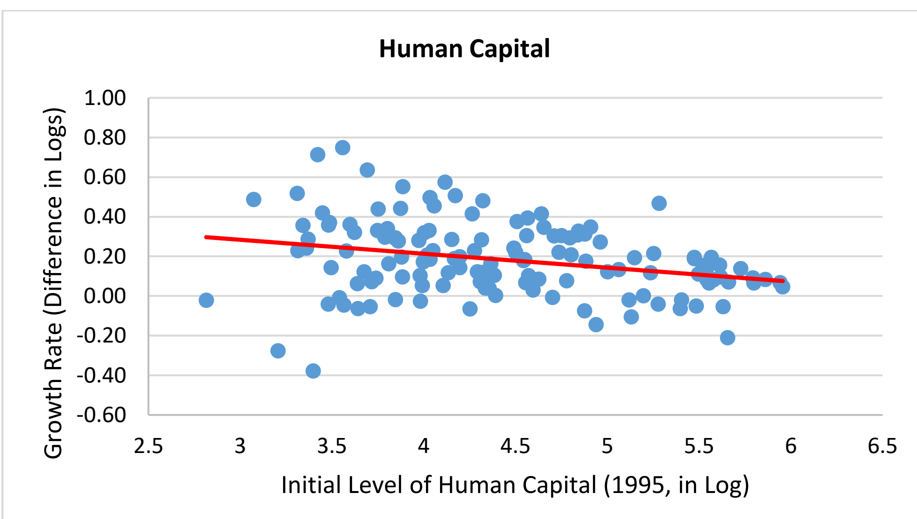
Since total wealth is estimated as the sum of produced, natural, and human capital (plus net foreign assets), we can look at all three main sources of wealth to assess which source appears to be responsible for the convergence observed in Figure 6. In Figure 7, initial levels of wealth (in logarithm) are displayed on the horizontal axes for all three types of capital. The vertical axis represents growth rates for each type of capital as approximated by the difference in values (in logarithm) between 1995 and 2014. There is clear declining slope for the regression line across the scatter plot for human capital, while this is less the case for produced and natural capital. This suggests that much of the convergence in wealth over the last two decades is due to human capital, which is not too surprising given massive investments to improve education and health outcomes in those countries, for example through the Education for All (EFA) initiative in the case of education. 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 done 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 for assessing convergence wealth per capita, as illustrated in chapter 7 of this volume by Nayihouba and Wodon (2017) for growth in human capital wealth per capita. Although not shown here due to space constraints, regression analysis suggests convergence in total wealth per capita between countries from 1995 to 2014. While this is encouraging, it must be noted that it will still take a very long time for poorer countries to catch up with richer ones.

Figure 7: Growth in the Main Components of the Wealth of Nations, 1995-2014



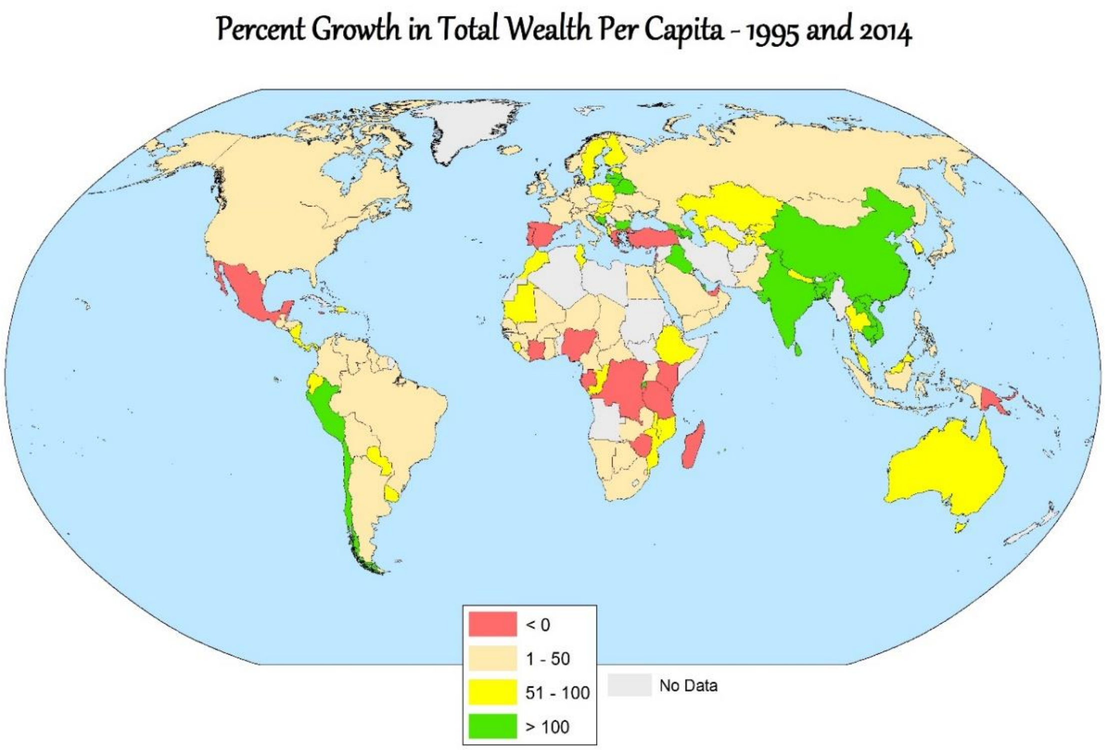




Source: Authors' estimations

The fact that there was some convergence in per capita wealth globally over the last two decades does not mean that all countries with lower initial endowments are catching up. In Figure 6, most countries have experienced an increase in wealth between 1995 and 2014, with often larger gains for initially less well-endowed countries. But there are also quite a few countries that lost ground, typically (but not always) because of a conflict or other shock. Figure 8 visualizes in map format the growth in per capita wealth over the last two decades in the various countries. In three regions—East Asia, South Asia and Latin America and the Caribbean, per capita wealth increased in all countries except Papua New Guinea (East Asia) and Mexico (Latin America). In Mexico, per capita wealth peaked in 2005, but declined thereafter due in part to losses in human capital for which additional work is needed to better understand the causes. The story for the other regions is one of mixed successes. In Africa's strong regional economies like South Africa, per capita wealth increased across all assets, but in some of the most populous countries, such as Nigeria, the Democratic Republic of Congo and Tanzania, gains in wealth did not keep pace with population growth and per capita wealth declined. The story is similar for parts of Europe and Central Asia, for example with losses in per capita wealth in Turkey, Greece, Spain and Portugal probably due in part to the great recession. In the Middle East and North Africa, most countries maintained or increased per capita wealth.

Figure 8



Source: Authors' calculations

Regional Analysis of Low and Middle Income Countries

The map in Figure 8 is a good way to transition to a discussion of trends by region. In this discussion we look closely at trends in the 97 low and middle income countries in our dataset and exclude the 44 high income countries, which are structurally different. We focus here on levels of wealth per capita, since these are better indicators of development than aggregate values. As shown in table 2 and Figure 9, when considering regions, the biggest story – not surprisingly, is the rapid growth observed in East Asia and the Pacific and South Asia, in part due to the role played by China. Most other regions also benefited from gains in wealth per capita, but in sub-Saharan Africa per capita wealth fell by three percent due to declines in some of the largest countries (including Nigeria and Democratic Republic of Congo), as shown in Figure 7 earlier.

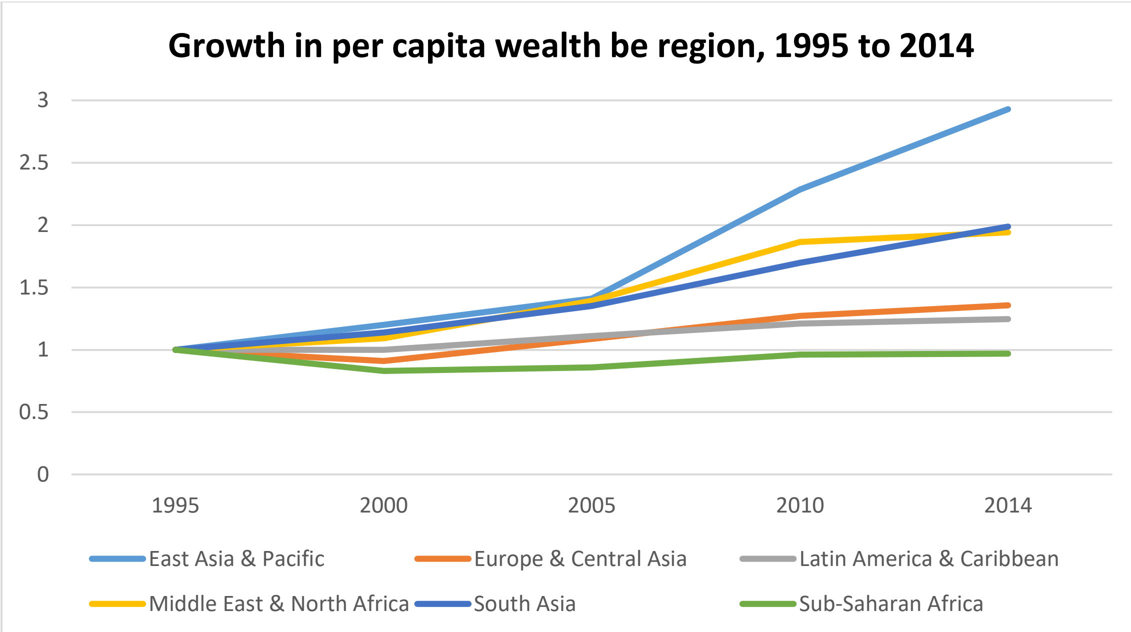
What about the trends by region and asset class? Figure 10 shows that the share of human capital in total wealth declined in East Asia, probably in large part due to aging of the labor force. In sub-Saharan Africa, the share of natural capital declined, in part due to a decline in the value of agricultural land, but also because of investments in education and population growth that also leads 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.

Table 2: Trends in Wealth Per Capita in Low/Middle Income Countries by Regions, 1995-2014

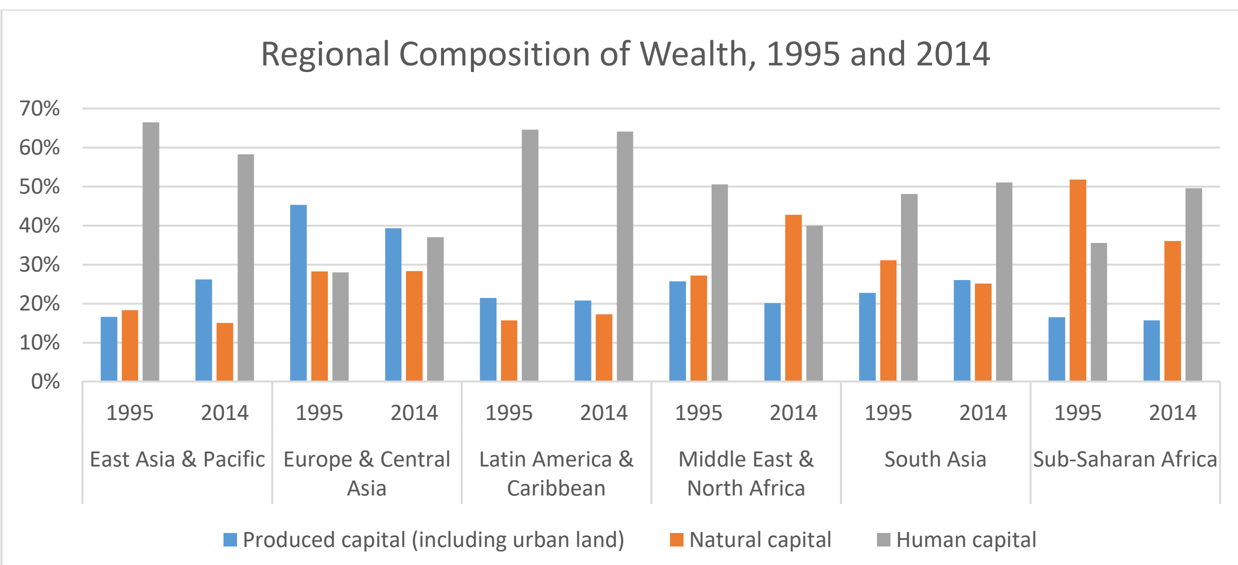
	1995	**2000**	**2005**	**2010**	**2014**	Annual growth
East Asia & Pacific	31,261	37,507	44,097	71,423	91,581	5.8%
Europe & Central Asia	51,967	47,276	56,494	66,066	70,530	1.6%
Latin America & Caribbean	112,849	112,977	125,448	136,665	140,663	1.2%
Middle East & North Africa	24,973	27,263	34,790	46,548	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	33,121	34,978	39,731	52,645	60,817	3.3%

Note: Only 97 low and middle income countries are included.

Source: Authors’ estimation.



Note: Only 110 low and middle income countries are included
Source: Authors' estimations



Note: Only 110 low and middle income countries are included
Source: Authors' estimations

Savings and Changes in National Wealth

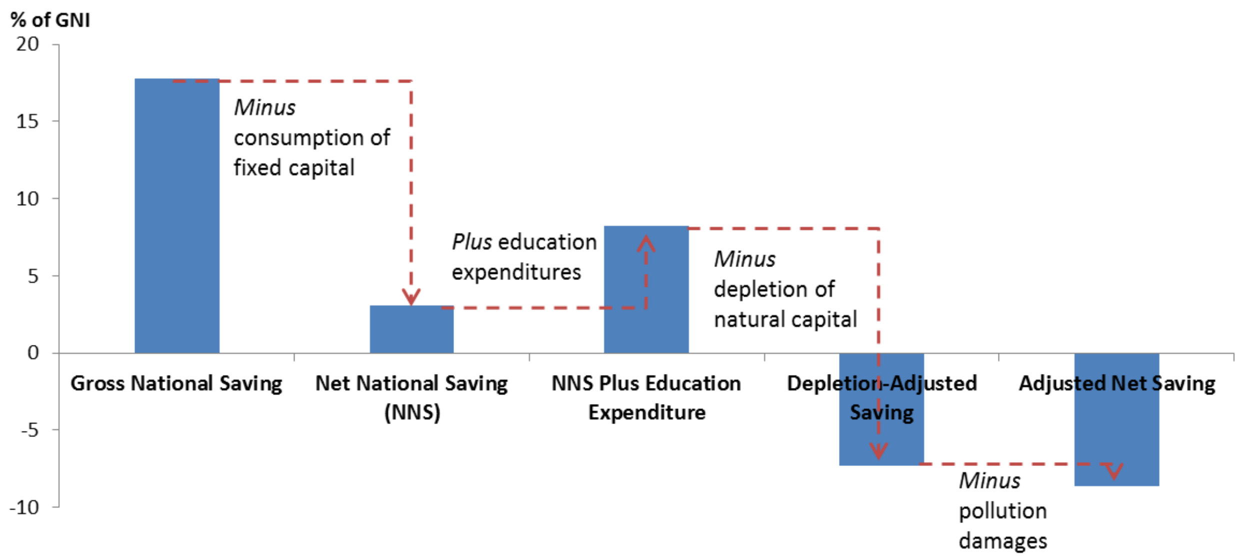
The key to increasing standards of living lies in building national wealth, which requires savings to finance this investment, as well as good institutions and governance to make productive use of assets.   We have looked at comprehensive wealth between 1995 and 2014; we now examine some of the dynamics that drive the 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 savings 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 point in time and can be used to monitor whether per capita wealth is maintained over time, a criterion for sustainable, long term growth. ANS doesn't show how *per capita* wealth is changing, but does provide a complementary indicator to help us look more deeply into 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 deforestation, air pollution damages to human health; and credited for education expenditures (see Figure 11). Conceptually, ANS differs from changes in wealth over time because it does not include exogenous impacts on wealth from i) changes in prices that can be substantial for natural resources; ii) it new discoveries of energy and mineral resources; or iii) other exogenous impacts such as the impact on produced and human capital of natural disasters, civil unrest, or other factors. Due to a lack of data, our current measure of ANS is also missing changes in agricultural land, an important asset. Other missing capital are common to both Comprehensive wealth and ANS, notably, water and fisheries. Current measures of ANS are not based on changes in the value of human capital as measured in this report (instead, they are based on expenditure data from public spending on education). Still, while ANS does not correspond completely to changes in wealth, it is a complementary indicator that is helpful to look in more details 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 percent 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 wellbeing. By breaking down the components of ANS, it is 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 longer lifetime and improved resilience to reduce depreciation of fixed capital, increasing investment in education and innovation to increase human capital, optimize use of natural capital (sustainable use of renewables and efficient extraction of non-renewables), or improving air quality to reduce pollution damage costs.

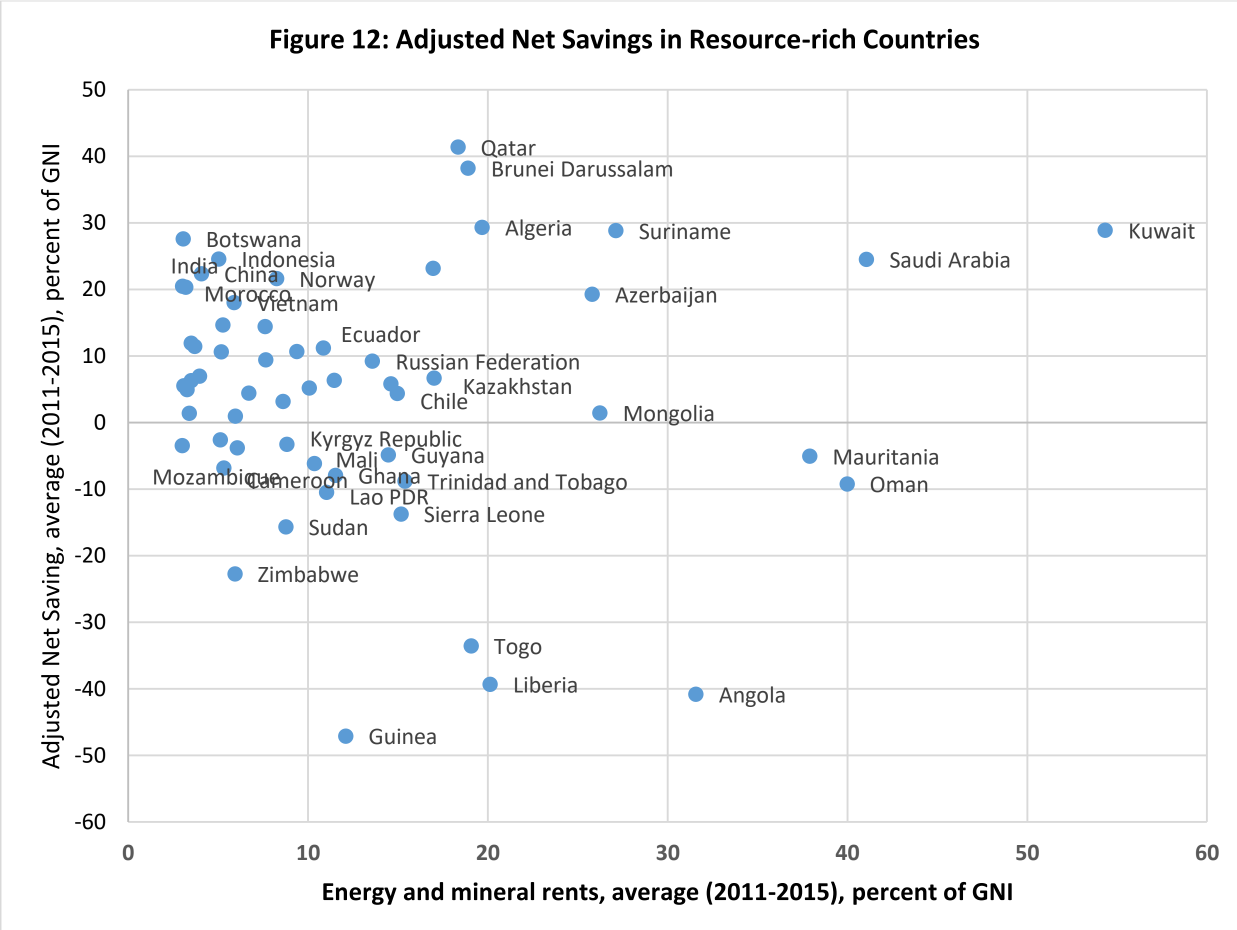
Figure 11: Procedure for Estimating Adjusted Net Saving



Source: Authors

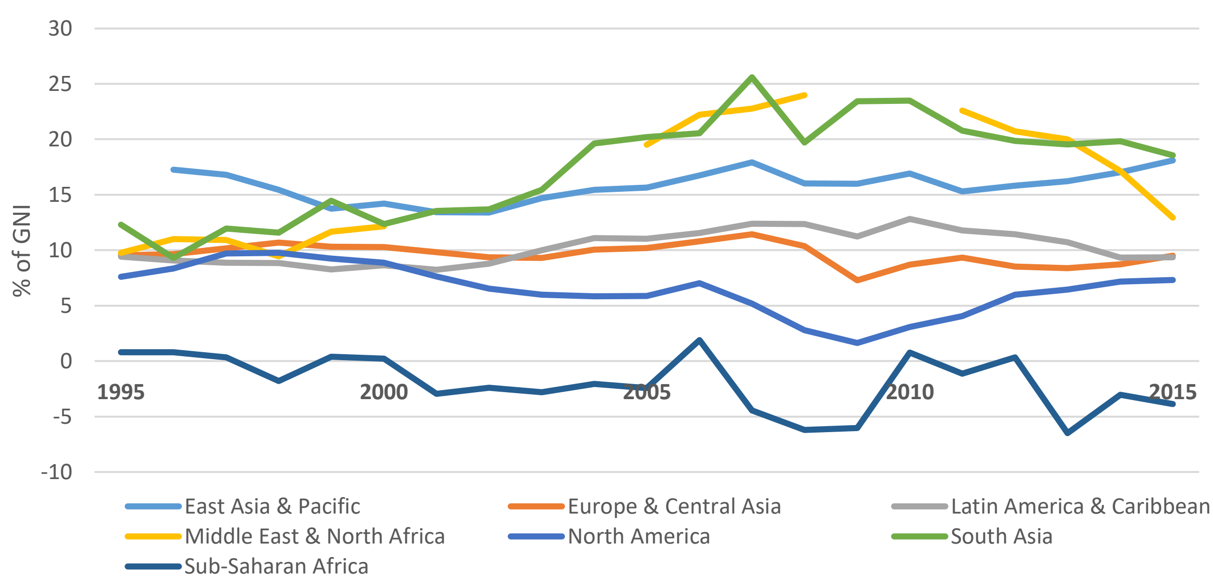
ANS can be a particularly useful indicator for resource rich countries where, as mentioned earlier (Box 1), transforming non-renewable natural capital into other forms of wealth is a major development challenge. Figures 12 plots countries in terms of the importance of resource rents in Gross National Income (on the horizontal axis) and ANS (on the vertical axis). In many countries, mineral depletion is offset by investment in other types of capital. But in countries with negative ANS, such as Angola and Guyana, natural capital is being depleted without being replacing, suggesting that these countries may be becoming poorer over time.

Looking at the regional trends in ANS over the past two decades in Figure 13, a divergence is clearly observed starting in the early 2000s. Average ANS in East Asia and South Asia showed strong gains, while other regions like Europe and Central Asia, Latin America and Caribbean, and North America remained relatively stagnant. Sub-Saharan Africa stands out among the regions, 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 last decade), suggesting that its development policies are not yet promoting sustainable economic growth sufficiently. Recall also that this was the only region with a decline in per capita wealth in our earlier analysis. A more detailed breakdown of trends in ANS for the various regions is provided in an annex.



Source: Authors' estimations

Figure 13: Adjusted Net Saving by Region, 1995-2015



Summing up

This chapter has provided a simple analysis of trends in the Wealth of Nations over the last two decades. Three main components of that wealth have been 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 among middle-income and high-income cuontries, 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, in that sub-Saharan Africa as a whole has been affected by a decline in total wealth per capita due to losses in a few large countries, as well as high rates of population growth in most countries that dilute the impact of 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 the country's natural capital. This will require substantial investments, especially in human capital.

This study is the first to provide measures of human capital wealth for more than 140 countries. One of the lessons from the analysis carried in this chapter is the rising importance of human capital wealth. While in upper middle and high income countries human capital wealth has decreased slightly as a share of total wealth in part due to ageing and stagnating wages, it has been rapidly rising as a share of total wealth in low and lower-middle income countries.

Overall, because this chapter covers a broad terrain, the analysis has remained fairly descriptive. Only broad trends have been discussed in order to set the stage for other contributions in the book. Many of these subsequent chapters in this volume are more analytical and focused on the importance of specific policies to boost the Wealth of Nations. It is hoped though that this chapter will have provided important 'big picture' stylized facts.

References

To be added.

Annex. Countries classified as low-income in 1995 and in 2014

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 gross national income (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 on 1995, but only 28 were so classified in 2014. For this book we use the country classifications for 2014 for the 141 countries in our dataset; the distribution is shown in Table A1.

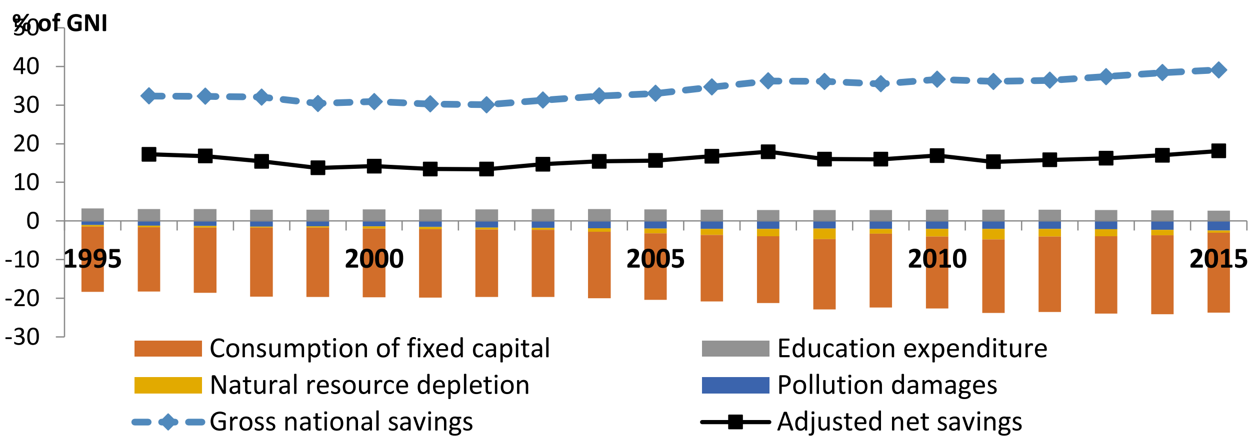
Table A1. Number of countries in the wealth accounting database by region and income group

Aggregate Group	Low income	Lower middle income	Upper middle income	High income: non-OECD	High income: OECD	Total
East Asia & Pacific	1	6	4	1	3	**15**
Europe & Central Asia		6	10	4	23	**43**
Latin America & Caribbean	1	6	12	3	1	**23**
Middle East & 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**

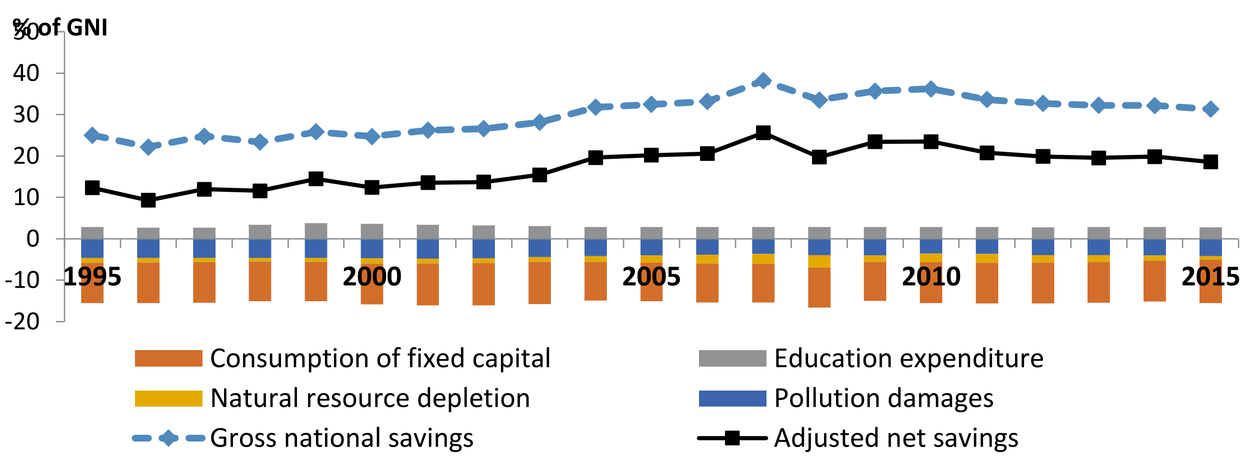
Annex: Regional Trends in Adjusted Net Saving

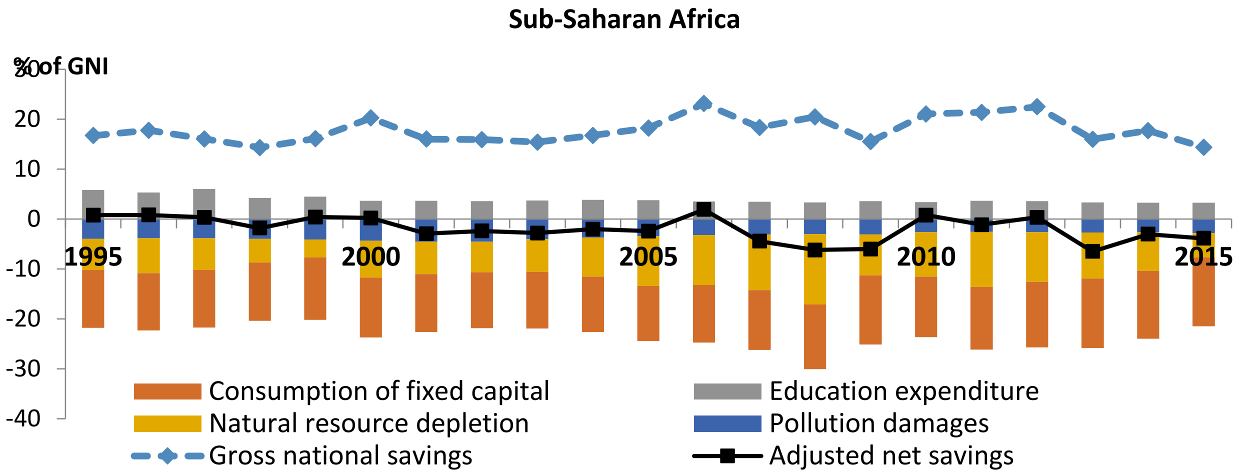
This annex provides a more detailed breakdown of the components underlying ANS calculations for selected regions over time. East Asia and the Pacific as well as South Asia sustained consistently high levels of gross saving, averaging 37 and 34 percent of GNI, respectively. Among the components of ANS, East Asia had much higher depreciation of fixed capital (due to its larger stock of produced capital) while South Asia had higher pollution damages. The net result is higher average ANs in South Asia (21 percent of GNI) compared with East Asia & Pacific (17 percent of GNI). In contrast, sub-Saharan Africa's gross saving averaged a much lower 19 percent of GNI over the last ten years. With a low starting point of 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 education have 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.

East Asia and Pacific

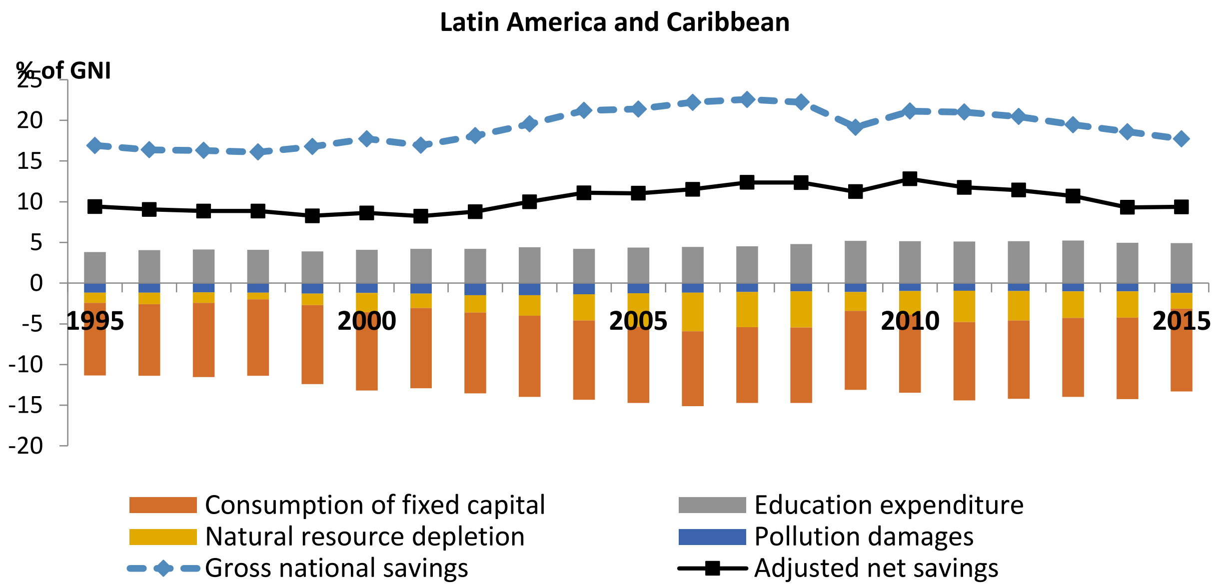


South Asia





Sub-Saharan Africa
% of GNI
30
20
10
0
-10
-20
-30
-40
1995
2000
2005
2010
2015
Consumption of fixed capital
Education expenditure
Natural resource depletion
Pollution damages
Gross national savings
Adjusted net savings



Latin America and Caribbean
% of GNI
25
20
15
10
5
0
-5
-10
-15
-20
1995
2000
2005
2010
2015
Consumption of fixed capital
Education expenditure
Natural resource depletion
Pollution damages
Gross national savings
Adjusted net savings

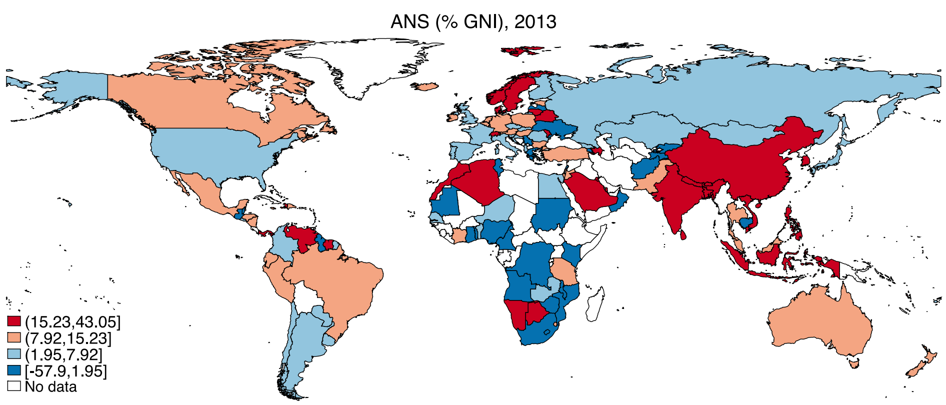
Chapter 3: From Adjusted Net Savings to the Underpinnings of Development: A Snapshot of Resource Rich Economies in Africa

Kevin Carey and Hania Sahnoun

This chapter discusses preliminary estimates of adjusted net savings (ANS) of resource rich countries in the context of development policies in sub-Saharan Africa (SSA). ANS can be a particularly useful indicator for resource rich countries where transforming non-renewable natural capital into other forms of wealth is a major development challenge. As chapter 5 notes, fossil fuel subsoil asset stock is depletable meaning that countries face a need to replace the depleting asset with alternative productive assets such as human or physical capital in the long term.

Adjusted Net (or genuine) Saving (ANS) is defined as gross national savings adjusted for the many of the annual changes in the volume of all forms of capital.[6] (Figure 1). It is one of a battery of indicators of sustainability, allowing us to delve into the process of building national wealth across many forms of capital and how policy might influence each part of the process. ANS provides a lower bound warning indicator showing whether a country is consuming more wealth than it is adding.[7]

Figure 1: Adjusted Net savings as percent of GNI in 2013



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[6] Taking the sum of financial savings and investments in education, and subtracting the market value of natural resources used up and the capital that has been depreciated through use computes what is defined as the "adjusted net savings" (ANS) of a country.

[7] It is worth noting that ANS (a flow measure) differs from changes in wealth over time because it does not include exogenous impacts on wealth from a) changes in prices that can be substantial for natural resource (which is the case for many SSA countries); b) new discoveries of energy and mineral resources (Ghana etc.); or c) other exogenous impacts such as the impact on produced and human capital of natural disasters, civil unrest, or other factors. Due to a lack of data, our current measure of ANS is also missing changes in agricultural land, an important asset. Other missing capital are common to both Comprehensive wealth and ANS, notably, water and fisheries. Current measures of ANS are not based on changes in the value of human capital as measured in this report (instead, they are based on expenditure data from public spending on education).

One caveat when using ANS to estimate the sustainability of an economy is that since ANS is a flow-based indicator, it essentially excludes capital gains. Also, since resource discoveries may often be larger than GDP, both Gross National Saving and ANS do not include the whole discovery as part of saving at the time it is made – but embeds the effect of the discovery outcomes in future income increases as well as an associated decrease in the depletion share of total rent. There are also data issues that preclude a full reconciliation of the flow (ANS) and the stock (total capital). Informational shortcomings provide some explanation for countries showing negative ANS but positive change in wealth that indeed highlight areas of future research and improvements. One informational issue is that the ANS measure does not currently account for any changes in agricultural land, whether improvements (e.g., better land management, increasing yields with fertilizers) or land degradation. Finally, human capital formation in ANS is not fully aligned with the current wealth accounts in the CWON dataset. Current public expenditure on education (the human capital proxy in ANS) is likely underestimating the change in human capital when compared to the total wealth measure.

Sustainability of fiscal policies: are resource rich countries consuming more of the earnings from natural resources than they invested?

The new *Changing Wealth of Nations* (CWON) data appears at a time of high volatility in financial and commodity markets. For financial markets, this volatility has persisted since the global financial crisis of 2008, and has been characterized in particular by extremely low "risk-free" interest rates. Commodity prices have seen varied patterns, but for hydrocarbon wealth, the key features have been elevated oil prices during 2010-2014, followed by several waves of decline. At the same time, concerns about the impact of climate change have increased, culminating in the first global agreement containing specific targets set in the Paris COP21 agreement.

For low and middle- income countries, which had linked their development aspirations to natural resources (Figure 2), the signals sent by these developments have been discouraging. But countries can still improve their policy frameworks to manage revenue volatility and embed the principle of converting resource rents into productive assets. Countries whose portfolio are currently heavy on natural resources (especially renewables) will continue to rely on these subsoil assets to develop their policy objectives. But there is a growing evidence base on informing the design of strategic development paths enabled, but not dominated, by natural resources.

For the purposes of the subsequent discussion, we draw on one such contribution (Van Eeghen et al, 2014).[8] This report shows that sustainable, shared prosperity is closely associated with

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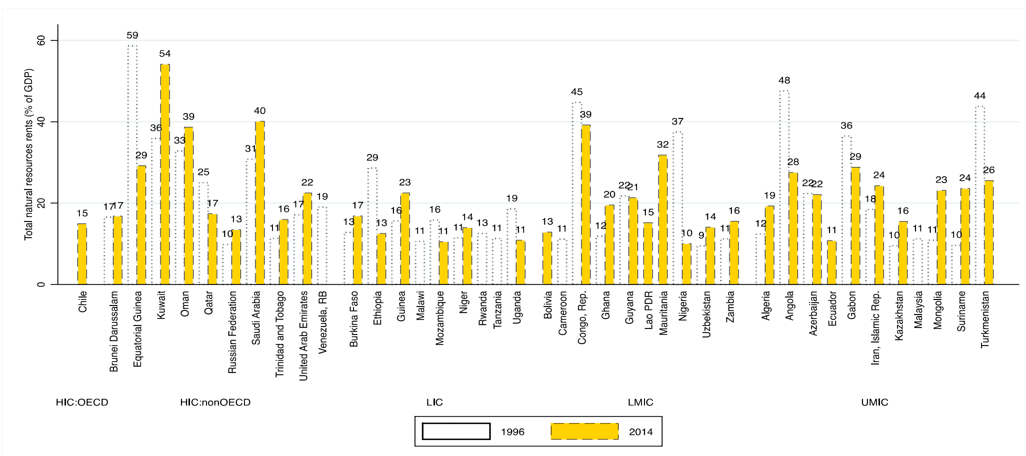
[8] Van Eeghen, M. Willem; Gill, Indermit S.; Izvorski, Ivailo V.; De Rosa, Donato. 2014. Diversified development : making the most of natural resources in Eurasia. Europe and Central Asia Studies. Washington, DC ; World Bank

having a balanced portfolio of assets: natural resources, human capital, and built capital. Achievement of this balanced portfolio is linked to intangible, but measurable, institutional capabilities in three critical areas: fiscal policy that is adapted to the volatility and rent flows from natural assets, effective delivery of social services (education and health), and a business environment conducive to competition, contestability, and new investment. Certainly, faced with sharp declines in revenues and a lack of buffers, some policymakers may have little flexibility in the short-term to embark upon such an approach if it was not there already. But some space may be available, whether through subsidy reform, domestic revenue mobilization, or prudent deficit financing to catch up on this agenda. For example, a fiscal rule could direct new fiscal space (whether from resource revenues or cuts in recurrent spending) into investments in physical and human capital, establishing the practice of investing new resources for sustainable development gains. Strengthening service delivery and the business climate may also seem more challenging when commodity prices (and thus fiscal revenues) are lower, but equally, the tighter revenue constraint may provide an impetus for improved performance in these areas.

Figure 2: Countries with total natural resource rents over 10 percent of GDP in 1996 and 2014, as per data availability (excludes fragile countries)



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

At a non-technical level, two macroeconomic criteria allow us to evaluate natural resource revenue management: First, was pro-cyclicality avoided? In other words, was the country able to avoid the volatility in resource rents being transmitted to the rest of the economy? Second, was the increase in the level of government spending financed by natural resources beyond the sustainable income flow from natural resources? Underlying these criteria is the deeper

Group. http://documents.worldbank.org/curated/en/2014/01/19157210/diversified-development-making-most-natural-resources-eurasia principle that resource revenues should be converted into capital, which will provide the foundation to sustain per capita income at a higher level following the development of natural 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, as fiscal rules do. Fiscal rules and resource funds only coincide in cases of "financing" funds – these are funds that are linked to implementation of a fiscal rule. The fund receives all resource revenue, and finances the budget's non-resource deficit by way of a reverse transfer. The objective is to finance the budget: the fund accumulates budget surpluses and finances budget deficits. Chile, Norway, and Timor-Leste funds are closest to this framework, as is Ghana's fund – on paper. For many resource rich countries, resource funds have been accumulating financial assets even as the overall stance of fiscal policy has depleted national assets.

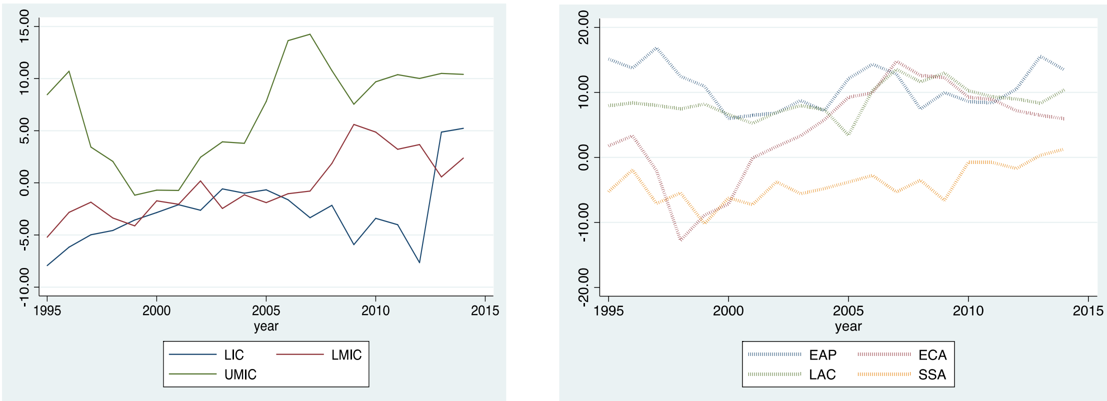
It is also important to think about time consistency. If a fiscal rule or operational rule requires some specific corrective action in the future, will that action actually be carried out when that time arrives? The credibility of any rule depends on some meaningful space to adjust as the rule becomes 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 like capital investment and maintenance. Most evidence on sustainable fiscal consolidations suggest that the space has to come from public sector compensation and non-contributory transfers and subsidies. If these can't be cut, any rule will not be time consistent.

Trends in ANS for selected resource rich Sub Saharan economies:

ANS was on average negative for SSA over the 1995-2014 period except for Botswana, Namibia and South Africa. The annual average over the period in SSA is largely negative because of 2 countries with large negative ANS in SSA (Angola, Republic of Congo). Upper middle-income countries have seen their ANS increase between 1995 and 2008 except for Angola. ANS levels are on average negative in resource rich low income and low middle-income economies but are however trending upwards. ANS seemed to have improved for LIC and UMIC as global demand for commodities resumed (recalling that oil prices peaked in 2014).

Many SSA governments have underperformed in terms of converting revenues into built capital. Between 1995 and 2010 the adjusted net savings rate in non-high income SSA's resource-rich economies was a negative 4 percent, the lowest over the period for similar countries. This is much lower than the 11 and almost 9 percent saving rates in resource-rich East Asia and Latin America economies respectively or less than the 4 percent saving rate in Europe Central Asia. In other words, the recent trend suggests that SSA countries may have consumed a significant amount of the earnings from natural resources than they are investing.

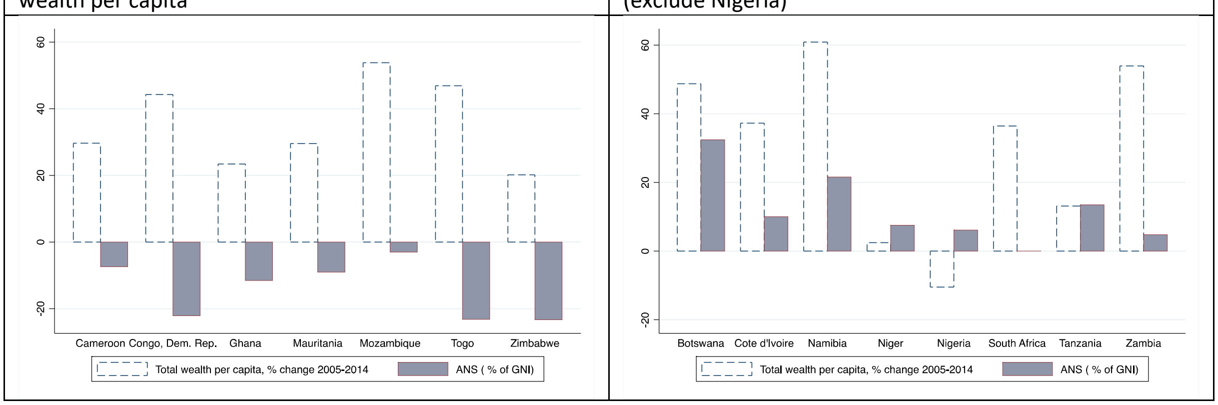
Figure 3: Trends in ANS (percent of GNI) in resource rich countries (excluding High income and fragile countries) –simple average



The preliminary estimates of SSA's ANS suggest a contrasted story within the group of resource rich countries in Sub Saharan Africa[9] between depletion adjusted net savers and net dis-savers. The countries with negative ANS suggest that the fiscal policies of the last decade (2005-2014) were not sustainable. Overall public sector net worth and a country's total wealth could start declining at a faster pace leading to potential public sector insolvency (unless fiscal performance is strengthened/improved) and declining wealth per capita in the long run. As noted earlier, the contradictory trends between positive change in total wealth per capita and negative ANS (Figure 4, the figure includes fragile countries such as Congo, Togo Cote d'Ivoire and Zimbabwe) should take into account the possible underestimation of human capital in the ANS measures. This is investigated further in below for the case of Ghana.

Figure 4: Depletion-adjusted savings in SSA resource rich countries, 2014 and percent change in total wealth per capita, 2005-2014

Negative ANS in 2013-2014 and positive change in total wealth per capita	Positive ANS and positive change in total wealth per capita (exclude Nigeria)



[9] For the purpose of this round of analysis, economies classified as FCS are not included.

Public spending pressures

Public spending pressures are prevalent in many resource-rich countries. Typically, greater resource revenue can create a deficit bias and reduce public savings. Spending pressures manifest themselves through, for instance, energy subsidies (Figure 7), unproductive public sector jobs, and higher public sector wages. Most energy subsidies are not only inefficient but also regressive in countries where the not so wealthy do not own cars or do not consume or have electricity.

Public sector employment is large in resource rich SSA. 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[10].

Figure 5: IEA subsidies as share of GDP and total natural resource rents, 2014, Percent of GDP

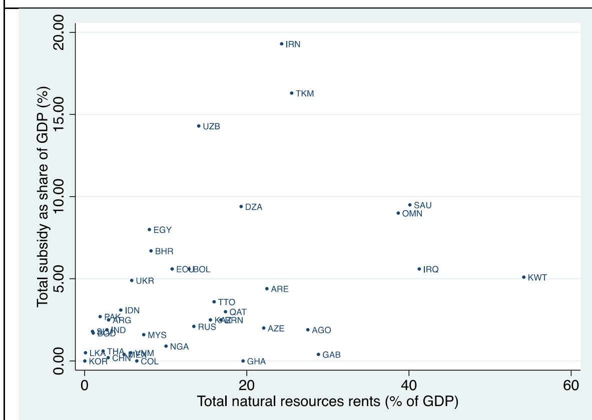


Figure 6: Resource rich countries and Public spending on education and health

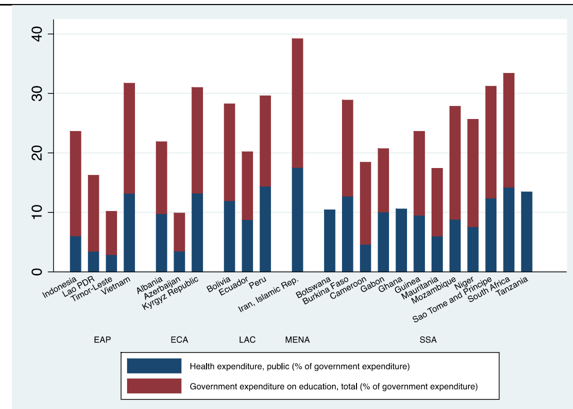


Figure 7: ANS and compensation of employees.

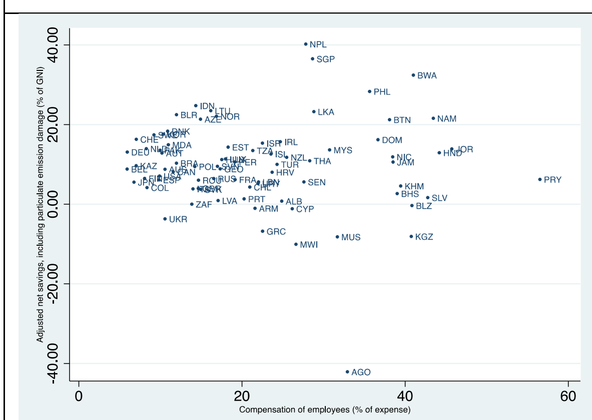
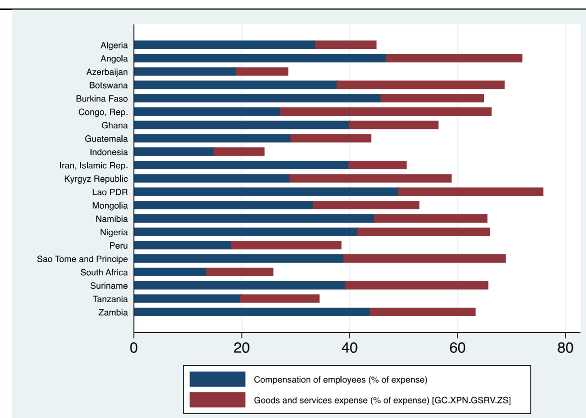


Figure 8: Government consumption in 2009, selected resource rich economies

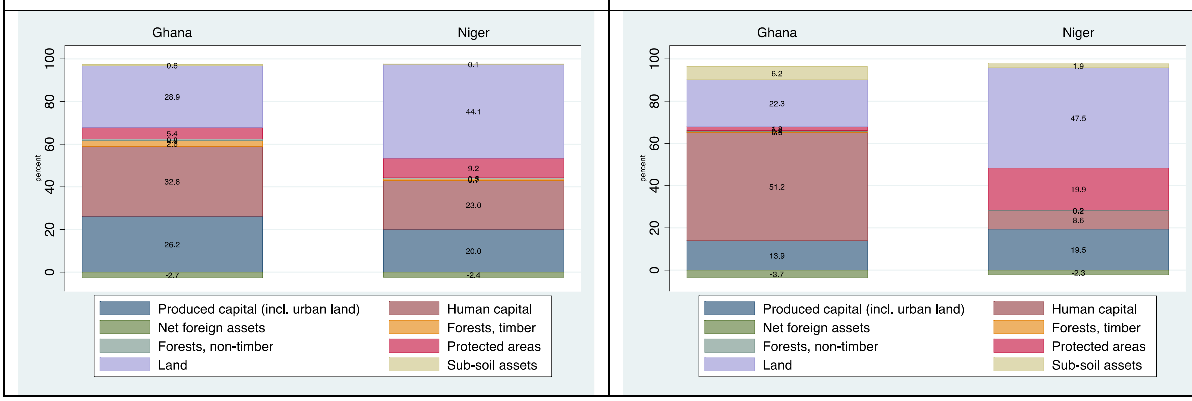


Savings trends and related policy issues in resource rich sub Saharan Africa through the lens of two countries

In the remainder of this chapter, we focus on the changing wealth of two nations: Ghana and Niger. These countries were selected on the basis of having fairly complete wealth of nations data (Figures 9 and 10) while presenting diverse contexts in terms of their natural resource base, other constraints, and recent conduct of fiscal policy. As will be seen, they bring out the very different role that human capital plays in national wealth depending on the broader growth and governance environment.

Figure 9: An increase in the share of subsoil assets for both Ghana and Niger but human capital drives the positive change in wealth in Ghana while for Niger it is natural capital.

1995 | *2014*



Resource rich Ghana: Oil, Gold and Cocoa - more oil, more *(capital)* consumption

Even before oil production began in 2011[11], and increasingly thereafter, Ghana found itself facing issues typical of middle-income and low-income natural resource rich countries. Between 2005 and 2014, Ghana saw its total wealth increase by 23.4 percent (or 2.4 percent annually). Human capital was the main source of new wealth as Ghana grew from 1995 to 2014 (Table 1). Natural capital also increased as a share of wealth between 1995 and 2014 (Figure 9).

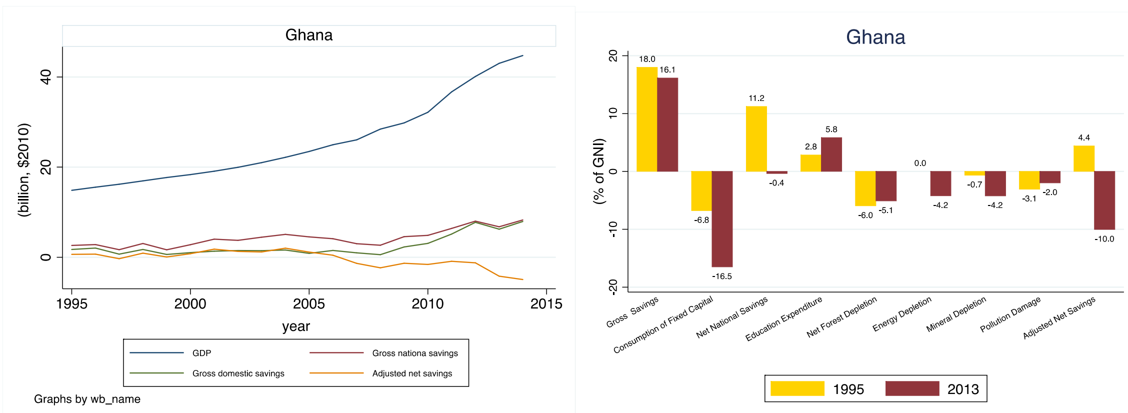
Table 1: Ghana, Wealth per Capita, 2005-2014, $2014

year	status	Total wealth	Produced capital	Land	Energy	Minerals	Total natural capital	Human capital	NFA
2005	LIC	20,292.7	5,029.0	7,144.5	4.9	184.7	8,079.8	7,776.8	-592.8
2010	LIC	18,991.5	2,890.2	4,585.8	7.0	599.0	5,760.5	10,922.2	-581.5
2014	LMIC	25,044.2	3,768.0	6,022.1	731.8	941.3	8,418.1	13,852.9	-994.8
% change 2005-2014		23.4	-25.1	-15.7	14887.20	409.7	4.2	78.1	67.8

[11] Ghana's discovery of oil in 2007

However, the preliminary estimates of ANS confirm the stresses on sustainability even in the midst of strong GDP growth (GDP tripled in real terms 1995-2014). But adjusted net saving in Ghana 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 savings failed to offset consumption of fixed capital and resource depletion (specifically land) over the whole period (Figure 10).

Figure 10: Trends in real GDP, domestic and national savings, and depletion adjusted net national saving



ANS was already rather low in per capita terms between 1995 and 2005, but it shrank and turned to a negative $189 in 2014 (

Table 2). This is also illustrated in the decline of ANS as a percentage of GNI (gross national income) from 5 percent in 2005 to a negative 12 percent in 2014 (Figure 10). Saving effort, measured in net terms, has declined, and when considering population growth, the decline is even more severe. The existing capital stock has thus to be shared with a new population cohort, a form of wealth dilution. This effect is captured in the measure of 'dilution per capita' in

Table 2.

Subtracting dilution from ANS per capita yields population-adjusted net saving (PANS) per capita, which is a key indicator of likely future wellbeing per capita. In Ghana, PANS per capita did not materialize. The combined effects of falling saving effort, as measured by ANS, and rising population growth reveals a marked deceleration of wealth creation per person, from -41 percent of total wealth per capita in 2010 to almost -50 percent in 2014. This has also consequences for the speed with which Ghana can hope to reach high-income country status.

Reversing the recent trend requires a renewed focus on increasing saving effort and associated investments as well as compressing spending pressures generated between 2006 and 2014.

Table 2: Decomposition of Ghana's population-adjusted net saving per capita, 2005-2014.

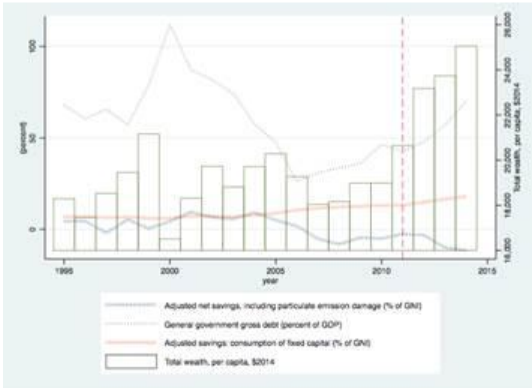
Ghana	1995	2000	2005	2010	2013	2014
Population growth rate	2.55	2.37	2.6	2.52	2.4	2.35
ANS/cap	39.5	42.3	55.6	-67.7	-164.3	-188.6
Dilution/capita	466.1	391.1	527.7	478.1	569.2	588.6
NWC/capita	-426.6	-348.8	-472.1	-545.8	-733.5	-777.2
ANS % of GNI	4.4	4.4	5.0	-5.1	-10.1	-11.6
NWC/cap % of GNI/cap				-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 in $2010	14.9	18.4	23.5	32.2	43.0	44.8

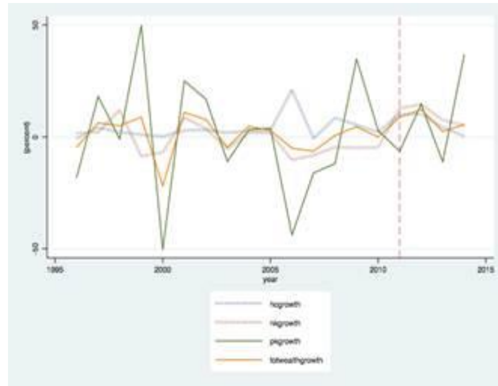
NWC=Net Wealth Creation (update table to PANS=population-adjusted net saving)

Augmenting the ANS perspective with Human Capital

As noted earlier ANS excludes capital gains and new discoveries. But it may also underestimate human capital formation. Taking the data in Figure 11, the first panel plots total wealth on the right axis with the debt to GDP ratio as well as depletion adjusted savings to GNI and consumption of fixed capital to GNI. The red vertical line is 2011 when Ghana started producing oil. The data suggests that negative ANS is mostly due to consumption of fixed capital. This would indicate that public sector capital stock on the balance sheet is contracting. At the same time, the second panel and plot percent changes of wealth per capita. The second panel of Figure 11 shows year on year growth rates over the 1995-2014 period, while Table 1 shows the percent change of per capita wealth by assets between 2005 and 2014. The trend shows that human capital is driving total wealth, increasing by almost 80 percent between 2005 and 2014. Produced capital has also increased in the last years.

Figure 11: Ghana: Total wealth per capita, debt, ANS and consumption of fixed capital- YOY change in total wealth per capita





The focus for resource rich countries is to offset the depletion of their natural resources by investing in produced capital—primarily infrastructure and human capital to preserve and accumulate wealth and build strong foundations for economic growth. But notwithstanding the new oil revenues and the massive increase in the debt stock, capital expenditure as a percentage of GDP has actually been on the decline in Ghana. From an average of 12.0 percent of GDP between 2004-2008, with the lowest level over this period being 9.1 percent in the 2008 election year, capital expenditure declined to 4.8 percent by 2011

Yet Ghana until very recently achieved high and sustained growth and impressive poverty reduction. The country's economic growth rate has consistently outperformed that of its African peers since the early 1990s and has further accelerated in the past decade, bringing the country into lower-middle-income status. Growth and job creation were accompanied by rapid urbanization and a gradual structural transformation of Ghana's economy, as agricultural work has largely given way to services jobs and to a lesser degree, to industry. Since 1991, the populations of the two major cities, Accra and Kumasi, have more than doubled, gaining over 2.4 million inhabitants. Secondary cities also expanded significantly. There are now more people living in urban areas than rural ones, and the urban population is expected to rise from slightly more than 50 percent to 70 percent of the total population by 2050 (UN 2014). The share of agriculture in value added and employment fell from 36 percent and 61 percent in 1991, to 24 percent and 43 percent, respectively, in 2012, while the share of services expanded from 36 percent to 48 percent between 1991 and 2005, and then remained constant. [12]

Ghana's story is thus not one of reduced growth resulting from external shocks[13]. The electoral races of 2008 and 2012, amid expected or newly available oil revenues, generated a situation

[12] https://elibrary.worldbank.org/doi/pdf/10.1596/978-1-4648-0941-5

[13] It aligns well with arguments from the political economy of macroeconomics. From a fiscal and monetary perspective, these include early management of expectations, a broad-based political commitment to fiscal discipline as opposed to a reliance on fiscal rules, full and real (as opposed to nominal) independence of the central

where the management of expectations was undermined by electoral promise. This in turn generated spending pressures that could hardly be contained. Institutional weaknesses took on precise practices of profligacy at the government level. Specifically, political consensus failed to materialize around sustainable fiscal management, weakening the nominal fiscal rules in place and central bank independence. Procedures for forecasting oil revenues were also not isolated against political upward pressure on the estimates (unlike, for example, in Chile)[14].

Election cycles are critical to understanding the changing wealth of Ghana. The fiscal expansion in the run-up to the December 2000 presidential and parliamentary elections launched a cycle of high inflation (Figure 12) and currency depreciation which 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 U.S. dollar. The country's gross international reserves were so depleted that they could only cover a month's imports (Figure 12), and external payments arrears started building up.

Figure 12: Percent change in real crude oil spot price and GDP deflator, $2010 (left panel) official ER and reserves (right panel)

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 HIPC debt relief between 2001 and 2006. Ghana operated under a quasi-fiscal rule during this period, introducing a major shift in macroeconomic policy from expansionary fiscal policy and monetary accommodation, to 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 (Figure 13). This coincides with a period of mostly positive ANS.

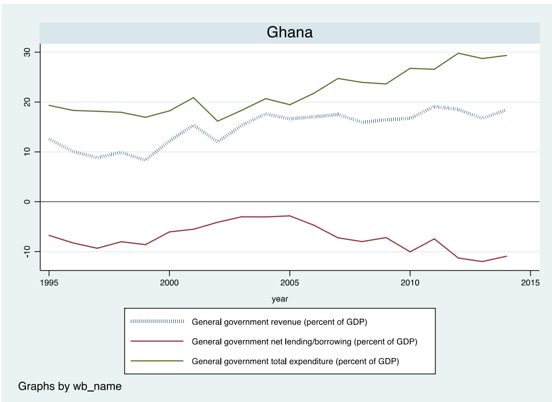
In the 2007-2008 cycle, inflation increased from 11 percent at the end of 2006 to 18 percent at the end of 2008, and the exchange rate depreciated by 20 percent. There was a subsequent

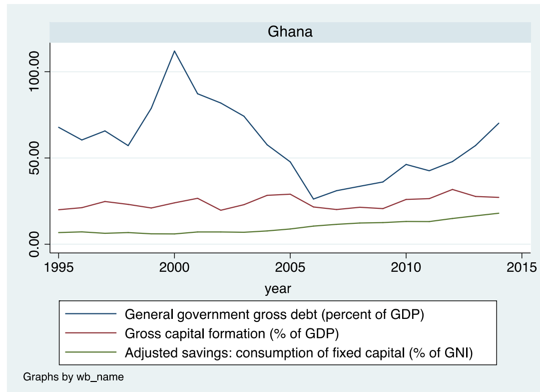
bank, as well as the establishment of means to isolate from political pressures the sovereign wealth fund and the government entity responsible for oil revenue projection.

[14] Page 7

correction, but this was in turn overtaken in the 2012 election year when the budget deficit reached 11.3 percent of GDP. This is also the period when ANS made a sharp turn negative.

Figure 13: a worsening fiscal position and increasing debt burden and contraction of public investment





Despite bouts of fiscal turmoil, 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 MDG1 met. By 2012, just one in five Ghanaians (21 percent) lived in poverty, and one in ten (10 percent) in extreme poverty (GSS 2014; Molini and Paci 2015). 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 has also increased (Figure 16).[15]

In short for Ghana, the prospect of oil revenues led to a classic bias towards consumption rather than investment. Ghana's growth model has become increasingly dependent on natural resources—and even more so since 2011, with the start of commercial oil production. Since the prospect of windfall caused was spent on public sector wages and employment, there was a squeeze on public capital and ANS flags the impact of this on wealth. Yet the country has avoided the debilitating effects of a natural resource cycle, so far, because the accumulation of human capital in the previous growth years has provided a big buffer.

Niger: Preserving Wealth Amid High Fragility

Despite its large endowment in renewable resources compared to subsoil assets, Niger relies heavily on oil and uranium assets to generate growth and savings (Figure 9). While Niger has a long history of oil exploration dating back to 1970, much like Ghana it is only in 2011 that the petroleum industry of Niger developed substantially with the opening of the Agadem oilfield and the Soraz refinery near Zinder. Large foreign direct investment (FDI) from China and France in new oil and uranium mining projects are taking place, transforming the country into a natural resource exporter. The new Azelik uranium mine, a relatively small uranium mine, began

[15] https://elibrary.worldbank.org/doi/pdf/10.1596/978-1-4648-0941-5

operating in 2011 as well. An integrated oil project (including an oil field and a refinery) started in 2012. The new Imouraren uranium will begin production at around 2019-20 when prices reach a level that would make the mine profitable. Natural resource outcome contributed to 12.3 percent of total GDP in 2013, and is projected to double as a share of GDP in 2020, while total government revenue from natural resources is expected to increase by about 2 percent of GDP[16].

Notwithstanding the recent minerals and mining endowments, Niger's share of renewables in total wealth (agricultural land, forest and protected areas) is quite substantial and actually saw a positive change from 2005 levels to 2014. There was also a significant gain over the last two decades in both the area and value of protected areas (see **Error! Reference source not found.**, in the Annex). These renewable assets continued to grow, but not as fast as the non-renewables (Table 3).

Table 3 Wealth per Capita, 2005-2014, $2014

year	status	Total wealth	Produced capital	Land	Energy	Minerals	Total natural capital	Human capital	NFA
2005	LIC	11,345.3	2,043.7	5,234.4	13.2	14.3	7,019.9	2,445.6	-163.9
2010	LIC	12,244.1	2,224.3	6,669.4	16.9	37.8	9,193.2	994.5	-167.8
2014	LIC	11,622.7	2,369.4	5,784.3	201.8	33.1	8,489.9	1,041.4	-277.9
% change 2005-2014		2.4	15.9	10.5	1431.13	131.9	20.9	-57.4	69.6

Despite the pitfalls of resource rents, ANS was trending upwards of zero from 2010 to 2014 (Figure 14). Niger has managed to shift its adjusted net savings from negative to a briefly positive in 2005 and 2006 and turned positive again in 2010 to reach over 7 percent of GNI in 2013. ANS as a percentage of Gross National Income increased from -24 percent in 1995 to over 7 percent in 2014. The combined efforts of saving, as measured by ANS along with fiscal restraint have improved the savings trend in recent years (Figure 14). However, total consumption expenditure (the difference between GDP and gross domestic saving) has increased at a sustained since 2011.

Moreover, population growth trends are now stifling savings efforts. Table 4 summarizes ANS per capita for Niger. Similarly to Ghana, ANS was negative in per capita terms between 1995 and 2005. In Niger, population-adjusted net saving per capita is also constrained by population growth. Niger one of the world's fastest growing population though the decline in the mortality rate indicates that Niger demographic transition is underway. However, with the highest fertility rate in the world of 7.6 children per woman, Niger's population growth rate has reached 4 percent a year in 2015. In the same vein, one particular feature of the wealth accounts for Niger is the negative trend in per capita human capital.

[16] IMF 2015, "Niger: Selected Issues"

Figure 14: Trends in GDP and savings, 1995-2014, $ 2010

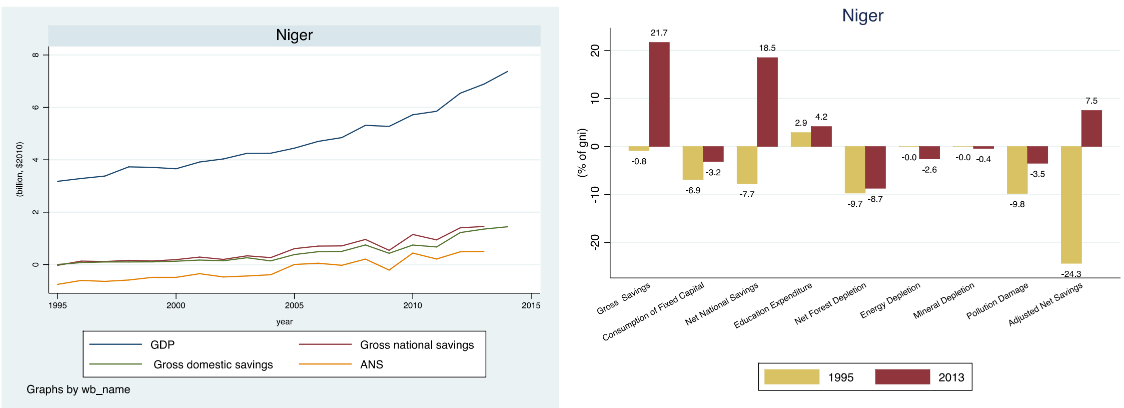


Table 4 Decomposition of Niger's population-adjusted net saving per capita, 2005-2014 ($2010 dollars , total wealth per capita $2014)

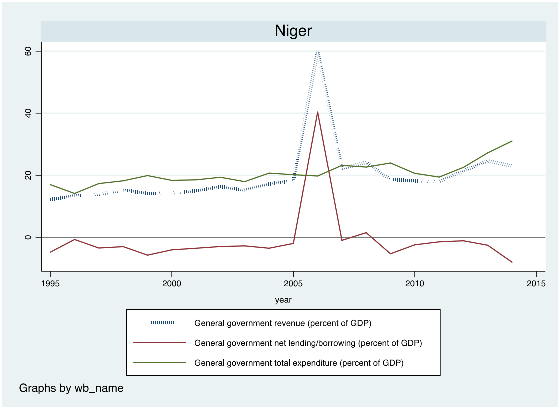
Niger	1995	2000	2005	2010	2013	2014
Population growth rate	3.5	3.7	3.7	3.9	4.0	4.0
ANS/cap	-84.5	-46.6	0.3	29.1	30.4	
Dilution/capita	363.1	389.7	419.4	474.9	467.9	468.3
NWC/capita	-447.6	-436.3	-419.1	-445.8	-437.5	
ANS % of GNI	-24.3	-13.5	0.1	7.8	7.5	
NWC/cap % of GNI/cap				-128.0	-119.5	
Total wealth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

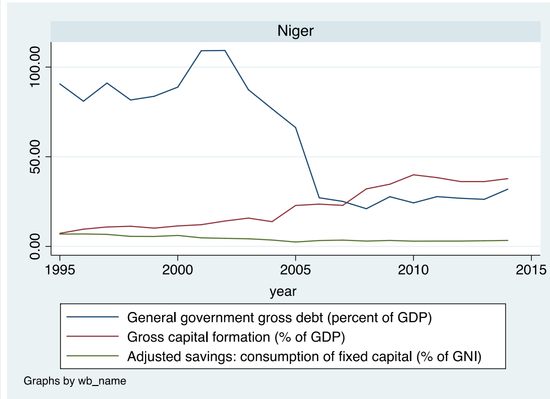
NWC=Net Wealth Creation- empty cells no data (update table to PANS=population-adjusted net saving)

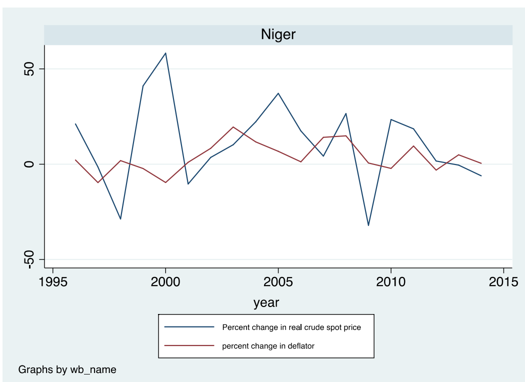
Whereas for Ghana fiscal volatility co-existed with a broader trend of wealth accumulation, for Niger, the fiscal story is a more dominant part of the overall picture. The ANS trend suggests that natural resource revenues have been largely invested or used to lower debt relative to its income level and related wealth accounts in the last decade. Indeed, the data suggests the strengthening trend in adjusted net savings is mostly due to the government's commitment to fiscal consolidation (Figure 15).[17]

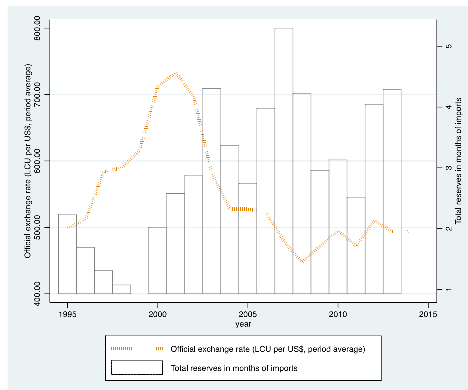
Figure 15: Fiscal consolidation

[17] IMF









The recent fiscal situation is itself linked to the management of resource rents. The fiscal balance started to deteriorate since 2013 (Figure 15), on the back of rapidly increasing public investment spending, while domestic arrears accumulated. Windfall resource revenues were directed at general public services and spending related to economic affairs (including agriculture, transport, and infrastructure), while social spending has also gradually increased. Thus, the central government fiscal deficit widened from 2.6 in 2013 to 9.1 percent of GDP in 2015 although government revenue was rising (Figure 15). These widening deficits were accompanied by the accumulation of domestic arrears and rapid growth of domestic financing, notably through the issuance of bonds in the regional market.[18]

Niger's public and publicly guaranteed (PPG) debt stock has also risen sharply in recent years, driven by rising natural resource projects and infrastructure. PPG debt reached an estimated 47 percent of GDP in 2016, up from 27.2 percent in 2013, and was 70 percent external and largely composed of concessional debt to multilateral creditors (54 percent). Such rapid growth reflects the scaling up of government borrowing to fund public investment in infrastructure,

[18] Niger PIRSC 2

including a US$1 billion investment facility from China Eximbank and the signing of a Chinese master facility agreement in 2013.

Obstacles to Building Capital

For Ghana, the growth in the youth population (15–24 years of age) will be peaking in the coming decade, adding pressures on both education systems and job creation for less-educated youth. Most jobs in Ghana are also low skill, requiring limited use of cognitive skills like reading and writing. The low earnings potential of jobs is mirrored in the limited use of skills in the jobs. Only urban formal sector workers use reading and writing skills regularly. By contrast, less than half of informal wage workers, and less than one-third of the self-employed, use these skills. Jobs are also characterized by a low technology content overall.

While access to formal education has increased in Ghana, the quality of education remains a problem. Education levels have increased in Ghana, and gender disparities are falling in the younger generation. However, two out of five women still have no more than a primary education, one in four young women (ages 15–24) cannot read and write, and less than half of women older than 25 are literate. Transition from school into productive jobs is too slow, especially for girls who bear the burden of family duties. The highly educated are concentrated in the public sector, which pays the highest salaries, and in the private wage sector.

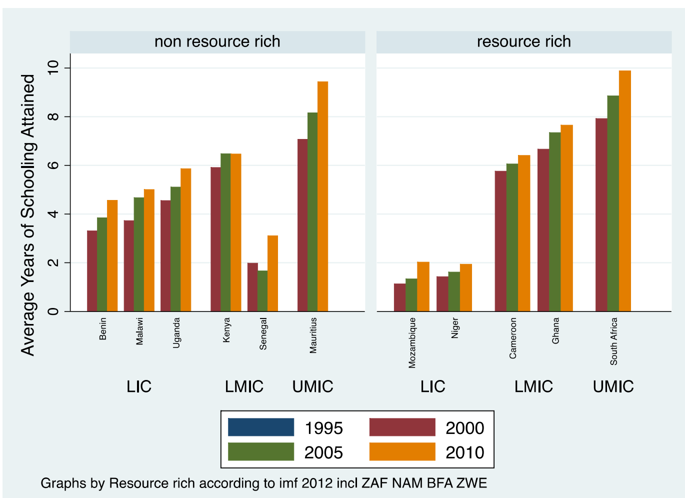
Urban areas in Ghana are suffering from lack of planning and insufficient infrastructure investments, which in turn results in slum development and negative environmental effects. More specifically, “urbanization” has not been connected with “industrialization” in Ghana, suggesting that some of the potential benefits of agglomeration have not been reaped. Urban growth and the concentration of population in urban areas are necessary conditions for accelerated growth and shared prosperity. However, they are not sufficient conditions, as many African countries have demonstrated. Urbanization has brought new challenges to Ghana, and its benefits have yet to be fully realized in terms of productivity, social inclusion, and poverty reduction.

Urbanization has accelerated in Ghana, especially in the past seven years, with the share of urban population now higher than rural population. One of the particular features of Ghana’s urbanization process it that urban growth has been surprisingly balanced: all regions of the country have experienced urbanization, and all types of cities—from small towns to metropolitan areas—have expanded. In fact, urban population growth has been faster in smaller cities than in larger ones. The capital city, Accra’s, share of urban population fell from 25 percent in 1984 to about 16 percent in 2010. Urbanization has taken place in a context of high economic growth and the promise of better job opportunities and living conditions.

By contrast, Niger displays much less urbanization and industrialization, and with it, challenges in accumulating wealth. The vast majority of Niger's 8.2 million poor[19] lives in rural areas where food insecurity is high. The average level of education is 1.4 years; only 52 percent of children have received a complete set of vaccinations and 44 percent of children under five years are stunted. Although public spending has been significantly increased, recent analysis show that the spending is significantly inefficient. This in turn has had a subdued effect on the growth impact of human capital compared other African countries and led to large gaps in productivity

In education, net enrollment rates in primary and secondary educations are 62.8 percent and 12.2 percent respectively, far below the level of other WAEMU countries. The level of education attainment is also the lowest in the region with Mozambique (Figure 16). While the quality of basic education service is poor, the school-age population is expected to keep rising over the next 20 years due to high fertility rate. By improving the efficiency in delivering education services, Niger is expected to have large gains in education outcome without increasing the level of spending (Grigoli, 2014)[20].

Figure 16: Average years of Schooling Attained (15 years old +), Barro-Lee



A recent World Bank country report also showed that infrastructure spending in Niger has only marginally contributed to annual per capita GDP growth, which is among the lowest in West Africa[21] (Dominguez-Torres and Foster, 2011). The poor condition of Niger's infrastructure, in particular the road network, is a critical bottleneck to growth. A noticeable lack of infrastructure exists outside the capital city Niamey and financing needs to fill the infrastructure gaps remain large. In addition, as observed in other low-income countries, high unit cost of

[19] 2014 estimate
[20] https://www.imf.org/external/pubs/ft/scr/2015/cr1564.pdf
[21] https://www.imf.org/external/np/fad/publicinvestment/#2

capital spending, and delays in budget execution have been impeding access to basic infrastructure (road, electricity, and information and communication technology)[22].

Niger's governance indicators have steadily improved over the last two years; but there is still a long way for this to trigger an investment acceleration, especially in the non-resource sectors. Except for a few firms that exploit natural resources in enclave activities and some large firms run by well-connected entrepreneurs, it makes for an unattractive investment climate for domestic as well as foreign entrepreneurs and a very large informal sector. For Ghana, although large macroeconomic imbalances now threaten growth and continued poverty reduction, the human capital base is much stronger and private non-resource investment is more vigorous. A successful fiscal adjustment could therefore open up the opportunity of strong resource-driven transformation.

[22] IMF 2015 Niger Selected Issues

Chapter 4: Accounting for Natural Resources When Measuring Multi-Factor Productivity Growth

Kirk Hamilton

Introduction

This chapter is concerned with a key question in economic analysis, the relationship between the inputs to production, typically fixed capital and labor, and the quantity of production. At one level this is a question of measurement: can we decompose the production process to understand the individual contributors to changes in output, particularly when we extend the analysis 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?

Of course no sensible economic model aims to maximize production. The general goal of economics is to maximize, or at least progressively increase, human wellbeing for the greatest number. But production provides the means to boost both wellbeing 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% of the total) who live in extreme poverty, defined as income less than $1.90 a day.

Growth accounting, decomposing the growth in output into its constituent factors, is a key tool in assessing the efficiency of economic production. Until recently a two-factor approach to decomposing the 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?* (World Bank 2006), has opened the door to a much more comprehensive approach to understanding the contributors to growth. In particular, work at the OECD as published by Brandt et al. (2017) has used the Bank's data on the quantity and value of selected natural resources assets to explore the question of how a broader measurement of the factors of production influences our 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 energy) and its impact on the measurement of production efficiency. The chapter presents the first steps on a journey to more comprehensively assess 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. We have seen where this world leads in the Solow (1956) model of economic growth. Diminishing returns combined with fixed technology mean that the development path for the economy is one where output per person approaches a long run steady state. Growth stops. In an unequal world this could imply millions of people trapped in extreme poverty.

When we do a careful accounting of the contributors to growth in economic production, whether with two production factors or many, we typically find that the growth in individual factors of production does not sum to the quantity of production observed, as measured by GDP. In most countries growth in GDP exceeds the 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 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 Multi-Factor Productivity (MFP) in the economics literature.[23] While it is measured as a residual in growth accounting, this does not mean that we are 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 to manage 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 wellbeing. Changes in the quality of factor inputs, as Jorgensen investigated (1995), is another potential contributor.

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

[23] An older literature on this measure of economic efficiency termed it Total Factor Productivity (TFP). The terms continue to be used interchangeably.

Recent work on MFP growth by the OECD

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

To estimate the growth rate of multi-factor productivity, Brandt et al. (2017) assume constant returns to scale in production and zero economic profits (other than the resource rental values that are used to bring resources into the MFP measurement framework).

In addition to estimating MFP growth rates for most OECD countries, in two OECD countries – Chile and Mexico – the underlying data do not support detailed estimation of the rental value of produced capital. In estimating MFP growth rates Brandt et al (2017) therefore measure the rental value of produced capital as a residual, thw share of GDP left over after accounting for labor and natural resource rental values. This approach is also applied to to two non-OECD countries that are highly resource dependent: Russia 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 XX.1.

Table XX.1 MFP growth with and without accounting for natural resources, selected countries, 1996-2008.

	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	0.90%	1.10%	5.07%	4.18%	6.63%
Mexico	0.97%	1.09%	2.81%	0.84%	3.73%
Russia	2.21%	2.50%	3.16%	2.12%	13.32%
South Africa	1.62%	1.70%	2.01%	0.65%	2.35%

Source: Brandt et al. (2017); data for 1997-2008 for Chile; natural resource data from World Bank (2011).

Brandt et al. (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 to the growth rates for a composite measure of natural capital.

This work represents an important step forward in the measurement of MFP growth rates based on a more comprehensive measure of national wealth. In the next sections of this chapter we present new estimates of MFP growth rates for a selection of oil and gas producers, extending Brandt et al. (2017) by including the rental value of agricultural land in the analysis in addition to oil and gas rental values.

Growth accounting to measure MFP growth

In any attempt to measure MFP growth the starting point is to decompose the factors that drive growth in GDP. 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.[24] 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 values 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 rental values 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,[25]

$$\frac{\dot{Y}}{Y} = \frac{F_K K}{Y} \cdot \frac{\dot{K}}{K} + \frac{F_L L}{Y} \cdot \frac{\dot{L}}{L} + \frac{F_N N}{Y} \cdot \frac{\dot{N}}{N} \qquad \text{(XX.1)}$$

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.[26] 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; 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

[24] These characteristics would hold if the economy were based on a Cobb-Douglas production function with constant returns to scale.

[25] A dot over a variable indicates an instantaneous change in a variable. As a result, $\frac{\dot{Y}}{Y}$ represents the rate of growth of GDP, in this case measured year on year.

[26] For a more technical presentation of this result see Brandt et al. (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.

constitute multi-factor productivity. If we denote these factors collectively as A, we can measure the growth rate of multi-factor productivity as,

$$\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \frac{F_K K}{Y} \cdot \frac{\dot{K}}{K} - \frac{F_L L}{Y} \cdot \frac{\dot{L}}{L} - \frac{F_N N}{Y} \cdot \frac{\dot{N}}{N} \qquad \text{(XX.2)}$$

Growth in multifactor productivity 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 production factors.

In the empirical estimates in the next section we follow Brandt et al. (2017) in assuming that the rental value of produced capital equals the residual in GDP, after accounting for the rental values 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 to the traditional practice of treating only labor and produced capital as factors of production. As the Annex 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 the production from cropland and pastureland. These non-OECD countries were chosen based on data availability and regional coverage. While agricultural land is a more or less a fixed factor, there are large variations in the rate of extraction of oil and gas over time for the selected countries.

Table XX.2 MFP growth rates, selected petroleum producers, 1996-2014

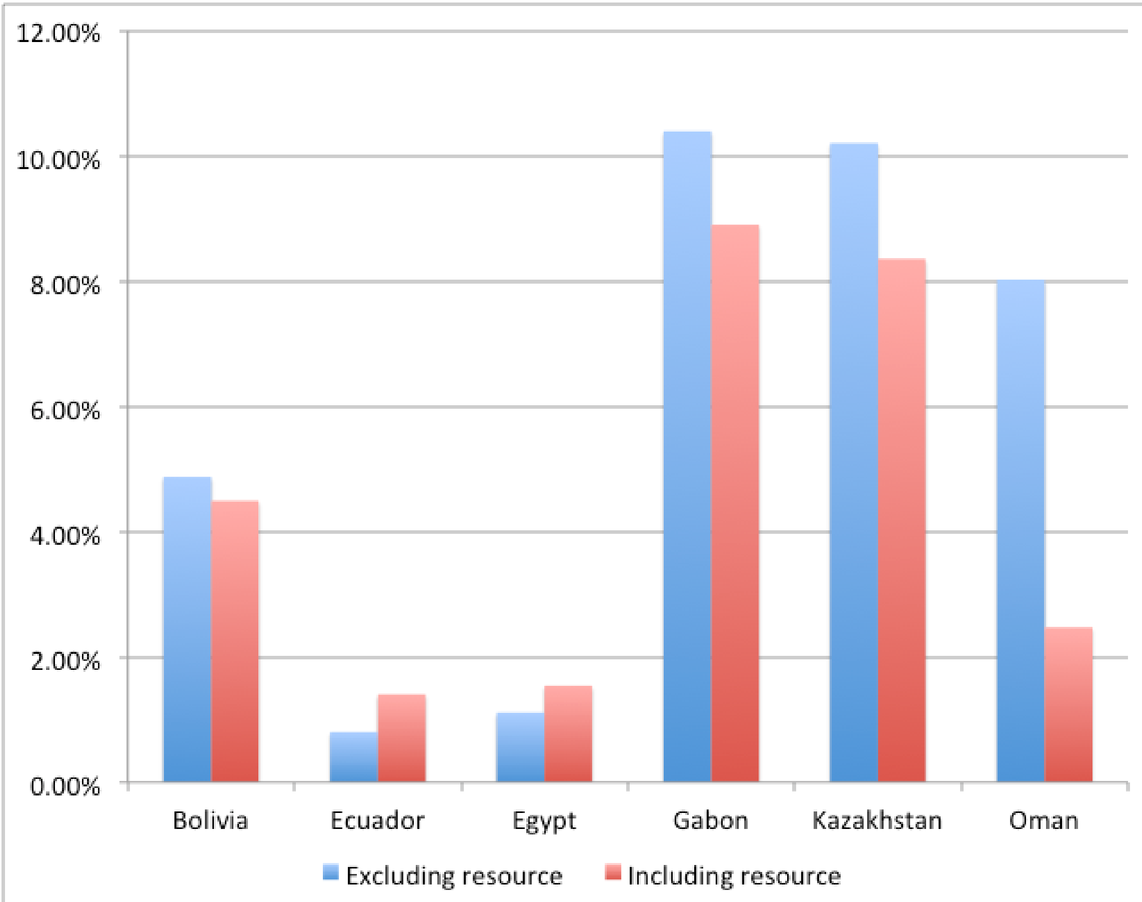
		MFP growth rate excluding resource	MFP growth rate including resource
Bolivia	Avg 1996-2014	0.96%	0.74%
	Avg 2004-2014	1.52%	1.18%
	2010	4.88%	4.49%
Ecuador	Avg 1996-2014	-0.30%	0.02%
	Avg 2004-2014	0.30%	0.79%
	2010	0.80%	1.40%
Egypt	Avg 1996-2014	2.11%	2.45%
	Avg 2004-2014	1.27%	1.72%
	2010	1.11%	1.54%
Gabon	Avg 1997-2014	-1.53%	0.07%
	Avg 2004-2014	0.67%	1.39%
	2010	10.39%	8.90%
Kazakhstan	Avg 1996-2014	5.49%	4.22%
	Avg 2004-2014	6.66%	5.46%
	2010	10.20%	8.35%
Oman	Avg 1996-2014	0.77%	0.88%
	Avg 2004-2014	-0.77%	-0.18%
	2010	8.02%	2.47%

Source: Author; averages are unweighted

Looking at the averages over time, the inclusion of natural resources as factors of production increases the estimated rate of MFP growth for most countries, the exceptions being Bolivia and Kazakhstan. In Ecuador over 1996-2014, Gabon over 1997-2014, and Oman over 2004-2014 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 (a year where the oil price was still rising and economies had started to recover from the Great Recession) Figure XX.1 plots the two estimates of MFP growth for the selected countries. Comparing Egypt and Oman in 2010, we see that MFP growth including natural resources exceeds the measure excluding natural resources in Egypt, while the opposite is true in Oman. Underlying this result are growth rates of oil production (which heavily dominates natural capital) that exceed that of produced capital (6.4% vs. -8.4%) in Oman, while growth rates of oil are less than that of produced capital (1.9% vs. 4.3%) in Egypt. This result corresponds exactly to the analysis in the Annex.

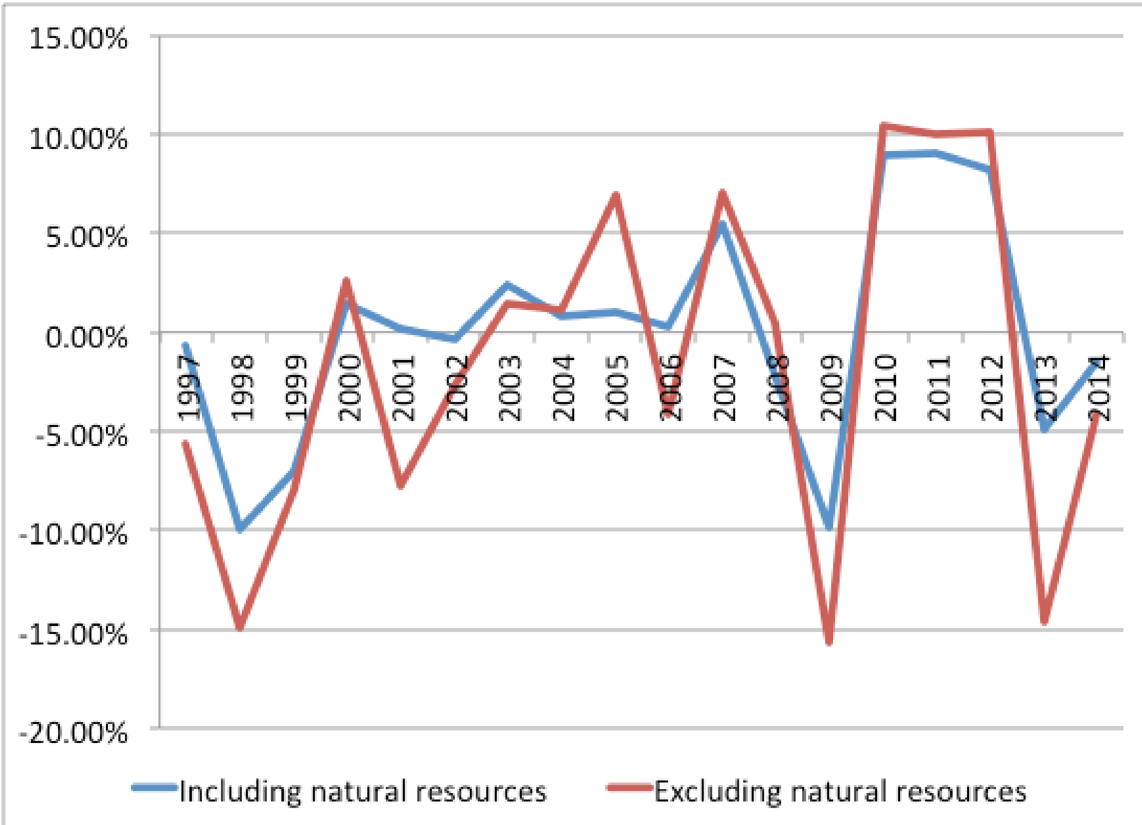
Figure XX.1 Comparing MFP growth measured excluding and including natural resources, selected petroleum producers, 2010



Source: Author

Figure XX.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. There is a suggestion in the graph that the measured MFP growth rate including natural resources is less volatile than the traditional measure limited to produced capital and labor. But much more comprehensive analysis of results across countries would be needed to confirm this empirical finding.

Figure XX.2 Gabon MFP growth rate, with and without the inclusion of natural resources, 1997-2014



Source: author

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

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 has shown, in these countries in particular there is a consistent relationship between the growth rate of produced capital, the product of public and private investment decisions, and the growth rate of natural resource extraction. As established in the Annex to this chapter, 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 policy-relevant since the Hartwick rule argues for investing natural resource rents in other types of capital, including produced assets, if wellbeing 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, incorporating natural capital, could be less volatile than the traditional measure of MFP growth. This points to a research agenda going forward, where these methods for estimating MFP growth would be applied to a much wider range of developing countries. It may also be the case that different types of developing countries will show consistent patterns in inclusively measured MFP growth – for example agriculture-dependent low income countries compared to extractive resource exporters, or lower-middle income countries where growth in industrial output has begun.

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Annex – 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} denote the growth rate of MFP calculated without taking natural resources into account, and g_A^{WNR} represent 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 where natural resources *are not* taken into account it follows that,

$$s_K = (1 - s_L)$$

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

$$s_K = (1 - s_L - s_N).$$

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

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

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

Straightforward algebra therefore implies that,

$g_A^{WNR} > g_A^{NNR}$ if $g_K > g_N$.

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 production factors will decrease if the growth rate of produced capital exceeds that of natural resources; this is owing to the reduction in the factor share of produced capital occasioned by the introduction of natural resources as a factor of production.

This result extends easily to the case where 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,

$$g_K > [\frac{s_{N_1}}{s_{N_1}+s_{N_2}} \cdot g_{N_1} + \frac{s_{N_2}}{s_{N_1}+s_{N_2}} \cdot g_{N_2}]$$

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.

Chapter 5: Intangible Capital as the Engine for Development in Morocco

Kirk Hamilton, Jean-Pierre Chauffour, and Quentin Wodon

Introduction

In the throne speech of July 30 2014, HM King Mohammed VI called for an assessment of Morocco's development which 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 an appreciation 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. While intangible assets are usually defined somewhat narrowly as consisting primarily of intellectual property in the System of National Accounts (SNA), the King had in mind a broader concept; a 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* that focuses on the role that intangible capital could play in accelerating Morocco's transition to upper middle income status (World Bank, 2017).

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 2000s was driven by investment in fixed capital, especially in the public sector. Second, and by contrast, while Morocco could benefit from a demographic dividend thanks to a large cohort of workers aged 15 to 35, gains in human capital have not kept pace. Investments in education have led to universal primary enrolment as well as higher enrolment rates in secondary and post-secondary education. But 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, 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 finally fostering social trust. The reforms are briefly discussed, and 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. Section 2 provides a rapid description of trends in Morocco's wealth, together with analysis of the main components of this wealth. Section 3 describes some of the reforms under consideration by the government. Section 4 provides estimates of the potential gains that could be achieved from some of the reforms. The analysis is meant to be illustrative only of the magnitude of the gains that could be achieved, but it is hopefully instructive. A brief conclusion follows.

Trend 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 the total wealth, especially for high income countries. This is confirmed in this study for the world as a whole (Lange et al., 2017; Hamilton and Wodon, 2017), as well as for Morocco. The country has enjoyed strong growth in wealth since 2005, as seen in Table 1 and Figure 1. Total wealth per capita grew by over 41 percent in ten 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.

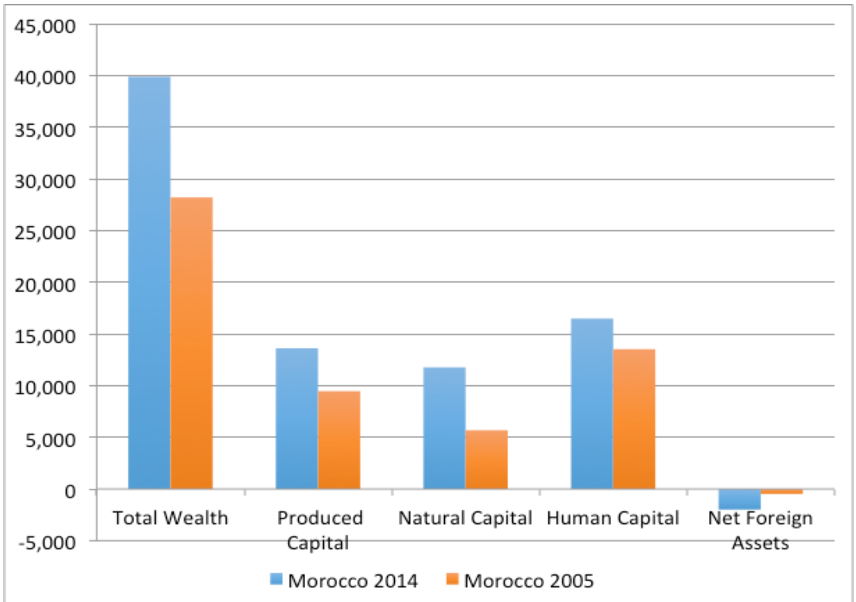
Table 1: Morocco's Wealth per Capita, 2005-2014, $2014

	Total wealth	Produced capital	Land	Energy	Minerals	Total natural capital	Human capital	NFA
2005	28,208	9,469	5,518	2	165	5,685	13,527	-472
2010	34,351	11,634	6,822	3	1,979	8,804	15,239	-1,325
2014	39,883	13,616	9,431	3	2,332	11,766	16,490	-1,990
% change 2005-2014	41.4%	43.8%	70.9%	95.0%	1313.3%	107.0%	21.9%	321.2%

Source: Authors.

Notes: NFA is net foreign assets. Land comprises primarily of agricultural land, with small values of forest land and protected areas.

Figure 1: Components of Morocco's Wealth per Capita, 2005 and 2014 ($2014)



Source: Authors

Comparator Countries

How does Morocco compare with neighboring competitor countries? Table 2 compares wealth levels in Morocco to those observed in Egypt, Jordan, Lebanon, Spain and Tunisia, as well as the average wealth in all upper middle income countries. Total wealth per capita in Morocco stood at just under $40,000 in 2014, a level similar to that observed in Egypt, but below the levels observed in Jordan, Lebanon, and Tunisia. Spain is also included in the table, with wealth per capita 12 times higher than in Morocco, despite the fact that wealth per capita declined in Spain over the last decade due to the great recession. Table 2 suggests that much of the gap between Morocco and other Middle East and North Africa (MENA) countries is the result of lower levels of human capital per capita. Denote by MENA-3 the three countries of Jordan, Lebanon, and Tunisia, the average level of wealth per capita in these three countries is just above $53,000. The main difference between the MENA-3 countries and Morocco is due to human capital wealth. If Morocco had the level of human capital wealth of the MENA-3 countries (a gain of close to $15,000 or almost the double of Morocco's current human capital wealth), the country would also have the highest level of total wealth per capita among the three MENA countries.

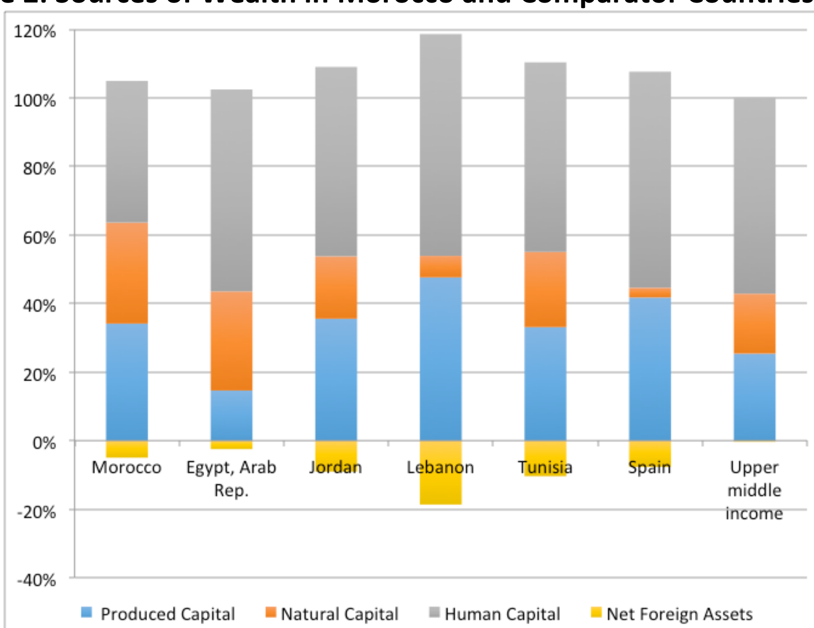
This is visualized in a different way in Figure 2 which decomposes wealth in Morocco and comparator countries by source. The composition of the wealth of Morocco and its peers shows distinct differences. Morocco stands out with a relatively low share of human capital, at roughly 40 percent of the total, 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 of natural capital (in absolute terms, the value of Spain's natural capital per person is on par with other countries).

Table 2: Wealth per Capita in Morocco and Comparator Countries, $2014

	Total Wealth	Produced Capital	Natural Capital	Human Capital	Net Foreign Assets
Individual Countries					
Morocco (1)	39,883	13,616	11,766	16,490	-1,990
Egypt, Arab Rep.	38,332	5,605	11,091	22,591	-955
Jordan	49,423	17,577	9,011	27,312	-4,478
Lebanon	65,111	31,015	4,094	42,153	-12,151
Tunisia	44,821	14,838	9,849	24,796	-4,662
Spain	341,925	142,821	9,753	215,593	-26,241
Upper middle income	120,177	30,498	21,039	68,800	-160
MENA-3 (Jordan-Lebanon-Tunisia)					
Average for MENA-3 (2)	53,118	21,143	7,651	31,420	-7,097
Morocco versus MENA-3					
Difference (2) – (1)	13,235	7,527	-4,115	14,930	-5,107

Source: Authors' estimations.

Figure 2: Sources of Wealth in Morocco and Comparator Countries, 2014



Source: Authors

Adjusted Net Saving

Another way to look at wealth accumulation consists of using data on Adjusted Net Savings (ANS). As discussed in chapter 2, ANS is essentially measured as gross national saving minus depreciation of produced capital, depletion of natural capital, plus public expenditures for education. While 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 future wellbeing. Said differently, 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 pollution damages.

Table 3 suggests that Morocco is experiencing a reduction in ANS per capita. ANS per capita was a healthy $688 in 2005, but it decreased to $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.[27] 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 'dilution per capita' in Table 3.

Subtracting dilution from ANS per capita yields Population-Adjusted Net Saving (PANS), which is a key indicator of likely future well-being per capita. In Morocco, PANS dropped from just over $400 per person in 2005 to just under $100 per person in 2014. In other words, the combined effects of falling saving effort, as measured by ANS, and rising population growth reveals a marked deceleration of net wealth creation per person, from 17 percent of total wealth per capita in 2005 to 3 percent in 2014. This 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.

Table 3: Decomposing Morocco's net wealth creation per capita, 2005-2014, constant $2014

	2005	2010	2014
Population growth rate	1.0%	1.2%	1.3%
ANS/capita	688	676	631
Dilution/capita	274	425	537
Population-Adjusted Net Saving (PANS)	414	251	95
ANS % of GNI	28.4%	23.3%	20.0%
PANS % of GNI/capita	17.1%	8.6%	3.0%
Total wealth / capita	28,208	34,351	39,883

Source: Authors, World Development Indicators.

Morocco 2040: Building Human Capital

As mentioned earlier, Morocco's produced capital grew at a rate similar to that of total wealth. Natural capital grew faster, but human capital lagged, with a growth rate at only half that of total wealth. Given that human capital is the largest source of wealth in most advanced countries, building Morocco's human capital is *the* development challenge. Indeed, the gap in wealth observed between Morocco and other MENA countries in table 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.

[27] If population grows by one percent, as it did in 2005, then, other things being equal, this leads to a 1 percent decline in wealth per capita.

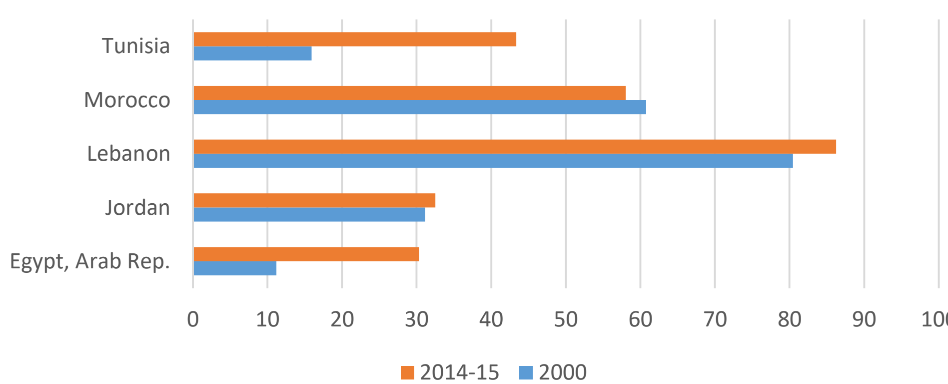
Early Childhood Development

As noted in chapter 8 in this volume, investing in 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, socio-emotional and cognitive development are closely linked (Shonkoff et al., 2012), with neurological studies showing 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 a lack of stimulation may therefore lead not only to poor physical growth, but they may 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. (2016) 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 to investments made later in life. This matters for human capital wealth since this wealth is essentially measured as the net present value of the population's future earnings. Interventions to provide psycho-social 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 et al., 2008, 2013). Enrollment in preschool also has been shown to have high returns (Engle et al., 2011).

How is Morocco doing in this area? Figure 3 provides rates of enrollment of children in at least one year of preschool for Morocco in comparison to our comparator countries. Morocco's performance is respectable, only lagging behind Lebanon (and Spain where enrollment is near universal). But Morocco appears to have lost a bit of ground between 2000 and 2014-15, while all the other countries have made gains.

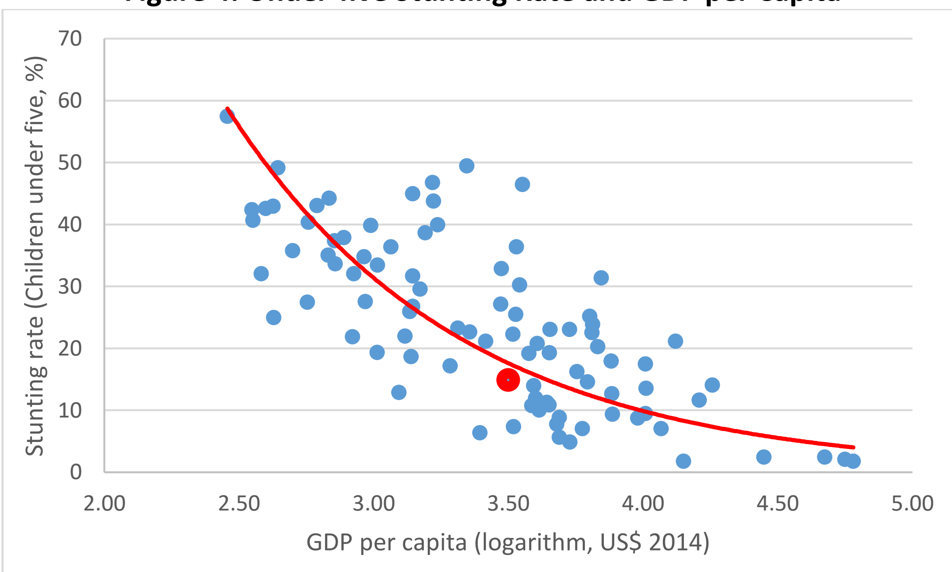
Figure 3: Enrollment Rates in Pre-primary (%)



Source: World Development Indicators.

Another widely used indicator of ECD is the stunting rate. A child is considered stunted if s/he has a height more than two standard deviations below the median reference height for that age. As noted in chapter 8, 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 4, where Morocco is represented by the red 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 GDP per capita). Yet, according to the literature, if stunting was reduced to the level in comparator countries this would result in a gain in earnings of about 25% for one sixth of the population, and thereby a gain in human capital wealth nationally of about four percent, which is far from being negligible.

Figure 4: Under-five Stunting Rate and GDP per Capita



Source: World Development Indicators.

Primary and Secondary Education

Morocco has high enrollment rates but also well-known weaknesses in education outcomes, both in terms of poor student performance on international tests and persistently high levels of adult illiteracy. Reforming the system will need to start in the school itself, with revisions to curriculum and teaching methods. An emphasis on basic skills is a starting point, and upgrading of vocational training to prepare students for the needs of enterprises will be required. 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 (ICT) can play a role in the teaching process, including or testing and training, but to be successful, ICT needs 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 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.

What could be the gains from such reforms? This is difficult to assess, since gains in wages depend both on 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, since 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. But 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. This can in turn create positive spillovers for family incomes and the welfare of children.

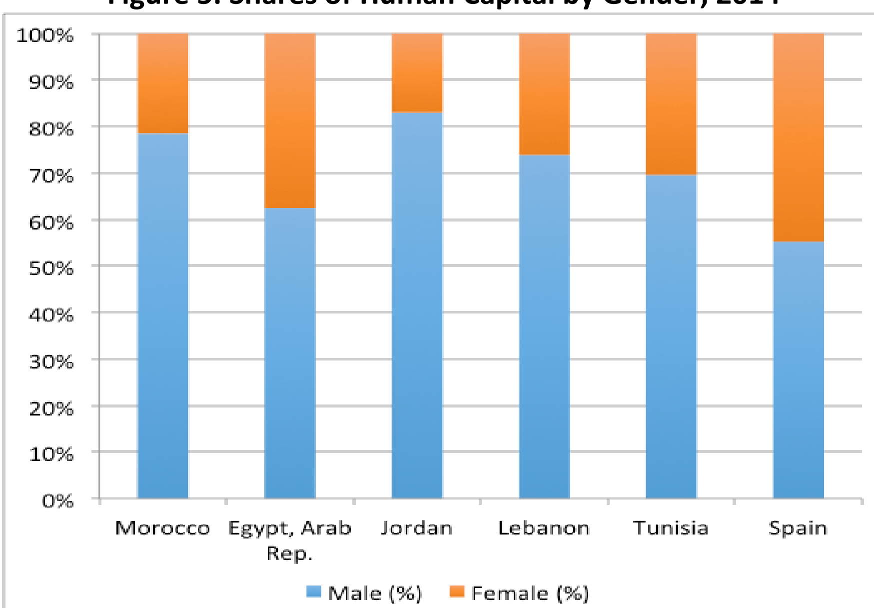
The constitution and laws of the Kingdom of Morocco regarding women's rights are among the most progressive in the MENA region. The 2011 Constitution embodies the central tenets of the UN Convention on the Elimination of all forms of Discrimination Against Women. It protects the political, economic, 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. Quotas for the representation of women exist in elections to the House of Representatives and regional bodies.

While this creates 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 (see Savadogo and Wodon, 2017, in this volume).

Figure 5 breaks down total human capital into its gender shares. The two Kingdoms of Morocco and Jordan stand out for distinctly low female shares of human capital, at slightly more than 20 percent of the total. This is due to both low labor force participation rates for women and lower educational achievement, which lead to lower earnings when women are working in the labor market. This compares with stronger figures for Tunisia and particularly Egypt, which falls only 7 percent below Spain. Increasing women's labor force participation and earnings could lead to major gains in wealth, as well as income generation and poverty education more generally.

To achieve the goals of *Morocco 2040*, further progress on gender equality will be essential. This would require 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 growing source of jobs for women. Better access to childcare 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 the enhancement of women's control over economic assets, strengthening property rights, 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.

Figure 5: Shares of Human Capital by Gender, 2014



Source: authors; Upper middle income countries not shown owing to missing data

What could be the magnitude of the gains in human capital wealth for Morocco from gender equity? In order to answer this question, assume for simplicity following Hamilton and Wodon (2017) 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 of men. As shown in table 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.

Table 4: Potential Gains in Human Capital Wealth from Gender Equity, 2014

	Gender Gap Ratio (x100) (Ratio of human capital wealth by gender)	Potential Gain from Gender Equity (Percentage increase from base)
Morocco	27.4	36.3%
Egypt, Arab Rep.	37.5	31.2%
Jordan	20.5	39.8%
Lebanon	35.4	32.3%
Tunisia	43.7	28.2%
Spain	81.0	9.5%
Upper middle income	67.0	16.5%

Source: Authors' estimation.

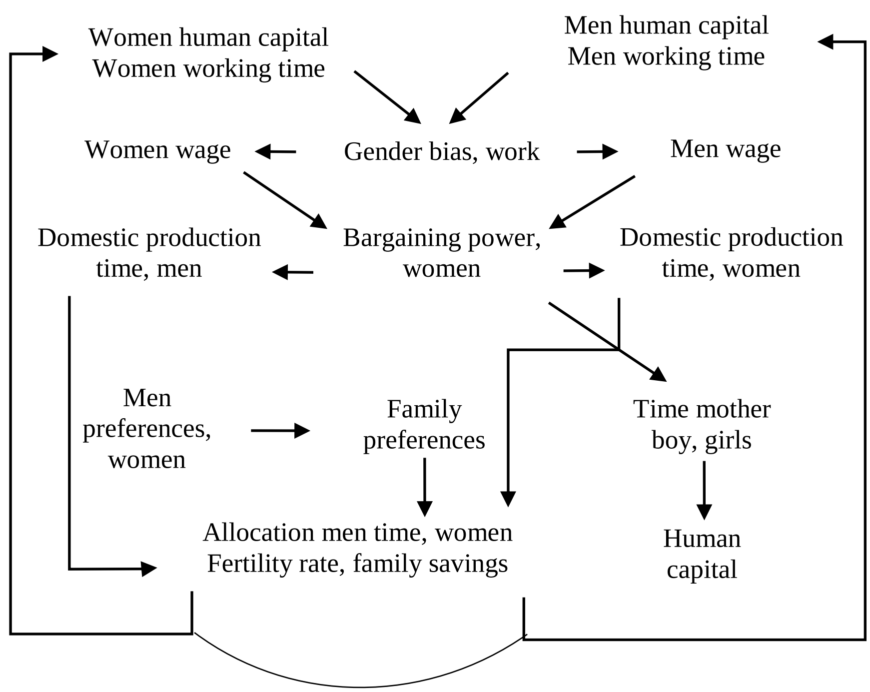
Public policies can be designed to both combat gender inequalities and promote economic growth. Economic and legal inequalities between the sexes and social norms and gender biases tend to reinforce each other in explaining women's low access to economic opportunities as well as women's low bargaining 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 and al., 2017). In the case of Morocco, the combined effects of these policies on economic growth could reach up to 2 percentage points on an annual basis (Box 2).

Box 2: Evaluation of the impact of public policies on gender inequalities and growth in Morocco

The impact of public decisions on gender equality and economic growth could be quantified by a computable overlapping generations and gender-differentiated model (Agénor 2012, 2017). Such a model was developed and calibrated in the case of Morocco on the basis of the 2014 General Population Census, employment surveys and the 2012 national survey on the time budget of the High-Commission for Planning (Agénor and al. 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 (Figure XX).

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.

Figure XX. Social norms, gender bias and bargaining power



Source: Agénor, P-R, Rim Berahab and Karim El Mokri. 2017. « Egalité de genre, politiques publiques et croissance économique au Maroc ». Chapter 6 « Evaluation de l'impact des politiques publiques sur les inégalités de genre et la croissance économique au Maroc ». Direction des Etudes et des Prévisions Financières (Ministère de l'Economie et des Finances du Maroc) and OCP Policy Center.

In a first simulation, the government implements measures to fight against women discrimination in the labor market (hiring parity, awareness campaigns, for example). The consequences are multiple: increase in family income, which leads to higher private savings and investment and then higher economic growth and tax revenues. The latter can then be used to increase education spending and promote human capital accumulation, also contributing to economic growth. In addition, these measures affect the time allocation between women and men by strengthening the women bargaining power within the family. By improving their income, women reduce the amount of time spent on domestic tasks (compensated by an increase in that of men). The time freed by women is then allocated between child rearing, participation in the labor market, human capital accumulation or leisure. In the case of Morocco, the model calibration leads to a reduction in the time that men spend on the labor market, as well as the time devoted to human capital accumulation and leisure, and an increase in the time dedicated to the production of domestic goods. In terms of the effect on growth, they are both positive and negative as women and men allocate their time in the labor market in opposite ways.

The second simulation focuses on the reallocation of mothers' time to their daughters, due to an awareness campaign for instance. In this case, economic growth is positively affected by women's human capital increases. Finally, a third simulation examines the effects of an improved bargaining power of women within the household. This leads to three changes: (1) women allocate less time to domestic tasks, unlike men; (2) because of the lower preference of women for current consumption, the saving 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 labor market and their own accumulation of human capital, but to the benefit of the children accumulation of human capital.

Overall, the positive impact of pro-gender measures on economic growth rate would be in the order of 0.2 to 1.95 percentage point on an annual basis depending on the scenarios (Table XX).

Table XX. Policies effect of reducing gender inequalities on the rate of economic growth (in percentage points)

	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

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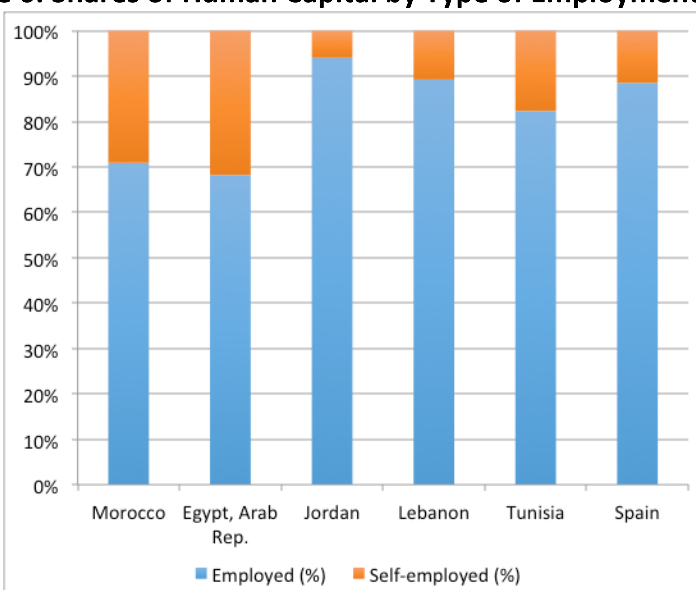
Agénor, P-R, Rim Berahab et Karim El Mokri. 2017. « Egalité de genre, politiques publiques et croissance économique au Maroc ». Chapitre 6 « Evaluation de l'impact des politiques publiques sur les inégalités de genre et la croissance économique au Maroc ». Direction des Etudes et des Prévisions Financières (Ministère de l'Economie et des Finances du Maroc) et l'OCP Policy Center.

Gap in Human Capital by Type of Employment

Building human capital concerns not only schooling but also the functioning of labor markets. Figure 6 compares the human capital of the employed the self-employed in 2014. Morocco and Egypt stand out with the self-employed constituting roughly 30 percent of total human capital, a much higher share than in the other countries. This points to a significant share of small-holder agriculture in the economy, resulting in high levels of self-employment combined with low earnings because small holdings are often inefficient. In addition, apart from self-employment in agriculture, many workers are often involved in self-employed, low productivity occupations. In order to improve labor market outcomes, current programs for training and skills promotion need an upgrade, 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 run 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 6: Shares of Human Capital by Type of Employment, 2014



Source: authors

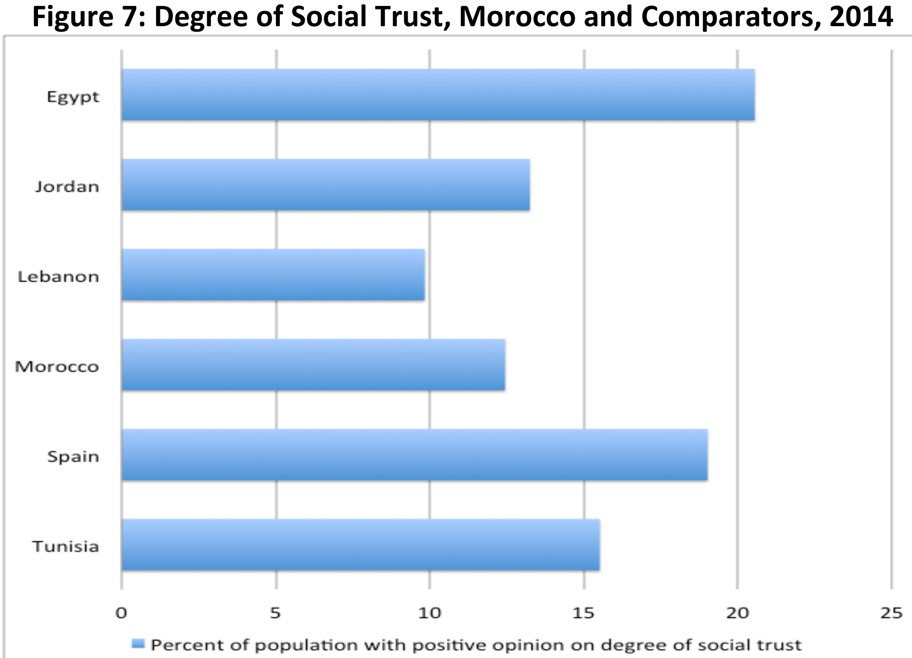
Morocco 2040: Institutions and governance

In his 2014 speech, HM King Mohammed VI emphasized not only the need for investments in human capital, but also the importance of institutions for development and wealth creation. While this volume does not provide measures of wealth associated with institutions, other indicators can be used to show where Morocco stands in comparison to 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 co-operation within or* *among groups*" (OECD 2001). Figure 7 reports on the degree of social trust in Morocco and its comparator countries using data from the World Values Survey. Levels of social trust are relatively low, with only 12 percent of respondents in Morocco saying that most people can be trusted. While trust is not much higher in comparator countries, Morocco tends to do less well than the average. Separately, Figure 9 compares governance indicators for Morocco and comparators countries in 2015 using the Worldwide Governance Indicators. Here, Morocco's performance is relatively strong when compared to selected countries in North Africa, as well as the aggregate score for upper middle income countries. On political stability leads its regional comparators, but lags the average for upper middle income countries. The main potential source of weakness for Morocco appears to be voice and accountability.

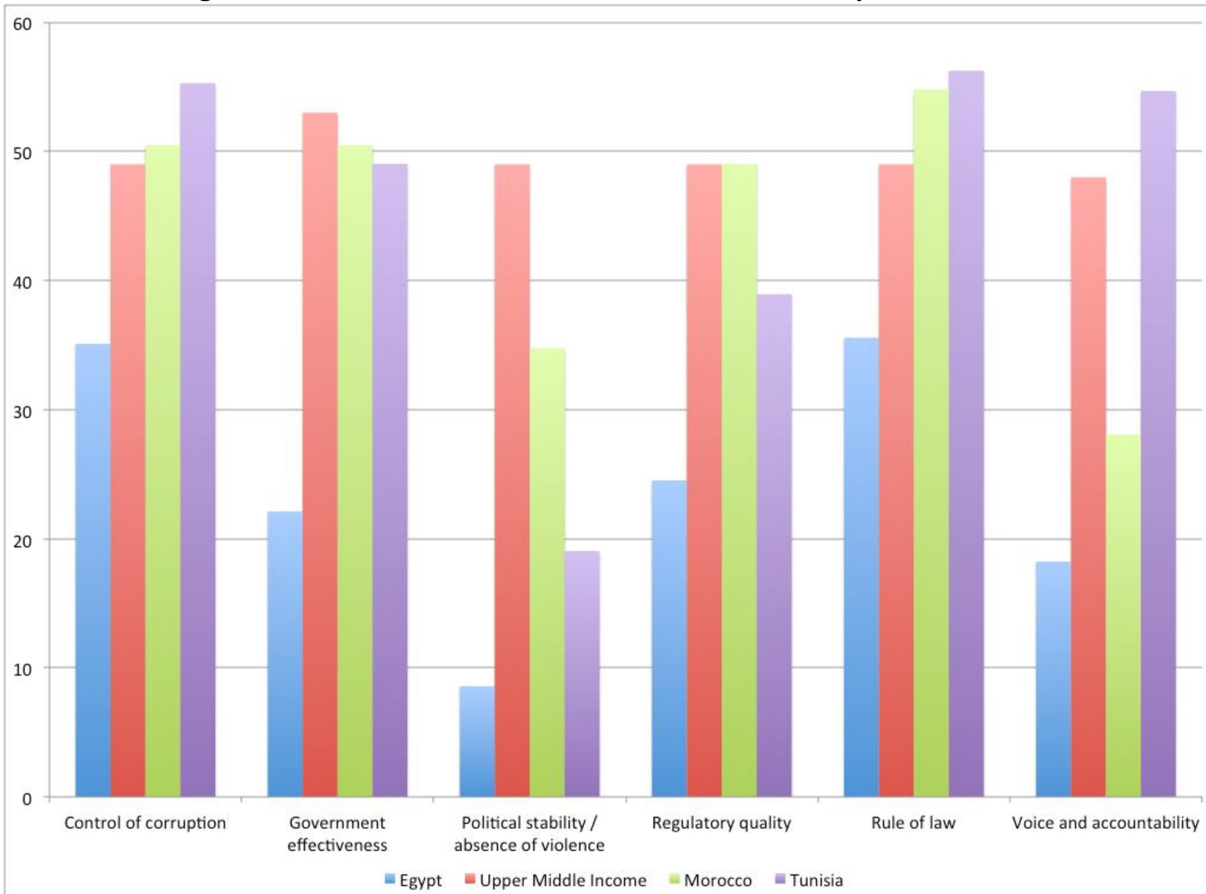
As a program for growth, *Morocco 2040* targets a wide spectrum of reforms, from macroeconomic policy to labor markets to the social sectors. However, underpinning these reforms is the need for transformation of public institutions and governance. The public sector enforces the rule of law, redistributes 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.

Figure 7: Degree of Social Trust, Morocco and Comparators, 2014



Source: World Values Survey (2015).
Note: Percent of 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: Governance Indicators, Morocco and Comparators, 2015



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

Reforms to two key management functions will also be critical for success. 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, 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 post-implementation 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, and as well as providing an opportunity to implement best civil service practice in the creation of new regional government structures. Decentralization can also 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 terms of 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 has achieved strong growth in per capita wealth from 2005 to 2014, at 41 percent over ten 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 adjusted net saving fell from roughly $400 per person in 2005 to just under $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 to 59 percent in Egypt and 65 percent in Lebanon. The gap in human capital versus 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 leading 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 four 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 the 2014 Throne speech, HM the King of Morocco highlighted the role of intangible capital in the powering the country's development. The *Morocco 2040* economic memorandum prioritizes 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 to 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 such as the organic law of the right of citizens to submit legislative proposals (2016), the organic law of the right to strike (soon adopted), and the right of access to information (also soon to be adopted), which is considered essential to enhance democracy and achieve societal developments. 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 have been approved by the Council of Ministers in 2015. They aim at organizing the functioning of the Supreme Judiciary Council and establishing the composition of the judicial system, the rights and obligations of magistrates, their situation 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 increase citizen participation in the management of local affairs and public services. This led to the consolidation of the current 16 regions in 12 bigger regions to increase their economic and social attractiveness and maximize synergies. In this context, three organic laws have been adopted in 2015. The main purpose of these organic laws is to provide the 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, the regional and local councils have been granted expanded powers and the corresponding resources based on the principle of subsidiarity.

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Chapter 6: The Carbon Wealth of Nations: From Rents to Risks[28]

James Cust, AFRCE World Bank and David Manley, Natural Resource Governance Institute

Abstract

Carbon wealth- measured in terms of fossil fuel resources – has been a source of prosperity for many countries. Of the total stock of global wealth, carbon-based wealth constitutes 3.4%, equivalent to US$39 trillion or roughly 50% of annual global GDP. However, it may become an increasing source of risk. Advances in technology and broadening climate policies may diminish the value of carbon assets and undermine traditional development pathways for carbon-rich nations.

This chapter discusses the extent of countries' risk exposure and the policies they might consider as avenues to mitigate this risk. In doing so, carbon rich nations face four challenges. First, they are often heavily exposed to risk that the value of carbon-based assets may diminish, both in terms of the share of total national wealth but also its per capita contribution. Second, they are constrained in their ability to diversify out of this risk- the rate of depletion being one such constraint. Third, they face economic and political pressures that may increase rather than decrease their exposure, such as the desire to build and sustain nationally-owned resource companies or invest in downstream industries and skills. And fourth, the historic record of countries using their fossil fuel wealth to diversify their asset base has been poor, even during the recent commodity price boom. In some cases, fossil fuel resources have been a curse.

We discuss four policies countries might consider to mitigate the risks and challenges they face. First, they should focus on diversification, both at the sectoral level but also as the asset level - investing the rents from fossil fuels into non-carbon linked human and physical capital. This may also involve divesting from fossil-fuel linked assets help in sovereign wealth funds or avoid favoring carbon-intensive sectors that might be exposed to similar risks. Second, countries should seek to reduce political risk faced by investors and promote the competitiveness of the resource sector. This can help ensure they remain a profitable destination for fossil fuel investment longer than other locations, even as the world decarbonizes. Third, countries should avoid subsidizing the fossil fuel sector- either explicitly through production or consumption subsidies, or implicitly such as overly generous contracts with companies. Finally, countries should carefully consider the rate of depletion and whether or not to extract.

[28] The authors would like to thank Kirk Hamilton, Glenn-Marie Lange and Michael Toman for comments. All remaining errors are our own. Corresponding author: jcust@worldbank.org

Introduction

Natural resources constitute a significant share of most nations' wealth. Of this share, carbon wealth (here we define as fossil-fuel resources, namely oil, natural gas and coal), can constitute a dominant proportion, for example in oil-rich nations. Of the total stock of global wealth, carbon wealth constitutes 3.4% equivalent to US$39 trillion or roughly 50% of global GDP in 2014. This share has been increasing in recent years, rising from US$11 trillion or around 1.6% of total wealth in 1995, driven by both new discoveries and higher prices.

Countries rich in carbon-based wealth face several challenges and risks. Some of these are well known, such as the so-called resource curse (van der Ploeg, 2011), while others are emerging risks linked to the carbon content of their natural wealth (Cust et al., 2017 & Manley et al., 2016).

Carbon-rich countries have to follow a series of steps. First, to realize the potential value of this wealth it must first be transformed into cash via extraction (or the selling of extraction rights). Second, since it is a depleting non-renewable resource, some proportion should be converted into productive assets such as physical or human capital, to ensure the total stock of wealth of the country does not diminish. Such pathways have proven challenging for developing countries, with few having much to show for the resource depletion observed in recent decades (Venables, 2016; Warner, 2015). Finally, broad based economic development may be best served by reducing risk exposure, such as to resource price volatility. Here economic diversification is often advised as a primary objective for these countries.

Additionally, the carbon-related risks faced by these countries are only beginning to emerge. If policy actions or technological innovation can decarbonize the global economy, the value of extracting carbon-based resources may be severely diminished. As such these countries face a series of dilemmas in terms of how they choose to develop these resources and their economies to maximize the value they can capture while minimizing the future risks they may face. Furthermore, a sustainable development path requires these countries to navigate choices around whether to deplete a polluting and non-renewable resource while ensuring they maximize the benefits left for future generations.

In this chapter, we present new data on the carbon wealth of nations and explore some of the challenges and opportunities such wealth presents. We discuss 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-based wealth is a key contributor to greenhouse gas emissions and human-activity induced climate change. According to the IEA (2017) meeting the 2 degrees warming goal by

2050 would require leaving 80% of coal deposits in the ground, 50% of oil reserves and 40% of gas reserves.

While the path to stabilizing the climate remains unclear both in terms of timing and how the world might achieve this goal, taking such risks seriously may prove important. Many carbon-rich nations hold more than 45 years of reserves at current rates of depletion, meaning many of them may see the value of these reserves fall, or even stranding of these subsoil assets- whereby they are no longer economically viable to extract - a concept we refer to as the risk of *Stranded Nations* (Manley et al, 2016).[29]

In this section we show how much carbon wealth countries probably have, as measured by the Changing Wealth of Nations study, and the uncertainties around 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 the carbon wealth of nations constitutes a substantial share of overall natural wealth. For example, the carbon wealth for the Middle East and North Africa is almost 30% of their total wealth. For sub-Saharan Africa, carbon wealth is a larger than average share. Populous carbon-rich countries such as Nigeria and DRC, have seen growth in population exceed growth in wealth, resulting in negative growth in total wealth per capita between 1995 and 2014.

From the perspective of a country, the carbon wealth of nations is a significant stock of assets but also one which poses a series of challenges. The value of fossil fuel subsoil assets can only be realized at the rate of extraction, combined with the government's ability to effectively capture the rent value associated with these resources. Further, the asset stock is depletable, meaning, if countries wish to at least maintain their total wealth, they need to transform the depleting fossil fuel asset with alternative productive assets such as human or physical capital (this is known as the Hartwick Rule).[30]

[29] Reserves are endogenous to market conditions and exclude undiscovered or unproven resources

[30] The Hartwick Rule states that all revenues from depletable resources must be invested to transform the below-ground fossil fuel wealth into above-ground financial or other assets (Hartwick, 1977).

Table 5 - Wealth by shares, by Region and Income Group, 2014

By WB region	Carbon wealth (% Total Wealth) [31]	Natural wealth (% Total Wealth)	Physical wealth (% Total Wealth)	Human wealth (% Total Wealth)
East Asia & Pacific	1.8%	14%	26%	59%
Europe & Central Asia	2.4%	28%	40%	37%
Latin America & Caribbean	3.1%	18%	21%	64%
Middle East & North Africa	28.6%	42%	20%	40%
South Asia	3.5%	22%	27%	53%
Sub-Saharan Africa	8.8%	34%	16%	51%
By income groups				
Low income	1.2%	31%	14%	55%
Lower middle income	6.0%	13%	29%	60%
Upper middle income	5.4%	16%	28%	88%
High income: non-OECD	1.1%		43%	49%
High income: OECD	0.6%	3%	39%	60%

Carbon wealth is distributed unevenly around the globe. Figure 17 below shows the location of carbon-rich countries, measured in terms of fossil fuel rents. Several countries are estimated to have fossil fuel rents over 50% of GDP, in particular MENA countries such as Kuwait, Iraq, Saudi Arabia and Oman.

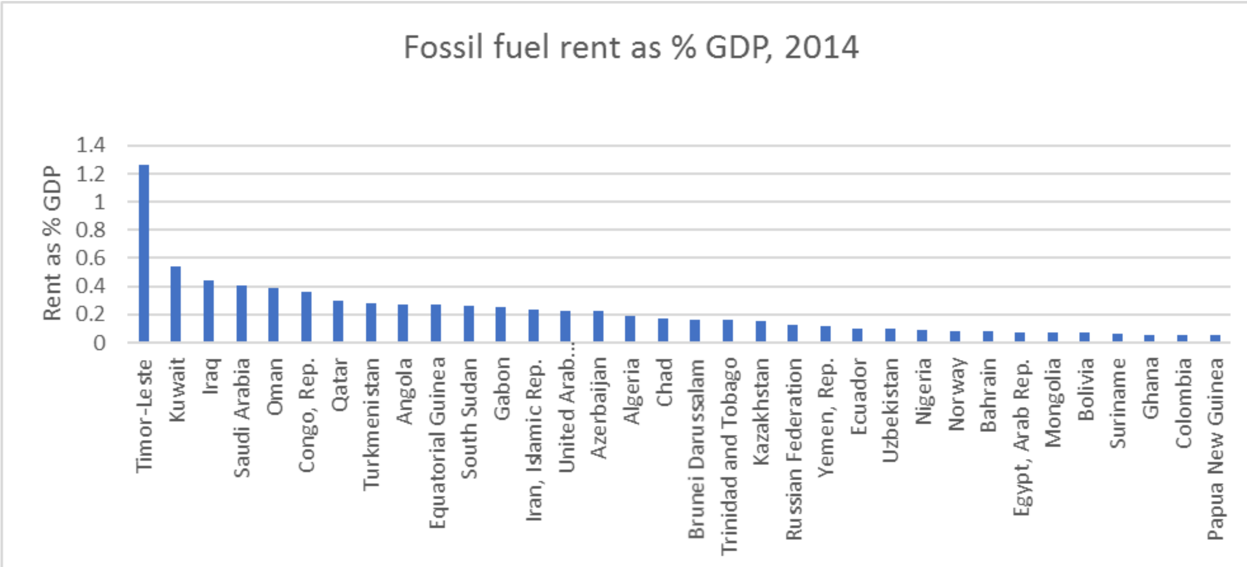


Figure 17 - Fossil fuel wealth (rent as % GDP), by country [To be converted into a map]

Calculating the carbon wealth of nations

The fossil energy resources valued in the World Bank wealth accounts are petroleum, natural gas, and coal. *The Changing Wealth of Nations* (World Bank 2017) values nations' stocks of non-renewable resources as the present value of expected rents that may be earned from extracting the resource until it is exhausted. This value, V_t, is given as:

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

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[32]) and *T* is the lifetime of the resource. Rents in the current year are calculated as revenues less production costs including a 'normal' rate of return.[33] The Appendix to this volume includes a detailed breakdown of the approach to calculating the rent values.

Uncertainty in rent estimates

The estimates of fossil fuel rents are averages across all fossil fuel extraction projects in a country, using costs aggregated to the regional level. These averages mask three qualities that are important to understand.

[32] The 4 percent assumption is based on the long run average rate of return on financial assets globally.
[33] It is important to note that since this is based long run average global returns it does not reflect the country-specific risk premia that may be necessary to compensate investors for investing in certain environments.

Rents adjust to reflect two changes across time: the cost of producing the resource (including the cost of capital) and the price paid for the resource. If either change the overall level of rents can change.

Prices for fossil fuels are relatively easy to measure—most types of fossil fuels are valued close to global market prices. For instance most types of crude oil are valued close to price benchmarks such as Brent or West Texas Intermediate. Prices vary, but the variation is mainly global, not local.

Costs, on the other hand, are more difficult to measure.

Costs vary at a global level over time and with the price of oil —as demand for oil rises, derived demand for the inputs to oil extraction also rise (Toews and Naumov, 2015). Further, costs vary by geology. For example, the challenge of drilling offshore versus onshore fields, even when they are located in the same country. Therefore, any average estimate at the country or regional level may not be informative about the rents associated with any single field or asset.

Costs also vary across the project life-cycle. Here in any given year the relationship between costs and revenues can vary widely depending on whether a field is at an early, mid or mature stage in development. For example, for the first few years of a field's life, costs are high as the operator develops the oil wells or mines. Once the project starts producing, average costs fall and revenues rise. As the field matures revenues decline again as the reserve is depleted.

When taken at the country or regional level, rents estimates average costs and prices across a wide range of fields and geology at different stages of development. It is therefore important to treat any interpretation with caution. For example, one cannot say that a country is under-taxing its resource sector by viewing rents numbers taken for a given year. Instead one much examine the question on a project-by-project basis, such as using the open-access Fiscal Analysis tool from the IMF.[34]

There exists considerable uncertainty regarding the value of reserves going forwards, and therefore the stream in income countries might expect from their carbon wealth. Some of this uncertainty is linked to usual unpredictability of resource prices, which exhibit a random walk. However, further uncertainty stems from technological advancement and climate policy that may drive a shift away from fossil fuels. We discuss this uncertainty in detail in Section 4.

The relationship between resource rents and carbon wealth: upper and lower bounds on carbon wealth

Carbon wealth in the Changing Wealth of Nations is expressed in net present values of carbon rents. However, since the Changing Wealth of Nations rent estimates do not include a risk-adjusted return on capital it is important to note that any such estimate represents an extreme

[34] http://www.imf.org/external/np/fad/fari/

upper bound of the portion that should or could accrue to resource owners, under conditions of zero additional risk beyond the opportunity cost of capital. In other words, the CWON rents numbers apply a flat 4% return on capital to the cost base for extraction. This reflects the opportunity cost of capital as it could be deployed to other sectors for such a return. This does not, however, reflect additional returns that need to accrue to capital owners to compensate them for, for example political risks, from operating in challenging governance contexts.

Positive rents numbers mean, at the simplest level, that there is an income stream above and beyond the costs of development and production. These may accrue to the capital owner- in the form of returns, or to the government in the form of royalties, profits-based taxation, production sharing or other revenue-capture instruments.

In most countries, the state owns fossil fuel reserves.[35] Daniel et al. (2010) and Garnaut and Ross (1974) argue that governments should levy taxes to capture the rents over the life-cycle of a given project. They argue that rents represent the full value of the resource beyond a fair return to private investors. In contrast, taxing much more than the rent—according to the definition of rent—will make projects no longer profitable and lead companies to stop development. Fossil fuel rents therefore provide an estimate of the maximum amount of money governments could receive over the long term. It is a widely held view (see for example Daniel et al. (2010)) that governments may fail to capture the maximum available rents associated with fossil fuel extraction for a variety of reasons, including differential risks being borne, significant uncertainties across time and asymmetry of information.

Since the rent estimates do not account for the risk-adjusted return on capital, a question remains what amount of rent should accrue to companies to fairly compensate for the various risks they take on. One proxy to estimate this could be the typical rate of return on capital in other industries or the oil industry on average.[36] However, the oil industry often operates in countries with challenging governance environments associated with high levels of political risk, such as the threat of expropriation (for a discussion of the extent to which investors are deterred by weak political institutions see Cust and Harding, 2015). Therefore, it may be the case that investors require a higher return than the average industry rate of return on capital, when operating in certain contexts.

An alternative proxy arises from an alternative interpretation of the estimated CWON rents numbers. Here, once we subtract the portion accruing government, we might consider the remaining rents as reflecting this risk-adjusted return on capital. This assumes such an outcome reflects a market equilibrium level of compensation to capital owners. In other words, in equilibrium, investors choose projects in high-risk environments versus high cost fields (like tar sands or deep-water fields) up to the point where they receive the observed level of

[35] The United States is a notable exception, where for non-Federal onshore sites, property owners hold the rights to subsoil resources.

[36] Long run global financial asset returns of 4% is the baseline assumption used by the CWON estimates of rent- and is therefore included in the costs rather than rents reported.

compensation for the risk they are taking (versus developing a high cost but low risk field). This means the observed return to investors, minus taxes, could be the correct level of risk-adjusted return; and therefore, attempts to reduce this by higher taxation may push a project beyond financial profitability, even where positive rents are still observed using the CWON methodology.

Therefore, rather than reflecting super-normal profits accruing to investors, such estimates may simply reflect the fair compensation required to operate in the country and geological basin they are observed operating in. Consider the counter-factual, if such incomes streams represent super-normal profits, in an industry with threat of entry, other investors should also choose to invest in a given country and pay the government a larger share of rents as tax, up to the point where such profits are competed away. We only observe the equilibrium outcome.

Therefore, marginal investment decisions may be a balance between the observed cost of operating in certain geological basins- such as deep water offshore in the Gulf of Mexico versus the unobserved cost of operating in certain institutional contexts such as onshore Democratic Republic of the Congo. In the latter case we may observe high hypothetical rents, when they may actually constitute risk-adjusted compensation for investors.

Carbon Risk

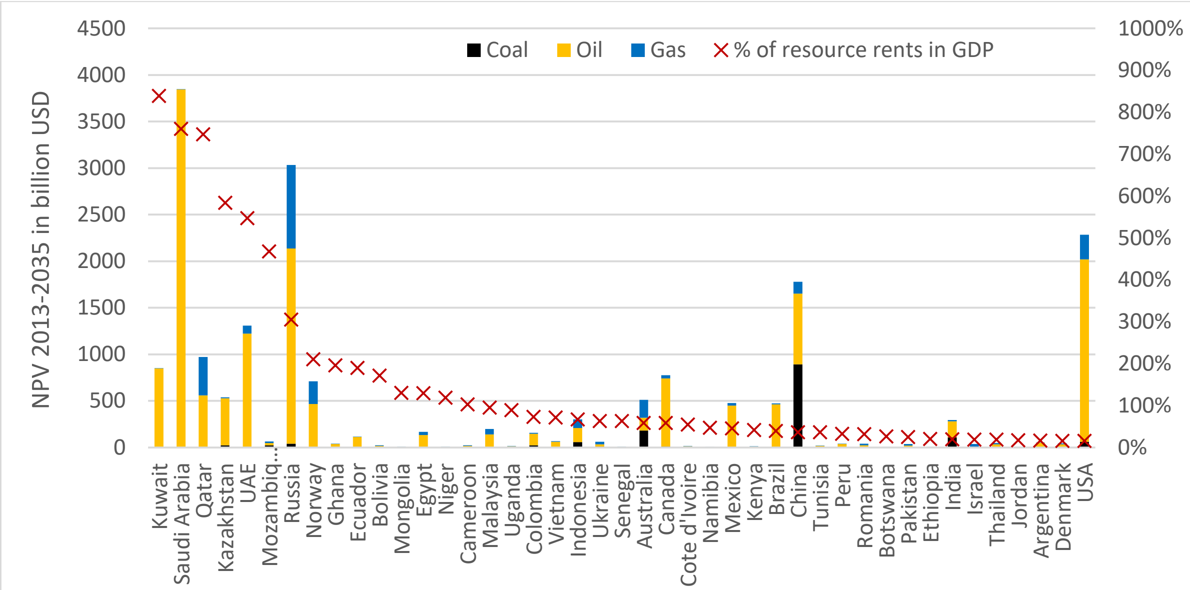
Carbon wealth- measured in terms of fossil fuel resources – has been a source of prosperity for many countries. Furthermore, many countries still hold a significant share of their total wealth in the form of carbon resources. Of the total stock of global wealth, carbon-based wealth constitutes 3.4%, equivalent to US$39 trillion or roughly 50% of annual global GDP.

The Changing Wealth of Nations provides a valuable tool to measure and evaluate the carbon wealth of nations. First, it quantifies it. Second it puts it into a context of other forms of wealth. Third, it provides a framework for considering how to estimate the carbon wealth and what its upper bound values might be, as we discuss in Section 3.

In section 4, we consider a new application of the Changing Wealth of Nations data, of putting carbon wealth in the context of climate change and the risks posed to carbon wealth by global decarbonization. The uncertainty regarding the timing, extent and distribution of this decarbonization process we refer to as “carbon risk”. This is the risk that global demand for fossil fuels will fall this century making countries’ carbon wealth significantly less valuable.

Not only does decarbonization pose a risk for the value of subsoil carbon assets. Additionally, countries have other forms of carbon linked wealth that are not measured explicitly by the CWON methodology. These fall into categories of physical capital (such as power plants or downstream industries and infrastructure) or human capital (such as petroleum sector skills and expertise), or other kinds of assets such a government holdings in national oil companies or fossil fuel stocks held by Sovereign Wealth Funds. Under conditions where carbon-intensity of production is subject to taxation or technological advances make such activities less demanded, these carbon-linked assets may also lose value.

Figure xx: Net present value of expected resource rents



Source: *WB staff calculations [to be updated with latest CWON estimates]*

Why is carbon wealth at risk?

Various authors and agencies (e.g. IEA 2015) state that the world cannot consume more than 20% of existing fossil fuel reserves in order to keep within the internationally set 2 degree 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.

While it is now widely accepted that consumption of fossil fuels must fall dramatically to avoid serious global warming, it is not yet clear how, or whether, such a decline might occur. However, carbon-mitigation commitments made on a country-by-country basis would fall short of such a goal at their current trajectories. Meanwhile, significant cost reductions are being achieved in alternative energy technologies such as solar and wind power that promise potential reductions in fossil fuel consumption as they may soon begin to undercut the costs of extraction of oil, gas and coal.

Stranded assets to stranded nations

The concept of stranded assets with respect to climate change policies has received widespread academic, NGO and media attention in recent years (Helm, 2015 and Leaton, 2013). However, it is often predicated on a hard carbon budget constraint imposed globally, for which there is little evidence is likely to occur. Further, even if such a budget constraint were imposed, the effects on the valuation of private companies- who discount future profits at commercial rates and hold relatively few years' worth of booked reserves on their balance sheet- 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. They 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.

Stranded Nations, on the other hand, can be thought of as the public (government) equivalent to the private sector concern around Stranded Assets. While the risk of Stranded Assets may be overstated according to commentators such as Helm, we argue the risk of Stranded Nations is far greater, more salient to public policy, and thus far relatively undocumented. Since sovereign states are the ultimate owners of fossil-fuel wealth, discount the future at a lower rate than private agents, and have economies which may be specialized in carbon-related sectors, skills and infrastructure, the amount and severity of potential *stranding* (i.e. loss of value in a variety of carbon-linked assets) is significantly higher (see for example Cust et al. 2017 & Manley et al, 2016).

How much carbon wealth is at risk?

Carbon-rich nations often have large shares of their total wealth at risk from a permanent decline in demand for fossil fuels. Figure 18 gives the countries ranked by the share of their total wealth coming from fossil fuel assets.

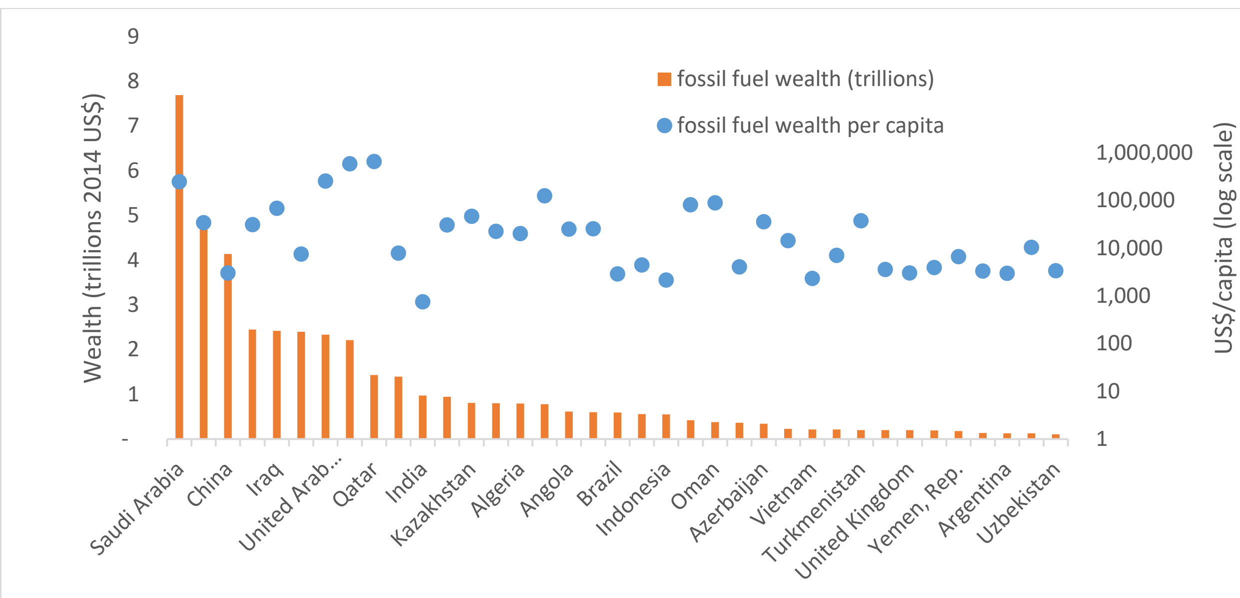


Figure 18- Fossil fuel wealth, by country, 2014

The risk exposure of carbon-rich nations can be defined in a variety of ways.

First, in terms of quantity. Countries with large amounts of untapped carbon wealth may see a large portion of this wealth left under the ground. Second, in terms of the cost of production. Here resources are likely to lose their value and be left in the ground if the cost of production (either full lifetime cost of production, or the operating costs of pre-existing assets) exceeds the price offered by the market (for example via falling prices for carbon resources, or a carbon tax putting a wedge between the market price and the pre-tax price).[37] Here high cost producers would face the most serious risks seeing their resources stranded first. Third, in terms of counter-factual revenue dependence. Countries who gather a large amount of taxes from the fossil fuel sector, including those who are able to tax a large share of the rents, face larger risks than those who may be failing to capture the rents currently, unless there are prospects for improvements in tax administration.

In countries with high estimated rents, the carbon risk exposure from a permanent decline in the value of fossil fuels has greater consequences than for countries with the same value of reserves but lower unit rents. On the other hand, countries with high rents may also be low cost producers, therefore may be able to continue profitable extraction even at lower fossil fuel prices, or higher levels of carbon tax. This is why it is important to put the carbon wealth of nations in the context of a countries total wealth, as captured by the Changing Wealth of Nations.

Therefore, rent numbers can give us a rough rule-of-thumb guide to the potential risk exposure of a country, in profit per barrel terms, this shows the amount of risk exposure per barrel (in contrast the companies risk exposure is their return on capital). The carbon wealth of nations is calculated directly from the rent/unit of resource, rather than its total value. Therefore, the rent is a reflection of the amount of national wealth at risk if the overall value of fossil fuel resources declines.

Viewed from the perspective of carbon-rich nations, some have high cost deposits- such as deep water offshore gas, or shale oil. Such sources of carbon wealth may be the first to be ‘stranded’ by declining costs in alternative technologies, or if countries seek to impose carbon taxes on consumption. Further where the carbon-content of fuels varies, carbon-intensive resources such as coal or tar sands may prove the first to be displaced. However, it is also the case that those countries with the highest unit rents (due to low costs of development) have the most to lose, but may also see the least stranding (since they have such low costs of development).

[37] Any such impact may be further effected by the carbon content of the resource. Coal, tar sands and other unconventional petroleum products contain a high ratio of emitted CO_2 per unit of energy they generate. As such, where a carbon policy or tax rises proportionately to carbon content to reflect the social cost of consumption, certain types of resource may be stranded first, above and beyond their private cost of extraction.

Table 6 - Regional distribution of reserves unburnable before 2050 for the 2-degree Celsius scenario

	Oil		Gas		Coal	
Country or region	Billions of barrels	% of total reserves	Trillions of cubic ft	% of total reserves	Gt	% of total reserves
Africa	28	26%	4.4	34%	30	90%
Canada	40	75%	0.3	24%	5.4	82%
China and India	9	25%	2.5	53%	207	77%
Former Soviet Union	28	19%	36	59%	209	97%
Central and South Asia	63	42%	5	56%	11	73%
Europe	5.3	21%	0.3	6%	74	89%
Middle East	264	38%	47	61%	3.4	99%
OECD Pacific	2.7	46%	2	51%	85	95%
Other Developing Asia	2.8	12%	2.1	22%	17	60%
USA	4.6	9%	0.5	6%	245	95%
Global	449	35%	100	52%	887	88%

***Source:** McGlade and Ekins. 2015*
***Note:** The calculations assume imposition of a globally uniform carbon price necessary to remain within the 2 degrees warming target.*

Challenge 1: Carbon nations cannot diversify carbon risk quickly or easily

It is uncertain when and how quickly the global economy will decarbonize; therefore, the risk faced by carbon-rich nations has an important temporal component. This temporal uncertainty is matched by a temporal challenge faced by carbon-rich nations- namely that they can only realize the value of fossil fuels at the pace of depletion. This is due to the practical challenge of getting fossil fuels out of the ground, which is limited by capital and technological capacity. However, countries are also constrained in their ability to transfer the rights to fossil fuel resources beneath the ground. In almost every country around the world – a key exception being onshore US non-Federal land- the government is the residual owner of subsoil assets. Under normal circumstances, such governments will license the rights to extract the resource, sometimes to nationally-owned companies, and otherwise to private agents. However, since governments cannot transfer ownership rights to the private sector, they rely on taxing the stream of rents as resources of extracted, thus limiting the ability to shift inter-temporal risks onto others.

Furthermore, publicly traded companies such as those listed on the New York Stock Exchange, face strong restrictions on how much of a country's reserves they can 'book' as part of their assets, limiting their risk exposure forwards in time.

Figure 19 shows many countries have over 50 years in current fossil fuel reserves at current rates of depletion. For carbon-rich developing counties, the median time to depletion is 45 years. These estimates rely on two crucial factors: the current rate of production, and the level of reserves. Both can change and both are somewhat within the control of governments and companies to affect.

Governments and companies can change the rate of production, but is limited, particularly on a project basis. Companies make choices at the level of individual wells, or fields or mines. Governments who are not directly engaged in operations have fewer ways to impact the rate of production. To a small degree fiscal incentives or penalties might be used to accelerate or decelerate extraction. Furthermore, governments typically determine the rate of licensing new fields for exploration and development, thus choices around the pace of licensing can affect future depletion rates.[38] Avoidance of consumption and production subsidies (implicit or explicit) can help manage the pathway towards carbon risk minimization- by helping a shift towards the socially optimal level of fossil fuel exploitation.

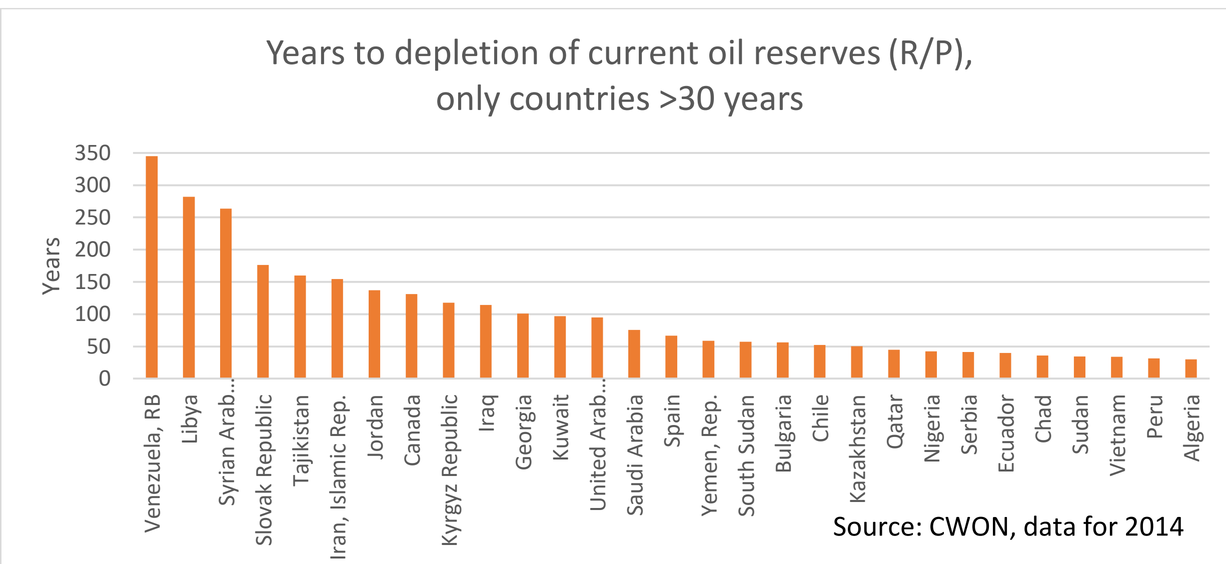


Figure 19 - Time to depletion based in current reported oil reserves

[38] The incentive to accelerate depletion created by uncertainty about future climate policies is known as the Green Paradox. This predicts that climate policies could induce earlier and faster depletion which in turn could push down carbon resource prices, and therefore delay a decarbonization (van der Ploeg and Withagen, 2012).

Challenge 2: Carbon nations' policies typically increase exposure to carbon risk

The risk exposure faced by carbon-rich nations is not limited to subsoil assets. Many countries choose to develop these resources in ways that may increase their risk exposure via above-ground assets also, including nationally-owned resource companies, sovereign wealth funds, or the exposure created by the specialization and structure of the economy.

These choices are in turn driven by political or economic rationale that may be hard to resist or reverse, even when future carbon risk is taken into account.

Traditional diversification has typically led countries to develop downstream value addition to complement resource extraction and export. Examples include refining, processing, power generation and industrial uses of fossil fuels. Such traditional diversification can also lead countries to develop human capital in these sectors, whose transferrable skills to non-carbon linked activities may vary. When viewed through the lens of future uncertainty regarding pathways to decarbonization, such policies may need re-evaluating to take into account the risks they might pose.

The role of nationally-owned resource companies

Many petroleum rich countries have opted to create national oil companies (NOCs) to allow state participation in the sector. For some, these companies have monopoly access to a countries resources, in others they play a leading operations and commercial role, but compete alongside private companies, and in others they are partners, sometimes holding minority stakes or free carried equity. More recently some countries have partially privatized NOCs, retaining a smaller state stake but otherwise listing these companies publicly.

In all the cases described above, the state has opted to hold public wealth in the form of a nationally-owned company. They do this for a variety of political and economically motivate reasons, including to maximize the rent capture from the sector, to exercise state control over a key strategic sector, or to build expertise and capabilities.

Whole the motivation for NOCs can be a risk-sharing strategy, such as to ensure the state captures more of the upside risk (such as from major discoveries or positive price shocks), in return for greater downside risk (exploration setbacks, negative price shocks or cost increases).

However, future carbon market risk poses additional risk factors for the NOC and hence the state. Where the value of fossil fuels may decline permanently in the future, the value of the NOC may also decline, particularly where their reserves, capital and capabilities are tied to the value fossil fuels. Hence, those countries with larger NOCs relative to the rest of the economy may be exposed to the greatest risk.

Furthermore, some countries encourage NOCs to grow and expand operations overseas. This has been a popular and successful venture for countries such as Malaysia (Petronas) and Norway (Statoil). However, such state controlled international companies may further increase risk exposure. First, to expand beyond domestic markets they require additional capital which ties up greater state resources than a domestic NOC. These resources, in additional to the licenses, reserves and investments the company makes abroad, all expose the country to additional carbon market risk, should the value of these resources decline in the future.

Table 7 below illustrates the value of NOCs and state share of that value, defined in terms of company assets. The top 10 largest state owned oil companies account for over US$2.3 trillion dollars of state capital, or around 3% of global GDP.

Table 7 - State's share of National Oil Companies, by total asset value

Country	State-owned company	Total assets (USD bn), as of	State share (USD bn)
China	China National Petroleum Corporation (incl. 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	Petróleos de Venezuela	226.8	226.8
Iran	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	Kazmunaigaz	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

Source: Annual reports of companies for most recent available of 2014 or 2015; adapted from Manley et al., 2016

Notes: Table does not include a number of smaller national oil companies from FFRDCs for whom data is unavailable, namely: Sontrach, Algeria; Socièté 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.

The role of sovereign wealth funds

Sovereign wealth funds have become a popular means for countries to hold revenues from fossil fuel extraction. 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 a vehicle for wealth diversification.

A simple objective for long term funds typically balances financial risk and reward to ensure a steady stream of income payments on investments. However, as has been noted in recent research (Bremer et al, 2013), funds may not be optimized with respect to the other assets held by the state. In particular, for fossil-fuel rich countries should seek to diversify their portfolio away from assets whose value may be positively correlated with their subsoil reserves or other state assets linked to fossil fuel prices – such as nationally-owned resource companies. Counter-intuitively, in the short run, the value green investments such as renewable energy company stocks, may also be positively correlated with the price of fossil fuels.

This caution is strengthened when considering the additional carbon risk associated with future decarbonization of the global economy. Such as shift could further damage the value of SWF assets whose value is linked to fossil fuel extraction.

Countries can help mitigate the above-ground risks by avoiding investments in carbon-linked assets, while considering the combined portfolio of above ground and below ground assets. In some cases this might include divestment from carbon linked assets, or ensuring maximum transferability of carbon-linked skills or carbon-linked sectors into low carbon alternatives.

Climate strategies of carbon dependent countries
(forthcoming World Bank report)

New analysis by the World Bank identifies the risks faced by carbon intensive countries under different carbon price and policy scenarios. This allows a quantification and examination of different pathways to risk mitigation, including via the diversification of sectors and assets.

Using CGE modelling, the analysis is able to evaluate the impact of carbon policy shocks on different countries and show 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 against *traditional diversification* which has tended to focus on downstream value-added activities which build off the carbon-intensive energy based available to carbon-rich countries. Instead, 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.

Challenge 3: Countries have found it difficult to diversify away from carbon wealth

Carbon-rich nations hold fossil-fuel linked assets above and below ground, exposing themselves to price volatility as well as potential carbon risk in the future. A typical policy prescription for resource-rich nations is to use the proceeds from extraction for economic diversification[39]. According to the Hartwick Rule, resource-rich countries should convert subsoil assets into productive assets such as human or physical capital. However, most resource-rich countries have found it difficult to diversity their economies (Venables, 2016, Warner, 2015).

The rate of conversion from a depleting asset into productive above ground assets is calculated in the form of Adjusted Net Savings (ANS), which also takes into account depreciation of capital, education expenditures and air pollution damages. The most resource-rich countries have seen the most negative ANS measures, while many resource-rich countries have seen average ANS values below zero, meaning they have failed to offset depletion with accumulation.

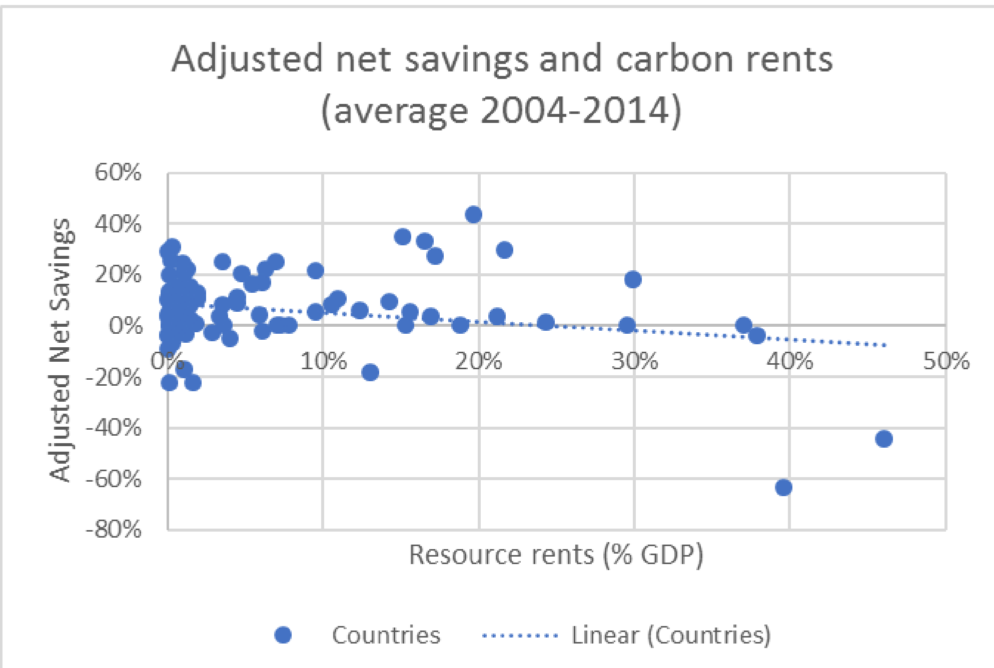


Figure 20 - Adjusted net savings and non-renewable resource depletion

Recent studies, such as the World Bank's report Diversified Development advocate balance-sheet diversification by resource-rich countries.[40] This may be preferable to achieve than sectoral or product line diversification which has been espoused more traditionally since it may more effectively diversify risks and provide a foundation for diversified growth.

[39] https://blogs.imf.org/2017/05/19/restarting-the-growth-engine-in-sub-saharan-africa/

[40] Diversified Development: Making the Most of Natural Resources in Eurasia https://openknowledge.worldbank.org/handle/10986/17193

Furthermore, for carbon-rich countries, balance sheet diversification may help shift risk exposure of the rest of the public and private economy from carbon risk. It will help encourage countries to avoid too much sectoral concentration in carbon-linked industries or investments. Given the historical record, and *resource curse* related challenges to fossil fuel exploitation, countries may wish to consider carefully their optimal rate of depletion and whether, or not, to extract.

Conclusion

While the scope, timing and modes of decarbonization of the global economy remain uncertain, the scientific consensus agrees on its importance and urgency. According to the IEA (2017) meeting the 2 degrees warming goal by 2050 would require leaving 80% of coal deposits in the ground, 50% of oil reserves and 40% of gas reserves. If such a 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). Further, such a fall in value would likely be distributed unevenly, in part due to the mode of the transition – for example technology induced or carbon price induced- but also due to the degree of carbon risk exposure at the level of different countries. There exist a set of actions countries can pursue to increase or decrease their exposure to this carbon risk.

We discuss four policy pathways countries might consider to mitigate the risk. First, they should focus on diversification, both at the sectoral level but also as the asset level- investing the rents from fossil fuels into human and physical capital. This may also involve divesting from fossil-fuel linked assets help in sovereign wealth funds or in state capital such as nationally-owned resource companies. Second, countries should seek to reduce political risk and promote the competitiveness of the resource sector. This can help ensure they remain a profitable destination for fossil fuel investment longer than other locations. Third, countries should avoid subsidizing the fossil fuel sector- either explicitly through production or consumption subsidies, or implicitly such as overly generous contracts with companies or failing to impose the social cost of carbon. Finally, countries should carefully consider the rate of depletion and whether or not to extract.

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Part 2. New Developments in Human Capital

Chapter 7: Human Capital and the Wealth of Nations: Global Estimates and Trends
Kirk Hamilton and Quentin Wodon

Chapter 8: Gains in Human Capital Wealth: Stylized Facts from Growth Models
Ada Nayihouba and Quentin Wodon

Chapter 7: Human Capital and the Wealth of Nations: Global Estimates and Trends

Kirk Hamilton and Quentin Wodon

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 volume as the net present value of the future flow of wages and other labor earnings of the population. As noted by Lange et al (2017), 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 does 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 in order to set the stage for the third part of this book, with more detailed analysis provided for some of those questions in subsequent chapters.

While 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. This chapter explains the motivations, concepts and methods lying behind the measurement of human capital wealth and presents the first ever estimates for close to 150 countries. In previous editions of the *Changing Wealth of Nations* reports produced by the 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 in this book and chapter suggest that much of intangible wealth is actually human capital wealth. As discussed in subsequent chapters, this has major implications for policy.

The chapter is organized in two main sections. First, we explain how our measures of human capital are estimated. On purpose, our measures of human capital rely on the economic benefits that a well-educated and healthy workforce generates. The fact that we emphasize the role of human capital in generating income through wages and earnings does not imply in any way that we are 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, our 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 well as some of the factors that are 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 our 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. A conclusion follows.

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 independently of its impact on production and wages. Yet in this chapter, these intrinsic benefits are not discussed (this does not mean that they are denied). The emphasis is deliberately and solely on the economic benefits that a productive labor force provides for a country's population. A detailed explanation of the steps for the estimation of human capital wealth measures is provided by Barrot et al. (2017). In this section, a summary of the methodology is provided in order to explain the basic intuition and approach.

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, currently, figures on Adjusted Net Saving published by the World Bank treat public sector expenditure on education as investment. This is technically correct from the point of view of wealth accounting, since these expenditures have the character of investment. But expenditures are measured gross and 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. Finally, these measures are only loosely connected to the value of the human capital created, owing to inefficient expenditures, particularly in developing countries. Analysis 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, and not the investments per se. This is the approach used here following Jorgensen and Fraumeni (1992a, 1992b). We define human capital wealth as the discounted value of future earnings for a country's labor force (see also Fraumeni, 2008, and Hamilton and Liu, 2014, for a basic introduction to the literature on human capital measurement). In other words, we consider human capital wealth as 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 wellbeing. One note of caution is needed, however, because our 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 upon an assumed recovery path for the economy.

While our definition of human capital wealth as the net 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 we define human capital wealth as the discounted value of future earnings for a country's labor force, we need to know how likely it is that various types of individuals will be working, and how much they will earn when working. By "various types" of individuals, we mean individuals categorized by age, sex, and level of education. Essentially, we construct using household surveys 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 (2015), the estimates of likely earnings are based on Mincerian wage regressions. The regressions enable us to compute expected earnings for workers throughout their working life, 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 age 65, but factoring in the fact that some may go to school beyond age 15 (for the purpose of our estimations until age 24). 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, 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 due to a lack of standardized household survey data to conduct the estimations in a systematic way. Thanks to the availability of the World Bank's International Income Distribution Database (I2D2) database of household and labor force surveys, the task can now be performed. The database provides access to surveys for more than 130 countries over more than 20 years (Montenegro and Hirn, 2009). It is used for estimates of 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 earning 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 in coherence with either the system of national accounts or population data for the countries. Therefore two adjustments are made.

First, in order to ensure consistency of the earnings profiles from the surveys with published data from the system of national accounts and 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 1) in GDP as available in the Penn World Tables (Feenstra et al,. 2015). To explain why this 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, so that total earnings from the survey may be too low in comparison to the share of labor earnings in GDP. Version 8 of the Penn World Tables (PWT) provides estimates of the income of the self-employed in nearly 130 countries. The PWT estimates draw on data on mixed income and make adjustments for returns to capital, persons employed as a share of total persons in the labor force from ILO, and value added in agriculture in low income countries with high agriculture shares of GDP (see Box 1). In practice, we adjust the earnings profiles by age, sex, and years of education 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 PWET data.

Box 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 Tables (PWT) to supplement the I2D2 database. Self-employment is important in many countries, especially in the agricultural sector of developing countries. In terms of estimations however, the fact that earnings of the self-employed reported in national surveys typically combine profits plus returns to human capital makes 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 questionnaire between countries).

Fortunately, as documented in Feenstra et al. (2015), version 8 of the Penn World Tables (PWT) provides estimates of the income of the self-employed in nearly 130 countries. The PWT estimates draw on data on mixed income and make adjustments for returns to capital, persons employed as a share of total persons engaged from ILO, 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 the shares of returns to capital and labor in mixed income by using the observed shares for the employed. For poor countries where small-holder farming dominates the agricultural sector, PWT treats all of the value added in agriculture as the return to self-employment. While these estimations are by necessity relatively crude, potential errors with this approach in poor countries are limited by the fact that these countries often have low capital inputs as well as relatively low land rents in agriculture-dependent economies.

Based on the Penn World Table figures, and filling gaps for countries not covered by PWT using regional averages, our estimates of human capital wealth augment the SNA compensation of employees figures to include the compensation of the self-employed. This implicitly assumes that the age-sex-education structure of the self-employed is the same as for 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 limit, but it is mitigated to the extent that the estimated earnings of the self-employed will tend to be quite low in these countries.

Second and separately, the estimations also rely on two variables obtained from data compiled by the United Nations Population Division: (1) population data by age and sex (so that the data in the household surveys can be better calibrated) and (2) 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). Again, we adjust data from the surveys to data from the United Nations for population estimates in order to ensure that estimates are adequate (while nationally representative, and due to limited sample sizes, household surveys may not estimate precisely the exact distribution of the population by age and sex as well as life expectancy).

Choice of the Discount Rate

Readers familiar with net present value computations recognize that the choice of discount rate can make a major difference in the estimates. This choice is somewhat arbitrary. A higher discount rate will generate lower values for human capital wealth, while a lower discount rate will lead to higher estimates of human capital wealth.

The discount rate used for the estimation of the net present value of future earnings for the labor force may implicitly vary between countries. To understand why this is the case, consider the fact that earnings profiles for the labor force are based on data from the most recent household survey for each country. The earnings profiles do not factor in potential future gains in productivity for the labor force as a whole that could lift the whole distribution of wages upwards in real terms. Assume for the sake of the argument that the labor force of a given country is expected to benefit from real gains in wages of 2.5 percent per year because of future gains in labor productivity of a similar magnitude. Because we do not know what future gains in productivity and real wages will be, we are relying solely on data on wages at the time of the household surveys, which leads to a discount rate of 2.5 percent for that specific country. To that implicit discount rate associated with future gains in productivity, we add an additional temporal discount rate of 1.5 percent in all countries. This means that in a country with expected gains in productivity and real wages of 2.5 percent per year, we implicitly use a four percent discount rate (the sum of the future gains in wages and the temporal discount rate) to compute the net present value of future earnings. Again, this choice is somewhat arbitrary, but the resulting discount rate is not unrealistic.

Coverage of Household Surveys and Gap Filling

Data from the Systems of National Account are available for all countries on a yearly basis, but this is not the case for household surveys. While 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 implement labor or household surveys with detailed information on earnings only every few years. When this is the case. The latest household survey is used for estimates in subsequent years, until a new survey is available. This means that estimates from the latest available survey are carried forward in time, but still with adjustments based on data from the national accounts on 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 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 a period of 20 years, from 1995 to 2014. Data are provided for human capital wealth globally, as well as by groups of countries according to their level of income. The objective of the section is not to conduct a detailed analysis, but rather to provide a few general stylized facts on the patterns of growth in human capital wealth being observed. Other chapters in this third part of the volume go more in depth into specific questions or issues.

Global Estimates and Estimates by Income Groups

As noted by Lange et al. (2017) in this volume, global wealth stood at $1,147 trillion in 2014. This represented an increase in total wealth of 65 percent over 20 years (average annual growth rate of 2.5 percent per year). Human capital wealth reached $742 trillion in 2014, an increase of 54 percent since 1995 (average annual growth rate of 2.2 percent). In this chapter, we focus on measures in per capita terms in order to control for population growth.

In per capita terms, total wealth stood at $169,349 per person in 2014 versus $130,032 in 1995. Human capital wealth stood at $109,424 per person in 2014 versus $ 89,977 in 1995. In other words, globally human capital accounts for just under two thirds of total wealth. This share is however declining slightly. With an average annual growth rate of 1.0 percent over the last two decades, human capital wealth per capita increased by 22 percent, versus 32 percent for total wealth per capita. This decline in the share of human capital wealth in global wealth is however not observed for all countries: it is observed only for comparatively richer countries.

In table 1, aggregate data are provided globally as well as for groups of countries according to their level of economic development. We consider six groups of countries: low income, lower middle income, upper middle income, High income non-OECD, and finally 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 above $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 estimated at $5,564 per person.

Table 1: Trends in Wealth Per Capita by Level of Development, 1995-2014

World	1995 ($2014)	2000 ($2014)	2005 ($2014)	2010 ($2014)	2014 ($2014)	Annual Growth (%)
Total wealth	130,032	139,031	147,107	159,404	169,349	1.40%
Human capital	89,977	97,445	98,923	103,211	109,424	1.04%
Human capital as share of total	69%	70%	67%	65%	65%	
Low income						
Total wealth per capita	11,601	10,435	10,240	11,802	13,629	0.85%
Human capital per capita	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						
Total wealth	17,718	16,745	19,426	23,675	25,948	2.03%
Human capital	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						
Total wealth	52,135	58,652	68,118	95,607	114,445	4.22%
Human capital	32,899	37,746	40,420	56,536	67,390	3.85%
Human capital as share of total	63%	64%	59%	59%	59%	
High income: non-OECD						
Total wealth	165,884	165,561	199,485	245,513	264,998	2.50%
Human capital	59,376	69,451	84,507	107,518	111,793	3.39%
Human capital as share ot toal	36%	42%	42%	44%	42%	
High income: OECD						
Total wealth	551,184	617,801	655,228	674,542	709,916	1.34%
Human capital	412,757	461,959	474,872	472,946	499,927	1.01%
Human capital as share of total	75%	75%	72%	70%	70%	

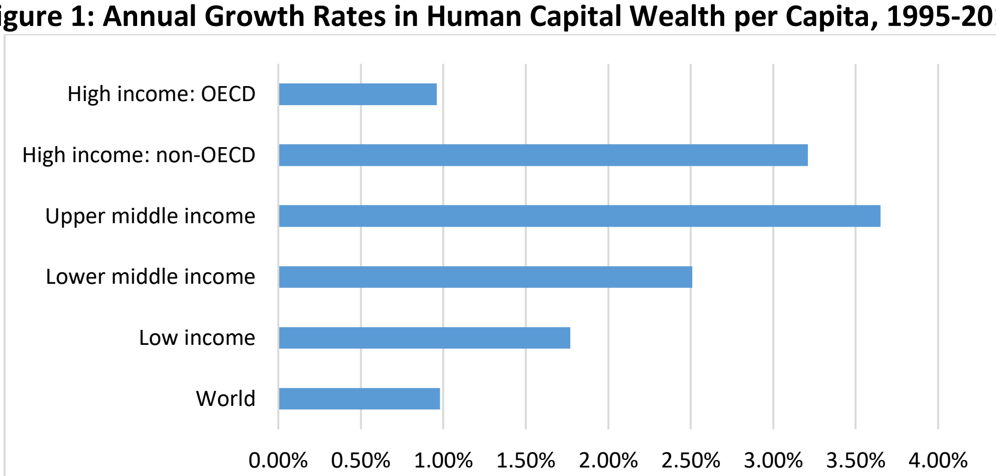
Source: Authors' estimation.

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. This is 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 our 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 due to technological change, stagnating wages, and in many countries a reduction in the share of the population in the labor force due in part to ageing.

By contrast, for low income and lower middle income countries, the share of human capital wealth in total wealth is rapidly increasing. This share increased from 32 percent to 43 percent in two decades in low income countries, and from 44 percent to 52 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 being reduced and the population is becoming better educated. We thus have diverging trends for poorer and richer countries in terms of the increasing or decreasing role played by human capital over time. However, overall it is clear that as countries achieve a higher level of economic development, human capital wealth clearly dominates, while at lower levels of economic development, produced and natural capital (not shown in table 1) tend to be larger.

Statistics provided in table 1 on growth rates in human capital wealth per capita are visualized in Figure 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 in high income countries. This would be akin to the convergence often observed in GDP per capita, but in this case the convergence would be observed for human capital wealth per capita. The fact that growth rates are indeed higher at lower levels of human capital wealth per capita appears even more clearly when looking at data for individual countries, as opposed to aggregated such as those I table 1 that tend to weight ore heavily larger countries. Nayihouba and Wodon (2017) in this volume provide 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 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).

Figure 1: Annual Growth Rates in Human Capital Wealth per Capita, 1995-2014



Source: Authors' estimation.

Regional Trends in Human Capital Wealth

Table 2 considers an alternative grouping for countries by geographic location. Seven regions are distinguished: East Asia and the Pacific, Europe and Central Asia, Latin America and the Caribbean, the Middle East and North Africa, North America, South Asia, and finally sub-Saharan Africa. The highest growth rate in human capital per capita was observed in South Asia (3.8 percent), followed by the Middle East and North Africa (2.2 percent), East Asia and the Pacific (2.0 percent), and sub-Saharan Africa (1.5 percent). Note that in sub-Saharan Africa, there has been 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 below 1.5 percent. These three regions are also those with comparatively higher levels of development, and more significant pressures in terms of declining labor shares in GDP.

Table 2: Trends in Wealth Per Capita by Regions, 1995-2014

	1995 ($2014)	2000 ($2014)	2005 ($2014)	2010 ($2014)	2014 ($2014)	Annual Growth (%)
East Asia & Pacific						
Total wealth per capita	78,011	85,103	90,819	118,807	140,787	3.16%
Human capital per capita	56,829	59,380	57,500	72,468	85,079	2.15%
Human capital as share of total	73%	70%	63%	61%	60%	
Europe & Central Asia						
Total wealth per capita	280,323	301,280	329,477	356,911	368,233	1.45%
Human capital per capita	176,535	193,916	208,334	221,080	227,581	1.35%
Human capital as share of total	63%	64%	63%	62%	62%	
Latin America & Caribbean						
Total wealth per capita	112,288	113,675	124,249	137,548	144,243	1.33%
Human capital per capita	70,898	74,398	78,925	85,813	88,700	1.19%
Human capital as share of total	63%	65%	64%	62%	61%	
Middle East & North Africa						
Total wealth per capita	91,203	95,076	113,731	143,965	158,892	2.96%
Human capital per capita	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	782,370	901,889	962,329	945,004	986,621	1.23%
Human capital per capita	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	9,251	10,523	12,511	15,710	18,400	3.69%
Human capital per capita	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	26,403	21,964	22,669	25,362	25,562	-0.17%
Human capital per capita	9,397	8,771	8,507	11,298	12,680	1.59%
Human capital as share of total	36%	40%	38%	45%	50%	

Source: Authors' estimation.

Components of Human Capital Wealth

Apart from estimates of total human capital wealth, our estimation procedure generates estimates of human capital wealth by gender and by type of employment (employed versus self-employed), as well as for a combination of both. The differences by gender and type of employment can be large. For example, in most countries, self-employed workers tend to fare less well in terms of 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. In addition, women also tend to fare less well than men in terms of earnings, both because of lower education levels and because of a higher likelihood of being self-employed.

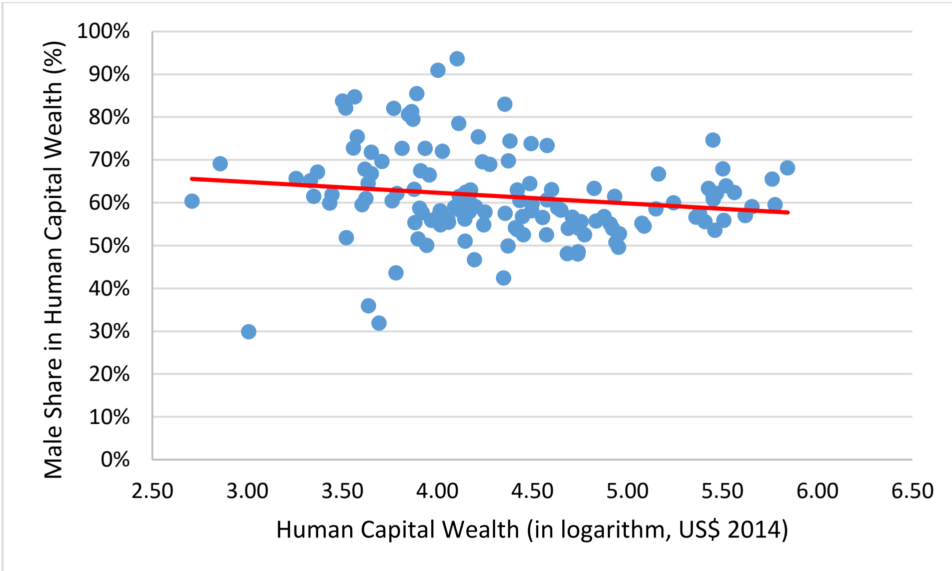
Globally, women account for just 38 percent of human capital wealth, versus 62 percent for men. In terms of types of employment, the differences are even more striking. Globally, the self-employed account for only 9 percent of human capital wealth, while employed workers account for 91 percent of that wealth. Global figures however can be misleading of the reality in most countries, simply because most of the human capital wealth is concentrated in upper middle and high income countries, so that these countries weight more in global estimates.

When looking at country-specific patterns, a number of interesting findings emerge. Consider for example in Figures 2 and 3 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 itself highly correlates with GDP per capita. In each of the two figures the respective shares are plotted on the vertical axis, while the level of human capital wealth per capita of the countries (in logarithm) is displayed on the horizontal axis.

In Figure 2, there is 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 suggests that apart from human capital wealth or more generally levels of economic development (given that both measures are closely correlated), other factors such as cultural norms may play an important role in driving differences in earnings between men and women. Interestingly, 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.

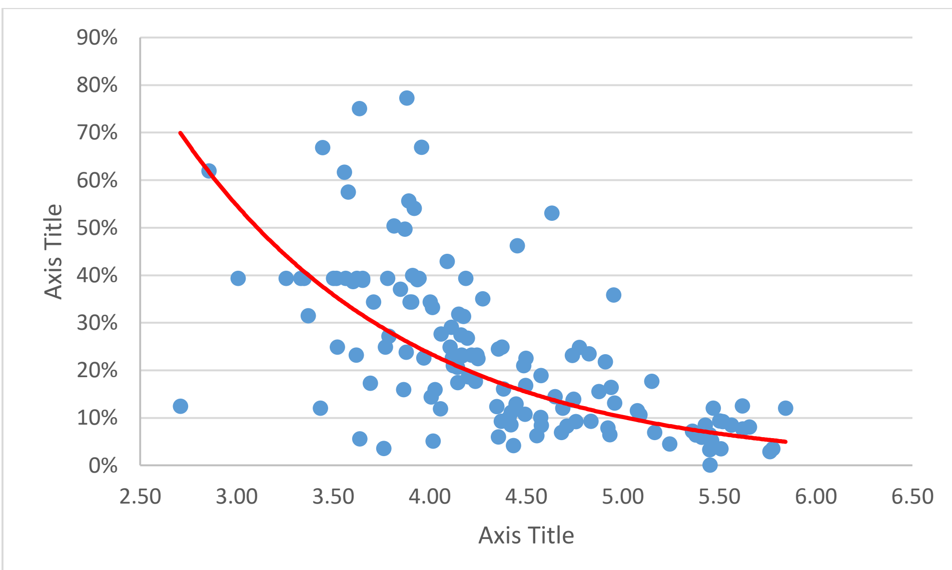
By contrast, the relationship between human capital wealth/economic development and the share of the wealth attributed to the self-employed is much stronger in Figure 3. Even though there is again quite a bit of variation around the central tendency, it is clear that the importance of self-employment is much higher in countries with lower levels of human capital wealth as well as lower levels of economic development. This was expected, given that in those countries many individuals are working in subsistence agriculture and (very) small businesses in the informal sector rather than in wage employment, but it is worth pointing out.

Figure 2: Male Share in Human Capital Wealth, 2014



Source: Authors.

Figure 3: Self-employed Share in Human Capital Wealth, 2014



Source: Authors.

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 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. But other factors also play a role. They include among others (i) careers that are interrupted for child-bearing, (ii) penalties for child care, as women work part time to meet family needs, and as employers question the commitment of women to their career, (iii) 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 (iv) a lack of women in leadership positions in the workforce. Gender discrimination fosters and reinforces many of these negative influences on women's earnings.

While there has been a trend towards greater gender parity in human capital wealth over time globally, this has not been the case in all country groups by income, and progress has been fairly slow. This also means that major gains in human capital wealth could still be achieved with gender equity. Globally, as already mentioned earlier and as shown in table 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 differences in human capital wealth by gender is South Asia, 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, but Eastern and Central Europe and sub-Saharan Africa are not far behind with 61 percent of human capital wealth attributed to men.

Table 3: Shares of Human Capital Wealth by Gender, 1995-2014

	Male Share					Female Share				
	1995	**2000**	**2005**	**2010**	**2014**	**1995**	**2000**	**2005**	**2010**	**2014**
World	63%	63%	62%	60%	60%	36%	37%	37%	38%	38%
Income groups										
Low income	66%	66%	66%	68%	67%	34%	34%	34%	32%	33%
Lower middle income	72%	74%	73%	70%	70%	28%	26%	27%	30%	30%
Upper middle income	60%	58%	60%	59%	60%	40%	42%	40%	41%	40%
High income: non-OECD										
High income: OECD	64%	64%	62%	61%	61%	36%	36%	38%	39%	39%
Regions										
East Asia & Pacific	68%	67%	68%	65%	65%	32%	33%	32%	35%	35%
Europe & Central Asia	62%	62%	61%	61%	61%	38%	38%	39%	39%	39%
Latin America & Caribbean	61%	58%	58%	56%	56%	39%	42%	42%	44%	44%
Middle East & North Africa										
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: Authors' estimation.

Table 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 countries, the gender gap ratio is especially low at 48.9 percent. In other words, women have on average in those countries 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. Denote this gender gap ratio by GGR.

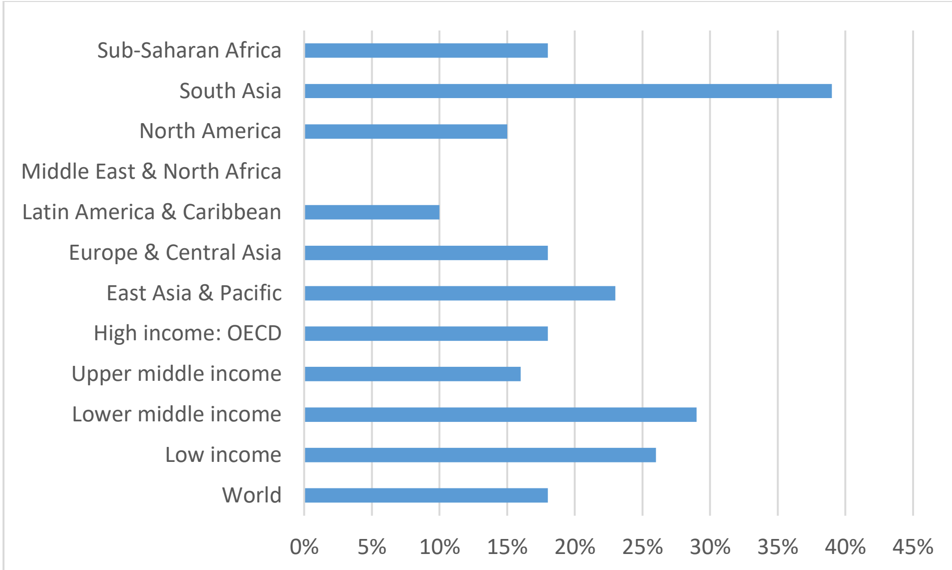
Assume for simplicity that the working age population is equally divided between men and women, each with a 50 percent share. Then, if the earnings of women were on par with those of men, the human capital wealth of women would rise considerably. Assuming no decrease in the human capital wealth of men, the resulting gains in human capital wealth (NG) can be estimated as NG=(100-GGR) × 0.50/100. As shown in table 4 and Figure 4, worldwide, human capital wealth could increase by 18 percent with gender parity. In low income and lower middle income countries where levels of wealth are lower, the gains would be larger. The differences between regions are especially striking. As mentioned earlier, the region with the largest differences in human capital wealth by gender is South Asia. In that region, if gender parity were achieved, this could increase human capital wealth nationally by almost 40 percent. These simple simulations do not account for the general equilibrium impact than an influx of women in 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.

Table 4: Potential Gains in Human Capital Wealth from Gender Equity, 1995-2014

	Gender Gap Ratio (x100) (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	58.1	58.5	60.6	63.6	63.1	21%	21%	20%	18%	18%
Income groups										
Low income	52.1	51.4	51.2	48.1	48.9	24%	24%	24%	26%	26%
Lower middle income	38.7	36.0	37.5	42.8	42.0	31%	32%	31%	29%	29%
Upper middle income	67.4	71.8	65.4	68.2	67.0	16%	14%	17%	16%	16%
High income: non-OECD										
High income: OECD	57.2	57.2	60.6	63.4	63.2	21%	21%	20%	18%	18%
Regions										
East Asia & Pacific	47.1	49.2	47.9	53.1	53.5	26%	25%	26%	23%	23%
Europe & Central Asia	62.5	62.1	63.8	65.1	64.4	19%	19%	18%	17%	18%
Latin America & Caribbean	64.7	73.8	73.6	77.1	79.1	18%	13%	13%	11%	10%
Middle East & North Africa										
North America	61.7	60.6	65.3	70.0	69.8	19%	20%	17%	15%	15%
South Asia	21.0	18.4	17.6	22.4	21.7	39%	41%	41%	39%	39%
Sub-Saharan Africa	66.5	65.7	72.0	65.0	64.0	17%	17%	14%	18%	18%

Source: Authors' estimation.

Figure 4: Potential Gains in Human Capital Wealth from Gender Equity, 2014



Source: Authors.

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 other evidence suggests, the returns to education are often higher for women than for men. Montenegro and Patrinos (2016) use data from 1970 to 2014 and 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 the 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 under the headings of discrimination, taste (preferences for certain occupations) and circumstances (related to child care needs). At least in the case of the Unites States, higher educational attainment could enable women to overcome the handicaps associated with discrimination, tastes and circumstances – through better bargaining, for example. Since men do not suffer such handicaps, the result is higher female returns to education.

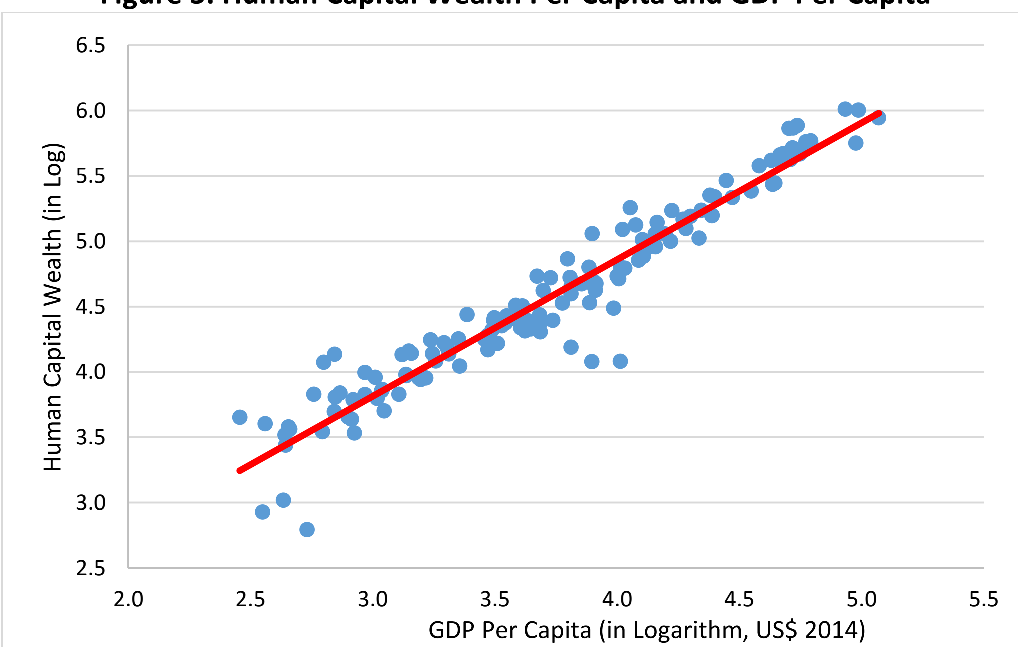
Human Capital Wealth and GDP per Capita

While this chapter provides the first set of comparable estimates of human capital wealth for more than 140 countries, the core findings presented above are not too surprising. Overall, there is a very close relationship between estimates of human capital wealth per capita and estimates of GDP per capita. Building on the underlying growth theory, pervious issues of the *Changing Wealth of Nations* reports measured total wealth as the present value of consumption in the national accounts. Since consumption accounts typically for 80 percent of GDP in many countries, this led to an almost perfect correlation between wealth estimates and GDP, whether in 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 accounted for the most part by our estimates of human capital wealth based on the net present value of future earnings. But since labor earnings typically account for about 60 percent of GDP (with some differences depending on the country), we again have a strong correlation between estimates of human capital wealth per capita and 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 is shown in Figure 5, where both measures are provided in logarithm. A simple univariate regression of human capital wealth on GDP per capita generates a R2 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. While in this chapter, out of necessity due to limited space the focus 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.

Figure 5: Human Capital Wealth Per Capita and GDP Per Capita



Source: Authors' estimations.

Conclusion

This chapter has provided the first ever set of comparable estimates of human capital wealth 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 is the case in poorer countries. Essentially, according to the results of our methodology, the large 'intangible capital residual' that was referred to the last issue of *The Changing Wealth of Nations* reports (World Bank 2011) turns out to be for the most part human capital wealth. Our estimates suggest that investing in human capital can be the 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.

Our focus in this chapter has been 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 *Wealth of Nations* series published by the World Bank. This is not to deny that education, good health, and knowledge are not sources of wellbeing in and by themselves, or that doing a job well is one of the great human pleasures. It simply reflects a focus that is useful in assessing and guiding economic policy.

Apart from country-wide estimates, estimates of human capital wealth were also provided 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 towards 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 made. But even with the data now available, additional analysis as well as simulations can be undertaken to inform policy. Subsequent chapters in this volume provide examples of such analysis and simulations.

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Chapter 8: Gains in Human Capital Wealth: Stylized Facts from Growth Models

Ada Nayihouba and Quentin Wodon

Introduction

Estimates provided in this volume (Lange et al., 2017) suggest that human capital wealth represents the largest share of the wealth of nations, and a larger share of wealth as countries achieve higher levels of economic development. This broadly suggests that investing in human capital is a smart strategy for countries to improve the well-being of their population in a sustainable way over long periods of time, since annual aggregate income, as measured by GDP per capita, can be broadly conceived as the return to a country's wealth.

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 in a stylized way 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 importance of investing in education and health is also discussed, as is the need to keep macroeconomic fundamentals sound. The analysis considers separately the human capital wealth of men and women, which allows for an interesting comparison of both.

The emphasis placed in our model and empirical analysis on population growth as well as growth in the labor force stems from the fact that issues related to the demographic structure of populations are getting renewed attention among policy makers under the umbrella concept of the demographic dividend. At the World Bank, the 2015-16 Global Monitoring Report was devoted to the demographic dividend (World Bank, 2015), and so was a major report completed for the Africa region (Canning et al., 2015). In January 2017, the Africa Union organized a key meeting in Addis Ababa on harnessing the demographic dividend for the realization of 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 in order to do so, a number of appropriate policies must be put in place.

A number of cross-country analyses of economic growth have suggested a one-to-one (negative) relationship between population growth and growth in GDP per capita. This 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 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 et al., 2015). All this matters for public policy.

Taking inspiration from the literature on economic growth as measured through GDP per capita, this chapter considers the correlates of the growth in the human capital wealth of nations. We apply a standard growth model to the uncovering some of the factors that may affect growth in human capital wealth per capita. In order to do so, the chapter is structured as follows. Section 2 first outlines our methodology for estimating human capital wealth per capita. Section 3 provides basic data on human capital wealth by gender. Section 4 presents our theoretical model for some of the factors likely to affect growth in human capital per capita. Section 5 provides a rapid description of the data used in the estimation of the growth model. Section 6 reports on the estimation results. A brief conclusion follows.

Measures of Human Capital Wealth

In order to model factors that may affect changes in human capital wealth over time, we rely on the data provided in the precious chapter in this volume by Hamilton and Wodon (2017). The main variable of interest (dependent variable in our estimations) 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 discussed within the context of the broader literature on human capital among others by Fraumeni (2008) and Hamilton and Liu (2014). Details on the construction of the estimates are provided in Barrot et al. (2017).

The estimation of the human capital wealth of countries is based on wage regressions that are used to compute expected earnings for individuals over their lifetime by gender, age, and education level. 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 (2015). 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 (I2D2) database (see Montenegro and Hirn, 2009 on the database).

Total earnings observed in the labor force surveys at the level of each country are adjusted to match estimates of the wage share in the national accounts for both employed workers and the self-employed (Feenstra et al. 2015). This adjustment is based on data from the Penn World Tables. The adjustment is used to ensure that there is compatibility between estimates of human capital wealth and other estimates of wealth for countries, which are not used here. In order to construct estimates of the discounted lifetime earnings of workers, population data as well as mortality rates by age and gender are used from the United Nations Population Division. The discount rate for the estimates obtained by age from the surveys is set at 1.5 percent. Note that this is based on data from the available household surveys holding constant the distribution of earnings observed at the time of the survey. Assuming, for example, that earnings may grow at a rate of 2.5 percent per year in real terms, this generates an actual discount rate of four percent. The same discount rate is used for all counties, both for the purpose of comparisons and because we do not have good data to suggest different rates.

The analysis in this chapter will be carried for two different periods of time: 1995 to 2010 and 1995 to 2014. The main reason for considering two different periods in the estimations is that this provides a simple robustness test. But in addition, for some countries, while 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 time periods, but the results obtained for the period from 1995 to 2010 are slightly better in terms of indeed yielding the results that the theoretical model suggests.

Table 1 provides summary statistics globally as well as by income group on the levels of human capital wealth observed. Differences are massive between countries. While human capital wealth per capita is at close to $500,000 in high income OECD countries, the corresponding value for low income countries is only at slightly more than $5,500.

Apart from estimates of total human capital wealth, our estimation procedure generates estimates of human capital wealth by sex. This means that the analysis of the drivers of growth in human capital wealth per capita can be done for men and women separately. Globally, as shown in table 1, women account for just under 40 percent of human capital wealth. These are also the proportions 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 account for only a third or less of human capital wealth. There has been progress in many countries towards greater gender parity in human capital wealth, but only slowly, and not in all countries.

Table 1: Levels and Gender Shares in Human Capital Wealth by Income Groups, 1995-2014

	1995	2000	2005	2010	2014
World					
Human capital wealth per capita ($)	89,977	97,445	98,923	103,211	109,424
Men's share	63%	63%	62%	60%	60%
Women's share	36%	37%	37%	38%	38%
Low income					
Human capital wealth per capita ($)	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					
Human capital wealth per capita ($)	7,992	7,917	9,301	11,421	13,117
Men's share	72%	74%	73%	70%	70%
Women's share	28%	26%	27%	30%	30%
Upper middle income					
Human capital wealth per capita ($)	32,899	37,746	40,420	56,536	67,390
Men's share	60%	58%	60%	59%	60%
Women's share	40%	42%	40%	41%	40%
High income: OECD					

Human capital wealth per capita ($)	412,757	461,959	474,872	472,946	499,927
Men's share	64%	64%	62%	61%	61%
Women's share	36%	36%	38%	39%	39%

Source : Authors' estimation.
Note: Income categories are skewed by lack of data by gender in China and the Gulf Cooperation Council (GCC) countries.

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 that 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 wage gap by gender in terms of both earnings and labor force participation will not be discussed in this chapter. But we should note 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.

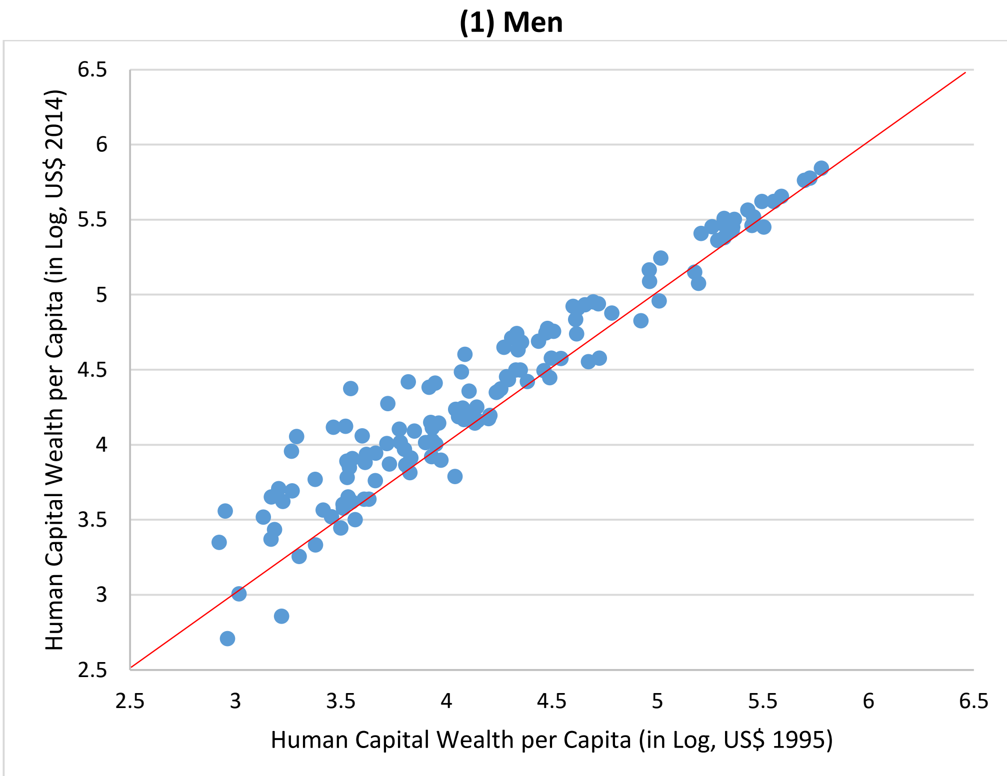
Convergence

In order to set the stage for the analysis of the drivers of growth in human capital, Figures 1 and 2 display scatter plots for the levels of human capital wealth per capita estimated in 1995 (on the horizontal axis) and in 2014 (on the vertical axis). This is done separately for men and women. Since estimates are in logarithms, the difference in 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.

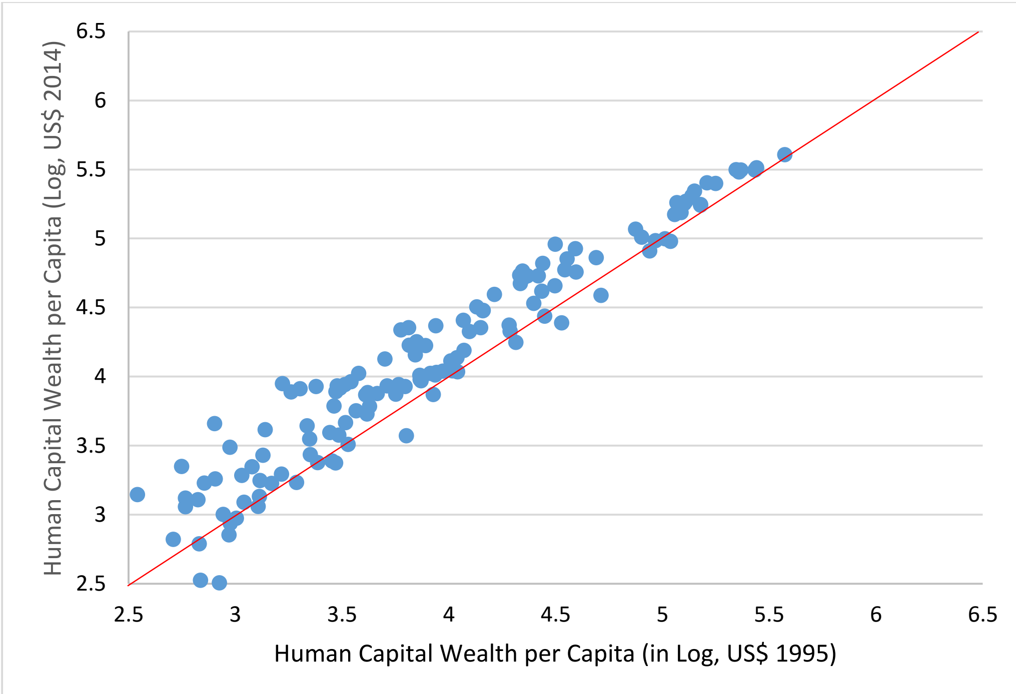
Several stylized facts emerge from the Figures. First, for both men and women, most countries lie above the diagonal, suggesting that an overwhelming majority of countries benefited from an increase in human capital wealth per capita between 1995 and 2014. However, a few countries have lost ground, often due to a conflict or other shock. Second, as already mentioned, the levels of human capital wealth tend to be lower for women than men. This can be seen by the fact that the scatter plot for men tends to be slightly on the right of the scatter plot for women in terms of the values on the horizontal axis. Third, and importantly for the topic of this chapter, growth rates in human capital tend to be higher for lower income countries. This can be seen through the fact that observations in the scatter plots for lower income countries tend to be located further away from the diagonal than for higher income countries. In other words, there appears to be some level of convergence in human capital wealth with poorer countries catching up. Again, this is observed for both men and women.

The fact 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 last two decades to improve education levels and 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 of a larger share of the population at working age. Finally, economic growth rates have also been higher in much of the developing world than in high income countries in the last two decades. The fact that there is apparently convergence does not however mean that poorer countries are catching up quickly – the differences in estimates of human capital wealth between countries remain massive, as shown in table 1 earlier.

Figure 1: Convergence in Human Capital Wealth per Capita by Gender



(2) Women



Model

Our objective is to assess in a stylized way some of the factors that may lead to faster growth in human capital wealth per capita. As discussed in Hamilton and Wodon (2017), our measure of human capital wealth per capita is essentially based on estimates of the discounted value of future wages for the working population. Therefore, when looking at the correlates of the growth in human capital wealth per capita, it makes sense to explicitly factor 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 the growth of the population and the growth of the labor force as well as other.

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

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. In order to introduce directly in 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 we denote by X a matrix of variables affecting steady-state growth, so that $z^* = X\beta$, we would estimate a regression model specified as follows:

$$g_z = \lambda(X\beta - z_0) + \varepsilon \quad (1)$$

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

$$g_h = \lambda X\beta - \lambda h_0 + \lambda \log\left(\frac{L}{P}\right)_0 + (g_L - g_P) + \varepsilon \quad (2)$$

Simple predictions can be made from this specification on some of the correlates of the growth in human capital per capita. First, the model suggests that the regression coefficient for the growth in the labor force should be equal to one, 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 the growth of the population should be minus one, so that higher population growth should reduce the growth in human capital. 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. In much of the literature, there appears to be 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 the growth in the working age population, in which case we need to decompose the labor force into a 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. Then we have $\log(H/P) = \log(H/L) + \log(L/WA) + \log(WA/P)$. 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:

$$g_h = \lambda X\beta - \lambda h_0 + \lambda \log\left(\frac{L}{WA}\right)_0 + \lambda \log\left(\frac{WA}{P}\right)_0 + (g_L - g_{WA}) + (g_{WA} - g_P) + \varepsilon \quad (3)$$

As mentioned earlier, the data on human capital wealth per capita is available for both men and women. Therefore, the model suggested in (3) can be estimated separately for men and women. In so doing, some variables will be specific to each sex, while other variables will be at the national level. Specifically, the population size P in the model will be the same for both sexes since the measures of human capital are per capita (taking into account the entire population). By contrast, we will use 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 will be specified at the national level, we will use variables related to the education and life expectancy of the labor force disaggregated by gender.

Basic Statistics

The dependent variables in the models are the growth rates in the human capital wealth per capita attributable to women and men separately over five year intervals. In terms of independent variables, apart from the initial level of human capital wealth, the regressors include two measures of human capital: the average years of schooling of the adult population (proxy for education-related human capital) and life expectancy at birth (proxy for health-related human capital). Given that macroeconomic conditions may affect wages and thereby estimates of human capital wealth, we also include in the covariates a number of variables related to on trade, government spending, investment, and inflation. Overall, these variables are typically those used in models for economic growth (e.g., DeLong and Summers, 1991; Mankiw et al., 1992). All variables are from the World Development indicators (2016), with two exceptions: the average years of schooling in the adult population are obtained from Barro and Lee (2015), and the measures of human capital wealth are those generated by Hamilton et al. (2017) in this volume (see also Barrot et al., 2017, for more details on the estimation procedure).

Summary statistics for the variables are presented in table 2 for the countries included in the regression (for some countries, some correlates are not available, which reduces the sample size for the regression analysis). The statistics are provided for two time 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 9.70 percent, while the median is 9.13 percent. For women, the growth rates are slightly higher: 10.65 percent for the mean and 9.49 percent for the median. This suggests than in real terms, the countries have experienced an average annual growth rate in human capital wealth per capita of about two percent, with women slowly catching up with men in terms of the net present value of their future earnings. “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 at just above $87,000, but the median is much lower at just under $22,500. By contrast, the human capital wealth attributed to women is lower (mean value just above $56,000 and median at about $15,500).

Table 2: Summary Statistics for the Variables

	Variables	Men Mean	Men Median	Women Mean	Women Median
		1995-2010			
g_h	5-year growth rate of human capital wealth pc (%)	9.61	9.18	11.28	10.04
H	Human capital per capita (2014 US$)	84,327	20,218	53,720	15,010
L/P	Share of the labor force in the total population (%)	25.38	25.78	18.82	19.80
WA/P	Share of working age population in the total population (%)	31.10	32.09	31.51	32.35
g_P	Five-year growth rate of population (%)	6.33	6.39	6.33	6.39
g_L	Five-year growth of labor force (%)	11.10	10.52	7.71	7.15
g_{WA}	Five-year growth of the working age population (%)	8.17	8.50	8.04	8.79
X	Average years of schooling	7.90	8.26	7.14	7.92
	Life expectancy	66.58	68.71	71.69	75.32
	Public investment (% GDP)	21.86	21.42	21.86	21.42
	Government spending (% GDP)	15.59	15.64	15.59	15.64
	Trade (% GDP)	88.34	74.10	88.34	74.10
	Inflation (%)	21.86	21.42	21.86	21.42
		1995-2014			
g_h	5-year growth rate of human capital wealth pc (%)	9.70	9.13	10.65	9.49
H	Human capital per capita (2014 US$)	87,031	22,475	56,040	15,515
L/P	Share of the labor force in the total population (%)	25.54	26.03	19.15	20.17
WA/P	Share of working age population in the total population (%)	30.97	31.96	31.39	32.27
g_P	Five-year growth rate of population (%)	6.27	6.32	6.27	6.32
g_L	Five-year growth of labor force (%)	10.56	10.52	7.55	7.34
g_{WA}	Five-year growth of the working age population (%)	7.74	8.30	7.64	8.27
X	Average years of schooling	8.11	8.34	7.40	8.11
	Life expectancy	67.46	69.14	72.52	75.86
	Public investment (% GDP)	22.05	21.44	22.05	21.44
	Government spending (% GDP)	15.79	15.95	15.79	15.95
	Trade (% GDP)	88.89	74.27	88.89	74.27
	Inflation (%)	22.05	21.44	22.05	21.44

Source: Authors.

The model predicts that the growth rate 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 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 is higher than the growth rate in the working age population, while the reverse is observed for women. Note also that because the growth in the labor force appears to be higher for men than for women, this suggests that 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 to men. Separately, it is also worth noting that 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 the growth in human capital per capita include proxies for human development. As noted earlier, two are used here. The average years of schooling for the adult population is at about eight years in the sample as a whole. As expected it is higher for men than for women. The life expectancy is at close to 70 years, and is higher for women than men, again as expected. As for macroeconomic variables, they 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 four fifth of GDP depending on whether the mean or median value is used. Finally, inflation is on average at slightly above 20 percent over a five year period.

Estimation Results

The predictions suggested by our model can be tested by estimating the model using a cross-country panel data set. We use two time periods for the analysis: 1995 to 2010, and 1995 to 2015, for the reasons mentioned earlier. Detailed results from six different specifications of the model are available in Nayihouba and Wodon (2017). Here we focus on the main results. These results are provided in table 3 for the most parsimonious and the most comprehensive specifications estimated by Nayihouba and Wodon (2017). 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 it also decomposes the demographic variables as per equation (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 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 as suggesting convergence, but these need not be discussed here. A shown in Figures 1 and 2, there does appear to be convergence statistically as well in that growth rates in human capital wealth per capita are higher at lower initial levels.

Table 3: Correlates of the Growth in Human Capital Wealth of Nations per Capita – Summary Results for Men and Women

	Parsimonious model: Equation (2) without macroeconomic variables				Extended Model: Equation (3) with macroeconomic variables			
	1995-2010		1995-2014		1995-2010		1995-2014	
	Men	Women	Men	Women	Men	Women	Men	Women
Lagged human capital	-0.076	-0.065	-0.071	-0.058	-0.074	-0.059	-0.068	-0.053
Years of schooling	0.021	NS	0.019	NS	0.017	NS	0.018	NS
Life expectancy	0.601	0.573	0.469	0.474	0.358	0.331	0.260	NS
Labor share	NS	0.076	NS	0.082				
Population growth	NS	NS	NS	NS				
Growth of labor force	NS	0.861	NS	NS				
Investment					NS	NS	NS	NS
Government spending					NS	NS	NS	NS
Trade					0.092	NS	0.103	0.100
Inflation					-0.212	NS	-0.231	NS
Log(L/was)					NS	NS	NS	0.393
Log(was)					-0.252	NS	NS	NS
gl-gwa					1.052	NS	1.077	NS
gwa-gp					0.259	NS	NS	NS
Constant	-1.193	-2.040	-1.710	-1.560	NS	NS	NS	NS

Source : Authors. Note: Levels of statistical significance: * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

The proxies for human development tend to have positive and statistically significant impacts on the growth in human capital wealth. For both men and women, the impact of life expectancy is positive. This could denote gains in productivity, as well as gains in the number of years for which workers are able to work. For men, the impact of the 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 the growth in the labor force is predicted to be equal to one, while the coefficient for the growth of the population is predicted to be minus one. 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 where the coefficient is statistically significant, the coefficient for the growth of the labor force for women is indeed close to one, as predicted by the model.

In the more extensive specification of the model, two main changes in specifications 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 one.

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 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 our 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 which 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 that 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 this comes from a larger share of working age individuals in the population or a higher share of those individuals actually in the labor force. Longer term, lower population growth may lead to a reduction in human capital wealth, as is observed with ageing in several high income countries. But for many developing 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 importantly, from the demographic dividend that has been associated in many countries with a larger share of the population working, and rising education levels in the population.

Finally, results for the macroeconomic variables suggest that more open economies tend to have a higher growth rate in 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 Our results align with the literature in that for coefficients that are statistically significant, the direction of the effects are as expected. Indeed, open economies tend to reward workers with higher levels of education, which could generate higher values of human capital wealth per capita. By contrast, inflation may erode growth as well as worker's wages and thereby affecting human capital wealth negatively.

Conclusion

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

The results of the analysis conform for the most part with the predictions of the model, at least for men. Higher rates of population growth tend to reduce the rate of growth in human capital wealth, while growth in the labor force have the opposite effect. Investments in human capital to increase the average years of schooling of the adult population (as a proxy for education) as well as life expectancy (as a proxy for wealth) have a positive effect on growth in human capital wealth per capita. The effect of life expectancy is also positive and statistically significant. When adding a set of macroeconomic variables to the estimation, we obtain familiar results, 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 was 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 wages, with wages clearly driven in good part by how the economy is doing as a whole.

Still, while none of the results are too surprising, they do help to emphasize the importance of investments in education and health (for life expectancy) to achieve growth in human capital wealth, and as importantly 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. The results obtained were stronger for women than men. This is not too surprising given that in the case of 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.

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Part 3. New Developments in Natural Capital

Chapter 9: Air Pollution: A Leading Health Risk and Disinvestment in Wealth
Christopher Sall and Urvashi Narain

Chapter 10: Marine Fisheries Wealth
Charlotte De Fontaubert, Rashid Sumaila, and Glenn-Marie Lange

Chapter 11. Progress Toward Ecosystem Accounting in the Wealth of Nations
Kenneth J. Bagstad, Simon Willcock, and Glenn-Marie Lange

Chapter 9: Air Pollution: A Leading Health Risk and Disinvestment in Wealth

Christopher Sall and Urvashi Narain

I. 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 that comprise it.

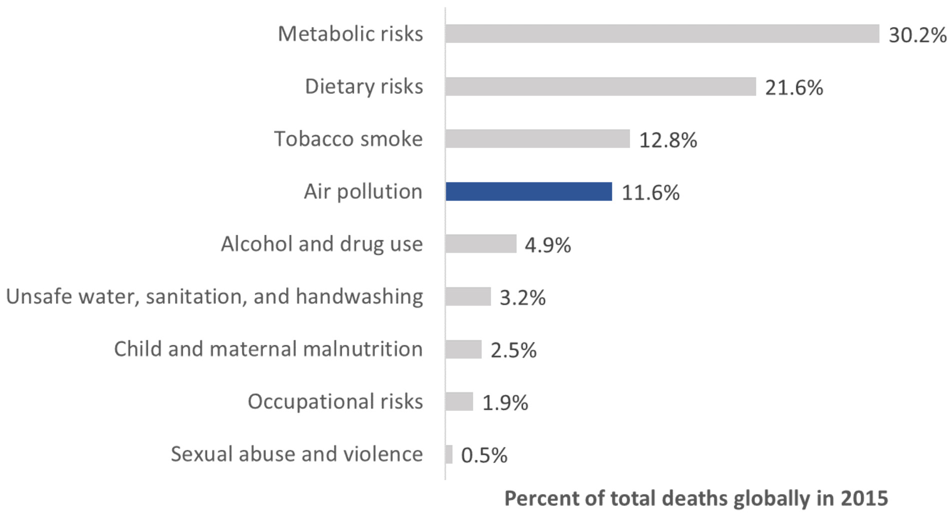
This chapter presents estimates of monetary losses in 172 countries from fatal health conditions caused by exposure to air pollution. The analysis draws from findings on the health effects of air pollution published for the Global Burden of Disease Study 2015 (GBD 2015), an international scientific collaboration led by the Institute for Health Metrics and Evaluation at the University of Washington, Seattle (IHME) (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 IHME in 2016 entitled *The Cost of Air Pollution: Strengthening the Economic Case for Action*. This chapter discusses the evolution of this methodology, which arose in part from the effort to improve the estimation of pollution damages for the adjusted net saving (ANS) indicator, described in Chapter 2. After presenting the results of implementing this methodology, the chapter closes with a discussion of how the valuation of the reductions in human capital due to pollution may be improved.

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; sources of $PM_{2.5}$ indoors include smoke from burning solid fuels like coal, wood, charcoal, or dung for cooking and heating. Secondary $PM_{2.5}$ may be formed from 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 (**Error! Reference source not found.**). 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.

Figure 21: Leading fatal risk factors globally, 2015



Source: IHME, Global Burden of Disease Study 2015, http://ghdx.healthdata.org/gbd-results-tool

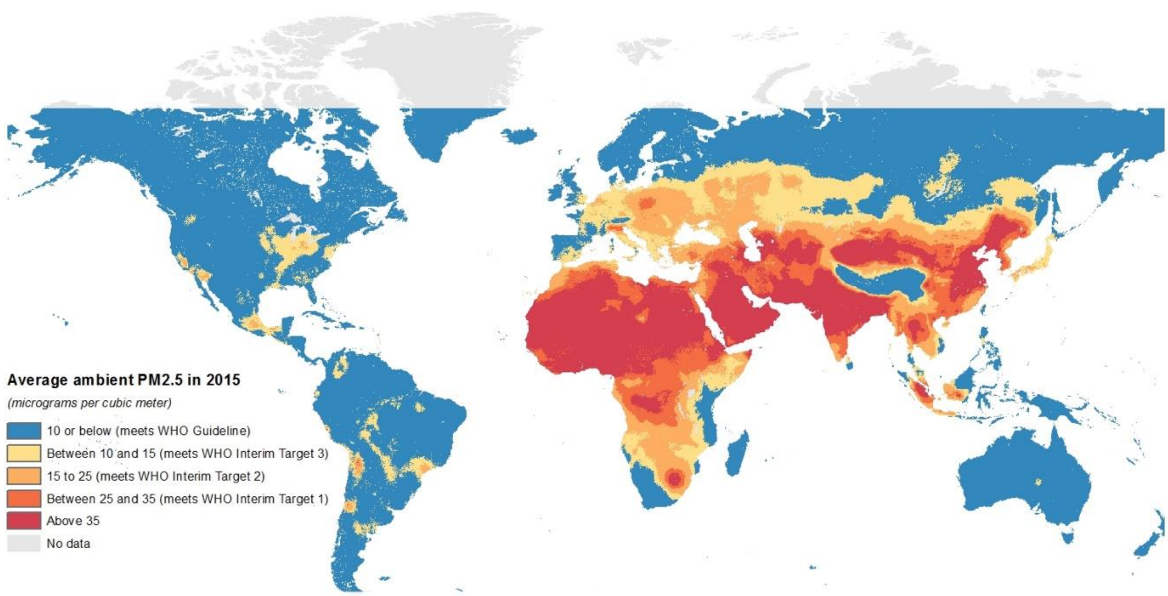
These estimates of the disease burden attributable to air pollution in the GBD are derived by first measuring the severity of air pollution and the extent to which people are exposed (Brauer et al 2016; Cohen et al n.d.; Forouzanfar et al 2016). Estimates of exposure to ambient $PM_{2.5}$ combine information from satellite observations of aerosols, numerical models of atmospheric chemistry, and ground monitoring of PM (van Donkelaar et al 2016; Shaddick et al 2016). Exposure to household $PM_{2.5}$ is estimated using data on the proportion of people reliant on solid fuels, the resulting concentrations of $PM_{2.5}$ 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 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 WHO guidelines (Figure 22). Air quality is deteriorating in many fast-growing, fast-urbanizing regions, particularly South Asia and East Asia and the Pacific, while 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 (

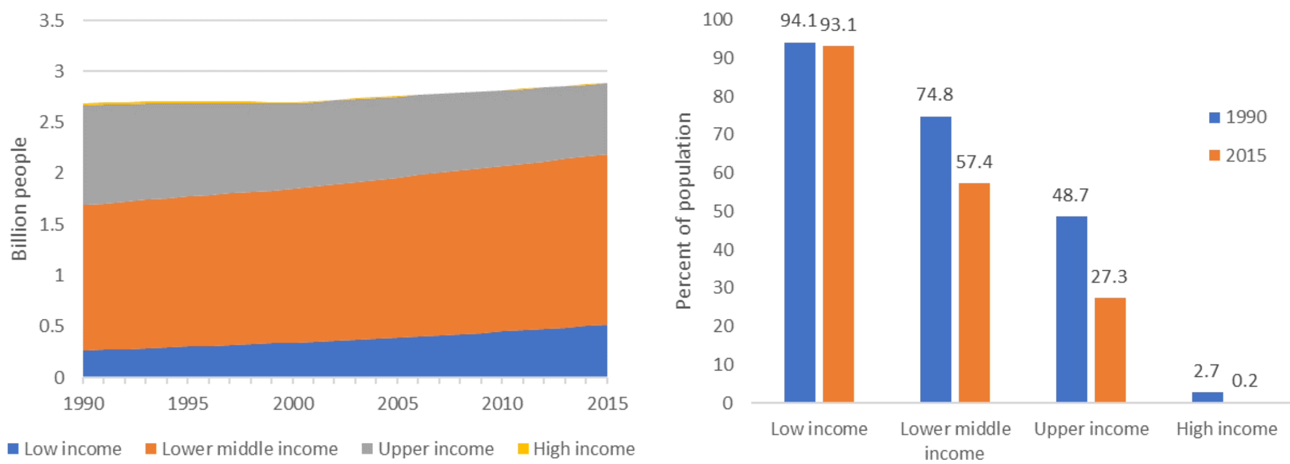
Figure ***23***). Rates of solid fuel use dropped the fastest in middle-income countries such as China. Yet, because the total population using solid fuel grew at an even faster rate, the number of people exposed to household air pollution increased, from 2.69 billion in 1990 to 2.89 billion in 2015. In the low-income countries, more than 90 percent of people continued to rely on solid fuels in 2015, as they did in 1990.

Figure 22: Mean annual concentrations of ambient $PM_{2.5}$ pollution in 2015



Note: includes concentrations of natural windblown dust and sea salt
Source: Authors, using data from van Donkelaar et al (2016), available at
http://fizz.phys.dal.ca/~atmos/martin/?page_id=140

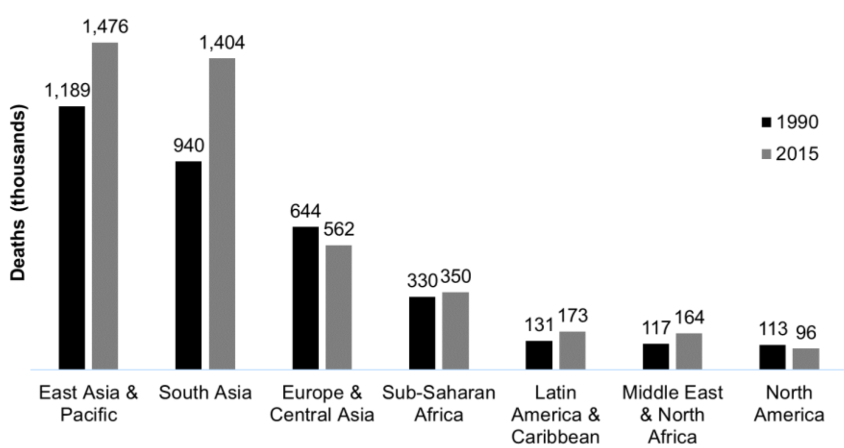
Figure 23: Population reliant on solid fuels, 1990-2015



Note: data for additional years extrapolated linearly according to year-on-year trends in percent of population
Source: Authors, using data from World Bank, http://data.worldbank.org/indicator/EG.NSF.ACCS.ZS

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 just less than 3.5 million in 1990 (Figure 24). The greatest increase in premature mortality due to ambient $PM_{2.5}$ occurred in South Asia, which accounted for 1.4 million deaths in 2015. Death rates continue to be highest in the middle-income countries.

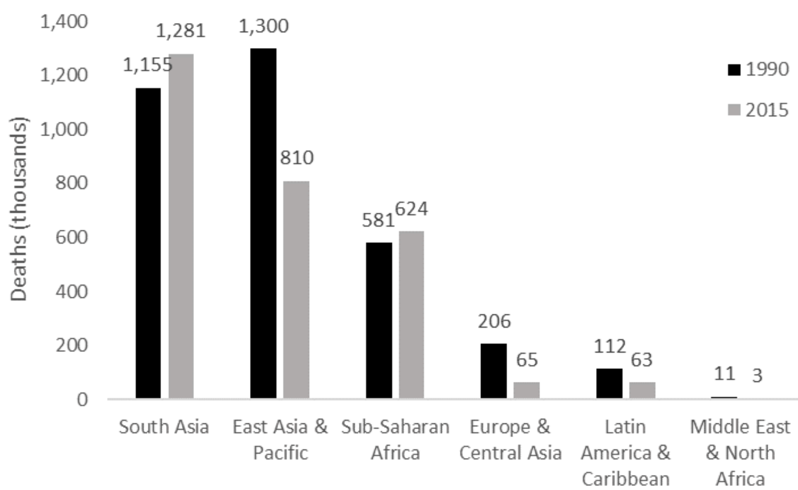
Figure 24: Premature deaths from ambient $PM_{2.5}$ pollution by region, 1990 and 2015



Source: IHME, Global Burden of Disease Study 2015, http://ghdx.healthdata.org/gbd-results-tool

In contrast with ambient $PM_{2.5}$, the number of premature deaths annually from household air pollution has declined, from just under 3.4 million in 1990 to about 2.8 million in 2015 (Figure 25). These declines reflect not only significant improvement in household access to modern forms of energy in regions such as East Asia and the 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 Europe and Central Asia.

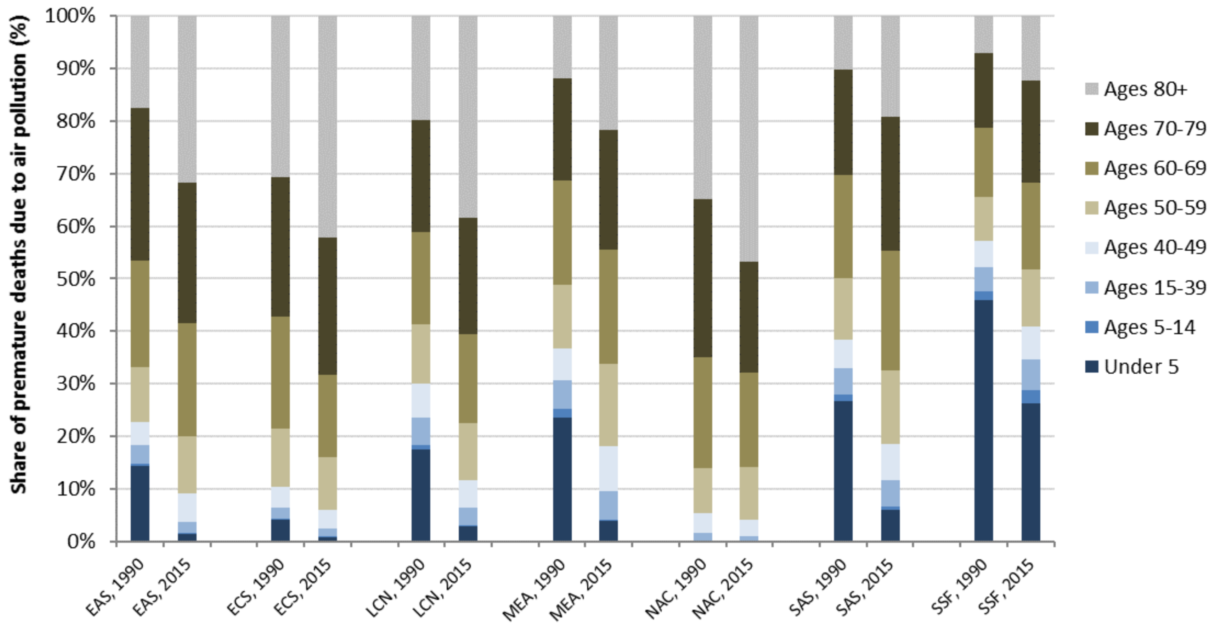
Figure 25: Premature deaths from household air pollution by region, 1990 and 2015



Source: IHME, Global Burden of Disease Study 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 26). Individuals 65-and-over make up about 8 percent of the world's population but accounted for 61 percent of fatalities due to illnesses attributed to air pollution. In Sub-Saharan Africa, in particular, a high portion of fatal health effects due to air pollution are also suffered by children under 5. Children represented 16 percent of the region's population in 2015 and 26 percent of pollution-attributed deaths.

Figure 26: Age profile of premature mortality due to air pollution, by region, 1990 and 2015



Note: EAS = East Asia and Pacific (all income levels); ECS = Europe and Central Asia (all income levels); LCN = Latin American and Caribbean (all income levels); MEA = Middle East and North Africa (all income levels); NAC = North America; SAS = South Asia; SSF = Sub-Saharan Africa (all income levels)
Source: IHME, Global Burden of Disease Study 2015, http://ghdx.healthdata.org/gbd-results-tool

II. Method of valuing the costs of air pollution for the adjusted net savings (ANS) indicator

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 represents a disinvestment in a nation's stock of human capital. The value of this disinvestment is captured explicitly within the framework of the adjusted net savings (ANS) indicator, which is published annually as part of the World Development Indicators (WDI). At this time, the impact of air pollution is only implicitly included in the measure of human capital in national wealth accounts presented in previous chapters. The World Bank's method for estimating losses from local air pollution as part of ANS has continued to evolve in recent years, and some important changes have been made that deserve mention.

At the time *The Changing Wealth of Nations: Measuring Sustainable Development in the New Millennium* was published (World Bank 2011), the scope of local air pollution damages included in ANS was limited to outdoor air pollution in urban areas with more than 100,000 people. Estimates of damages relied on an econometric model (GMAPS) that predicted PM_{10} concentrations in cities based on the meteorological and topographical features of the city along with a slew of country-level variables such as fuel consumption and GNI per capita. Average $PM_{2.5}$ concentrations were derived from PM_{10} by assuming the ratio of $PM_{2.5}$ to PM_{10}

was 0.5 for all cities. Elevated risk of mortality from lung cancer and cardiopulmonary disease caused by long-term exposure to $PM_{2.5}$ was then calculated using the dose-response coefficients from the American Cancer Society (ACS) study by Pope and coauthors (2002), while mortality risk from acute respiratory infections among children ages 0-4 caused by exposure to PM_{10} was estimated using dose-response coefficients from a meta-analysis by St. George's Hospital Medical School (see Cohen et al 2004). Concentrations of $PM_{2.5}$ and PM_{10} were truncated at 50 micrograms per cubic meter (μg/m^3) and 100 μg/m^3, respectively, because the ACS study did not observe the effects of more severe pollution beyond this range. Years of life lost due to pollution exposure were then monetized by applying a Value per Statistical Life Year (VSLY). The VSLY was derived by dividing a Value per Statistical Life (VSL) of US$ 3.6 million (1990 prices) by 22, corresponding to the average discounted remaining life expectancy for respondents in the studies done in the United States from which the VSL was estimated. The VSLY was transferred from the study context in the United States to other countries by adjusting for differences in per capita income at market exchange rates, assuming an income elasticity of the VSLY equal to one.

The methodology for valuing the costs of air pollution as part of ANS underwent a major shift with the release of WDI 2015. Following the recommendations of a review by Resources for the Future (Cropper and Khanna 2014), the World Bank replaced the GMAP model with new estimates of the health impacts of air pollution from the Global Burden of Disease Study (GBD), an international scientific effort coordinated by the Institute for Health Metrics and Evaluation at the University of Washington, Seattle (IHME) to replace the GMAP model. The new estimates from the GBD included the health impacts of ambient outdoor $PM_{2.5}$ pollution in urban and rural areas as well as household $PM_{2.5}$ pollution from cooking with solid fuels (see Lim et al 2012). The GBD 2010 provided one of the first truly global pictures of exposure to outdoor $PM_{2.5}$ pollution, as described in the introduction Apart from how health impacts were estimated, the World Bank also replaced the VSLY-based approach to monetizing premature mortality with an income-based approach, described in greater detail below.

Since the publication of WDI 2015, the World Bank has continued its collaboration with IHME to make improvements in valuing air pollution damages for ANS. For WDI 2016, estimates of the health impacts of air pollution were updated with data from the GBD 2013 (Forouzanfar et al 2015). The scope of air pollution damages was also expanded to include premature deaths from ambient ozone in addition to ambient $PM_{2.5}$ and household $PM_{2.5}$ from solid fuels. For WDI 2017, estimates of the health impacts were again updated, with new data from the GBD 2015 (Forouzanfar et al 2016). The methodology for estimating forgone labor output was refined following Narain and Sall (2016).

Under the present methodology for ANS, losses due to premature mortality from air pollution exposure are equated with the discounted 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 is measured under ANS. This approach does have its limitations, however. First, we are unable to measure the costs of non-fatal illness. Second, the income-based approach to valuing increased mortality risks fails to reflect the cost of pain and suffering and the loss of many intangible things in life that people value beyond their paychecks. Third, beyond human health, air pollution affects the economy in a myriad of other ways too, for example, by reducing crop yields and depressing real estate prices.[41] 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.

Losses due to premature mortality are estimated per five-year cohort for ages 15-79 as:

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

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.

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

$$I = (GDP \cdot s)/w \tag{2}$$

where *s* is the labor share, $GDP \cdot s$ is total labor income in the economy, and *w* is the total number of employed workers. Data on *s* are drawn from a variety of sources, as indicated in Table 8 below.[42] For sources 1-3 in the table, estimates of *s* are comprised of employee compensation, a standard item in national accounts, plus an adjustment for labor income of the self-employed. For sources 4-6, estimates of *s* are limited to employee compensation. To ensure consistency, only one data source for *s* is used per country. If available, data for *s* from sources 1-4 are given priority; otherwise, the data from sources 4-6 are used. Estimates of *s* from sources 4-6 are further adjusted to include labor income of the self-employed. This is done by adding the average labor share for self-employed workers for each income group

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[41] See Wang and Mauzerall (2004), Avnery et al (2011), and Zheng et al (2014) for evidence from China.

[42] Equation 1 shows that the calculation of forgone labor output involves similar elements of the lifetime labor income approach used to estimate human capital. From table 1, it can also be seen that the data sources used for estimating forgone labor output as part of the ANS indicator differ from some of the sources used to estimate human capital. Opportunities to better integrate the ANS estimates of forgone labor output and the human capital account are discussed in more detail in section IV of this chapter.

($s_{self,g}$) to employee compensation as a share of GDP ($s_{emp,c}$). The total labor share is thus approximated for these countries as $s_{tot,c} = s_{emp,c} + s_{self,g}$. For any countries missing data on *s* from sources 1-6, the income group average of the total labor share ($s_{tot,g}$) is assumed (see ***Table 9***). Estimates of the total employed workforce (*w*) are by the ILO and include "all persons of working age who, during a specified brief period, were in one of the following categories: a) paid employment (whether at work or with a job but not at work); or b) self-employment (whether at work or with an enterprise but not at work)."[43] Because of year-on-year volatility, average labor income per worker is smoothed by taking a lagged 5-year average.

Table 8: Data sources for the labor share of GDP

No.	Source
1	R.C. Feenstra, R. Inklaar, and M.P. Timmer, "The Next Generation of the Penn World Table," *American Economic Review*, 105, no. 10 (2016), 3150-3182, http://www.ggdc.net/pwt.
2	ILO, "Global Wage Report 2014/2015" (2014), http://www.ilo.org/global/research/global-reports/global-wage-report/2014/lang--en/index.htm.
3	The Conference Board, The Conference Board Total Economy Database™ (Original version), November 2016, https://www.conference-board.org/data/economydatabase/.
4	OECD, "D1 – Compensation of Employees," Annual National Accounts – Main Aggregates, OECD.Stat database, http://stats.oecd.org/Index.aspx.
5	UN Statistics Division, "II.1.1 Generation of income account – Uses Compensation of Employees," National Accounts Official Country Data, Table 4.1 Total Economy (S.1), http://data.un.org/Explorer.aspx.
6	M. Lenzen, D. Moran, K. Kanemoto, and A. Geschke, "Building Eora: A Global Multi-Region Input-Output Database at High Country and Sector Resolution," *Economic Systems Research* 25 (2013): 20-49, http://www.worldmrio.com/.

Table 9: Average labor share of GDP, by income group, 2014

Income group	Labor share (% GDP)
Low income	54.5%
Lower middle income	50.5%
Upper middle income	43.5%
High income: non-OECD	45.2%
High income: OECD	52.4%

Source: Authors, using data from sources indicated in Table 8

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:

[43] ILO, "Employment by sex and age – ILO modeled estimates" (EMP_2EMP_SEX_AGE_NB), ILOSTAT database, http://www.ilo.org/ilostat.

$$T_j = \sum_{t=j}^{79} s_{j,t} \cdot \ell_t \quad (3)$$

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.[44] ILO estimates of ℓ are available by five-year age group for ages 15–64 and for the open-ended 65 and up age group.[45] The probability of being economically active in any given year is assumed to be independent of whether an individual was active in previous years, so individuals may move in and out of the workforce freely. Although the ILO estimates of workforce activity do not set a maximum working age for the 65 and up group, it is assumed that no person above the age of 79 works. The average ℓ for the 65 and up group is applied to the 65–69, 70–74, and 75–79 groups. As for the younger age groups, working life is assumed to begin at age 15, and so the present value of future lifetime earnings among children must be discounted further into the future. Of course, not everyone will enter the workforce upon turning 15, and not everyone will work until the age of 79. Adjusting *T* for ℓ is one way of capturing when people tend to enter and retire from the workforce in different countries. Because of the likelihood of gender bias in the labor force statistics from which ℓ is derived, a reasonable compromise is to apply the average ℓ for males to both sexes in calculating *T.* Survival probabilities, *s*, are calculated from mean death rates, *d*, so that *s* = 1 – *d*. The GBD 2015 provides estimates of mean death rates by age group for ages <1 year, 1–4 years, 5–9 years, 10–14 years, and so on up to the open-ended 80 and up age group.

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, as for adults in equation (2). In equation (1), the present value of labor income is discounted farther into the future, assuming working age begins at 15.

III. Results

Globally, annual labor income losses from premature mortality due to air pollution exposure totaled nearly US$ 179 billion in 2015,[46] an increase of about US$ 47 billion or 36 percent in real terms since 1995 (Table 10).[47] Losses from ambient $PM_{2.5}$ exposure increased the quickest over

[44] 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.
[45] The ILO'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).

[46] All dollar figures reported in this chapter are in 2014 US$ at market rates.
[47] Here, total losses are for the 157 countries for which data are available for all years from 1995-2015. Estimates of forgone labor output in 2015 exist for another 8 countries that are missing data for some earlier years. Including these countries, labor income losses in 2015 were US$ 179.8 billion (2014 US$, market rates).

this time (Figure 27), 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.

Table 10: Labor income losses due to air pollution by region, 1995-2015 (billion year 2014 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 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**

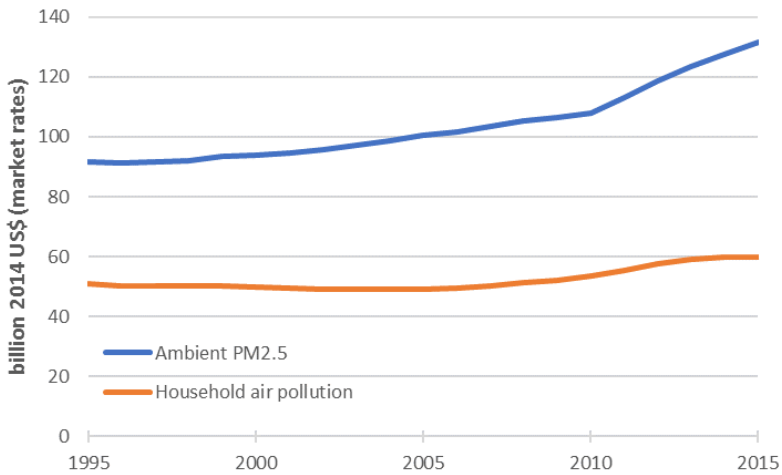
Note: data are for a balanced set of 157 countries with data for all years; deflated to constant 2014 US$ at market rates
Source: Authors, using data from World Bank, "Adjusted savings: particulate emission damage (current US$)" (NY.ADJ.DPEM.CD), World Development Indicators database,
http://data.worldbank.org/indicator/NY.ADJ.DPEM.CD.

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 experience the most rapid increase, as losses more than doubled between 1995 and 2015, reaching US$ 62 billion or the equivalent of 0.29 percent of regional GDP.[48] 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 28). Meanwhile, two regions have achieved significant reductions in damages since 1995: Europe and Central Asia and Latin America and the Caribbean. Losses in Europe and Central Asia dropped from US$ 15 billion to US$ 26 billion in 2015, while losses in Latin America and the Caribbean dropped from US$ 15 billion to US$ 9 billion. The declines in these regions were mainly the product of improving access to non-solid fuels and reduced mortality from household air pollution, as shown by Figure 29. The Middle East and North Africa region also experienced significant improvements in household air pollution, though these were canceled out by worsening exposure to outdoor air pollution. Concerningly, despite the longer-

[48] Forgone labor income does not represent a deduction of GDP because GDP produced in a given year reflects the lower labor inputs resulting from air pollution. Losses are compared to GDP merely to provide a sense of relative magnitude.

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.

Figure 27: Global labor income losses from ambient $PM_{2.5}$ and household air pollution, 1995-2015

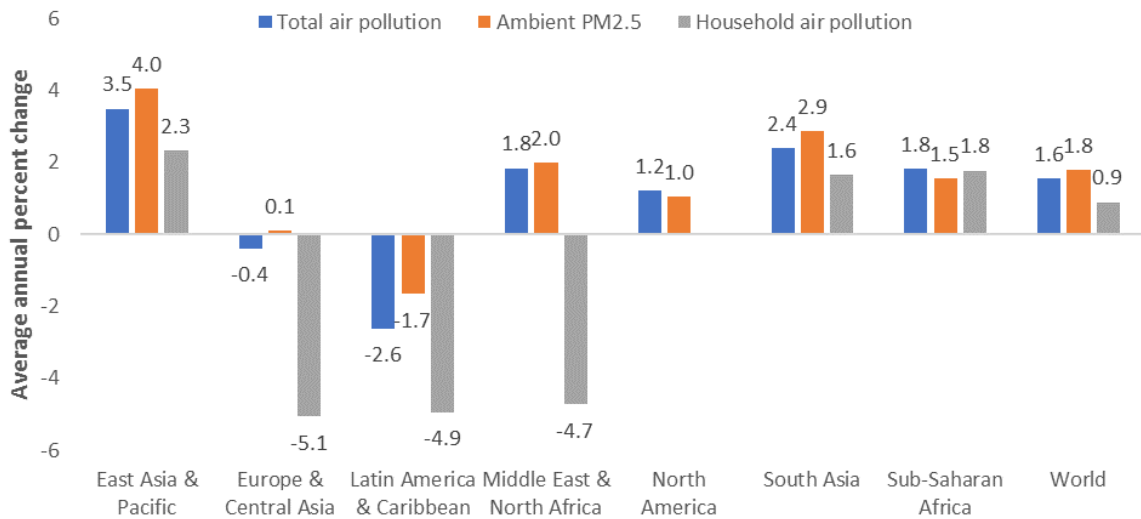


Source: Authors, using data from IHME (2016)

Figure 28: Labor income losses due to air pollution by region, 2015 (percent equivalent of GDP)

Source: Authors, using data from IHME (2016)

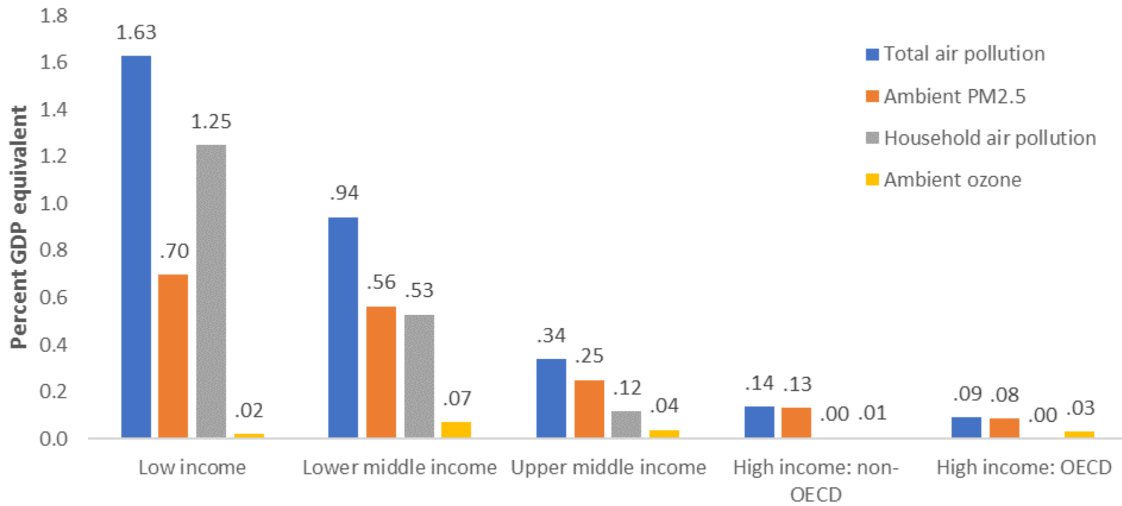
Figure 29: Average annual change in labor income losses from air pollution, by region, 1995-2015



Note: Average annual percent change in losses as measured in constant 2014 US$ at market rates
Source: Authors, using data from IHME (2016)

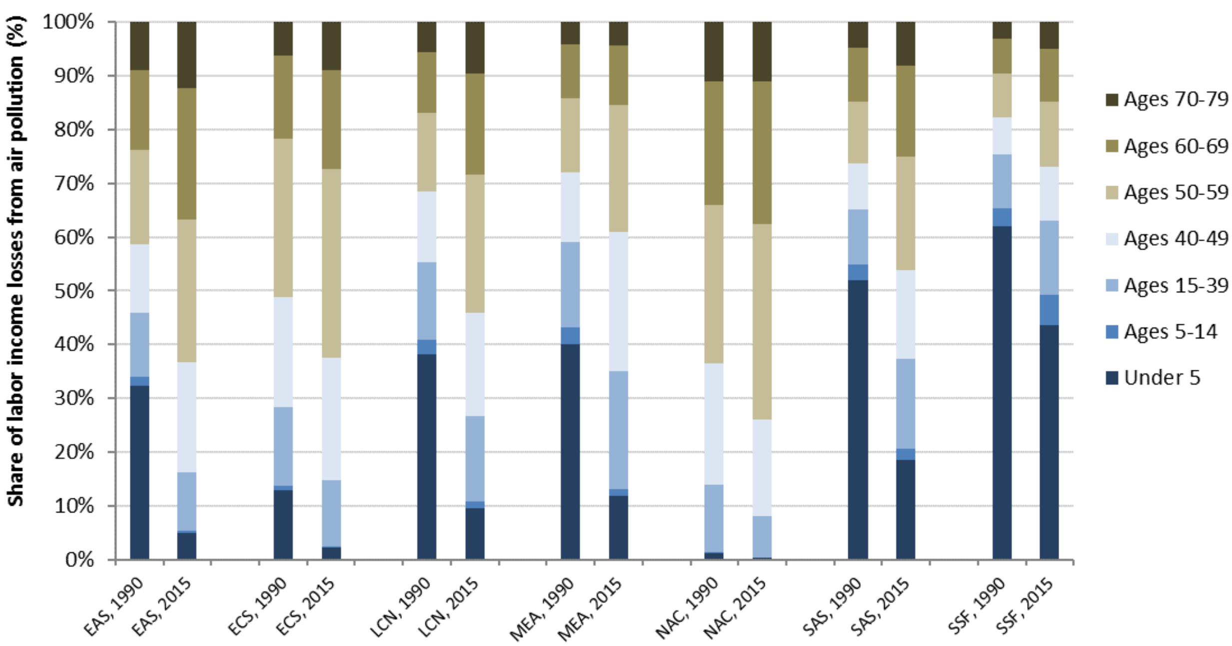
When trends in pollution losses are viewed instead by income level, the heavy burden of air pollution on the world's poorer countries becomes apparent. Forgone labor output in low- and lower-middle income countries averaged the equivalent of 1.63 percent of GDP and 0.94 percent of GDP, respectively, in 2015 (Figure 30). These relatively high losses owe to the continuingly 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 among 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 under 14 (Figure 31). 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 life.

Figure 30: Labor income losses due to air pollution by income group, 2015 (percent equivalent of GDP)



Source: Authors, using data from IHME (2016)

Figure 31: Age profile of labor income losses from air pollution, by region, 1990 and 2015

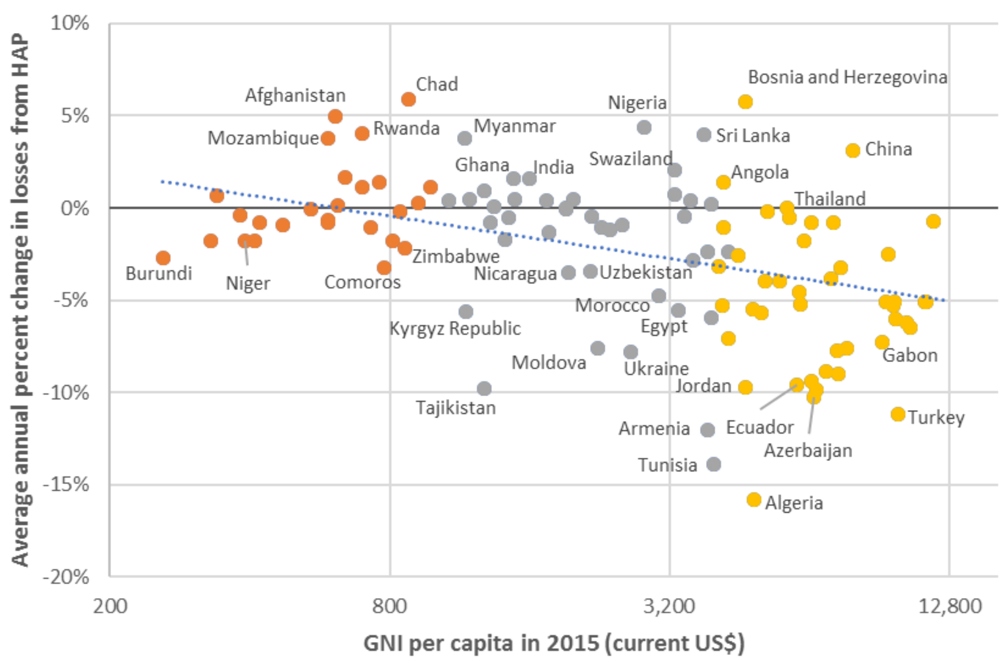


Note: EAS = East Asia and Pacific (all income levels); ECS = Europe and Central Asia (all income levels); LCN = Latin American and Caribbean (all income levels); MEA = Middle East and North Africa (all income levels); NAC = North America; SAS = South Asia; SSF = Sub-Saharan Africa (all income levels)
Source: Authors, using data from IHME (2016)

Losses from household air pollution have largely followed improvements in access to non-solid fuels and show a clear relationship with income. Year-on-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 32). The greatest reductions in household air pollution losses were achieved by Algeria, Tunisia, Armenia, Turkey, and Azerbaijan. The greatest increases occurred in Chad, Bosnia and Herzegovina, Afghanistan, Nigeria, and Uganda.[49] 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 33). Year-on-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 Kuwait, Bosnia and Herzegovina, Afghanistan, China, and Iraq.[50] The countries with the largest annual decreases were Tajikistan, Turkey, Azerbaijan, Comoros, and Gabon.

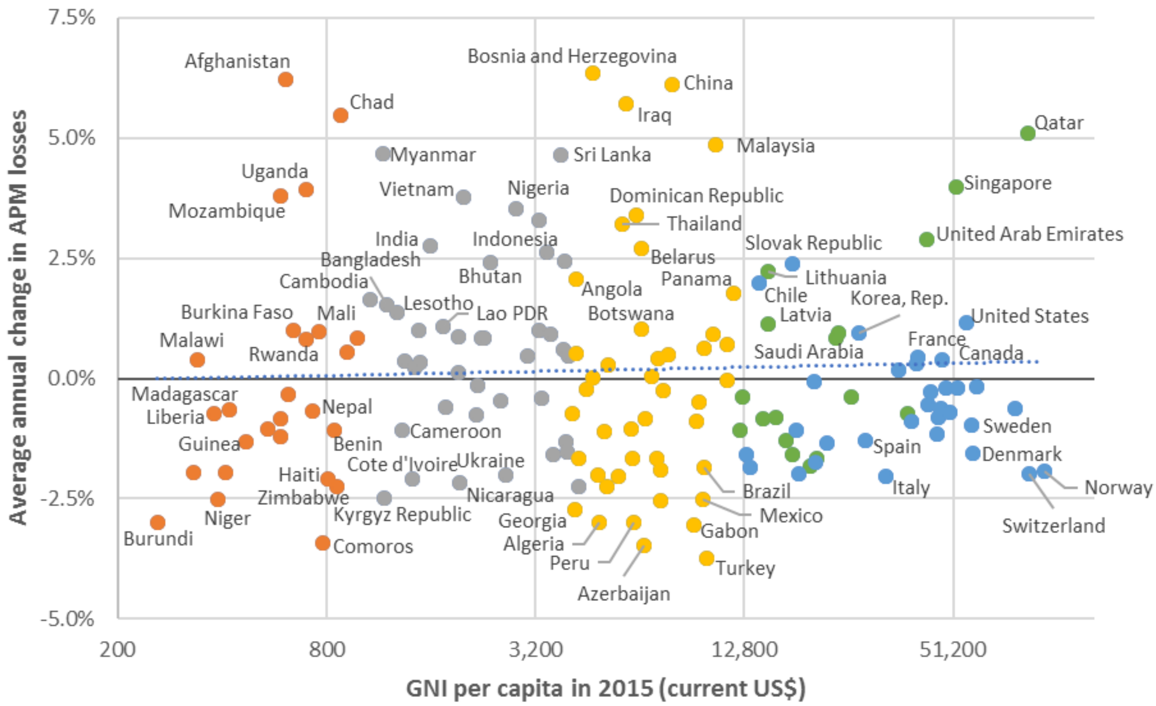
Figure 32: Average annual change in losses from household air pollution in low- and middle-income countries, 1995-2015, versus income level in 2015



Note: "HAP" = household air pollution; orange = low income; grey = lower middle income; yellow = upper middle income; Equatorial Guinea not shown. HAP exposure and losses in high-income countries are negligible so are not included.
Source: Authors, using data from IHME (2016)

[49] 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.
[50] 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.

Figure 33: Average annual change in losses from ambient PM$_{2.5}$, 1995-2015, versus income level in 2015



Note: "APM" = ambient particulate matter; orange = low income; grey = lower middle income; yellow = upper middle income; green = high-income non-OECD; blue = high-income OECD; Kuwait and Equatorial Guinea not shown.
Source: Authors, using data from IHME (2016)

IV. Recommendations for the way forward – improving the measure of pollution losses for ANS

The development of human capital accounts, described in Chapter 6, offers an opportunity to make further improvements to the measure of pollution losses for the ANS indicator. Following the methodology pioneered by Jorgensen and Fraumeni (1989, 1992a, 1992b), human capital is valued according to expected lifetime income for persons of different age, sex, and educational attainment. The method of estimating lifetime labor income by five-year cohort closely resembles that implemented for valuing income losses due to premature mortality from air pollution, though with significant refinements. As discussed in chapter 6 of this book, estimates of human capital have been constructed for [141] countries using richly detailed data on demographics, earnings, and educational attainment from the International Income Distribution Database (I2D2), an extensive collection of nationally-representative household surveys.

Currently, pollution losses are valued by assuming that annual labor income is the same for all adult workers (aged 15-79), regardless of skills, experience, or education. Using the more granular data from the I2D2 would refine the existing estimates of expected lifetime labor income. Beyond sex and age group, however, the GBD data on health impacts presently do not allow for further disaggregation by other characteristics such as schooling, work experience, or income. Thus, in calculating losses, average labor earnings by sex and age group would still have to be assumed for all sufferers of pollution-caused illnesses, even though empirical evidence from countries such as the United States and China points to a disproportionate burden of pollution on poorer, more vulnerable segments of society.[51]

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. The estimates of human capital presented in this volume are restricted to people between the ages of 15 and 65. About 69 percent of premature deaths in 2015 due to air pollution exposure were suffered by children under the age of 15 and adults over the age of 65. Deaths among children under 15 and adults between the ages of 65 and 79 in 2015 accounted for 30 percent of total labor income losses. Thus, the majority of health impacts and a sizeable share of income losses are represented by people of ages not presently included in the human capital accounts. Extending the human capital accounts to cover older individuals would be particularly relevant for low- and middle-income countries, where the ILO estimates about 25 percent of the 65-and-over population is still active in the labor force. Furthermore, if forgone labor output due to air pollution is incorporated into the wealth accounts, care would also need to be taken to avoid double counting. Reductions in human capital due to premature mortality would in principle already be factored in the “missing” population not included in the accounts (i.e., if death rates due to air pollution were lower, more laborers would be alive to have their income counted and working life expectancy would be longer on average). Losses from air pollution could be compared against but not deducted from overall changes in the value of the human capital stock from year to year.

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. Table 11 below presents estimates of premature mortality from other environment-related health risks. Together, more than 9 million deaths were attributed to these risks in 2015, causing labor income losses of more than US$ 276 billion.[52] Apart from environment-related risks, the GBD

[51] For discussions of distributional impacts in the United States and China see Katz 2012, Ma and Schoolman 2011; Schoolman and Ma 2012; Zhao et al 2014; Zheng Siqi et al 2014a and 2014b.

[52] The figure for total deaths from environment-related health risks is equal to the sum of deaths from what the GBD categorizes as “environmental and occupational risk factors” minus deaths due to “occupational injuries.” Injuries may be subtracted from total deaths in this manner because there is no overlap in the causes of death due to injury and other causes of death due to other environment-related risk factors. Estimates of additional labor

also provides data for other risk factors, such as tobacco smoke, alcohol and drug use, sexual abuse and violence, unsafe sex, dietary risks, and childhood and maternal malnutrition that may be relevant for economic valuation for social and policy purposes. An approach to estimating the impact of stunting on human capital and wealth is presented in Chapter 8.

The valuation of air pollution losses for ANS would also be improved by continuing to explore how non-fatal 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. From a theoretical standpoint, such non-fatal outcomes are more difficult to value because they involve a plurality of health endpoints (lost work days, hospital admissions, expenditures for long-term medical treatment, etc.) suffered by a plurality of agents (the patients as well as the patient's family, coworkers, friends, and so on). This raises the possibility of double counting or inconsistency in the cost estimation methods for different health outcomes. Data may be mission on health expenditures and medical treatment costs for a wide array of countries. Differences in health care systems between countries—and how costs are allocated to patients, care providers, and the public treasury—is also a problem (see WHO-OECD 2015). Yet, though difficult to measure, these costs are not insignificant. For example, the OECD has conservatively proposed that such morbidity costs are probably at least 10 percent of the mortality costs from air pollution (WHO-OECD 2015; Hunt et al 2016). If the valuation of losses for ANS is expanded beyond air pollution to encompass other risk factors for which more of the total health impacts come in the form of non-fatal outcomes, then accounting for these costs would be even more relevant.

Table 11: Premature mortality from other environment-related risk factors in 2015

Risk factor	Million deaths
Total environment-related risks	9.1
Air pollution	6.5
Ambient particulate matter	4.2
Household air pollution from solid fuels	2.8
Ambient ozone	0.3
Unsafe water, sanitation, and handwashing	1.8
Unsafe water source	1.2
Unsafe sanitation	0.8
No handwashing with soap	0.9
Workplace environmental risks	0.9
Lead exposure	0.5
Residential radon	0.1

income losses are made by applying the same methodology for valuing forgone labor output from premature mortality due to air pollution as described in this chapter.

Note: workplace environmental risks include occupational exposure to carcinogens, asthmagens, particulate matter, gases and fumes; "total environmental-related risks" is deaths from "environmental and occupational risks" less occupational injuries

Source: IHME, Global Burden of Disease Study 2015, http://ghdx.healthdata.org/gbd-results-tool

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Chapter 10. Marine Fisheries Wealth

Charlotte De Fontaubert, Rashid Sumaila, and Glenn-Marie Lange

One of the primary motivations for the early natural capital accounting efforts in the mid-1980s was 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, represent an important component of natural capital, especially in coastal nations or small island developing states. Approximately one in ten people rely on fisheries and aquaculture for their livelihoods (FAO, xxx). Commercial capture fisheries, including post-harvest activities, were estimated to contribute at least $274 billion to the global GDP in 2007 (de Graaf and Garibaldi, 2014).

Despite their global importance, fisheries are measured and assessed on the basis of data that are frequently incomplete, limited, or even inaccurate. This impedes 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 effort of other natural capital assets such as forests and subsoil assets. The System of Environmental Economic Accounting (SEEA; European Commission et al., 2012) provides the framework for accounts, further elaborated for fisheries in SEEA-Agriculture (2016) and SEEA for Fisheries (FAO, 2006). But fisheries resources are poorly represented in most national environmental accounting efforts largely due to a lack of data.

The Changing Wealth of Nations has not included fish assets because available data do not meet our criteria for inclusion. Assets are included in CWON when the necessary data are i) available for a large number of countries (at least 100), ii) are updated regularly to provide a times series, and iii) are publicly available. The general approach to asset valuation, as described in Chapter 1 and following European Commission et al., 2012) is to estimate the discounted stream of rents a fishery is expected to generate over its lifetime; if managed sustainably, the lifetime and stream of rents is infinite; if not, then the lifetime is limited, as it is for minerals. Data requirements include catch volume and price and costs of harvest to estimate the rent, and information about the size and condition of the underlying stock to assess the potential lifetime of the stock and rents generated. While some country studies are available and one-off studies (see Box 1), the available data with global coverage has largely been limited to catch volume and value.

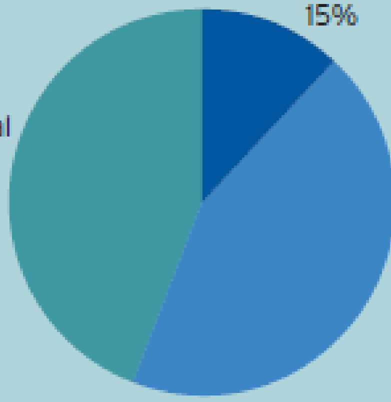
Nevertheless, and in spite of these data challenges, recent initiatives have improved our understanding of what is really at stake, and to take steps toward including fisheries wealth in future versions of the Changing Wealth of Nations.

Accounting for fish wealth in Mauritania

In 2014, the World Bank conducted an analysis of Mauritania's existing capital stock to assess the country's produced, intangible, and natural capital—both renewable and nonrenewable. The study results showed that the country's stock of natural capital amounts to approximately US$30–35 billion, or roughly US$9,000 per capita, and represents 44 percent of the total capital. More than half of the country's natural wealth is concentrated in renewable resources, which, given effective sustainability-focused policies, could theoretically support a continuous income flow over the long term. Such sustainable management is not a given, however, and unsustainable management of renewable resources can lead to permanent depletion of capital stocks in much the same way as the finite extraction of nonrenewable resources.

FIGURE B.4.1.1

The estimated composition of natural wealth in Mauritania



Source: Mele 2014.

The fisheries sector represents the largest share of natural wealth in Mauritania, and with an estimated US$10 billion value (or roughly US$2,800 per capita), fisheries account for just over a quarter of the country's natural capital. Commercial fishing represents approximately 90 percent of the sector, with artisanal fishing accounting for the remaining 10 percent. Fishing contributes just 3 percent to annual GDP, but the sector registered double-digit growth rates in 2010 and 2011, and is expected to grow by 5 percent per year over the medium term. Meanwhile, the revenues generated by international fishing agreements have remained roughly constant as a share of total revenues for much of the past seven years, typically accounting for around 20 percent of public sector income.

However, the presence of significant natural wealth does not always translate into shared prosperity, either for the current population or for future generations. The failure to responsibly manage natural resources and adopt policies that expand the economic impact of resource exploitation can jeopardize broad-based growth and poverty reduction both now and in the future. Some of Mauritania's local fish species are already overexploited, and widespread global overfishing is expected to boost the value of remaining fishery resources. This situation underscores the importance of optimizing rents from commercial fisheries and using a share of those resources to ensure that the sector is properly regulated. 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. If left unchecked, overexploitation could transform the fisheries sector into a so-called "finite resource," which is a renewable resource that is rendered nonrenewable and thus may become biologically or commercially extinct over time.

Source: Mele 2014.

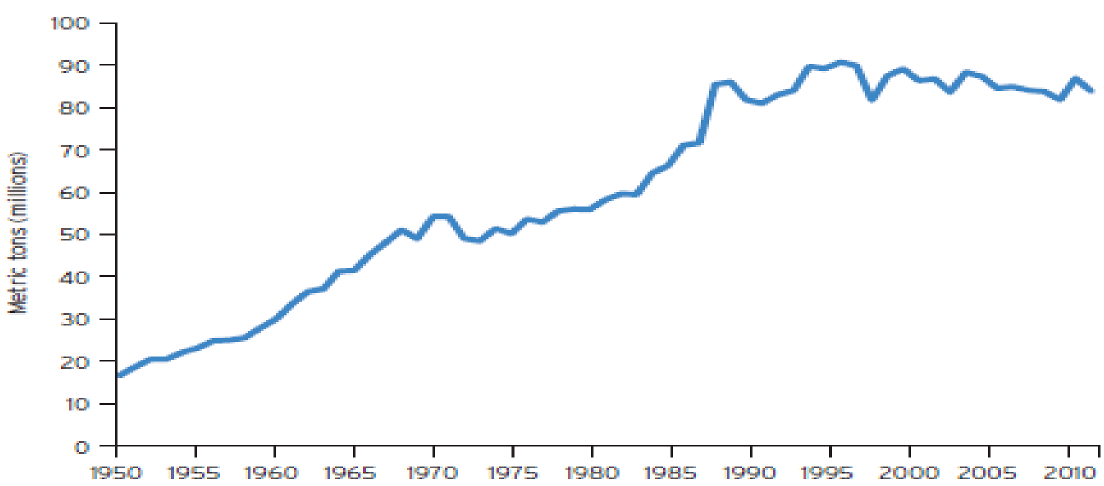
The Sunken Billions made a first attempt to measure global rents from marine fisheries and found that massive overfishing, supported by subsidies, resulted in forgone rents of $51 billion dollars in 2004 (World Bank, 2009). An update of this report found that foregone rents reached $83 billion in 2012 (World Bank 2017). A negative rent means that the fish stock itself has a zero value, 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 points to widespread overfishing, declining fish stocks and likely negative rents on many countries.

State of Global Marine Fisheries

According to the UN Food and Agriculture Organization (FAO), after steadily increasing over decades, annual global capture fisheries production has plateaued just above 80 million metric tons (MTs), fueled by a sustained demand from developed and, increasingly, developing countries, with China representing the lion's share in the latter group. Figure 1 illustrates the evolution of global marine catches from 1950 to 2012, showing a steady increase (around 1.4 million tons each year) until the early 1990s, followed by a period of stagnation, fluctuating between 79 and 86 million tons per annum. From the peak of 86 million tons in 1996, global marine catches have shown a small downward trend of about 0.2 million tons per annum, a shift from a regime of growing catch to a regime of stagnation in the early 1990s.

Figure 1.

Global marine catches 1950-2012

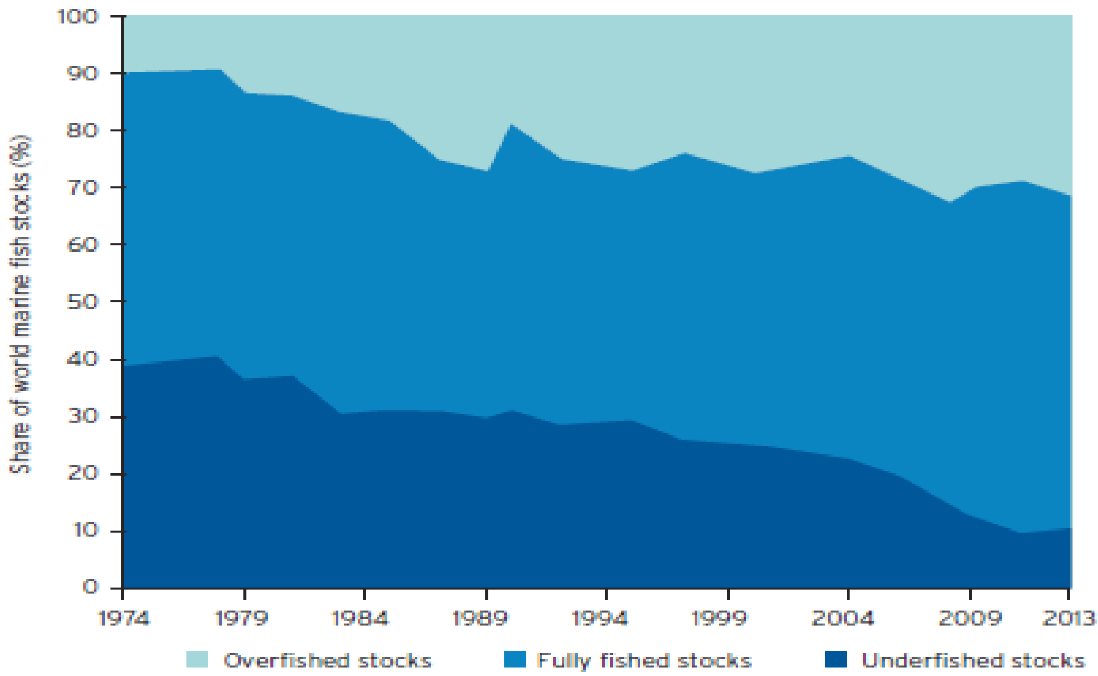


Source: FAO FishStat Plus database.

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 just above 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 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 stock size that is larger than that at MSY level. Therefore, the FAO assessment of the biological state of the fish stocks indicates that approximately 90 percent of the world's fisheries likely were subject to economic overfishing in 2011.

Figure 2

State of global marine fish stocks, 1974-2013



Source: FAO 2016.

Just as global marine catches stagnated and even declined, fishing effort[53] appears to have increased. While 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). Thus, 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 that catch per unit effort (CPUE), often considered as a measure of fishing productivity.

We have already seen that estimates of global rent from marine fisheries was negative; recent work under the Sea Around Us and the Global Ocean Economics projects of the Fisheries Centre at the University of British Columbia helps us begin to estimate fisheries asset value at the

[53] 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

country level. Their database covers landed value, costs of harvest and subsidies in 2014 for 139 maritime countries, which collectively represented approximately 98% of global landings in 2005.[54]

The first step is to determine if rent net of subsidies, as currently managed is positive for a country or not. If negative, as mentioned for the global study, the productive value of the fish stock itself is zero. If rent is positive, the next step is to evaluate management of the fishery, whether it is sustainable or not. At the global level, the most striking finding from these new data is that, overall, global fisheries do not generate positive rent. Landed value in 2014 was $164 billion, with rent -$24 billion. Subtracting subsidies results in net rent of -$44 billion. These findings cannot be strictly compared to the estimates of the Sunken Billions reports – mostly because of major differences in how subsidies are accounted for and even landing values measured, but the message is similar, and a worrisome one.

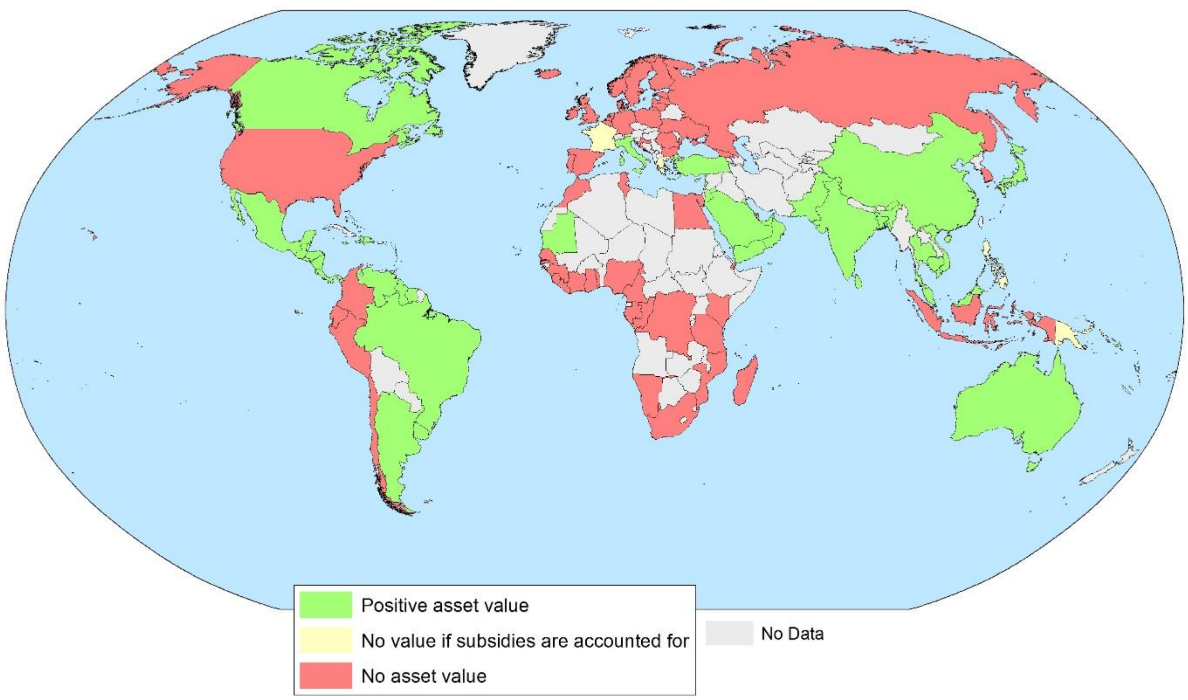
Of course, global figures do not reflect what is going on in every country. Figure 3 shows that fisheries in 64 out of 139 countries generate positive rents, even after accounting for subsidies, and fisheries contribute to national wealth, but in 75 countries they do not. For six countries with negative net rents, the subsidies make the difference, pushing net rent.

Fisheries in nearly half the countries (64) generate positive rents, even net of subsidies, and do contribute to national wealth. In six countries fisheries generate positive rents, but if the subsidies are accounted for, the net rents are negative, and fisheries do not contribute to national wealth. Fisheries in the remaining 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 fisheries' biophysical sustainability. 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 (warming ocean temperatures, acidification) should also be taken into account. These data will be developed and used to fully incorporate fisheries in future versions of the Wealth of Nations.

[54] The data focuses 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 seafood industry.

Where Fisheries contribute to the Wealth of Nations



References

Chapter 11. Progress Toward Ecosystem Accounting in the Wealth of Nations

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1. Introduction

The natural capital component of wealth accounts currently includes agricultural land, protected areas, forests, minerals, and 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 water and fisheries (discussed in Chapter x), as well as the value of renewable energy resources from wind and geothermal power. One of the characteristics of natural capital, except for minerals and energy resources, is that it often provides multiple goods and services. We measure some goods reasonably well, such as timber produced by forests. But the value of most 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, due to lack of information. 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 a nation being “more wealthy than we thought,” but is essential for supporting decision-making that makes the best use of the assets that nations have.

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, U.N. 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 only covers 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, U.N. et al., 2014b). As its title implies, accounting for ecosystems is still at an early stage; there are not yet agreed-upon guidelines, and many issues remain resolved. 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 assets in CWON are estimated as the discounted sum of the stream of benefits they are expected to provide over their lifetime. 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 in CWON can be directly observed, or reasonably derived from observable information including official statistics and administrative data, sometimes in combination with modeling. Ecosystem accounts rely much more on modeling.

To construct ecosystem accounts, we begin by quantifying ecosystem services biophysically, then converting these quantities into monetary values; finally a projection about the delivery of future bundles of services must be made. For the first step, 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. Like 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 CWON when the necessary data are (1) available for a large number of countries (at least 100), (2) are updated regularly to provide a times series, and (3) are publicly available. This sets a rather high bar for some ecosystem services, for which such data are not readily available. There have been many one-off studies of specific ecosystem services and attempts to value ecosystems, but there is limited data that meet our criteria at this time.

Nevertheless, in recent years, the remarkable change in the availability of biophysical information about ecosystems and the services they provide is rapidly advancing ecosystem accounting. This change is due to an increase in availability of remote sensing data, improvements in data processing, and our understanding of how to model and interpret these data. Valuation remains a challenge because of the highly site-specific nature of economic value. Meta data analysis has been used by economists to try to overcome the data gaps, but is limited in applicability. However, new data sources and modeling approaches make biophysical assessment of natural capital increasingly possible for a large number of countries.

This moves natural capital a step closer toward fuller inclusion in wealth accounts. In this chapter, we review recent advances in remote sensing and environmental modeling that address the first step in ecosystem accounting: biophysical quantification of ecosystem services. We focus on those ecosystem services where most rapid advances are likely. We highlight data sources and modeling approaches that can support wealth accounting (Section 2), next steps for mapping and biophysical modeling of ecosystem services (Section 3), and considerations for integrating biophysical modeling and monetary valuation (Section 4). Although global natural capital asset values do not yet exist, the approaches we describe could make their inclusion increasingly feasible in future versions of wealth accounts–for example, within a 5-year timeframe.

2. Biophysical quantification of ecosystem services

Biophysical modeling of ecosystem services often begins with Earth observations, including satellite images, which are often validated with ground-based field data. Remote sensing uses satellites and other technology to measure how the Earth's surface reflects visible and non-visible light. Remote sensing provides an increasingly complete view of the global land and sea surface, including more frequent, high-resolution measurements of weather and climate, primary productivity in vegetation, and other Earth 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 datasets* like land cover, vegetation condition, or population density using manual approaches or algorithms. Finally, images are typically then validated against data from ground-based observations. Satellite images are increasingly stored in public data archives (e.g., NASA's Landsat or ESA's Copernicus program). When combined with supercomputing and cloud computing resources (e.g., Google Earth Engine), remote sensing supplies increasing volumes of data. These can be used as inputs to ecosystem service models (Schröter et al. 2015), supporting ecosystem service assessment and wealth accounts.

NASA'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 at 30 m resolution. The ESA's Sentinel satellites began service starting in 2014 and collect a wide variety of data. Data from both 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 et al. 2013, Araujo Barbosa et al. 2015).

To inform wealth accounts, biophysical measures of ecosystem services should: (1) be publicly available, (2) cover most (i.e., >100) and ideally all countries, and (3) be regularly updated, in order to show changes in wealth over time (i.e., not one-off studies). With global ecosystem service data, national estimates could be compiled, allowing comparisons within and between nations over time. Although we know of no studies that meet all of these criteria, a series of studies have spatially quantified ecosystem service flows at the global scale.

We summarize a subset of global ecosystem service studies below (Table 1). Studies like 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 (see Section 3). While not a comprehensive list, Table 1 includes ecosystem services that address the attribution problem (e.g., crop pollination and aspects of sediment regulation that are included in economic production measures but not accurately attributed to ecosystems) and the production boundary problem (e.g., carbon sequestration and storage, coastal flood regulation, and aspects of sediment regulation are currently outside wealth accounts' production boundary). We rank each ecosystem service by its current feasibility for repeated global assessment, with currently feasible approaches ranked "high," approaches still requiring substantial new data and methods as "low," and intermediate cases as "moderate." We exclude global studies that use land cover-based value transfer, which are not informative for wealth accounts (e.g., Costanza et al. 2014). We also exclude modeling tools that have not yet been applied at global scales (e.g., ARIES, InVEST, or others; Sharp et al. 2016, Villa et al. 2014).

Table 1. Environmental modeling and mapping approaches for ecosystem services in support of wealth accounting.

Ecosystem service	**Example modeling & mapping approaches**	**Key data inputs (*remote sensing-derived)**	**Representative examples**	**Current feasibility**	**Comments**
Crop pollination	Global mapping of pollination-dependent crops and pollinator habitat	Cropland extent & type*, pollinator habitat*, pollination dependency ratios, agricultural values	Lautenbach et al. 2012	High	High social relevance given rapid agricultural intensification and pollinator declines
Water supply & use	Global water balance models; spatially allocated global water use estimates	Weather & climate*, soils*, vegetation*, elevation*, water use across sectors	Mulligan et al. 2013, Wada et al. 2014	Moderate	Global-scale modeling requires simplifications of groundwater-surface water interactions & dry-season flows
Sediment regulation	Global erosion models paired with dams or other beneficiary data	Soils*, elevation*, vegetation*, rainfall*, dams*	Naipal et al. 2015	High	Could pair global erosion models with dams data (e.g., Lehner et al. 2011) and water routing algorithms to roughly quantify sediment transport
Carbon sequestration & storage	Global mapping biomass & net primary productivity mapping (terrestrial); Modeled	Primary productivity*, biomass*, soils*, rainfall*, land & tree cover* (terrestrial); Climate*,	Scharlemann et al. 2014, Avitable et al. 2016, Spalding et al. 2016	High	Methods frequently used to track carbon stocks and flows for REDD+ and other programs

	mangrove biomass using climate as predictors (blue carbon)	mangrove extent* (blue carbon)			
Coastal flood regulation	Statistical models of coastal ecosystems' ability to reduce wave energy	Elevation & bathymetry*, coastal ecosystems (coral reefs, mangroves, seagrass, coastal wetlands)*, population*, property value	Halpern et al. 2015, Spalding et al. 2016	Moderate	For coastal and marine ecosystem services, Halpern et al. (2015) provide rankings (0-100) with annual change and by country; has encountered some criticism related to construction of the index (Halpern et al. 2013, Visbeck et al. 2013). Spalding et al. 2016 provide some monetary values but do not yet include changes over time.

It is beyond the scope of this chapter to describe all ecosystem services that could be globally modeled. We excluded services already included in economic production (e.g., fisheries, recreation/tourism, and other ecosystem goods). In one such example, Karp et al. (2015) explored 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 FAO data. Despite these limitations that make the study unsuitable for wealth accounts, Karp et al. (2015) provide one example of how provisioning services can be tracked globally using existing data. Advancements in Earth observation and environmental modeling will likely make it possible to model more ecosystem services in the future using methods like those shown in Table 1.

An important step in biophysical ecosystem service assessment is in distinguishing 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 instance, watersheds that provide sediment regulation upstream of 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 (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 (e.g., WorldPop 2017), market access (Verburg et al. 2011), and other sources may be useful for this. 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 aid our understanding of the sustainability of service supply and use.

3. Guidelines for data and models in supporting wealth accounting for natural capital

Before being used in wealth accounts, studies like 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. In Section 1, we noted that data should (1) be publicly available, (2) cover most or all nations, and (3) be amenable to repeated measure. The first criterion means that the authors of each study will need to be willing to share their data. Studies should also be (4) quantitative, with metrics amenable to monetary valuation (making rankings or semi-quantitative studies unsuitable, e.g., Dickson et al. 2014). Studies should be (5) of adequate spatial and temporal resolution to detect changes over time at the national level, 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, annual outputs produced at 1 km resolution may be a "sweet spot" for global ecosystem service models (Willcock et al. 2016). Modeling studies should be (6) calibrated wherever possible to field-collected observations. Similarly, remotely sensing data should be ground truthed and have an accuracy assessment completed with acceptable results. Finally, (7) the caveats of each study should be carefully reviewed, in order 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 measure over time. Time trend estimates of ecosystem services are not yet common at broad geographic scales (Willcock et al. 2016), though this is changing (see Karp et al. (2015) and studies from Europe (Maes et al. 2015) and China (Ouyang et al. 2016)). Despite the limitations 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 its consistent measurement over time is important. Land cover data are increasingly available on an annual basis. For instance, in 2017 the European Space Agency-Climate Change Initiative released a 300 m global land cover dataset available annually from 1992 to 2015.

Other spatial data will also needed for terrestrial and coastal/marine environments. Various data integration challenges will need to be overcome, like how to handle datasets from non-overlapping years, which introduces uncertainty into model results. The Earth Observation for Ecosystem Accounting (EO4EA) initiative within the Group on Earth Observations (GEO) is working to identify data needs that support applications of the System of Environmental-Economic Accounting Experimental Ecosystem Accounts (SEEA-EEA). Many of its findings will also be highly relevant to wealth accounting.

In future wealth accounts, ecosystem service models themselves will also need to be periodically updated. This will be a challenge, because global models have tended to either be systems dynamics models that lack a spatial component or one-off studies as described in Section 2. However, with steady data and computing improvements, such studies are increasingly feasible. A key decision for future wealth accountants will be whether to work (1) 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. This allows model ensembles to be used to quantify uncertainties, like 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 as failing to do so can compromise the analysis of temporal trends. This approach is currently undertaken in other forms of environmental assessments (e.g., 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. Such data would contribute to wealth accounts, but could also serve as initial estimates for country use of the SEEA-EEA (with global estimates replaced by local results where available). Lastly, beneficiary data will need to be better incorporated into the models to estimate potential supply and ecosystem service flows, and valuation data will be needed to generate natural capital asset values.

4. Economic valuation for wealth accounting

Lastly, ecosystem service flows are valued monetarily as assets–typically first on an annualized basis, then as asset values (i.e., net present value). Monetary valuation is likely to be at least as challenging as biophysical modeling of ecosystem services, but its full treatment is beyond the scope of this chapter. While value transfer has been widely used to provide faster monetary values for ecosystem services, it is fraught with problems if done incorrectly (Plummer 2009). However, by using benefit transfer functions, including those that incorporate spatially explicit data (e.g., Siikamäki et al. 2015), acceptable valuation estimates may be achievable for some services. Recent studies to value groundwater (Fenichel et al. 2016) and fisheries (Yun et al. 2016) in a wealth accounting framework also provide useful examples of valuation in support of wealth accounting. Although prices are likely to shift as the quantity of ecosystem services changes, we make the common simplifying assumption that prices remain constant over time. With this assumption, we can reduce the uncertainty surrounding price changes and not mix the signals of changing prices and quantities. As mentioned previously, proper natural capital accounting re-attributes value to specific services and the ecosystems that provide them. For instance, 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 re-attributed to natural capital should be deducted from the rental value estimates of cropland. The same holds true for estimates of the value of pasture, forests, or other ecosystem types.

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Annex 1. Summary of Methodology and Data Sources

This annex summarizes the data and methods behind the comprehensive wealth and Adjusted Net Saving estimates. The methodology builds on the foundation laid in previous works by the World Bank, including the *Expanding the Measure of Wealth* (1997), *Where is the Wealth of Nations?* (2006), and *The Changing Wealth of Nations* (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. For more detailed documentation of the methodology, data sources, gap-filling measures, and country-specific exceptions, please refer to the wealth and Adjusted Net Saving documentation available for download online <url tbc>. Also available for reference are a number of scoping studies and background papers that underlie the revised methodology and data sources.

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***, comprising energy (oil, natural gas, and coal), minerals, agricultural land (crop and pasture), protected areas, and forests (timber and some non-timber forest products);
- ***Produced capital***, comprising machinery, structures, equipment, and urban land;
- ***Human capital***, including the knowledge, skills, and experience embodied in the workforce;
- ***Net foreign assets***, 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, where total wealth was estimated by (i) assuming that consumption is the return on total wealth, and then (ii) 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 missing or mismeasured assets. Now with a direct measurement of human capital, total wealth can be estimated as the sum of each category of assets.

Natural Capital

A few assumptions are applied to the valuation of natural resources, that should be highlighted upfront. First, in calculating the net present value, a discount rate of 4 percent[55] is used across all resources and years (same as the previous *Changing Wealth of Nations* (2011) report). 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 US$. 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 is applied.

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

Energy and Mineral Resources

Non-renewables resources valued in the World Bank wealth accounts include fossil energy and mineral resources. As described in *The Changing Wealth of Nations* (World Bank 2011), the value of a nation's stock of a non-renewable 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:

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

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 previous wealth editions, there is no cap on *T*. Rents in the current year are calculated as:

$$R_t = \pi_t q_t$$

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 denoting the quantity of resource extracted. Rents are converted into constant US 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 include bauxite, copper, gold, iron ore, lead, nickel, phosphate rock, silver, tin, and zinc.

[55] The 4 percent discount rate is the long run (100 years+) real return on financial assets globally, derived from the Credit Suisse data.

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 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 below, and users should refer to the technical documentation for more detailed information.

Table 1. Data sources of energy and mineral resources

Resource	Indicator	Data sources and notes
Oil and Natural Gas	Production	• Rystad Energy, UCUBE (Upstream Database) • International Energy Agency (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 • US Energy Information Administration, International Energy Statistics • UN Statistics Division, UN Monthly Bulletin of Statistics *Production data from difference 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	Proved reserves	• BP, Statistical Review of World Energy • US Energy Information Administration, International Energy Statistics
Coal	Production	• International Energy Agency, World Energy Statistics • US 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 (GEM) database • Case studies from various sources • World Bank, Manufactures Unit Value (MUV) 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 then used to calculate average rental rates by region for thermal and metallurgical (coking) coal. Average rental rates are weighted by production.*

Resource	Indicator	Data sources and notes
Coal	Proved reserves	• US Energy Information Administration (US EIA), International Energy Statistics • BGR (2015)
Metals and Minerals	Production	• US Geological Survey (USGS), Minerals Yearbook, Vol. I: Metals and Minerals, various years • USGS, Mineral Commodity Summaries, various years • British Geological Survey (BGS), 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 (MUV) 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

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:

$$V_t = \sum_{i=t}^{t+T-1} \frac{\bar{R}_t}{(1+r)^{i-t}}$$

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

$$R_i = \pi_i Q_i$$

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 below. Rents are converted into units of constant US dollars at market rates using country-specific GDP deflators before averaging to obtain $\bar{R}$.

Table 2. Data sources of forest timber resources

Indicator	Data sources and notes
Production	• UN Food and Agricultural Organization (FAO), FAOSTAT database *Roundwood production is the sum of coniferous industrial roundwood, nonconiferous industrial roundwood, and woodfuel*
Unit price	• UN Food and Agricultural Organization (FAO), 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 (2016) *A regional rental rate is applied to total revenues, in the absence of country-specific production costs 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* for data on total forest area and its breakdown, net annual increment, and growing stock of timber

Forest Resources: Non-timber

Timber revenues are not the only contribution forests make. Non-timber forest benefits such as minor forest products, hunting, recreation, and watershed protection are significant benefits not usually accounted, which leads to the undervaluation of forest resources. This edition features new estimates of non-timber forest wealth, based upon a recent meta-analysis study that predicts annual, per-hectare values for each service category per country based upon a spatially explicit meta-regression model.

The annual value of non-timber 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 (non-wood forest products; recreation, hunting, and fishing; and watershed protection). The capitalized value of non-wood services is equal to the present value of annual services, discounted into the future. The present value of non-timber services is given by the following equation:

$$\mathrm{PV}(S) = S + \frac{S}{r}$$

where *S* is the sum of per-hectare service values for the three benefit categories; and *r* is the discount rate of four percent. Services received during 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.

Table 3. Data sources of forest non-timber resources

Indicator	Data sources and notes
Total forest area	• FAO, *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; non-wood forest products (NWFP); and watershed protection.*

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 pasture land. There are potentially two alternative 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:

$$\mathrm{V}_t = \overline{R_t} + \frac{\overline{R_t}}{(r-g)}$$

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. 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 (Rosengrant et al 1995). Total rents *R* are converted into units of constant US 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 degradation) that may affect rents in the future.

Table 4. Data sources for crop and pasture land

Item	Indicator	Data sources and 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 (e.g., 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.*

Rental Rates

Rents are estimated for crops as:

$$R_{c,k,t} = q_{c,k,t} * p_{c,k,t} * a_g$$

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:

$$R_{c,k,t} = \left(q_{c,k,t} * p_{c,k,t} * 2a_g\right)e_c + \left(q_{c,k,t} * p_{c,k,t} * a_g\right)(1 - e_c)$$

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.[56] The same 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 percent of ruminant meat produced in grazing systems, as estimated by the FAO for its Global Livestock Environmental Assessment Model.[57] FAO estimates the percent 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 pasture).

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 instance, 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

[56] As recommended by Pierre Gerber, Senior Livestock Specialist, World Bank, April 2016.
[57] See FAO, Global Livestock Environmental Assessment Model (GLEAM), http://www.fao.org/gleam/en/.

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:

$$V_t = \left(\overline{R_t} + \frac{\overline{R_t}}{r}\right) A_t$$

where V_t is the value of protected areas in year t; $\overline{R_t}$ is the minimum of total rents per square kilometer (sq km) of cropland and total rents per sq km of pastureland, averaged over a five-year period from year t to year t-4; 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 below.

Table 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 (sq km)" (AG.LND.TOTL.K2), World development Indicators (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 • World Bank, "Land area" (AG.LND.TOTL.K2), WDI database

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.

For the calculation of physical capital stocks, several estimation procedures can be considered. 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 the accumulation methods and, in particular, the perpetual inventory method, are cheaper and more easily implemented since they require only investment data and information on the assets' service life 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 OECD (Organisation for Economic Co-operation and Development) 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 (PWT) 9.0 database[58] (Feenstra, Inklaar, and Timmer (2015)). The PWT authors use the perpetual inventory method to estimate produce capital stocks for 172 countries from 1970 to 2014.

The physical capital estimates include the value of structures, machinery, and equipment, since 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, like Kunte et al. (1998), a constant proportion equal to 24 percent is assumed:

$$U_t = 0.24K_t$$

where *U* is the value of urban land and *K* is the produced capital stock (machinery, equipment, and structures).

Net Foreign Assets

Net foreign assets (NFA) are a measure of the cross-border assets and liabilities held by a country's residents. A country's external asset position, or net foreign assets (*NFA*), is calculated as:

$$NFA = FA - FL$$

where *FA* are total foreign assets and *FL* are total foreign liabilities. Total foreign assets are:

$$FA = equity_a + FDI_a + debt_a + derivatives_a + forex$$

where $equity_a$ are portfolio equity assets; FDI_a are foreign direct investment liabilities; $debt_a$ are debt assets; $derivatives_a$ are financial derivatives assets; and $forex_a$ are foreign exchange reserves (excluding gold). Similarly, total foreign liabilities are:

$$FL = equity_l + FDI_l + debt_l + derivatives_l$$

where $equity_l$ are portfolio equity liabilities; FDI_l are foreign direct investment liabilities; $debt_l$ are debt liabilities; and $derivatives_l$ are derivatives liabilities.

The primary data source of *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 a total of 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 in order to extend the country coverage.

[58] Data available for download at http://www.ggdc.net/pwt

Human Capital

The approach used for measuring human capital is outlined in this volume in chapter 6, and in more detailed in a companion piece by Barrot et al. (2017). Our measures of human capital wealth rely on estimations conducted with household surveys, with calibration of the results 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:

$$\ln(y_i) = \alpha + \beta_1 e_i + \beta_2 x_i + \beta_3 x_i^2 + \varepsilon_i$$

On the basis of these regressions, a matrix of expected earnings 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:

$$H_{ae} = n_{ae} \exp(\beta_1 e + (\beta_2 + \beta_3 x_{ae}) x_{ae})$$

Total expected earnings 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 labor earnings in the survey. 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 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 sell 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 in employed or 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, since 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 aged 25-65 (assumed to have finished schooling), and those aged 15-24 who have some probability of still being in school. Denote the discount rate by d. This rate factors in a net discount factor as well as the assumed growth rate over time of aggregate real earnings. For an individual with age a and education e randomly drawn from the subpopulation aged 25-65, the discounted lifetime income h_{ae} is estimated based on the following recursion:

$$h_{ae} = p_{ae}^m w_{ae}^m + p_{ae}^s w_{ae}^s + d * v_{a,a+1} * h_{a+1,e}$$

This expression states that the lifetime income of a representative individual aged 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 aged between 15 and 24, the expression is slightly more complex in order 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 their work (holding the same education level as before) and earn income of $d * v_{a,a+1} * h_{a+1,e}$ with the probability $(1 - r_{ae}^{e+1})$; the second is to undertake one more year of education and (after finishing) to receive income as $d * v_{a,a+1} * h_{a+1,e+1}$, 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:

$$h_{ae} = p_{ae}^{m} w_{ae}^{m} + p_{ae}^{s} w_{ae}^{s} + (1 - r_{ae}^{e+1}) * d * v_{a,a+1} * h_{a+1,e} + r_{ae}^{e+1} * d * v_{a,a+1} * h_{a+1,e+1}$$

When adding disaggregation by sex, the approach results in a measure of human capital wealth with four components, namely the net present values of future earnings by sex and by type of employment (wage earners versus self-employed).

Table 6 provides the data sources used for the analysis.

Table 6. Data sources for the estimation of human capital

Indicator	**Data source(s)**
Annual earnings (by age, gender, educational attainment)	International Income Distribution Database (I2D2)
Returns to schooling (Mincer equation)	Updated estimates, based on Montenegro and Patrinos (2015) derived from I2D2
Educational attainment (by age, gender)	International Income Distribution Database (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

Adjusted Net Saving

The table below provides a brief overview of the underlying components of the Adjusted Net Saving (ANS) indicator and their primary data sources.

Table 7. Adjusted Net Saving's components and primary data sources

	Component	Description	Primary data source(s)
GNS	Gross National Saving	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*
CFC	Consumption of fixed capital	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 Timmler 2015), with missing data estimated by World Bank staff
EDU	Current public expenditure on education	Standard savings measures only count as an investment that portion of total expenditure on education (usually less than ten percent) which 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 included 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
NFD	Net forest depletion	Calculated as the product of unit resource rents and the excess of round-wood harvest over natural growth. If growth exceeds harvest, this figure is zero.	See section above on "Forest Resources: Timber"
END	Depletion of fossil energy resources	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 above on "Energy and Mineral Resources"
MID	Depletion of metals and minerals	Calculated as the ratio of the value of the stock of mineral resources to the remaining reserve lifetime. It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate rock	See section above on "Energy and Mineral Resources"
CO2	Carbon dioxide damages	Damages due to 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 year 2014 U.S. dollars for CO_2 emitted in the year 2015) times the number of tons of CO_2 emitted.	World Bank, *World Development Indicators*
POL	Air pollution damages	Damages due to exposure of a country's population to air pollution, including ambient concentrations of particulates 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. Damages are calculated as forgone labor output due to 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
ANS	Adjusted Net Saving	ANS = GNS – CFC + EDU – NFD – END – MID – CO2 – POL	

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Annex 2. Per Capita Wealth for 2014

The following tables show estimates of total wealth and its subcomponents by economy and aggregate averages (income group, geographic region, region with only low and middle income countries). Estimates are in 2014 US dollars per capita.

Country	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
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	**197,899**	32,067	36,978	*1,437*	*7,187*	*7,251*	*6,313*	*5,979*	*8,811*	132,713	-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
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	**155,703**	27,857	15,932	*278*	*2,640*	*2,060*	*2,984*	*3,331*	*4,640*	114,088	-2,175	47,791,393
Comoros	**8,836**	2,585	2,898	*269*	*28*	*301*	*1,876*	*424*	*0*	3,402	-50	769,991

Country	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
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
Cote 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
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	**69,650**	12,033	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

Country	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
Ireland	**627,256**	189,309	15,912	*241*	*1,223*	*1,191*	*1,272*	*11,618*	*367*	473,656	-51,620	4,617,225
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	**584,500**	179,277	3,741	*105*	*1,714*	*426*	*946*	*507*	*43*	377,731	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
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	**114,446**	39,918	14,629	*220*	*1,941*	*1,008*	*2,411*	*3,252*	*5,797*	63,308	-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

Country	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
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
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
Swaziland	**52,670**	17,889	7,125	*209*	*403*	*143*	*3,859*	*2,131*	*380*	26,811	846	1,269,112

Country	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
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

Aggregate Groups

Income Group	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
Low income	**13,629**	1,967	6,421	*565*	*103*	*1,195*	*2,472*	*1,518*	*568*	5,564	-322	525,385,124
Lower middle income	**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	**114,445**	28,527	18,960	*469*	*1,248*	*1,635*	*6,176*	*2,810*	*6,623*	67,390	-432	2,196,796,195
High income: non-OECD	**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	**709,916**	195,929	19,525	*500*	*4,366*	*1,600*	*3,017*	*2,031*	*8,011*	499,927	-5,464	1,046,598,271
World	**169,349**	44,760	15,841	*353*	*1,195*	*1,149*	*3,819*	*2,063*	*7,262*	109,424	-676	6,781,648,569

Geographic Region	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
East Asia & Pacific	**140,787**	39,185	14,739	*375*	*956*	*900*	*5,982*	*1,658*	*4,868*	85,079	1,784	2,145,669,572
Europe & 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 & Caribbean	**144,243**	32,568	25,347	*733*	*3,926*	*3,676*	*4,278*	*3,872*	*8,861*	88,700	-2,372	608,240,663
Middle East & 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

Region, only low and middle income	Total Wealth	Produced Capital	Natural Capital	*Forest: Timber*	*Forest: Non-Timber*	*Protected Areas*	*Crop Land*	*Pasture Land*	*Subsoil Assets*	Human Capital	Net Foreign Assets	Population
East Asia & Pacific	**91,581**	24,018	13,772	*386*	*316*	*941*	*6,433*	*1,707*	*3,989*	53,387	404	1,939,183,399
Europe & 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 & Caribbean	**140,663**	29,233	24,341	*752*	*4,157*	*4,187*	*4,359*	*4,164*	*6,721*	90,191	-3,103	513,384,647
Middle East & 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