

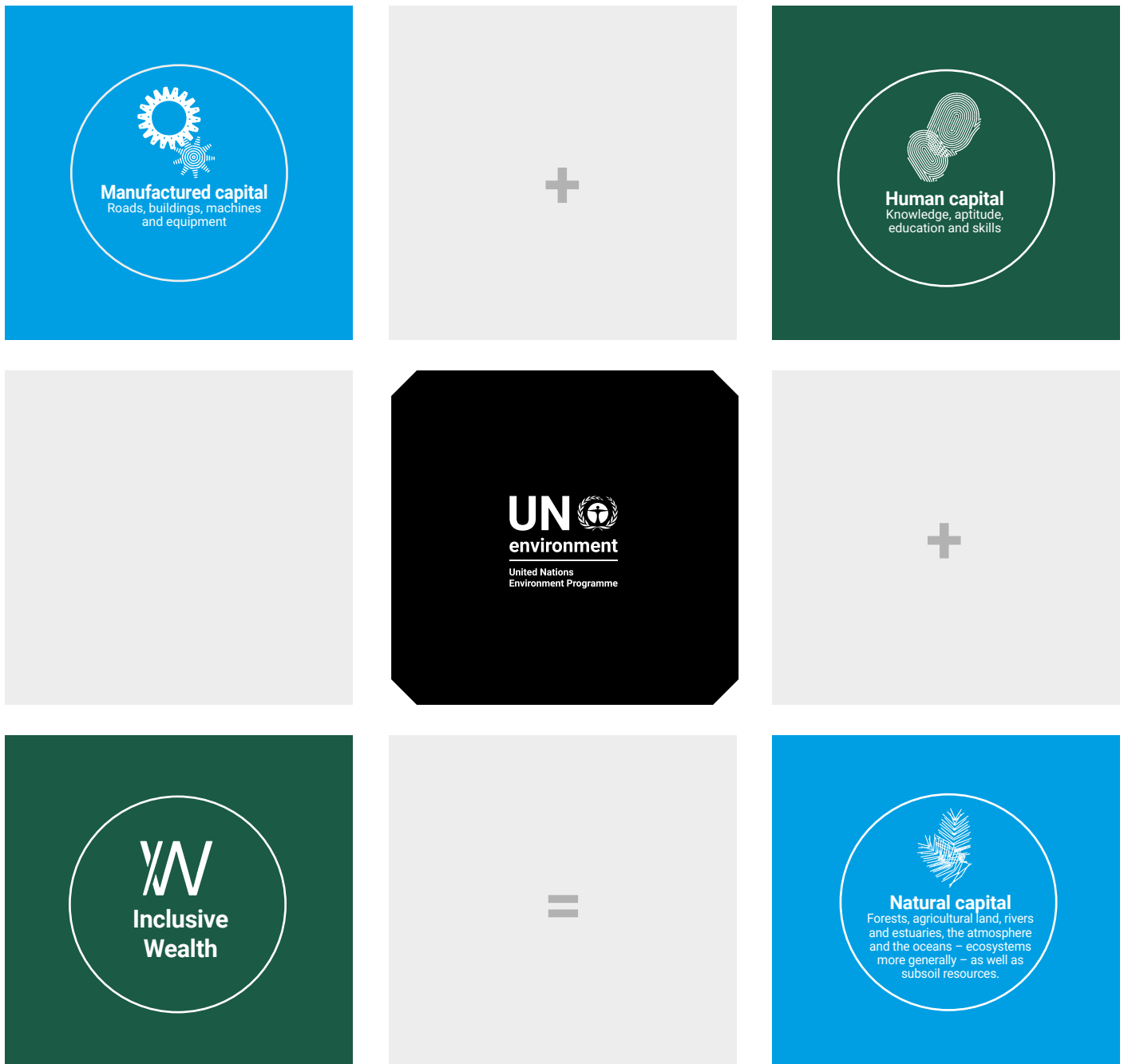
INCLUSIVE WEALTH REPORT 2018





WHAT IS INCLUSIVE WEALTH?

The Inclusive Wealth Report (IWR) is a biennial effort led by UN Environment to evaluate national capacities and performance in terms of measuring economic sustainability and well-being. Existing national statistical systems use Systems of Environmental and Economic Accounts, which are geared towards measuring the flow of income. These flows critically depend upon the health and resilience of capital assets like manufactured capital, human capital and natural capital.



PART II: NATURAL CAPITAL

CHAPTER 4: RECONCILING INCLUSIVE WEALTH AND PIKETTY: NATURAL CAPITAL AND WEALTH IN THE 21ST CENTURY

Edward Barbier



4.1. Introduction

In his book *Capital in the Twenty-First Century*, Piketty (2014) documents the rise in the wealth-income ratios from 1970 to 2010 for eight high-income economies – the United States, Japan, Germany, France, the United Kingdom, Italy, Canada and Australia. For each of these countries, the wealth-income ratio increased from 200–400 percent in 1970 to 400–600 percent in 2010. In addition, the rise in this ratio was accompanied by another important trend. Over the past four decades, much of the accumulated capital in rich countries has been predominantly private wealth, including largely financial and industrial capital and urban real estate. The effect of these trends has contributed to what Piketty (2014, pp. 193–194) refers to as the “financialization” of the global economy, and as a result, increasing wealth and income inequality:

“Broadly speaking, the 1970s and 1980s witnessed an extensive “financialization” of the global economy, which altered the structure of wealth in the sense that the total amount of financial assets and liabilities held by various sectors (household, corporations, government agencies) increased more rapidly than net wealth. In most countries, the total amount of financial assets and liabilities in the early 1970s did not exceed four to five years of national income. By 2010, this amount had increased to ten to fifteen years of national income (in the United States, Japan, Germany, and France in particular) and to twenty years of national income in Britain, which set an absolute historical record.”

To construct these measures of wealth and income for 1970 to 2010, Piketty (2014) uses official national accounts for each country, following the UN System of National Accounts (SNA). Wealth is defined conventionally as market-value “national wealth”, which can be decomposed into domestic capital, including land and real estate, and net foreign assets.³⁴ Income is “net-of-depreciation national income”, which means the sum of GDP and net foreign income, less any domestic capital depreciation. Similarly, the national saving flow that adds to wealth is measured net of capital depreciation.

As pointed out by Barbier (2015 and 2016), the SNA approach used by Piketty (2014) to estimate wealth, net income and net savings does not include the depreciation in natural resources essential to production and income, such as fossil fuels, minerals and forests. These resources are important sources of “natural” capital, and the value of their net depletion should also be deducted from annual income and savings (Arrow *et al.* 2012; Hamilton and Clemens 1999; Hartwick 1977 and 1990; Solow 1986;

Weitzman 1976; World Bank 2011). If we use up more energy, mineral and forest resources to produce additional economic output today, then we have less natural capital for production tomorrow. Thus, net national income and savings today should also account for any natural capital depreciation.

Accounting for natural capital depletion in wealth accounts is a key and familiar contribution of the inclusive wealth approach, as highlighted in previous IWRs (UNU-IHDP-UNEP 2012 and 2014). Barbier (2016) has shown it is possible to reconcile this approach of accounting for natural capital depreciation with Piketty’s method of estimating net national income and savings.

Specifically, this leads to two key indicators: the net national saving rate adjusted for natural capital depreciation, and the ratio of this saving rate with respect to the long-run average annual growth in adjusted net national income per capita. Using World Bank data, Barbier (2016) applies these two indicators to examine the impacts of depreciation of key natural resources, such as fossil fuels, minerals and forests, on the accumulation of adjusted net wealth over 1970 to 2013. The analysis used the same eight rich countries analysed by Piketty (2014) and Piketty and Zucman (2014), and for comparison, over 1979 to 2013 for 95 low- and middle-income economies.

In developing economies capital accumulation has largely kept pace with rising natural capital depletion, but in the rich countries, adjusted net savings have fallen to converge with the rate of natural capital depreciation. This suggests less compensation by net increases in other capital.

Natural capital depreciation clearly matters for wealth accumulation and long-run wealth-income ratios in all economies, including rich countries. Moreover, missing out natural capital depreciation has important implications for Piketty’s explanation for growing global inequality. If overall wealth accumulation net of natural capital depreciation is slowing in rich countries, then the “financialization” of economies observed by Piketty (2014) will continue to worsen wealth and income inequality.

34 See also Piketty and Zucman (2014) for a more detailed modeling approach and investigation of the 1970–2010 wealth trends analysed by Piketty (2014). Note that both Piketty and Zucman (2014) and Piketty (2014) use the terms “national wealth” and “national capital” interchangeably.

The purpose of this chapter is to adjust Piketty's method of estimating long-run trends in wealth-income ratios with net income and savings taking into account natural capital depreciation. In addition, the analysis is extended from Piketty's original group of eight rich countries to 30 high-income economies that are members of the Organization for Economic Cooperation and Development (OECD) over 1970 to 2014. Evidence suggests that growing income and wealth inequality has been pervasive in all OECD economies (OECD 2011), and thus determining whether natural capital depreciation impacts long-run wealth accumulation in these economies may be an important factor underlying this trend.

This chapter also extends the analysis by Barbier (2016) to 113 low- and middle-income, developing, economies from 1970 to 2014. For comparison, the subgroup of 26 low-income countries is analysed separately, and turns out to display different trends over 1970–2014 than either all developing or the rich OECD economies.

Over the past four decades the rate of natural capital depreciation has been on average five times larger in developing countries than in the rich OECD economies. However, in low- and middle-income economies other forms of capital investments have largely compensated for the rising natural capital depletion that has occurred since the late 1990s. In contrast, in rich countries, the rate of adjusted net savings has converged to the rate of natural capital depreciation. For low-income economies, adjusted net wealth accumulation fell on average each year at a rate four times greater than long-run growth, although since 2000 this trend may have been reversing. If this rising trend continues, low-income countries could experience accumulation in net adjusted wealth at a faster pace than long-run per capita income growth.

Over the past 40 years there may have been substantial accumulation of wealth relative to income in rich economies. However, natural capital depreciation is being compensated less and less each year by net increases in other forms of capital, so a measure of national wealth that excludes natural capital depreciation likely exaggerates the actual increase in an economy's wealth over time. This is especially true in countries where accumulation of other forms of wealth is failing to compensate for diminishing natural capital, like rich countries. This means income and wealth inequality may be worsening in rich countries particularly, and in the global economy generally, as emphasized by Piketty (2014).

4.2. Conventional versus Adjusted Net Income Accounting

Because official national account statistics do not routinely account for changes in stocks of natural capital – even fossil fuels, minerals, forests and similar natural resources that can be bought and sold on markets – it is difficult to measure directly long-run trends in the natural capital/national income ratio for an economy. However, it is possible to indicate

how natural resource depreciation affects wealth accumulation, through extending the approach to measuring national wealth developed by Piketty (2014) and Piketty and Zucman (2014).³⁵

The appendix to this chapter outlines how this can be done, and the approach is summarized here. Let W_t denote the market value of national wealth at time t , and Y_t be conventionally defined net national income (NNI), which is gross national income less any depreciation in domestic capital assets, like factories, machines, equipment, and buildings, each year. Similarly, S_t is conventional net national savings (NNS) at time t ; this means gross savings adjusted for domestic capital depreciation. Consequently, Piketty (2014) and Piketty and Zucman (2014) focus on three important relationships among these conventional indicators:

$$\text{Net wealth accumulation: } W_{t+1} - W_t = S_t$$

$$\text{Net national saving rate: } S_t/Y_t = \beta_t$$

$$\text{Wealth-income ratio: } W_t/Y_t = \beta_t$$

However, as argued by Barbier (2016), an economy contains a stock of available natural resources for production, with market value at time t of.

$$\bar{N}_t^0 \geq 0$$

This suggests that the adjusted net wealth of the economy is $W_t^* = W_t + \bar{N}_t^0$. As wealth now includes an endowment of natural capital, net national income Y_t and net national savings S_t need to be adjusted for natural capital depreciated through its use in production over t and $t+1$. Let Y_t^* and S_t^* represent the adjustments to net national income (ANNI) and savings (ANNS) for any natural capital depreciation, respectively. This leads to three additional indicators:

$$\text{Adjusted net wealth accumulation: } W_{t+1}^* - W_t^* = S_t^*$$

$$\text{Adjusted net national saving rate: } S_t^*/Y_t^* = s_t^*$$

$$\text{Natural capital depreciation rate: } (\bar{N}_{t+1}^0 - \bar{N}_t^0)/Y_t^* = n_t^*$$

Fig 4.1 outlines how the conventional economic indicators of gross and net national income can be adjusted for natural capital depreciation to derive ANNI. Similarly, Fig 4. 2 shows how conventional gross and net savings can be adjusted to determine adjusted net national savings (ANNS).

Barbier (2016) also suggests that the savings rate S_t^* can be expressed as a ratio with respect to the long-run average growth in ANNI per capita, \bar{g}^* . This leads to another indicator:

- Saving-ANNI growth ratio: S_t^*/\bar{g}^*

Trends in this ratio indicate how the rate of wealth accumulation over time, $\frac{W_{t+1} - W_t}{Y_t}$, compares with the long-run growth rate of an economy.

The rest of this chapter explores long-run trends in S_t^* , n_t^* and s_t^*/\bar{g}^* for high-income OECD, developing and low-income economies along with the implications of these trends for the wealth and income inequality arguments of Piketty (2014). However, first we show the key trends that lead Piketty to conclude that inequality has been worsening in the major rich countries and the global economy.

Fig 4.1: Net national income (NNI) adjusted for natural capital depreciation

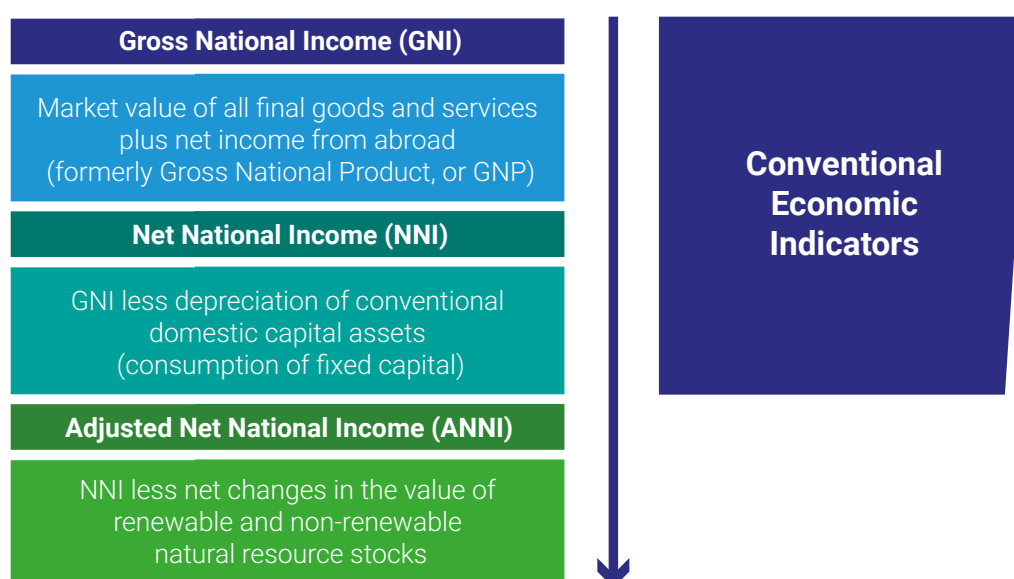
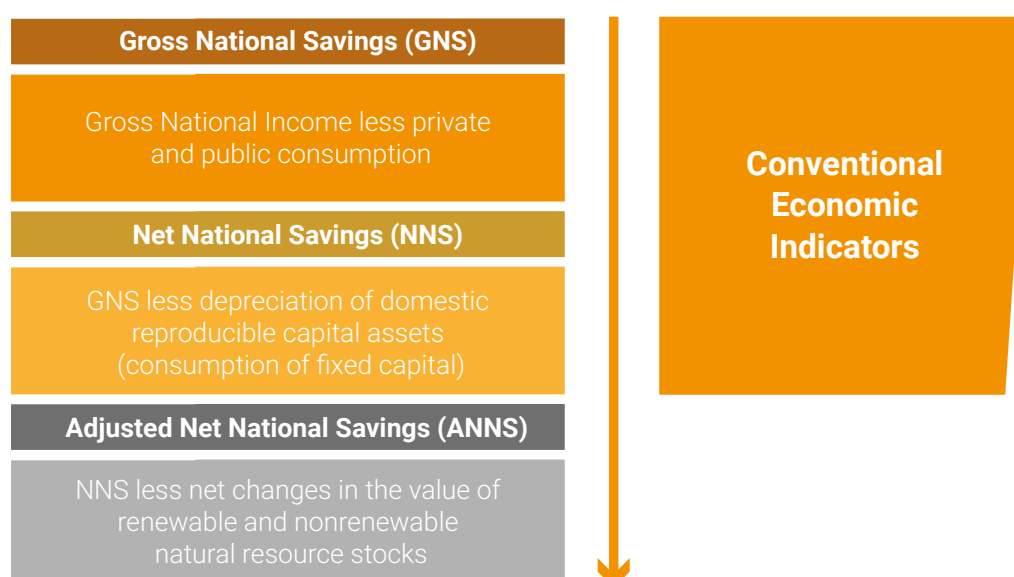


Fig 4.2: Net national savings (NNS) adjusted for natural capital depreciation

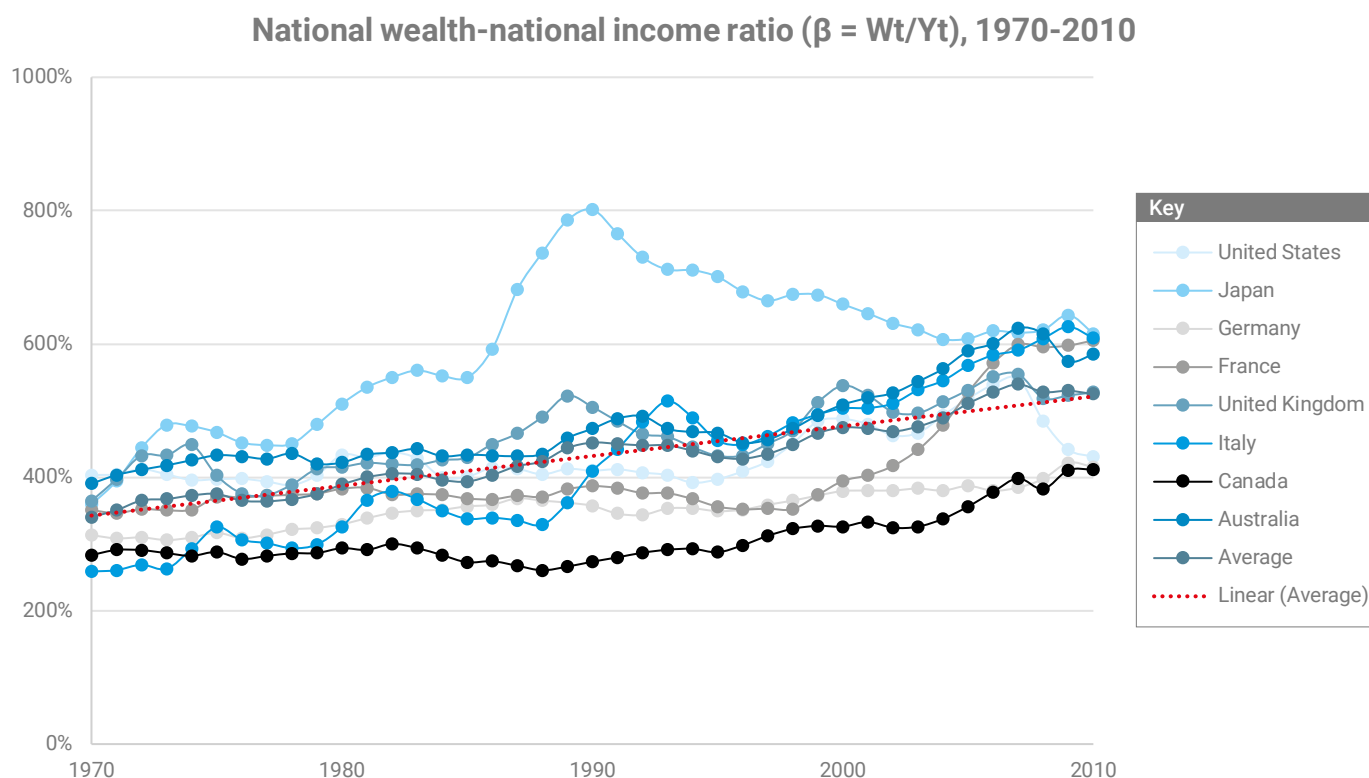


4.3 Financialization and Inequality

Piketty (2014) argues rising wealth and income inequality is attributed to several important features of wealth accumulation in the world economy. First, the ratio of conventionally measured national wealth to income has increased steadily over 1970 to 2010 for the eight richest economies; Fig 4.3 recreates these trends in the wealth-income ratio for these countries.

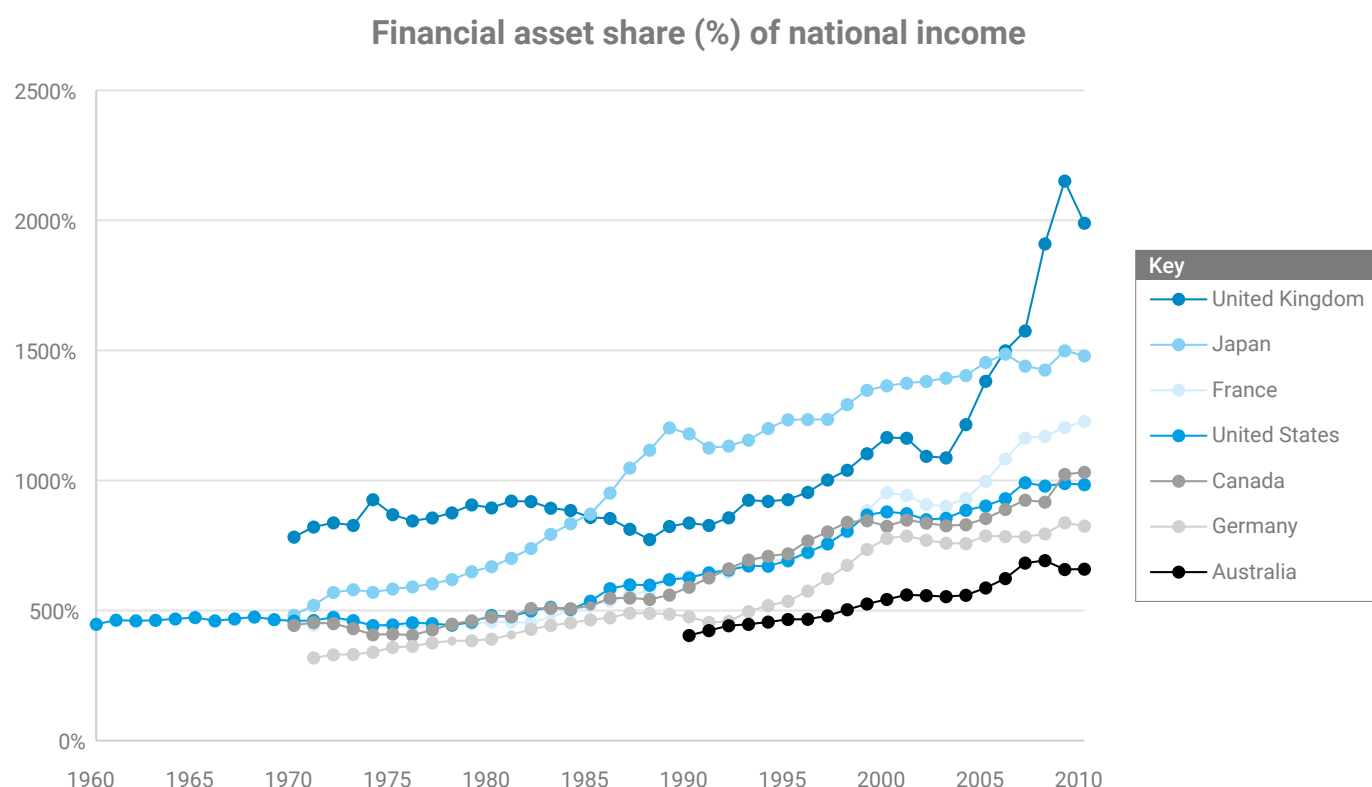
For the past four decades the average trend in the wealth-income ratio for this group of wealthy economies has been rising. In 1970, wealth ranged from two to four years (200–400 percent) of national income for these countries, and by 2010 wealth was four to six years (400–600 percent) of income.

Fig 4.3: Wealth-Income ratios in rich countries, 1970–2010



Source: Piketty and Zucman (2014), Appendix Table A1: National wealth-national income ratio 1870-2010 (annual series), available at <http://piketty.pse.ens.fr/fr/capitalisback>

Financial assets are the total amount of financial assets and liabilities held by various sectors (household, corporations, government agencies) of an economy.

Fig 4.4: Financial asset-income ratio in rich countries, 1960–2010

Source: Piketty and Zucman (2014), Appendix Table A30: Gross financial assets of all domestic sectors 1960–2010 (percentage of national income), available at <http://piketty.pse.ens.fr/fr/capitalisback>

Piketty (2014) notes that national wealth in rich countries is predominantly private wealth, comprised of largely financial and industrial capital as well as urban real estate, for example housing. In contrast, agricultural land is no longer a significant share of wealth in these economies. In particular, the ratio of financial assets to national income has risen markedly, which Piketty calls the extensive “financialization” of rich countries, and thus the global economy. Fig 4. 4 replicates Piketty’s trends in the financial asset-income ratio in rich economies from 1960 to 2010.³⁶

Especially since the 1980s, the financial asset share of national income in all wealthy economies has risen sharply (see Fig 4. 4). In 1980, this share amounted to four to nine years (400–900 percent) of income in these countries. By 2010, financial assets accounted for seven years (700 percent) of national income in Australia, 10–15 years of income in the United States, Japan and Germany, and 20 years in the United Kingdom. As can be seen from comparing Fig 4.3 with Fig 4.4, the financial asset share of national income has risen much more quickly than the overall wealth-income ratio in rich countries. Piketty (2014) argues this extensive and rapid “financialization” is the main cause of the jump in the growing income and wealth inequality in recent decades. In particular, the widening gap between rich and poor is due to the increasing wealth of the world’s rich, who benefited most from the financialization of the world economy.

For example, based on estimates by Piketty (2014) compiled from data on billionaires’ wealth in Forbes magazine, Table 4. 1 indicates how the wealth of the very rich increased from 1987 to 2013 compared to average world wealth per adult.

The wealth of the global rich appears to be growing much faster than that of the average individual. Out of 3 billion people in the 1980s, the richest billionaires in the world consisted of 30 adults, and their average wealth was US\$3.4 billion in 1980. This group’s accumulated assets grew by 6.8 percent each year to 2013, when it totalled US\$32.3 billion. There were 150 billionaires globally in the 1980s, and their average wealth grew at 6.4 percent per year between 1987 and 2013, from US\$1.6 billion to US\$14.0 billion. In comparison, average world wealth per adult increased by only 2.1 percent annually from 1987 to 2013, and average income per person by just 1.4 percent.

Table 4.1: Increase in wealth of the world's rich, 1987-2013

	Wealth or Income in:		Average annual growth (%) 1987-2013
	1980	2013	
The richest billionaires ^a	\$3.4 billion	\$32.3 billion	6.8
Billionaires ^b	\$1.6 billion	\$14.0 billion	6.4
Average world wealth per adult	\$26,065	\$76,628	2.1
Average world income per adult	\$7,759	\$19,187	1.4
World adult population	2.85 billion	4.68 billion	1.9
World gross domestic product (GDP)	\$22,119 billion	\$89,719 billion	3.3

All values are in US dollars, and adjusted net of inflation (2.3 percent per year from 1987 to 2013).

^a About 30 adults out of 3 billion in the 1980s, and 45 adults out of 4.5 billion in 2010.

^b About 150 adults out of 3 billion in the 1980s, and 225 adults out of 4.5 billion in 2010.

Source: Thomas Piketty. 2014. *Capital in the Twenty-First Century*. Harvard University Press, Cambridge, MA, Table 12.1 and Supplementary Table S12.3 <http://piketty.pse.ens.fr/capital21c>

Most analysts agree that, although data on long-run trends are available for only a handful of countries, the wealth of the super-rich, the wealthiest 1 percent of all adults, has been increasing since the early 1970s for some economies and since 1980 for others.³⁷ More importantly, worldwide:

- the top 1 percent today account for almost half of the all the wealth in the world,
- the richest 10 percent own 87 percent of all assets, and
- the lower half of the global population possess less than 1 percent of global wealth.³⁸

Wealth inequality is not only continuing to rise but also spreading throughout the world economy. Table 4. 2 depicts the level of inequality in 46 major economies, and also indicates whether the level has been rising or falling from 2000 to 2014. Wealth inequality is high or very high in 30 of these countries.

Moreover, since 2000, nine countries have experienced a rapid rise in inequality, five have seen a rise, and three a slight rise. Of particular concern is that nine of these countries that have seen some form of rise in inequality are members of the Group of 20, which comprises the largest and most populous economies. Wealth inequality also appears to be a problem for a number of developing economies, although for most of these it appears to be unchanged or falling.

37 See, for example, Alvaredo *et al.* (2013) and Stierli *et al.* (2014). The ten countries with long-term wealth inequality data that are the focus of Stierli *et al.* (2014) are Australia, Denmark, Finland, France, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and the United States. Alvaredo *et al.* (2013) also analyse long-term trends for Canada and Japan, but not Denmark, Finland, the Netherlands, Norway and Switzerland.

38 Stierli *et al.* (2014, p. 13).

Table 4.2: Trends in wealth inequality across countries, 2000-2014

Change in wealth share of the top decile, 2000-2014							
Top decile wealth share, 2014	Rapid fall	Fall	Slight fall	Flat	Slight rise	Rise	Rapid rise
> 70% Very high inequality (US ca. 1910)		Malaysia Philippines	Switzerland	Peru South Africa Thailand United States		Brazil Indonesia	Argentina Egypt Hong Kong India Russia Turkey
> 60% High inequality (US ca. 1950)	Poland Saudi Arabia	Colombia Mexico	Denmark Germany	Austria Norway Sweden	Chile	Czech Republic Israel	China South Korea Taiwan
> 50% Medium inequality (Europe ca. 1980)		Canada France New Zealand Singapore		Australia Finland Greece Ireland Italy Netherlands Portugal	United Arab Emirates	United Kingdom	Spain;
< 50% Low inequality	Japan			Belgium			

The top decile is the wealthiest 10% of all adults. 46 countries, with the Group of 20 (G20) countries indicated in italics. The members of the G20 include 19 countries (Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, the UK and the US), plus the European Union.

Source: Markus Stierli, Anthony Shorrocks, Jim Davies, Rodrigo Lluberá and Antonios Koutsoukis. 2014. *Global Wealth Report 2014*. Credit Suisse Research Institute, Zurich, Table 1, p. 30 and Table 2, p. 33.

If natural capital depreciation does matter for long-run wealth accumulation in all economies, including rich countries, then there may be further implications for Piketty's explanation of growing global inequality. Current measures of national wealth, income and saving that exclude natural capital depreciation likely exaggerate the actual increase in an economy's wealth over time, especially in those countries where accumulation of other forms of wealth is failing to compensate for diminishing natural capital.

This suggests income and wealth inequality may be even worse than in the global economy generally, as emphasized by Piketty (2014) and other scholars. To examine whether this is the case, the next section explores long-run trends in s_t^* , n_t^* and s_t^*/g^* for high-income OECD, developing and low-income economies.

4.4. Measuring Adjusted Net National Income, Saving and Growth

The World Bank's World Development Indicators contain values for net natural resource depletion, net national saving rates, and ANNI from 1970 to 2014 for most countries of the world (World Bank 2017). Using these data, it is possible to construct long-run trends in the natural capital depreciation rate n_t^* , the adjusted net savings rate S_t^* , and the saving-ANNI growth ratio s_t^*/\bar{g}^* for high-income OECD, developing and low-income economies.

The World Bank defines the value of net natural resource depletion as the sum of net forest, fossil fuel and mineral depletion.³⁹ Net forest depletion is unit resource rents times the excess of roundwood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime, capped at 25 years; it covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime, also capped at 25 years. It includes tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate.

The World Development Indicators (WDI) provide annual estimates from 1970 to 2014 of the World Bank's aggregate value of net natural resource depletion, as a percentage of gross national income (GNI) for the eight high-income countries. Converting this estimate to natural resource depletion as a share of ANNI (constant 2010 \$), which is the natural capital depreciation rate n_t^* , involves multiplying the WDI's annual measure of net natural resource depletion as a percentage of GNI by its measure of GNI (constant 2010 \$), and then dividing the result by the WDI's annual estimates of ANNI (constant 2010 \$).

Annual NNS, which are gross national savings less the value of consumption of fixed capital, are also calculated as a percentage of GNI in the WDI. Estimating the adjusted net savings rate S_t^* requires first adjusting the annual NNS rate for natural capital depreciation as a share of GNI, multiplying by GNI (constant 2010 \$), and then dividing by ANNI (constant 2010 \$). Finally, the average annual growth of ANNI per capita over 1970 to 2014, which is already estimated in the WDI, serves as the measure of \bar{g}^* .

4.4.1 OECD high-income countries

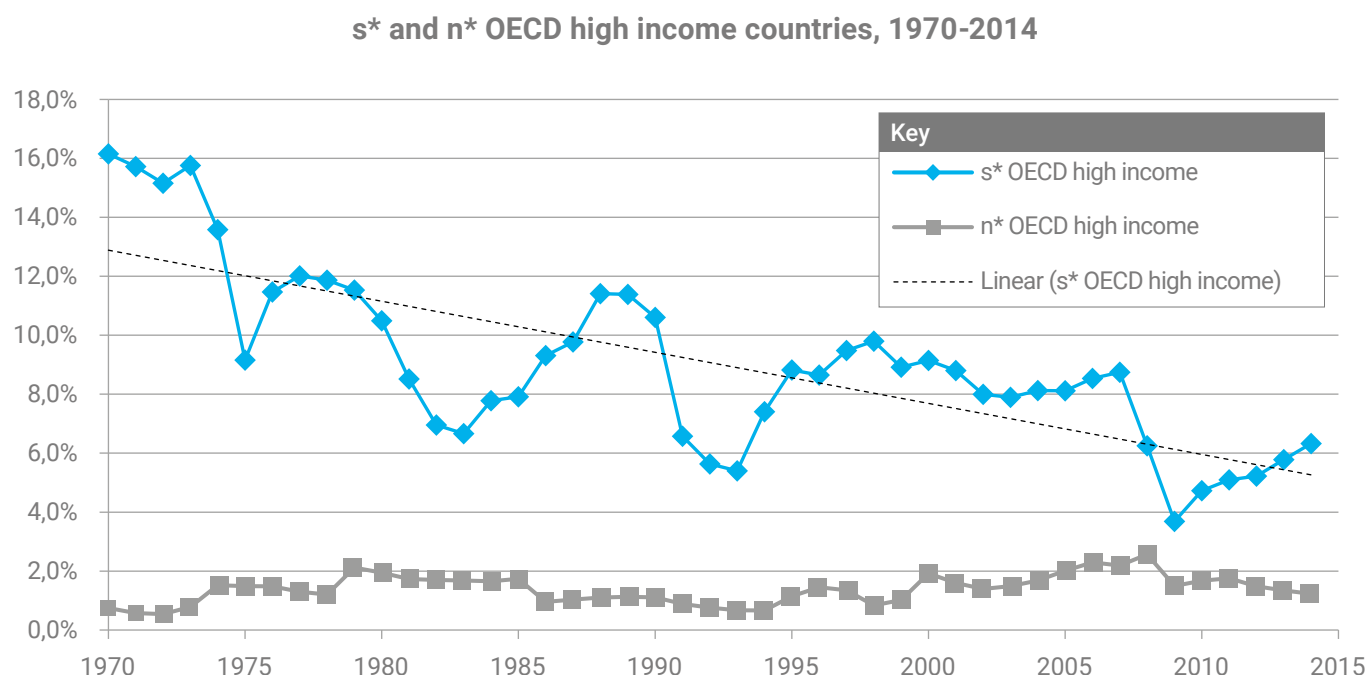
Fig 4. 5 depicts the estimates over 1970-2014 of n_t^* and S_t^* averaged across 30 high-income countries that are also members of the OECD. They include the eight countries originally analysed by Piketty (2014) – the United States, Japan, Germany, France, the United Kingdom, Italy, Canada and Australia.

The adjusted net savings rate for these countries declined considerably during these four decades. It was around 15–16 percent in the early 1970s but from the mid-1990s to mid-2000s hovered around 8–10 percent. The savings rate fell to below 4 percent during the Great Recession, but has recovered since to above 6 percent. On average from 1970 to 2014, S_t^* was 9.1 percent (see Fig 4. 5). In contrast, natural capital depreciation has remained between 1–2 percent of ANNI for most of the past 40 years. Thus, it appears that for the rich economies of the world S_t^* and n_t^* have been converging. In these economies there is less accumulation of other forms of capital each year to compensate for ongoing natural capital depreciation. The result is the overall annual accumulation in adjusted net wealth relative to income has been trending downward since the 1970s.

39

Further details on this methodology can be found in World Bank (2011) and in the notes accompanying World Bank (2017). Although the depreciation of key natural resources, such as fisheries and freshwater supplies, are missing from this measure, the net depletion of sub-soil assets and forests by economies accounts for much of their natural capital used up in current production and wealth accumulation.

Fig 4.5: Adjusted net savings and natural capital depreciation in OECD high-income countries, 1970–2014



The 30 OECD high-income countries are Australia, Austria, Belgium Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States. High-income economies are those in which 2015 GNI per capita was \$12,476 or more.

The data are based on the WDI (World Bank 2017). The measure of s^* is gross national savings less the value of consumption of fixed capital and the value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$); the measure of n^* is annual value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$).

From 1970 to 2014, the average s^* for these eight countries was 9.1 percent, and average n^* was 1.4 percent. The margin of error (95 percent confidence level) associated with the sample mean for s^* and n^* was 1.7 and 1.2, respectively.

Fig 4.6 shows the estimate in the saving-ANNI growth ratio $\frac{s_t^*}{g^*}$ averaged for the 30 OECD high-income economies over 1970-2014. For illustrative purposes, the figure also includes the trend in the conventional capital-income ratio $b_t = \frac{W_t}{Y_t}$ averaged for the eight rich countries over 1970 to 2010, estimated by Piketty and Zucman (2014). Finally, Fig 4.6 also includes the average ratio over the four decades.

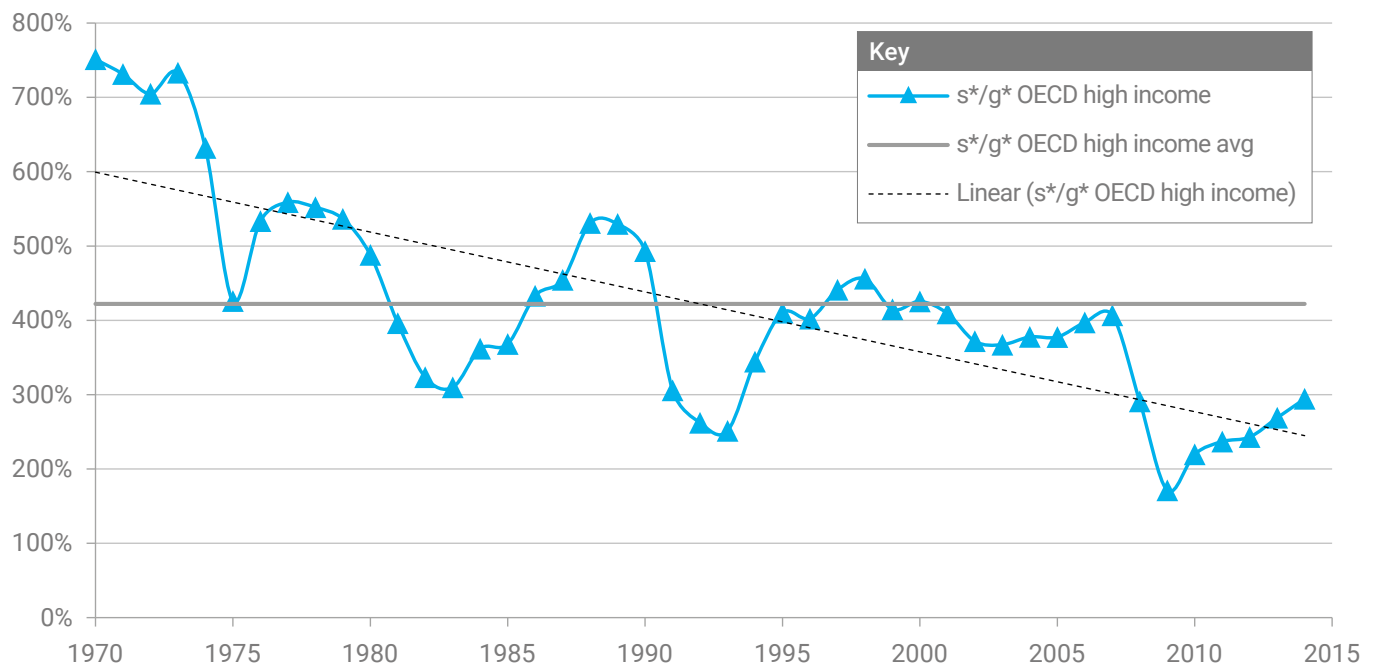
The trend in β_t depicted in Fig 4.6 confirms Piketty's finding that the capital-income ratio for the eight wealthiest countries has increased steadily over 1970 to 2010. In 1970, their average capital-income ratio was around 340 percent (i.e. more than three years) of national income, and has risen to 525 percent (more than five years) of national income in 2010.⁴⁰ In contrast, the saving-ANNI growth ratio for all 30 OECD high-income countries displays a distinctly downward trend.

In the early 1970s, this ratio was around 700 percent, which suggests that the annual rate of adjusted net wealth accumulation was more than seven times the long-run average growth rate for the 30 countries from 1970 to 2014. But since the mid-2000s, the $\frac{s_t^*}{g^*}$ ratio has fallen below 300 percent, which indicates the rate of adjusted net wealth accumulation each year has been less than three times the growth rate. On average, from 1970 to 2014, the saving-ANNI growth ratio was 422 percent, i.e. the rate of adjusted net wealth accumulation each year was four times long-run growth.

40

However, Jones (2015) shows that, when the value of the capital stock for the United States, France and the United Kingdom calculated by Piketty and Zucman (2014) and Piketty [2014] excludes land and housing, the rise in the capital-output ratios for each of these three countries in recent decades is more gradual. For example, in France, "the rise in the capital-output ratio since 1950 is to a great extent due to housing, which rises from 85% of national income in 1950 to 371% in 2010" (Jones 2015, p. 41).

Fig 4.6: Wealth-income accumulation relative to growth in OECD high-income countries, 1970–2014



High-income economies are those in which 2015 GNI per capita was \$12,476 or more. The 30 OECD high-income countries are Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States.

β is the capital/income ratio averaged for eight countries over 1970 to 2010, based on the national income-national wealth annual data series in Table A1 of the online technical appendix accompanying Piketty and Zucman (2014), available at <http://piketty.pse.ens.fr/en/capitalisback> (Accessed 12 June 2014). The eight countries are the United States, Japan, Germany, France, United Kingdom, Italy, Canada and Australia.

The data for constructing the s^*/g^* ratio are based on the WDI (World Bank 2017). The measure of s^* is gross national savings less the value of consumption of fixed capital and the value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$); the measure of g^* is average annual growth of NNI per capita adjusted for the value of net natural resource depletion (constant 2010 US\$).

From 1970 to 2014, the average s^* for these eight countries was 9.1 percent, and g^* was 2.1 percent; consequently, the average s^*/g^* ratio for this period was 422 percent. The margin of error (95 percent confidence level) associated with the sample mean for s^* and g^* was 1.7 and 0.5, respectively.

The falling trends in s_t^* and s_t^*/\bar{g}^* depicted in Fig 4.5 and Fig 4.6 indicate that the rate of net national saving adjusted for natural capital depreciation has declined even faster than any slowdown in long-run growth in rich economies from 1970 to 2014. This could have implications for long-run adjusted net wealth relative to income in these countries. For example, it is possible that the decline in saving-ANNI growth ratio over the past four decades in OECD high-income countries will continue into future years. If so, the rate of net wealth accumulation relative to growth will continue to fall well below the average rate of 422 percent from 1970 to 2014. To verify this possible long-run trend will require more analysis of these trends in the coming years.

4.4.2 Developing countries

In comparison, very different trends in s_t^* , n_t^* and s_t^*/\bar{g}^* have occurred for low- and middle-income countries over the past few decades. Fig 4. 7 indicates the average annual rates of adjusted net saving s_t^* and natural capital depreciation n_t^* for 113 developing economies from 1970 to 2014.

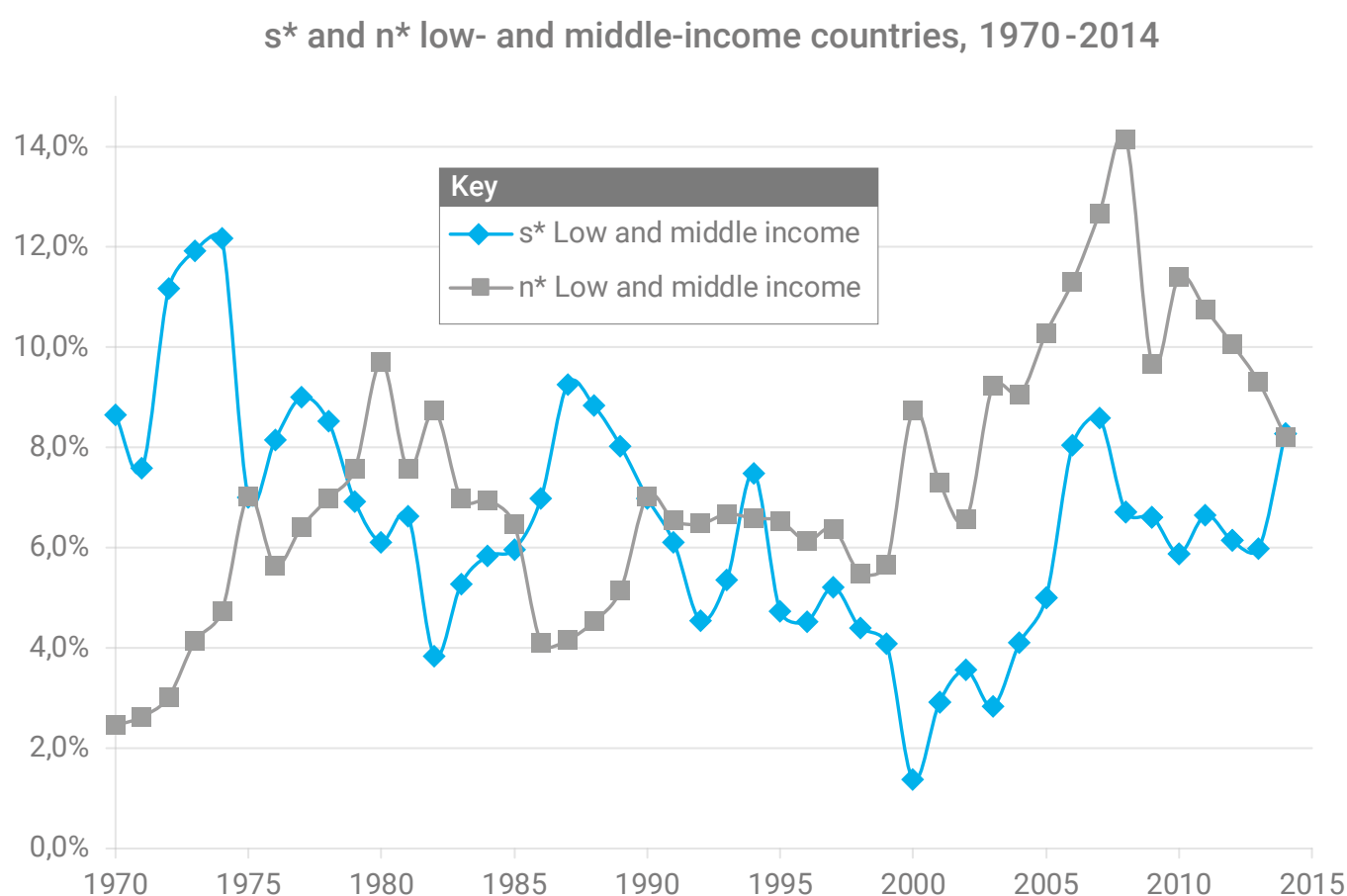
Both rates have varied considerably; there were distinct periods when the adjusted net saving rate has been above then fallen below the rate of natural capital depreciation. For example, in the 1970s the rate of natural capital depreciation was generally below the rate of savings, whereas from the mid-1990s onward the rate of natural capital depreciation has largely exceeded the adjusted net savings rate. One reason is the natural capital depreciation rate began rising from around 6 percent in the 1990s to peak at 14 percent in 2008, before declining to 8 percent by 2014. However, since its low point in 2000, the adjusted net savings rate has

also increased, and in more recent years has been hovering around 6–7 percent. On average, from 1970 to 2014, both the rates of natural capital depreciation and adjusted net saving in developing countries were around 6–7 percent.

These long-run averages, plus the possibly converging trends in the two rates since 2005, indicate that, by and large, increases in other forms of capital may be keeping pace with the large natural capital depreciation occurring in these economies.

Overall, the saving-ANNI growth ratio s_t^*/\bar{g}^* has declined for low- and middle-income countries from 1970 to 2014 (Fig 4. 8). The ratio has been rising since 2000, although in more recent years it has tended to fluctuate around the long-run average of 371 percent. This is still slightly lower than the average ratio of 422 percent over the 1970–2014 period for the OECD high-income economies (see Fig 4. 6). It is unclear whether the long-run average s_t^*/\bar{g}^* ratio for developing countries will rise, as that will require the current trend of accumulating more net wealth relative to increasing income to continue into the future.

Fig 4.7: Adjusted net saving and natural capital depreciation in developing countries, 1970–2014

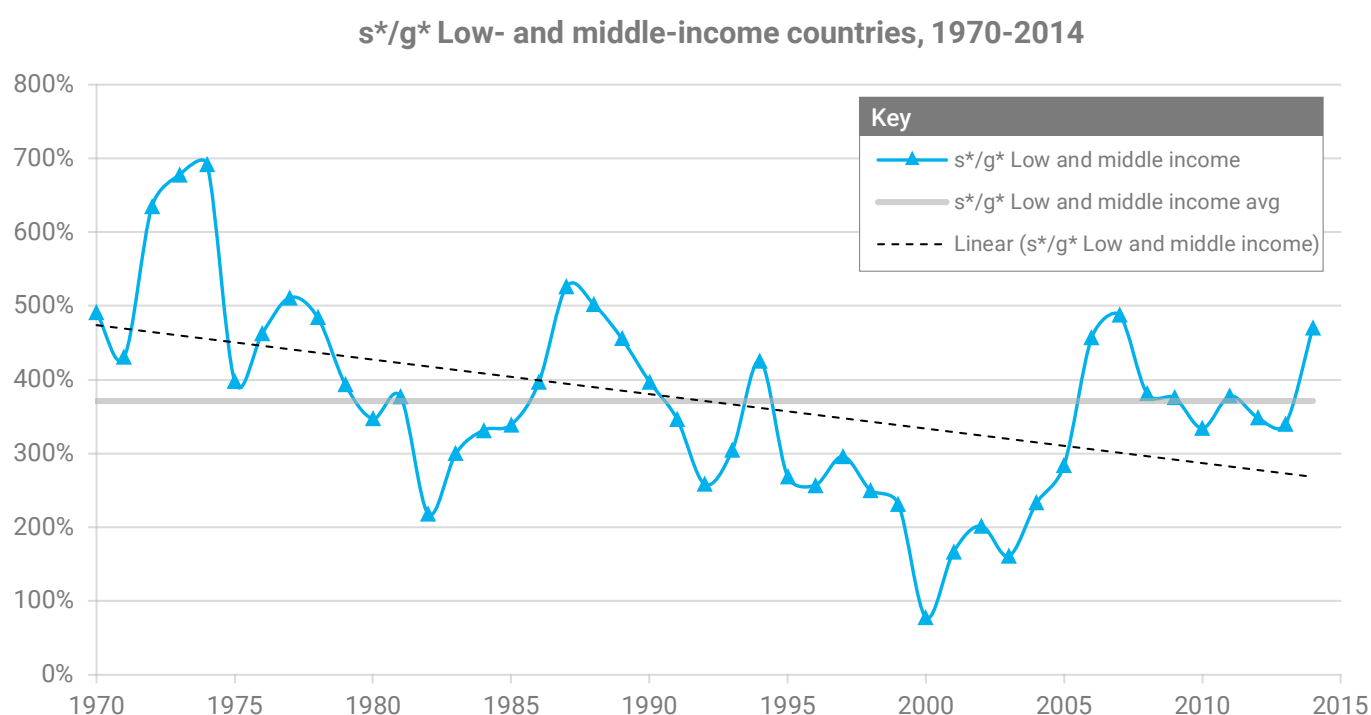


Based on a sample of 113 low- and middle-income (or developing) countries, which are economies with 2015 per capita income of \$12,475 or less.

The data are based on the WDI (World Bank 2017). The measure of s^* is gross national savings less the value of consumption of fixed capital and the value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$); the measure of n^* is annual value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$).

From 1970 to 2014, the average s^* for these developing countries was 6.5 percent, and average n^* was 7.3 percent. The margin of error (95 percent confidence level) associated with the sample mean for s^* and n^* was 2.1 and 2.8, respectively.

Fig 4.8: Wealth-income accumulation relative to growth in developing countries, 1970–2014



Based on a sample of 113 low- and middle-income (or developing) countries, which are economies with 2015 per capita income of \$12,475 or less.

The data for constructing the s^*/g^* ratio are based on the WDI (World Bank 2017). The measure of s^* is gross national savings less the value of consumption of fixed capital and the value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$); the measure of g^* is average annual growth of NNI per capita adjusted for the value of net natural resource depletion (constant 2010 US\$).

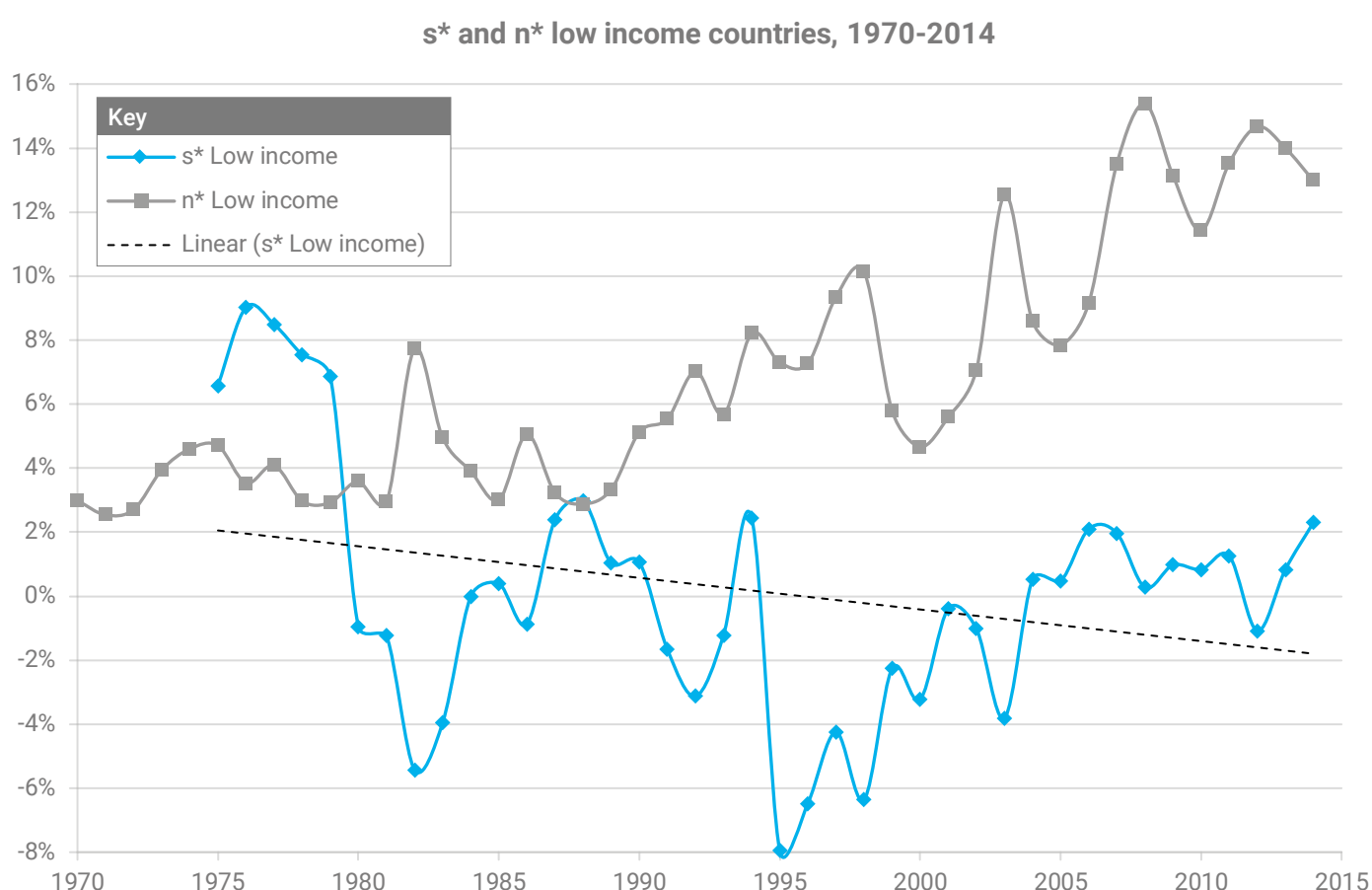
From 1970 to 2014, the average s^* for the sample of developing countries was 6.5 percent, and g^* was 1.8 percent; consequently, the average s^*/g^* ratio for this period was 371 percent. The margin of error (95 percent confidence level) associated with the sample mean for s^* and g^* was 2.1 and 1.4, respectively.

4.4.3 Low-income countries

As shown in Fig 4. 9, the adjusted net saving rate across 28 low-income economies has averaged 0.1 percent from 1975 to 2014, which is much lower than the average rate of 6.5 percent for the 1970–2014 period for all 113 developing countries (see Fig 4. 7). Moreover, for low-income countries, there is still a considerable gap between the long-run adjusted net saving rate and the natural capital depreciation rate of 6.9 percent. Although s_t^* has been rising since 1995 for poor economies, so has n_t^* .

The result is that the gap between these two rates is still considerable, and may even be growing. Since the mid-2000s, the adjusted net saving rate for low-income countries has fluctuated between 0 percent and 2 percent, whereas the rate of natural capital depreciation has risen from 8–9 percent to around 13–15 percent.

Fig 4.9: Adjusted net saving and natural capital depreciation in low-income countries, 1970–2014



Based on a sample of 28 low- and middle-income (or developing) countries, which are economies with 2015 per capita income of \$1,025 or less.

The data are based on the WDI (World Bank 2017). The measure of s^* is gross national savings less the value of consumption of fixed capital and the value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$); the measure of n^* is annual value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$).

From 1970 to 2014, the average s^* for these developing countries was 0.1 percent, and average n^* was 6.9 percent. The margin of error (95 percent confidence level) associated with the sample mean for s^* and n^* was 4.7 and 4.3, respectively.

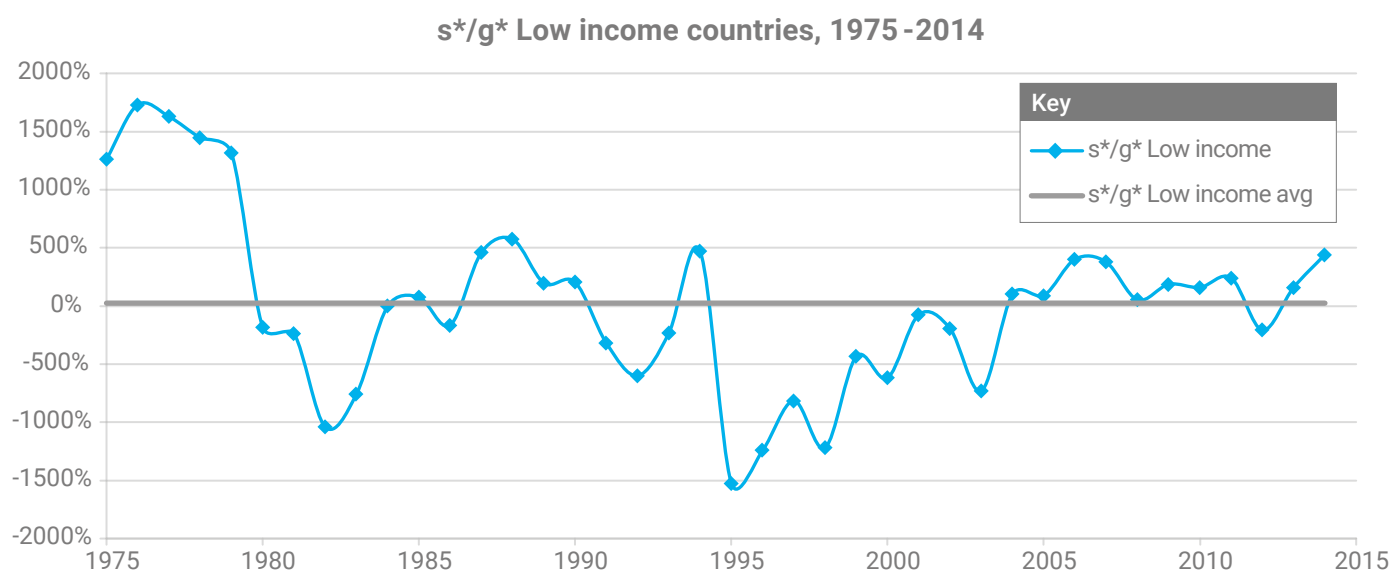
These trends in n_t^* and s_t^* have important implications for long-run wealth-income accumulation relative to growth in poor economies (Fig 4. 10). First, the long-run average growth in ANNI per capita \bar{g}^* was only 0.5 percent for low-income countries from 1975 to 2014.

This was much lower than the equivalent rate for all developing countries, 1.8 percent (see Fig 4. 8).

Consequently, the average ratio of adjusted net saving to this growth rate over this period was only 24 percent, and there have been long stretches over the past four decades when this ratio has been significantly negative (see Fig 4.10). However, since 2000 the s_i^*/g^* ratio for the 28 low-income economies has been rising, and from 2005 to 2014, has averaged 190 percent.

If this positive trend continues, low-income countries will continue to experience accumulation in net-adjusted wealth at a faster pace than long-run per capita income grow

Fig 4.10: Wealth-income accumulation relative to growth in low-income countries, 1975–2014



Based on a sample of 28 low- and middle-income (or developing) countries, which are economies with 2015 per capita income of \$1,025 or less.

The data for constructing the s^*/g^* ratio are based on the WDI (World Bank 2017). The measure of s^* is gross national savings less the value of consumption of fixed capital and the value of net natural resource depletion as a percentage of ANNI (constant 2010 US\$); the measure of g^* is average annual growth of NNI per capita adjusted for the value of net natural resource depletion (constant 2010 US\$).

From 1975 to 2014, the average s^* for the sample of developing countries was 0.1 percent, and g^* was 0.5 percent; consequently, the average s^*/g^* ratio for this period was 24 percent. The margin of error (95 percent confidence level) associated with the sample mean for s^* and g^* was 4.7 and 1.0, respectively.

To summarize, the high and rising rate of natural capital depreciation in low-income countries remains a concern. Although the rate of adjusted net saving has been rising since 1995, it remains very low, at less than 2 percent. This implies that in poor countries, accumulation of other forms of wealth is not keeping pace with ongoing natural capital depreciation.

The increase in wealth-income accumulation relative to growth in poor economies is encouraging, but this is in large part due to the very low growth in ANNI per capita over the long run (0.1 percent) in these countries. Reducing natural capital depreciation and increasing accumulation of other forms of capital is essential to improving long-run net wealth accumulation in poor economies in the long term.

4.4.4 Implications for wealth-income ratios and inequality

As the above analysis indicates, the wealth-income ratios for OECD high-income economies over the past four decades are clearly influenced by the depreciation of key natural resources, such as fossil fuels, minerals and forests. Although there may have been substantial accumulation of wealth relative to income, natural capital depreciation in these rich economies is being compensated less and less each year by net increases in other forms of capital. This implies that wealth accumulation, net of natural capital depreciation, has declined as a share of national income. As depicted in Fig 4. 5, this trend has been steadily falling over the past four decades.

If overall wealth accumulation net of natural capital depreciation as a share of national income is falling while private financial wealth is rising, the gap between rich and poor will continue to widen in all economies (see Table 4.1 and Table 4.2). If these trends for rich countries continue into the future, there will be even less net wealth creation relative to growth in these economies. If this is accompanied by increased financialization as observed by Piketty (2014), the result will be worsening wealth and income inequality. Piketty finds national wealth in rich countries is predominantly private wealth, and it comprises largely financial and industrial capital as well as urban real estate. This concentration of wealth is the source of much of the inequality in these countries, and the global economy. Unsurprisingly, studies of inequality in OECD countries already suggest that the problem is a serious one for these economies (OECD 2011).

For developing countries, although net wealth accumulation appears to have increased relative to income in recent years (see Fig 4. 7), the high rate of natural capital depreciation remains a concern. In the long run, the current rate of more than 7 percent across all low- and middle-income countries may adversely affect their net wealth accumulation. The overall trend of saving to ANNI growth has also been negative over the past four decades (see Fig 4. 8). Finally, as indicated in Table 4. 2, wealth inequality appears to be a problem for some developing economies. High rates of natural capital depreciation that reduce net wealth accumulation in low- and middle-income countries will only exacerbate this problem.

The high and rising rate of natural capital depreciation in low-income countries is a major concern (see Fig 4. 9). The long-run average rate is around 7 percent, but in recent years it has climbed from 8–9 percent to 13–15 percent. The gap with the current adjusted net saving rate, which is 0–2 percent, is therefore considerable, and indicates that investment in other forms of wealth is failing to compensate for the high rate of natural capital loss in poor economies. Unsurprisingly, the long-run average growth in ANNI per capita (0.5 percent) and net saving relative to this growth (24 percent) is extremely low for these countries. Although it is difficult to determine the implications for wealth inequality in low-income economies, the lack of progress in net wealth accumulation does not bode well for either fostering sustainable development or reducing any inequality.

4.5 Conclusions

It is possible to reconcile the inclusive wealth approach with Piketty's efforts to analyse long-run trends in wealth-income ratios and the composition of wealth for major economies. Given improved data sources, it is feasible to extend such an analysis to a wider set of economies. Here, the approach of adjusting to net national saving, income and growth for natural capital depreciation has been extended to 30 high-income economies, all members of the OECD, from 1970 to 2014. We have also examined the resulting implications for net wealth accumulation and inequality that have been observed by Piketty (2014) and other studies.

These trends have several important implications. For the OECD high-income countries, the long-run convergence of adjusted net savings rates with natural capital depreciation rates should raise concerns about overall wealth creation and growing inequality in these economies. For these countries, policies to encourage more economy-wide investment in other forms of capital to raise adjusted net saving rates, especially the long-run rate of net wealth accumulation relative to growth, are urgently needed. Although human capital accumulation is not included in the analysis of this chapter, there is also concern that investments in skills, training and education in these economies are lagging in these economies, both absolutely and relative to natural resource use (Barbier 2015; Goldin and Katz 2008; OECD 2011).

For developing countries, although net wealth accumulation appears to have kept pace with income growth in recent years, the high rate of natural capital depreciation is worrisome. This is especially true in low-income economies where the problem appears to be worsening. Over the long run, these high rates of depreciation are bound to affect the sustainability of development efforts adversely, and to worsen inequality. A key focus of policies should be to improve the efficiency and sustainability of natural resource use so that natural capital depreciation in developing countries is diminished substantially. This could be especially important for low-income countries, where reducing natural capital depreciation may prove instrumental to improving the adjusted net wealth-income ratio of these poorer economies over the long run.

To verify the long-run trends in net national saving, income and income growth adjusted for natural capital depreciation will require long-term data on natural capital stocks as well as depreciation rates. As we develop better measures of natural capital stocks and depreciation for 70 to 100 years or even longer, other considerations need to be taken into account. These include the role of demographic transitions, TFP changes, appropriate accounting for long-run natural capital asset and price appreciation, and the economic contributions of ecosystems and other environmental assets beyond fossil fuels, minerals and forests (Arrow *et al.* 2012; Fenichel and Abbott 2014; Greasley *et al.* 2014).

Finally, the long-run trends identified here confirm a bigger issue, which is explored by Barbier (2015). Namely, the world economy faces two major threats: increasing natural resource degradation and the growing gap between rich and poor. These two threats are symptomatic of a growing structural imbalance in all economies, how nature is exploited to create wealth and how it is shared among the population. As argued by Barbier (2015), the root of this imbalance is that natural capital is underpriced, and hence overly-exploited, and the resulting proceeds are insufficiently invested in accumulating other forms of wealth, especially human capital. The long-run trends in net national saving, income and income growth analysed for rich and poor economies in this chapter gives some indication of this structural imbalance. We need further development of such indicators – and perhaps others too – to shed further light on the possible links between growing environmental and natural resource scarcity and inequality in all economies.

REFERENCES

- Alvaredo, Facundo, *et al.* 2013. "The Top 1% in International and Historical Perspective." *Journal of Economic Perspectives* 27:3-20
- Arrow, Kenneth J., *et al.* 2012. "Sustainability and the Measurement of Wealth." *Environment and Development Economics* 17(3):317-353.
- Barbier, Edward B. 2015. *Nature and Wealth: Overcoming Environmental Scarcities and Inequality*. Palgrave Macmillan, London and New York.
- Barbier, Edward B. 2016. "Natural Capital and Wealth in the 21st Century." *Eastern Economic Journal* 1-15, online, doi:10.1057/s41302-016-0013-x. <http://link.springer.com/article/10.1057/s41302-016-0013-x>
- Fenichel, Eli P. and Joshua K. Abbott. 2014. "Natural Capital: From Metaphor to Measurement." *Journal of the Association of Environmental and Resource Economists*. 1:1-27.
- Greasley, David, *et al.* 2014. *Journal of Environmental Economics and Management* 67:171-188.
- Hamilton, Kirk and Michael Clemens. 1999. "Genuine Savings Rates in Developing Countries." *World Bank Economic Review* 13(2):333-356.
- Hartwick, John M. 1977. "Intergenerational Equity and the Investment of Rents from Exhaustible Resources." *American Economic Review* 67(5):972-974.
- Hartwick, John M. 1990. "Natural Resources, National Accounting and Economic Depreciation." *Journal of Public Economics* 43:291-304.
- Jones, Charles I. 2015. "Pareto and Piketty: The Macroeconomics of Top Income and Wealth Inequality." *Journal of Economic Perspectives* 29:29-46.
- Organization for Economic Cooperation and Development (OECD). 2011. *An Overview of Growing Income Inequalities in OECD Countries: Main Findings. Divided We Stand: Why Inequality Keeps Rising*. OECD, Paris.
- Piketty, Thomas. 2014. *Capital in the Twenty-First Century*. Harvard University Press, Cambridge, MA.
- Piketty, Thomas and Gabriel Zucman. 2014. "Capital is Back: Wealth-Income Ratios in Rich Countries, 1700-2010." *Quarterly Journal of Economics* 129:1255-1310.
- Solow, Robert M. 1986. "On the Intergenerational Allocation of Natural Resources." *Scandinavian Journal of Economics* 88(1):141-149.
- Stierli, Markus, *et al.* 2014. *Global Wealth Report 2014*. Credit Suisse Research Institute, Zurich.
- United Nations University (UNU)-International Human Dimensions Programme (IHDP) on Global Environmental Change-United Nations Environment Programme (UNEP). 2012. *Inclusive Wealth Report 2014: Measuring Progress Toward Sustainability*. Cambridge University Press, Cambridge and New York.
- United Nations University (UNU)-International Human Dimensions Programme (IHDP) on Global Environmental Change-United Nations Environment Programme (UNEP). 2014. *Inclusive Wealth Report 2014: Measuring Progress Toward Sustainability*. Cambridge University Press, Cambridge and New York.
- Weitzman, Martin L. 1976. "On the Welfare Significance of National Product in a Dynamic Economy." *Quarterly Journal of Economics* 90(1):156-162.
- World Bank. 2011. *The Changing Wealth of Nations : Measuring Sustainable Development in the New Millenium*. The World Bank, Washington, DC.
- World Bank. 2016. *World Development Indicators*. The World Bank, Washington DC. <http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators>. Accessed on 02/01/2017.

APPENDIX

Adjusting Conventional National Income and Savings for Natural Capital Depreciation

Following the approach developed by Barbier (2016), it is possible to modify the conventional income and savings measures used by Piketty (2014) and Piketty and Zucman (2014) to allow for natural capital depreciation.

Following their approach and notation, let W_t denote the market value of national wealth at time t , and S_t is the net national savings flow between time t and $t+1$. In the absence of any capital gains or losses between t and $t+1$, then wealth accumulation is simply $W_{t+1} - W_t = S_t$. If Y_t is net national income (i.e. national income less domestic capital depreciation) at time t , then the corresponding net national saving rate in the economy is $s_t = S_t/Y_t$ and the ratio of wealth (or capital) to income is $b_t = W_t/Y_t$.

Suppose that, in addition to W_t , an economy also contains a stock of available natural resources for production, with market value at time t of $N_t^0 \geq 0$.

The total wealth of the economy at time t is therefore $W_t^* = W_t + N_t^0$. As wealth now includes an endowment of natural capital, both net national income and net national savings in time t should be adjusted for any depreciation of natural capital depletion through its use in production over t and $t+1$, net of any changes in the endowment due to new discoveries over the year and also renewable resource growth. Barbier (2016) refers to this modification of Piketty's definition of wealth W_t^* as adjusted net wealth.

Let Y_t^* and S_t^* represent the adjustments to net national income and savings for any natural capital depreciation, respectively. It follows that the accumulation in adjusted net wealth between t and $t+1$ is

$$W_{t+1}^* - W_t^* = S_t^*$$

Dividing both sides by adjusted net national income Y_t^* yields

$$\frac{W_{t+1}^* - W_t^*}{Y_t^*} = \frac{DW^*}{Y_t^*} = s_t^* \quad (1)$$

where $s_t^* = S_t^*/Y_t^*$ is the net national saving rate adjusted for natural capital depreciation, or the adjusted net saving rate. As equation (1) states, s_t^* is an indicator of the annual change in wealth (inclusive of natural capital) relative to net national income (adjusted for natural capital depreciation).⁴¹

The saving rate s_t^* can also be expressed as a ratio with respect to the long-run average annual growth in ANNI per capita. For any period of T years, the latter growth rate is

$$\bar{g}^* = \frac{1}{T} \sum_{t=0}^{T-1} \frac{DY_t^*}{Y_t^*} \quad \text{Consequently,}$$

$$\frac{s_t^*}{\bar{g}^*} = \frac{DW^*/Y_t^*}{\bar{g}^*} \quad (2)$$

The ratio indicates how annual changes in adjusted net wealth relative to income compare with the average annual income growth per capita over some defined time period of T years. For example, if this growth rate is 2 percent per year, and adjusted net saving is 10 percent, then the rate of adjusted net wealth accumulation each year is 500 percent of long-run growth. However, if the adjusted net saving rate falls to 4 percent, then the rate of annual wealth accumulation relative to income is only 200 percent of \bar{g}^* . Thus, this ratio is an important indicator as it depicts, over a defined period of T years, how the annual rate of net wealth accumulation compares to long-run growth over that period. Consequently, if there is a discernible trend in the s_t^*/\bar{g}^* ratio, it indicates whether or not adjusted net wealth is accumulating relative to increases in income over the long term.

41 As shown in the appendix to Barbier (2017), the adjusted net savings rate is also an indicator of the annual change in adjusted net wealth per capita relative to adjusted net national income per capita $\hat{s}_t^* = \frac{D\hat{W}^*}{\hat{Y}_t^*}$, where η_t represents population growth and a "hat" (^) indicates a per capita variable.