

## 0 Chapter 4 – Growth, Human Development and Planetary Welfare

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- 1 **Coordinating Lead Authors**[\[1\]](#): Purnamita Dasgupta, Ottmar Edenhofer
- 2 **Lead Authors**[\[2\]](#): Adriana Mercedes Avendano Amezcuita, Antonio Bento, Simon Caney, David De la Croix, Augustin Fosu, Michael Jakob, Marianne Saam, Kristin Shrader-Frechette, John Weyant, Liangzhi You
- 3 **Contributing Authors**[\[3\]](#): Gian Carlo Delgado, Marcel Dorsch, Christian Flachsland, David Klenert, Kai Lessmann, Junguo Liu, Linus Mattauch, Gregor Schwerhoff, Kristin Seyboth, Jan Steckel
- 4 **Chapter Management**[\[4\]](#): Kristin Seyboth
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69 **Summary**

70 There are many competing definitions of economic growth. Determinants of economic growth and stagnation include population and demography (4.2.1), education and human capital (4.2.2), technological change (4.2.3), resource endowments, geography and environment (4.2.4) and various actors, institutions and politics (4.2.5) This chapter shows that as economic growth increases, birth and death rates drop and education increases. As knowledge grows and advances in technological change are made, economic growth results. While resource endowments, geography and the environment have been shown to be critically important for economic growth, there is debate in the literature as to the exact mechanisms by which economic growth is affected. In addition, while in all countries there is a mix of generalized institutions (those applying to all economic agents equally) and particularized institutions (those applying only to a subset of agents), generalized institutions have been found to be particularly important for economic growth.

71 Economic growth is often much lauded, but it also has its critics. Such positive and critical evaluations rest on both empirical and normative commitments. There is widespread recognition that Gross Domestic Product (GDP) in itself only matters in that it contributes to other goods, such as preference satisfaction (4.3.1.1), happiness (4.3.1.2), capabilities to function (4.3.1.3) and the meaning of life (4.3.1.4). Status consumption (4.3.1.5) has been linked to preference satisfaction, happiness and to an extent also to capabilities to function, and is therefore also a tool to evaluate economic growth. On the counter side, economic growth has also been linked to industrial-technological pollution (4.3.1.6) and harmful impacts to

nature and animals, which are argued to have an intrinsic value in themselves (4.3.1.7). One final measure of economic growth concerns its impact on political stability and legitimacy (4.3.1.8).

- 72 Having reviewed what matters above and beyond GDP, the chapter discusses the distribution of those goods - if economic growth should be judged in terms of its contribution to maximizing the good (4.3.2.2), ensuring equal amounts of it (4.3.2.3), raising people above a certain threshold (4.3.2.4), or giving priority to the least advantaged (4.3.2.5), each of which has arguments pro and against. Environmental pollution linked to economic growth has been shown to negatively impact certain more vulnerable groups than others - environmental injustice - which argues for the right of each individual to have equal opportunity to breathe clean air, drink clean water and be protected from environmental toxins (4.3.2.6).
- 73 Economic growth as witnessed since the industrial revolution has impacted both social (4.4.1) and natural wealth (4.4.2). It has been correlated with fundamental transitions in the way societies are organized, changed fertility patterns, an increase in manufacturing and service sectors (4.4.1.6) as well as energy and material consumption (4.4.1.7), increasing investment in education and rapid urbanization (4.4.1.4). Economic growth doesn't necessarily contribute to poverty reduction, though it can provide a means to do so (4.4.1.3). Finally, it has been shown to be associated with a widening gap in the control of global income/wealth, suggesting that the gains of economic growth have not been evenly distributed (4.4.1.2).
- 74 In terms of natural wealth, economic growth has been correlated with environmental damage, such as climate change (4.4.2.2), water scarcity and pollution (4.4.2.3) and species extinction (4.4.2.5). Food security and hunger are also linked to a broad web of disciplines that connect to economic growth (4.4.2.4). Water crises have a limiting impact on economic growth, whereas if water resources become secure, it may enable economic growth and sustainable development. More generally, countries endowed with rich natural resources systematically grow slower than resource-poor countries. There is a broad discussion in the literature as to why this may be (4.4.2.6). There are parameters in which development must operate to preserve the safety of this and next generations (4.4.2.1).
- 75 There are many linkages between economic growth, sustainable development and social welfare (4.4.2.7). Sustainability should be examined separately from well-being, and is best measured using a set of indicators (i.e. a dashboard), rather than a single indicator (4.4.3.2).

- 76 GDP cannot act as an accurate measure of welfare, as it neglects distributional issues, doesn't account for the impact of economic activities on stocks of natural capital (among others) and does not include household production of services. (4.4.3.1) Growth is strictly a mechanism to achieve other, welfare based objectives – it is not a goal in itself. (4.4.3.3) Well-being is a better indicator about the status of the economy, and includes multidimensional indicators including health, education, political voice, environment, etc. (4.4.3.2) Several improved welfare measures have been developed over the last decades, classified into monetary and non-monetary measures. Some of these measures include gross national happiness, the capability approach, synthetic indicators and the net national product (4.3.2.7). Welfare diagnostics provide guidance on how to simultaneously address over-use of natural resources and under-provision by putting a price on the former and using the associated public revenues to fund the latter (4.6.1).
- 77 Economic growth has been shown to have adverse effects on the global commons (resource domains or areas that lie outside of the political reach of any one nation state), but at the same time global commons can also be a source of resources and environmental services which in themselves can facilitate economic growth. There is therefore a need, in terms of the principles of justice, to protect the global commons and ensure that any use is sustainable over time (4.3.2.1). Governance of those commons is a collective action challenge subject to strong free-riding incentives and involves a specification of complex rules and property rights (4.5.1 and 4.5.1.2) Neoclassical solutions to addressing the tragedy of the commons involve either a global tax on utilization of a common, or a global trading scheme for rights to utilize or pollute (4.5.1.1). Important lessons can also be taken from cooperative management regimes of local common-pool resources. Though international agreements remain necessary to address international free-riding incentives, polycentric approaches involve an adaptive and decentralized system of multiple self-governing and interacting units of different scales (4.5.3.4 and 4.5.3.3).
- 78 Capitalism, which has been credited with unprecedented economic growth, has been critiqued for many ills in human society, including in particular the biases in distribution of gains and rise in inequality among stakeholders (4.6.5.4). An integrated perspective allows for an evaluation of the costs and benefits of capitalism, but also provides pathways for the transformation of contemporary capitalism, maintaining its driving forces, but addressing inequalities and protecting natural resources (4.6.5.3).
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## 4.1. Introduction

### 4.1.1 Concepts and measurements of growth

Economic development today is understood in multidimensional terms. Income continues to be an important component, though there are several other dimensions to defining an acceptable notion of development in an economy such as health, people empowerment, etc.

Economic growth is the process by which the amount of goods and services one can earn with the same amount of work increases over time. Almost everything people buy today requires fewer days of work than it did in the past. A classic example is provided by Nordhaus (1996, Table 1.6) in his history of lighting. According to him, 10 minutes of work today buys 3h of reading light each night of the year, while it only bought ten minutes of light per year two centuries ago. Economic growth generally implies that income per person rises over time, unless hours of work fall steadily. Assuming constant hours of work per person in the long-run, the economic rate of growth is equivalent to the rate of change over time of the real (price-adjusted) total goods and services produced, usually measured by the gross domestic product (GDP) for a given country, from which the growth rate of the population is subtracted.

The above definition has the merit of stressing that economic growth is rooted into productivity improvements. Rising GDP per capita is just one possible manifestation of these improvements. The productivity based view is consistent with most of the theories of growth developed so far. Later in this chapter, we consider the multidimensional measures of human development and discuss the relationship to economic growth (both positive and negative aspects).

The accepted view on the relationship between economic growth and other aspects of development has appreciably widened over the years. It now accounts for the multiple factors that impact growth, from the role of natural, social, political and institutional capital, to the challenges of sustaining economic growth in terms of distributional concerns across people, societies and time.

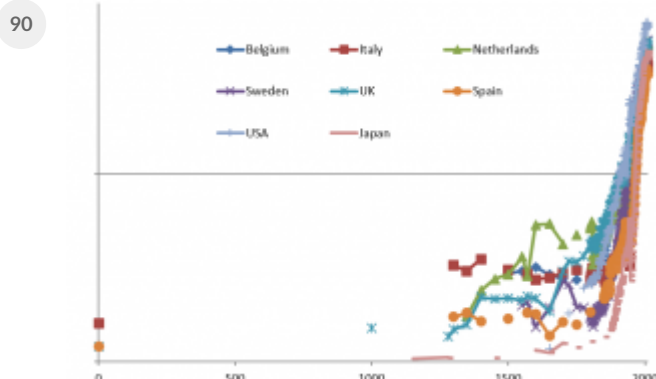
Several alternate measures have been proposed in place of the GDP-type definitions to account for the environment, such as the Measure of Economic Welfare (MEW) (Nordhaus and Tobin, 1972) and the Index of Sustainable Economic Welfare (ISEW) (Daly and Cobb, 1989).

86 The concerns with the inadequacy of the existing measures of economic growth in capturing human progress have led to the emergence of a number of viewpoints in which the dimensions of human development are intricately linked with economic growth. There are many illustrations of these such as the propagation of the capabilities approach, and the multidimensional poverty index for policy planning purposes in developing countries.

87 The following sections elaborate on the evolution of definitions and narratives on economic growth. Alternatives that question conventional productivity based theories (whether bottom up or trickle down) are discussed, as is the challenge of inequality in economic growth.

#### 88 4.1.2 The great acceleration/transition from stagnation to growth: empirics and historical context

89 Measuring growth is difficult, especially for periods for which little information is available. National Accounts were set up in most countries after World War II. They provide different ways to measure income per capita (Gross Domestic Product, etc...). Making data comparable across countries requires correcting for differences in price levels to obtain estimates that capture the real purchasing power of income. The most comprehensive database so far is the Penn World Tables version 8.0 (Feenstra et al. 2013) which provides information on relative levels of income, output, inputs and productivity, covering 167 countries between 1950 and 2011. Based on a broad set of historical studies, Maddison (2003) reconstructed income per capita data over the past two centuries, and added some point estimates for earlier periods (in 1CE, 1000CE, 1500CE, 1600CE and 1700CE). Such estimates very often require educated guesses on unobservable trends - nonetheless, they show the best information given what is known at one point in time. Very recently, Bolt and van Zanden, (2013) have revised and complemented Maddison's work (the "Maddison project"). Figure 4.1 presents the latest estimates for GDP per capita for selected countries.





91 **Figure 4.1:** GDP per capita in selected countries, 1-2010CE. Logarithmic scale. Horizontal line = 5,000 dollars (1990 GK\$). Source: Bolt and van Zanden, 2013.

92 Over the past millennium, income per capita in the selected countries has increased 32-fold, from \$717 per person per year around the year 1000 to \$23,086 in recent years. This contrasts sharply with the previous millennia, when there was almost no advance in income per capita. The figure shows that it started rising and accelerating around the year 1820 and it has sustained a steady rate of increase over the last two centuries. One of the main challenges for growth theory is to understand this transition from stagnation to growth and in particular to identify the main factor(s) that triggered the take-off.

93 Is the finding that there was stagnation in the standard of living until 1820 truly robust? This claim is particularly striking given that mankind experienced significant technological improvements that would have been expected to increase productivity and income per person, from the Neolithic revolution to the invention of the printing press. Three facts corroborate the idea that there was indeed stagnation over the most part of human history: first, estimates of life expectancy computed on specific groups across time and space do not display any trend before 1700CE (de la Croix and Licandro 2015). Second, body height computed from skeletal remains does not display any trend either, while height is known to depend very much on nutrition when young (Koepke and Baten, 2005). This indicates that there was no systematic improvement in nutrition over time. Third, real wages computed from historical sources did not tend to rise in any sustained way before the Industrial Revolution (Allen, 2001).

94 More recently, developing economies have been growing faster than their developed counterparts, consistent with neoclassical theory (Solow, 1956). The net real GDP growth of low and middle-income countries relative to high-income countries has been much more evident and rapid since the early-1990s (Fosu, 2011, Fig. 1). Such acceleration in developing countries' economic growth may help to explain the substantial improvements in human development and poverty reduction in the world.

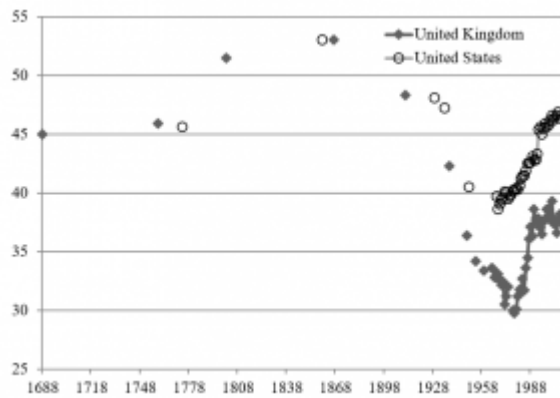
#### 95 **4.1.3 Correlations (health, democracy, inequality and growth)**

96 As discussed in Section 4.1.1, growth in income per capita is a narrow definition of economic growth. Still, it is correlated with many desirable features a society may display, including health, democracy, gender equality and poverty reduction. It can also be correlated with

undesirable features, such as environment destruction (see next section). There are also important correlations with inequality that must be considered.

- 97 As far as welfare is concerned, the most important correlate of growth is health. Looking at historical changes, it is hard to escape the conclusion that in the long run, improvements in health have been the result of economic growth. Many scientific discoveries, medical advances, and public health initiatives that have produced enormous health gains in the most advanced countries would not have occurred outside the context of industrialization and growth (Weil, 2014).
- 98 Income per person is also strongly correlated with institutions that are usually considered positive for welfare: for example, democracy and gender equality. Most countries were not democracies before the modern growth process took off at the beginning of the nineteenth century. Democratization came gradually together with income growth. This observation is rationalized by the so-called modernization theory Lipset (1959). This view is challenged by Acemoglu et al. (2009), who show that the correlation between income and the likelihood of transitions to and from democratic regimes only holds when considered in isolation and that controlling for country fixed effects turns it insignificant.
- 99 Economic growth is highly correlated with progress on poverty. It has been the main force behind poverty reduction globally (Dollar and Kraay, 2002). Economic growth is a crucial factor in attaining human development, though the process is not straight-forward. For example, while economic growth can lead to human development, it must be generally accompanied by human development in order to render the growth sustainable (Ranis et al., 2000). In sub-Saharan Africa, political instability has tended to attenuate the rate at which economic growth is transformed to human development (Fosu, 2002, 2004). In Africa as a whole, income growth is, on average, also the primary determinant of poverty reduction (Fosu, 2015).
- 100 The relationship between growth and inequality is another important consideration. The 'Kuznet curve' suggests that inequality first increases and then decreases in the course of the growth process. (See Figure 4.2) The rising part of the curve is true by definition (as growth proceeds a gap tends to emerge between leaders and laggards), but the decreasing part is dubious in light of the rise in inequality observed in both the more advanced countries as well as the emerging economies in the last 30 years.

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**Figure 4.2** Long run inequality trends (Source: Roine, J., Waldenström, D. (2015).)

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Is inequality good or bad for growth? Most of the existing literature on inequality and growth concentrates on the accumulation of physical capital. In countries with large numbers of poor, there is a high demand for redistribution policies, which in turn lead to tax distortions that slow growth. Inequality can also influence growth because of its effects on the accumulation of human capital, in particular if the poor are subject to credit constraints, preventing them from investing enough in human development (e.g. education, health and skill formation).

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Demographic variables must be taken into account in order to assess the effects that economic growth may have on income distribution (differential fertility and mortality). When inequality is high, fertility of the poor is very high as compared to that of the rich, making it more difficult to accumulate human capital in the economy (de la Croix Doepke, 2003)

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#### 4.1.4 Chapter Overview

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This section has shown that there are many competing definitions of economic growth. The determinants of economic growth and stagnation are discussed in the subsequent section, 4.2. Economic growth is often much lauded, but is also has its critics. There is widespread recognition that Gross Domestic Product (GDP) in itself only matters in that it contributes to other goods, such as preference satisfaction, happiness, capabilities to function and the meaning of life, which are discussed in Section 4.3. The section continues to discuss the distribution of those goods - if economic growth should be judged in terms of its contribution to maximizing the good (4.3.2.2), ensuring equal amounts of it (4.3.2.3), raising people above a certain threshold (4.3.2.4), or giving priority to the least advantaged (4.3.2.5), each of which has arguments pro and against. As these sections have shown, growth is strictly a mechanism to achieve other, welfare based objectives, so Section 4.4 moves on to discuss other indicators of well-being. Section 4.5 discusses

governance of the global commons, which is important as economic growth has been shown to have adverse effects on those commons. The chapter closes by presenting both positive and negative narratives of economic growth as it relates to capitalism.

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## 4.2. Determinants of economic growth and stagnation

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Determinants of economic growth include changes in demographics (4.2.1), accumulation of human capital (4.2.2), endogenous technological innovation (4.2.3), resource endowments, geography and the environment (4.2.4) the existence of institutions (4.2.5) and cultural, social movements and social capital (4.2.6).

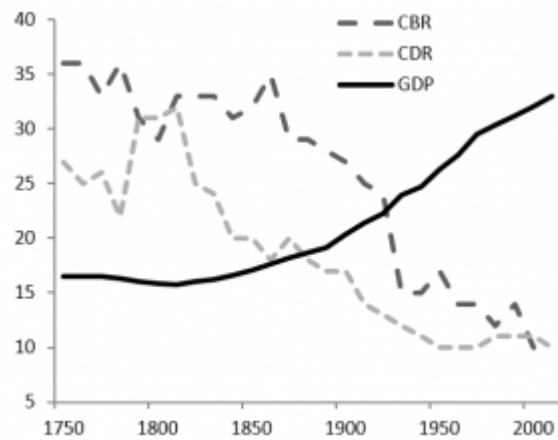
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### 4.2.1 Population and Demography

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The growth take-off was systematically accompanied by a demographic transition. Figure 4.3 exhibits this transition, as took place in Sweden[5]. Birth and death rates were systematically high before the takeoff, then mortality went down, while fertility stayed high for some time. During this period, population size increased fast. Then fertility dropped quickly and population growth decelerated. Once economic growth had taken-off, both birth rate and death rate were low, and population growth became negligible (or even negative in some cases). The demographic transition took two centuries in England and other European countries. In East Asia, it was much faster, of the order of half a century. Causality between the two transitions goes both ways: the demographic transition was triggered by the income take-off, at least as far as the drop in mortality is concerned. At the same time, the economic take-off was made possible by the demographic transition, because investment in the education and health of a smaller number of children was made possible.

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**Figure 4.3. Correlation of economic growth and demographics in Sweden.** Left axis: crude birth rate (CBR) (dark gray dashes) and crude death rate (CDR) (light gray dots) in Sweden in per 1,000. Right axis: GDP per capita. Logarithmic scale (1990 GK\$).

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Galor (2011) and many other authors (see e.g. Cervellati and Sunde, 2005 and the references therein) have stressed that the link between the demographic transition and the take-off of economic growth is a process of “quality-quantity trade-off”. This originates in a simple budget constraint, which holds both at the individual level and at the country level:

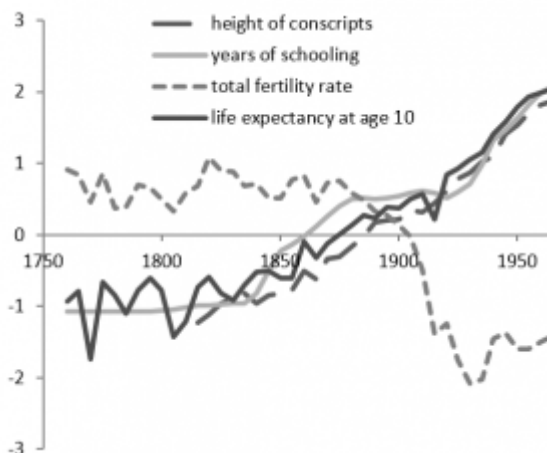
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Total spending on children = number of children x spending per child

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Keeping the total spending constant, enhancing the “quality” of children by spending more on each child requires reducing their number. Consequently, the drop in fertility observed during the demographic transition allows for an increase in spending on education and health, thereby making the accumulation of human capital from one generation to the next easier. For the case of Sweden, Figure 4.4 shows that the drop in fertility comes with a sharp increase in formal education, with a rise in adult longevity, and with a rise in people’s height, which signals better nutrition and a lower exposition to disease when young (see de la Croix and Licandro 2015).

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- 117 **Figure 4.4.** The quantity-quality trade-off for 1760-1965 birth cohorts in Sweden. Three measures of quality (body height, years of schooling, life expectancy at age 10), vs. total fertility rate. All data normalized.
- 118 In addition to the view based on the quality-quantity tradeoff, there is also the simple approach resulting from neo-classical growth theory is that a high rate of population growth could not be supported by a corresponding increase in investment, thus lowering growth of income per capita. This negative relationship between population and economic growth calls for population control policies.
- 119 Demographics also matter for growth by means of the “demographic dividend” (see Lee and Mason, 2006). According to this view, countries face a window of opportunity to grow just after fertility has gone down. At that moment, the population is mostly composed of working age persons, and the burden of dependent (both young and old) is small. This view is confirmed by the empirical literature, which finds that in general there is a non-significant correlation in cross-country studies (see e.g. Kelley and Schmidt, 1995). From these studies, it is also clear that the impact of population growth has changed over time and varies with the level of development. The composition of the population, as well as age-specific variables, is relevant to growth. A decrease in the death rate of workers in particular does not have the same effect as a decrease in the death rate of dependents, young or old (Lindh and Malmberg 2007).

#### 120 **4.2.2 Education and human capital**

- 121 The accumulation of human capital (the combination of education, experience and health) is one way to sustain growth. Even if a country cannot increase its supply of labor indefinitely, it can enhance the quality of labor. Human capital can be accumulated in two ways: 1) by education during the early stage of life; and 2) by accumulating experience (learning-by-doing) during the working life or on-the-job training. Investment in formal education has increased substantially all over the world. In England for example, the number of years spent at school went from two on average in 1820 to more than fourteen today. (Maddison, 2007). In developing countries, school enrolment grew rapidly between 1960 and 2000.
- 122 Several explanations for the take-off towards modern growth rely on incentives to accumulate human capital. If, for some reason, it becomes profitable for households to invest in education, growth can be sustained thanks to the human capital externalities stressed in the endogenous growth model literature. Two types of shocks are considered here. The first is based on Ben-Porath (1967)’s idea that the return on investment in education depends on the length of time

during which education will be productive, implying that a longer active life makes the initial investment in human capital more profitable. Provided that human capital is an engine of growth, an initial increase in longevity (for exogenous biological/climatic/medical reasons) may in turn sustain the permanent accumulation of human capital and income growth (see e.g. Cervellati and Sunde 2005). The second type of shock triggering education can be institutional. For example, Engerman and Sokoloff (2002) identify conditions under which a country will introduce public education early, favoring a skilled workforce and a rapid industrial revolution. One key condition is to have a relatively equal distribution of land among the population, avoiding the case where a land rich elite would oppose to education reform, fearing more skilled workers and more taxes.

123 Human capital accumulation may run into the problem of diminishing returns. Even without diminishing returns, its accumulation may be limited by the finite lifetime available for learning and the fact that, though institutions and social conditions may affect the productivity of learning, each generation has to accumulate its human capital anew.

124 It is however fair to recognize that many poor countries experienced an educational boom without an accompanying take-off in economic growth. Empirical studies stress the lack of correlation between educational attainment and growth. As Maloney and Valencia (2016) explain, “Empirically, documenting the impact of even very basic measures of human capital on growth or relative incomes has proved surprisingly complex”. The accumulation of human capital is a necessary condition for growth, but it does not seem to be a sufficient condition.

125 Recent literature stresses that the quality of education matters more than its quantity. OECD (2010) demonstrates a positive, strong and robust correlation across countries of growth performance and test scores obtained by secondary school students in math and science. The correlation does not rely exclusively on Asian dragons (Hong Kong, Singapore, South Korea, and Taiwan), which displayed consistently high growth and excellent scores. Finnish education, whose standards in quality are higher than those of the average OECD country, is accompanied by an advantage in growth of income per person of 0.87% each year. Cumulated over several years, this size of this effect is impressive, pointing towards a high cost of bad education system.

#### 126 4.2.3 Technological Change

Technological change is the main factor of explanation for growth over the long-run in economic history, economic theory and empirical research. This section gives a brief overview of the research approaches used and the results found, focusing mainly on historical approaches putting the culture of knowledge at the center stage of the growth process, the theory of endogenous technical change and empirical research using production functions to assess the contribution of technology and knowledge assets. Technological progress has always been present in human history, but it led to a sustained increase in standard of living only during the last few centuries. Many economists and economic historians agree that innovation and technological change are the only possible source of long-run growth in income per capita. Modern economic growth requires the continuous creation of new knowledge. It is characterized by long phases of continuous improvements in the standard of living at a pace that can be experienced from one generation to the next. But how did an economic system emerge that makes the continuous creation of economically useful knowledge possible? Much of the work in economic theory and economic history identifies similar main factors of that transition from slow and stepwise technological change to a continuous process: geography, demography, education, institutions (in particular the development of markets), culture and political developments such as war and colonialization (Broadberry, 2007; The Economist, 2013). But the mechanism by which these factors interact and their respective weights differ in different approaches. Mokyr's historical explanation of the take-off of modern economic growth with the industrial revolution sees the main driving force in a new culture of knowledge developing with the enlightenment. Knowledge building turned away from theological to empirical reasoning and the spheres of propositional knowledge ("knowing that") and prescriptive knowledge ("knowing how") became increasingly intertwined, generating a process of self-propelling technological change. This was supported by innovations like the spread of common international measures for physical units, the development of scientific journals and societies and by a number of people who became active in both the scientific and the industrial sphere. Experimentation with new technologies in production led to further discoveries and laid the ground for scientific advances that were in turn translated into other new technologies (Mokyr, 2005).

Continuous creation of new knowledge is also the main feature of the formal theory of economic growth that has developed from Solow's model (1956). Two properties of knowledge that are essential for contemporary growth theory are non-rivalry and partial excludability (Jones, 2005). Non-rivalry means that knowledge can be used by many agents simultaneously without anyone's individual use of it being diminished. Partial economic excludability means that



it is possible to exclude others from some of the economic benefits of knowledge (e.g. via a patent), but not from all benefits, since knowledge that has been made available at some point can always serve as a basis for creating new, useful knowledge. This applies in particular to codified knowledge. One far-reaching prediction implied by the non-rivalry of knowledge is that a larger population generating new ideas based on existing ideas will lead to faster technological progress and faster growth in income per capita. This prediction is, however, hard to test because the international diffusion of knowledge makes it difficult to define the set of knowledge generated and used by a particular population (Jones, 2005).

129

While increases in production factors (mainly capital and land) lead to growth in income per capita to some extent, they run into diminishing returns at constant production methods. Holding everything else, in particular labor and technology, constant, each additional unit generates a return, but this additional return is diminishing and converging to zero. Modelling growth as an endogenous phenomenon requires getting rid of the decreasing returns of factors of production that the economy can accumulate (physical or human capital). Externalities (spill-overs) play a central role here and they are related to the non-rivalry of knowledge. If, when a firm or an individual invests, this investment has positive spill-overs on other firms or individuals, the private return of the investment (to the firm or the individual) is smaller than the social return (to all firms or individuals together). Investments may thus still have decreasing private returns, but constant social returns thanks to spill-overs. For example, investments in research leading to advances in knowledge benefit the firm which has invested in them, but with decreasing returns (otherwise the firm would tend to invest infinitely). Such advances, however, benefit the whole society at a higher, and non-decreasing, rate. Free availability of knowledge for further knowledge creation is one kind of externality associated with technological change. Another externality occurs in learning-by-doing, when better production methods are developed as part of the practical use of technology. Much of technological knowledge used in production is tacit, which means that the agents use it without verbalizing or documenting it explicitly. The generation of knowledge by externalities are is one key source of modern economic growth, another is purposeful knowledge creation within firms.

130

Growth theorists endogeneizing technical change have pointed to the importance of what they have termed a research and development (R&D) sector in the process of growth, which either invents new goods or increases the quality of existing goods (See Barro and Sala-i-Martin, 1995.) This theory attributes a preeminent role to the R&D sector in generating growth, and makes a crucial link

between innovation and market power. Indeed, the incentive to innovate is provided by monopoly rights on the new goods (a way to enforce partial excludability of knowledge), which grant extra profits to research firms. Such models also open up interesting policy debates, essentially on the optimal patent protection laws, and the optimal level of subsidies required to stimulate research.

131 Based on the idea of “creative destruction” by Schumpeter (1942) the growth theory developed by Aghion and Howitt (1998) emphasizes the fact the technological change often evolves in a way that makes old processes or products obsolete. At the individual level, the development of new technologies is a costly and risky process that entails sunk cost and may result in failure. The extent to which markets and institutions support risk-taking and allow the appropriation of benefits from new technological knowledge (and thus the partial exclusion of others from these benefits) is crucial for continuous technological change. In modern economies, an important part of new technological knowledge is created in large R&D organizations that are in some cases parts of private firms but to an important part also universities and state institutions.

Mazzucato (2013) emphasizes that the state plays a fundamental role in generating radically new knowledge (e.g. inventing the Internet) for which there is initially no predefined market. According to her account, private companies in sectors such as IT and pharmaceuticals benefit from the results of that research without sharing the risks to the same extent.

132 When new basic technologies such as the steam engine, electricity or the computer give rise to innovations throughout the economy, economists speak of general purpose technologies” (Bresnahan and Trajtenberg, 1995). Associated with the spread of these technologies “long waves” of variations in economic growth rates lasting each several decades have been observed (first by Kondratieff and Stolper (1935)).

133 In an economy where large R&D departments are located in industrial firms and where production and employment shares increasingly move to services, expenditure on creating new knowledge is rising. This includes technological knowledge but also expenditure on improving organizations or increasing brand value. What these expenditures have in common is that they are to a large part targeted revenues beyond the scope of the current business year. Thus they represent economic investments. As of 2016, R&D expenditure has been included into the GDP measure of investment in major advanced economies such as the United States, Canada and the EU countries. But other knowledge investments, especially in organizational capital, are still omitted from GDP. Data for some countries is available from research projects (see, e.g. Corrado,

Hulten and Sichel, 2005; Corrado, Haskel, Jona-Lasinio and Iommi (2012). A further trend of recent decades, which has already been analyzed more in depth, is the increasing importance of information and communication technologies (ICT). While much of the early research on economic effects of ICT was motivated by Solow's famous statement "You can see the computer age everywhere but in the productivity statistics" (Solow, 1987) empirical evidence on the contribution of technological change in the ICT sector and ICT investment in all sectors to economic growth are nowadays well established. Both factors are seen as a major driver of the differential in aggregate labor productivity growth between the Anglo-saxon countries and continental Europe.

134 Modern economic growth has been delayed in other parts of the world. Countries that continue to have low living standards, such as those in Sub-Saharan Africa, have adopted a number of modern technologies but their periods of economic growth are interrupted by civil wars, famines and other setbacks. The global gap in living standards has been widening for most of the 20th century – a phenomenon described as the "great divergence". One important reason for this divergence is that technological knowledge does not diffuse costlessly. Important expenditures are associated with technology transfer and adaptation to other firms, industries and countries. Local institutions, the skills of the local workforce and "absorptive capacities" in a more general sense are crucial for the adoption of new technologies from other countries.

#### 135 4.2.4 Resource endowments, geography and environment

136 Determinants of growth including physical and human capital, endogenous technological innovation, and price distortions have been discussed in previous sections. A growing body of literature that relies on cross-country comparisons, however, is increasingly pointing to the critical importance of resource endowments, geography, and the environment (Rodrik, 2002). Several competing theories attempt to explain the channels through which resource endowments affect economic growth and its distribution. Easterly et al. (2003) emphasize that the presence of certain types of endowments that affect the policies and institutions that emerge in different countries. Kim (1999) argues that factor endowments determine the geographical distribution of manufacturing over time, potentially facilitating the exploitation agglomeration benefits. Auty (1997, 2001) documents an empirical link between resource endowments, landholding systems, the type of political state, the choice of development strategy, and the overall economic performance of a country. Interestingly enough, resource-deficient countries out-perform resource-rich ones. The former have peasant-dominant landholding systems, which according to Auty (2001) are

important for the creation of autonomous political states, and the development of economic linkages that are growth-promoting. In contrast, resource-rich countries have dispersed landholding patterns, which tend to lead to conflicts over rents, and fragmented political states. The attempt to capture rents diverts capital and other resources away from activities that promote economic linkages, and, as a consequence, growth is not sustained. Auty (2001) documents that the existence of certain types of resource endowments can also lead to inefficient industry and the failure to exploit agglomeration economies. Resource-deficient countries tend to grow faster, simply because these countries cannot afford misallocation of resources to unproductive industries. Therefore, they follow development strategies that tend to use scarce resource endowments in a more efficient fashion. Spilbergo et al (1999) and Roos (2005) further note that there are empirical links between resource endowments, trade, and income distribution. The richer is the natural resource endowment, typically the less equal is the income distribution.

137

When it comes to the role that geography plays in the process of economic development and growth, the debate has focused on whether geographical endowments, such as temperature and other climatic variables affect growth directly, or whether growth is determined by geography exclusively through its effects on transportation costs (Gallup et al. 1999). Redding and Venables (2004) provide convincing evidence that access to markets and sources of supply explain cross-country variation in per capita income. Some authors (Easterly et al. (2003)) note that by shaping diseases, geographical endowments can constitute a limit to growth. Gallup et al (1999) demonstrate the effects that location and climate have on income levels and income growth, attributing these to channels such as transportation costs, disease burdens, agricultural productivity. Some geographic areas have been conducive to agglomeration of population and the development of cities and ideas that lead to increased growth through learning and agglomeration. Geography can limit growth in regions located far from coasts or navigable rivers, where transportation costs are high and, as a consequence, possibilities for trade are limited. Geography also appears to limit growth in tropical regions, since these bear a heavy burden of disease. These geographical barriers to growth are likely to become increasingly problematic, since most of the expected population growth will occur in these disadvantaged regions (Sachs and Warner, 1997), and can further be exacerbated by climate change (references).

138

From a microeconomics perspective, and starting with the theory of the firm, Ellison and Glaeser (1997) note that agglomerations can arise through two channels: localized industry-specific spillovers, and

when firms locate in areas that have natural cost advantages. Very much like the more macro literature cited above, here agglomeration and growth results because of geography.

#### 139 4.2.5 Actors, institutions and politics

140 Institutions are often blamed or praised for their role in promoting growth. Their influence on economic growth is discussed in economic history, theoretical and empirical economics and other disciplines of social sciences. In a survey of a variety of studies investigating the institutional conditions of the emergence of economic growth, Ogilvie and Carus (2014) come to the following conclusions: (1) Public-order institutions are necessary for private-order institutions, in particular markets, to function. (2) While in all countries a mix prevails between generalized institutions (applying to all economic agents equally) and particularized institutions (which only apply to a subset of agents), generalized are those that are important for economic growth. This applies in particular to property rights (3) The importance of strong parliaments for growth has been discussed in a number of pivotal studies on institutions and growth (North and Weingast, 1989). However, they do not guarantee economic success. (4) Distributional conflicts play a crucial role in shaping institutions that are important for growth (see e.g. Acemoglu et al., 2005). While individual studies disagree to some extent with these statements, they give a good idea about the range of hypotheses that has been discussed regarding institutions and growth. Formal theoretical models tend to provide more deterministic explanations of the relation between institutions and growth than purely historical accounts.

141 In endogenous growth models, good or bad policy may indeed permanently affect the growth rate of the economy itself. Acemoglu et al. (2002) argue that relatively rich countries colonized by European powers in the 1500s are now relatively poor and vice versa. They explain this 'reversal of fortune' by the types of institutions imposed by European settlers. 'Extractive' institutions were introduced in the relatively rich countries for the benefit of the settlers rather than to increase general prosperity. In the relatively poor areas, there were fewer incentives to plunder, and so to prevent the development of investment-friendly institutions. As a result, the decline or rise of those countries is rooted in a major - exogenous - institutional change linked to colonization. A number of authors have also linked the poor performance of many developing countries with governance issues: corruption, ethnic fragmentation, wars etc. (Bloom et al., Collier and Hoeffler, 2000, Easterly and Levine, 1997, Mauro, 1995).

142 So far the discussion has focused on institutions that affect growth but that also form a society in a much more general way (e.g. private property). Taking a narrower focus it is also possible to see the institutional framework as integral part of the innovation process that fuels economic growth. Underlying the concept of intangible investment discussed in section 2.3 is a notion of innovation in production methods and in organization of the firm that is not limited to technological innovation. The institutional setup that leads to the success of both technological and non-technological innovation has been in the focus of the systems of innovation literature. As Soete et al. (2010) summarize in their overview: "The central idea in modern innovation systems theory is the notion that what appears as innovation at the aggregate level is in fact the result of an interactive process that involves many actors at the micro level, and that next to market forces many of these interactions are governed by non-market institutions. Because the efficiency of this process observed at the macro level depends on the behaviour of individual actors, and the institutions that govern their interaction, coordination problems arise. It is mainly through comparative historical analysis that scholars began to adopt such a systemic view of innovation."

#### 143 4.2.6 Culture, social movements and social capital

144 Social interactions over time arise as culture, social movements and social capital. Individuals organize into groups according to historical, environmental, economic, religious and geographic values, which translate into cultural patterns. Culture is influenced by development and growth - notions that have been widely discussed over the last three decades.[6] Culture (as a set of identities and practices) has transitioned regularly because the economic growth model is imposed uniformly. The consumer culture is one example. On the one hand, a culture may be dependent on technology. On the other, it may also pursue social restitution of the environment through a vast range of "green" products. This, among many other forms of consumption, has an impact on the dynamics of economic and also on the cultural patterns of the various social groups.

145 The merging of cultural values and the economic growth model of accumulation and expansion of capital unleash social movements. These movements pursue social justice in all its dimensions by means of different channels of knowledge and territories. According to Leff: "[...]the inability of governments to regulate and control the eco-destructive and ethnocide effects of economic growth, has prompted the emergence of a new environmental consciousness that mobilizes and encourages people to organize around the defense of their cultural values, their natural resources and their quality of life threatened by environmental degradation" (Leff 1986 , 117).

- 146 Social movements are characterized by the integration of actors from the common class as well as scholars[7] This integration promotes the incorporation of academic knowledge to popular struggles. The result of these intersections is key to opening paths to a better model of development and growth, which may more effectively address issues of social justice by appealing to decision makers and managers of public policy. The increase in social movements addressing environmental causes, among others, demonstrates that the empowerment of the masses through knowledge can bring to decision makers.
- 147 The concept of “social capital” is relatively new in the discourse of economic development. Although it has had different interpretations, the element of strengthening social networks is common throughout. According to Bourdieu ‘social capital’ means "all potential and current resources related to the possession of a durable network of more or less institutionalized relationships of mutual knowledge and recognition" (Bourdieu 2000), appears as a key element in the pursuit of social justice, because it is part of economic development as well as the processes of governance and democracy. According to the United Nations, social capital efficiently promotes the social development of societies in terms of the following dimensions, which are in constant interrelation: trust within a society, associative capacity, civic consciousness and ethical values. Social capital reflects collective action and its features, such as social movements or the identities of diverse communities. As such, the adoption of the definition proposed by Bourdieu could be a potential trend that reflects the value of the social assets of a society, and suggests an active relationship between its dimensions.
- 148 Thus, culture, social movements and social capital contribute to the strengthening of social justice, as it is proportional to economic growth. Nevertheless, two substantial barriers hinder their effective contribution. Firstly, the current paradigm of growth and social progress implies that environmental resources,(which are also the basic resources for survival)\_be managed and processed, ignoring their finiteness. Secondly, a lack of systematic planning. If systemic planning were implemented, individuals could participate as community leaders, but could also be direct beneficiaries of political, environmental, economic and cultural achievements and transformations. If these barriers were to be addressed, comprehensive training focused on regional issues, but with a global perspective, would be required.
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## 4.3. Evaluation of growth, welfare and human development

150 Economic growth is often much lauded, but it has its critics too, including classic texts such as Mishan (1967) and Meadows, Meadows, Randers, & Behrens (1972), as well as more recent critiques (Jackson 2011) (See Section 4.1.4.2) Such positive and critical evaluations rest on both empirical and normative commitments. In this section we consider various normative criteria that can be used to evaluate growth. These normative criteria have been introduced in Chapter Two.

151 Here we focus on the normative standards *specifically as they apply to economic growth*. The section is divided into two halves. First, Section 4.3.1 identifies different accounts of what should be deemed to be a benefit and what a burden. Its focus is on ‘what matters’ – happiness, preference satisfaction or something else. There is widespread recognition that analyses of economic growth that assess it simply by appealing to Gross Domestic Product (GDP) are unsatisfactory since GDP does not *in itself* matter. It matters because, and to the extent that, it contributes to other goods (Stiglitz, Sen, Fitoussi 2010). Section 4.3.1 considers some accounts of what they might be. Once we have an account of what matters, the next question is what is the right rule concerning those benefits. Should economic growth be judged in terms of its contribution to maximizing the good, or ensuring equal amounts of it, or raising people above a threshold, or some other criterion? These issues are explored in Section 4.3.2. Not all of the goods to be discussed in Section 4.3.1 (such as political stability) are easily treated as goods to which distributive principles can be applied. Some, however, (such as benefits like happiness, preference satisfaction or capabilities) are, and thus a discussion of what rule should govern the distribution of those goods is required.

### 152 4.3.1 What matters

#### 153 4.3.1.1 Preference satisfaction

154 Some hold that what matters is that people’s preferences are satisfied. To evaluate economic growth or the lack of it one must, on this view, determine what impacts it has for the satisfaction of people’s preferences. Many economists, for example, place a great emphasis on revealed preferences. The preference satisfaction view has some appeal is that it seems to take each individual’s views seriously.



155 Is it valid to appeal to preference satisfaction to evaluate economic growth? One challenge is posed by Amartya Sen, who argues that preferences formed in unjust social circumstances might reflect this (Sen 1987, p.11). The appeal of the preference satisfaction approach is lost if the account simply reflects unjust circumstances set up by the powerful in ways that advantage them.

156 A second concern arises from the phenomenon that J. K. Galbraith referred to as the “dependence effect” in his classic *The Affluent Society* (1958, chapter 11). His claim was that if people had exogenously given preferences then the fact that an economic system satisfied them would count in its favour, but since economic systems create preferences they deserve little credit for satisfying people’s preferences.

157 Advocates of a ‘preference satisfaction’ view can respond to some of these objections. For example, in response to Sen’s critique they might stipulate that a person’s good is what he or she would desire in a situation in which – as well as having full information and being fully rational - they have genuine choice and are not subject to the manipulation of others (Brandt 1979). This might also help respond to Galbraith’s challenge for the emphasis would then be *not* on satisfying preferences produced and created by the existing economic system, but rather preferences that a well-informed non-manipulated rational agent would choose. This takes us far from actual desires to desires formed in rather idealized circumstances (Griffin 1986, chapter 1 especially pp.10-15).

#### 158 4.3.1.2 Happiness

159 A second criterion that might be used to evaluate economic growth equates the good with happiness, where happiness is defined in terms of pleasant mental states. (On happiness more generally see Haybron (2008), Parfit (1984, p.493).) One well-known study that takes this criterion seriously is Richard Easterlin’s paper ‘Does Economic Growth Improve the Human Lot?’ which argues that economic growth does not promote happiness (2010, pp.13-45: originally published in 1974). (For critical evaluation see Stevenson and Wolfers (2008).) Since Easterlin’s study, others have also adopted this kind of perspective, including Andrew Oswald (1997) and Richard Layard (2011).

160 Should we then judge economic growth in terms of its impact on happiness? Several objections have been pressed against this criterion. First, Robert Nozick criticized it in *Anarchy, State and Utopia*. He gives an example of what he terms the “experience machine” (Nozick 1974, pp.42-45). This gives people wonderful pleasant mental states. Nozick then asks if we would want to be

plugged into this for life, which would guarantee a lifetime of pleasant mental states. Nozick points out that we would balk at hooking ourselves up to this machine for life, and as he observes, this shows that we care about more than pleasant mental states.

161 A second objection reflects on the implications of Easterlin's claims about economic growth. Some have argued that economic growth does not promote happiness, but, they reason, this does not necessarily tell against the idea of economic growth. Rather, they argue, it shows that happiness is not a unreliable criterion as to what matters. Dan Moller, for example, responds to Easterlin's argument in this way, reasoning that other goods matter and that economic growth has value to the extent that it furthers these goods (Moller 2011, pp.186-189). The point is also nicely expressed by Marc Fleurbaey and Didier Blanchet: "The "paradox" in Easterlin's paradox is that it has served to popularize the happiness challenge to the economic approach, whereas it is the best proof that the happiness approach is problematic" (Fleurbaey and Blanchet 2013, p.173).

#### 162 4.3.1.3 Capabilities to function

163 A third criterion by which one might judge economic growth is the "capabilities" approach pioneered by Amartya Sen (1987; 1999; 2009, Part III) and Martha Nussbaum (2006, pp.69-81). Unlike the preference satisfaction and happiness theories, it takes a more objective approach. It identifies human functionings and evaluates social, economic and political institutions (and so economic growth) in terms of their effects on people's capability to enjoy these functionings. Nussbaum has developed a list of 10 "central human capabilities" (Nussbaum 2006, p.76). These include "life", "bodily health", "bodily integrity", "senses, imagination, and thought", "emotion", "practical reason", "affiliation", "other species", "play", "control over one's environment" (Nussbaum 2006, pp.76-78).

164 Using these one might assess economic growth (or its absence) in terms of its impacts on capabilities. For example, economic development that lifts people out of poverty will, of course, promote several key capabilities (Alkire 2002, Sen 1999). At the same time, growth can also result in harms to other capabilities. In particular, environmental externalities (such as climate change and biodiversity loss) will have adverse effects on some capabilities, most notably the capability for good health as well as control over one's environment. The "capabilities" approach can thus provide a set of criteria by which economic growth can be evaluated.

165 This approach is, however, not without critics (Fleurbaey and Banchet 2013, p.225ff). One question concerns the issue of how one identifies 'capabilities'. Nussbaum's list of 10 capabilities is plausible

but one might ask why we should accept this particular list rather than another. Sen, by contrast, declines to specify what the capabilities include. He has expressed concern about a theorist prescribing a particular list, and has instead emphasized that the list should emerge from “fruitful public participation on what should be included and why” (Sen 2004, p.77; 2009, p.242). His procedural approach might avoid the problems associated with Nussbaum’s substantive approach, but it, in turn, cannot guide us in the absence of those deliberative procedures.

166 These concerns notwithstanding, the capabilities approach provides a useful and intuitive framework for evaluating growth.

#### 167 4.3.1.4 Meaning of Life

168 Some might argue that the previous three criteria do not constitute an exhaustive basis on which to judge economic growth. They might, thus, appeal to the idea of a “meaningful” life to evaluate economic growth. Human beings do not exclusively strive for happiness, but a sense of meaning also matters for the conception of individual targets in life. Some correlates of happiness and meaning, such as religion, friends, and family overlap. Others, however, point in opposite directions. For instance, one recent cross-country study (Oishi and Diener 2014) found that people in poor countries on average enjoy a greater sense of meaning in life than people in rich countries. Likewise, one recent study in the US (Baumeister et al. 2013) points out that “concerns with personal identity and expressing the self contribute[s] to meaning but not happiness”, concluding that one can lead an unhappy, but nevertheless a meaningful life.

169 Identity is closely linked to questions such as “what kind of person am I?” and “what is my place in society?”. Recent economic analyses have argued that identity constitutes a fundamental factor for e.g. choice of employment (Akerlof and Kranton 2000). That is, an occupation is not only chosen because of consideration of income or the enjoyment the activity brings, but also as a function of how it conforms to the self-ascribed role related to being a member of e.g. a gender or an ethnic group. In a similar vein, using survey data, Howell (2013) shows that people adopt low-carbon lifestyles for reasons that extended beyond a desire to merely reduce greenhouse gas emissions, including values such as equality, social justice, and unity with nature. The reasoning that living a good life means living in accordance with one’s values, i.e. that one’s identity is constituted by adhering to these values. This perspective is closely related to ancient concept of virtue ethics, which states that a leading a good life means striving for fundamental virtues, such as wisdom or

justice. This line of reasoning has recently received renewed attention by philosophers (Sandel 2013) as well as economists (Bruni and Sugden 2013).

#### 170 4.3.1.5 Status consumption

171 At this point it is worth considering the phenomenon of “status consumption”, defined as:

172 “the motivational process by which individuals strive to improve their social standing through the conspicuous consumption of consumer products that confer and symbolize status both for the individual and surrounding significant others” (Eastman, Goldsmith and Flynn 1999, p.42; Eastman and Eastman 2011, p.10).

173 Does it matter that economic growth promotes status consumption, and, if so, in what ways? Answering this question requires us to consider the earlier possible accounts of what matters. It must thus be judged in terms of its contribution to people’s ‘good’. Thus, for a preference satisfaction theory, it matters whether status consumption aids in satisfying people’s desires. If, for example, it does not, or if it just generates further insatiable desires then status consumption does not advance someone’s good. Similarly, for a happiness-based theory status consumption has value because, and to the extent that, it results in happiness; but if acquiring the goods turns out not to result in the pleasant mental states then it will not count as advancing people’s good.

174 A capability approach will take a different tack. It is hard to apply Sen’s version since, as noted above, he has not set out an account of the capabilities (though one can assume that they will cover core basic needs). With Nussbaum’s approach, status consumption would matter only insofar as it contributes to one of the 10 capabilities. Note that one of her capabilities is what she terms “affiliation”, where this includes (a) forming associations with others and (b) “having the social bases of self-respect and nonhumiliation, being able to be treated as a dignified being whose worth is equal to that of others” (Nussbaum 2006, p.77). It is arguable that status consumption can contribute to this capability. An argument along these lines was put by Tibor Scitovsky in *The Joyless Economy* (1976). He argues that people have a strong desire to belong to society at large as well as to smaller social groups; and they seek to enjoy an equal status within them. He further argues that people often engage in status consumption in order to do so (Scitovsky 1976, pp.114-120, especially p.115), and so it can help people enjoy an equal states with others. At the same time, Scitovsky notes that “status can be sought in many different ways” (Scitovsky 1976, p.115) and so it need not take the form of material possessions. Status consumption may also

just result in an endless competition (Scitovsky 1976, p.120). Furthermore, whilst it might be rational for an individual to seek status consumption to keep up with others this does not show that society as a whole should pursue economic growth in order to realize this. Status consumption may occur however poor or wealthy a society and so the level of wealth may not make much of a difference.

#### 175 **4.3.1.6 Industrial-technological pollution**

176 [Note to reviewers: Section to be amended to make application to economic growth more explicit.]

177 One of the greatest threats to current human and planetary welfare and development is pollution. World Health Organization databases show that throughout the planet, every year roughly 9 million people die prematurely and avoidably because of air, water, and soil pollution. One in 7 deaths in low- and middle-income countries is caused by pollution. It is a far bigger killer than malaria, pneumonia, tuberculosis, or AIDS. Preventable pollution-caused deaths number about 35,000 per year in Brazil; roughly 63,000 annually in the Philippines; and more than two million each year in India. (GSHP, 2014)

178 Air pollution is a problem for much of the globe, especially particulate matter (PM), which is estimated to cause between 3 and 7 million of the 9 million annual preventable, pollution-related deaths. PM sources include electric-power plants, industrial facilities, automobiles, trucks, trains, ships, biomass burning, and fossil fuels used for heating. (Rohde and Muller, 2015) In China, air pollution contributes to 1.6 million premature deaths each year, about 17 percent of all deaths in the country. Even in the United States, PM and ozone air pollution from the combustion sector, annually cause more than a quarter of a million premature and avoidable deaths. (Caiazzo, Ashok, Waitz, Yim and Barrett, 2013)

179 In developing nations some of the solutions to these 9 million annual avoidable pollution deaths include joining development planning with pollution control and integrating finance ministries with health and environment ministries. Pollution solutions also include educating people to know that benefits of pollution control outweigh their costs, that pollution control drives growth, and that pollution and not infections is the greatest cause of death in developing nations. (GSHP, 2014)

180 In the developed world, solutions to pollution are mainly regulatory and educational. Government needs to mandate more protective pollution control and to educate citizens about the cost-effectiveness of pollution control. For instance, the US

Environmental Protection Agency or EPA recently computed year 1990-2020 costs of implementing the 1990 Clean Air Act at about \$65 billion, while benefits for the same period are roughly \$2 trillion. If EPA is right, clean-air benefits outweigh its costs by more than 30 to 1. Moreover in only one year, 2020, these mandated clean-air expenditures would save 230,000 people from premature death---- at a cost of less than \$300,000 per avoided death. Reducing air-pollution-related deaths thus makes medical sense, economic sense, and climate-change sense. (US EPA, 2011; Caiazzo, Ashok, Waitz, Yim and Barrett, 2013)

181 **4.3.1.7 Non-anthropocentric values, intrinsic value of nature and animal welfare**

182 [Note to reviewers: Section to be amended to make application to economic growth more explicit.]

183 The focus, so far in Section 4.3.1 has been on ways in which economic growth impacts human beings. Anthropocentric concerns have been the primary values that traditional western philosophers have recognized. For instance, Aristotle wrote that nature has made all things for humans and that non-human beings have merely instrumental value. John Locke went so far as to estimate that human labor contributes 99 percent of the value of natural things. Although Locke warned that Earth should be managed for the preservation of all, he thought natural objects such as trees or land had value mainly because of the various ways that humans could make use of them to satisfy their needs. Likewise Immanuel Kant wrote that cruelty to nonhuman animals is wrong mainly because of how such actions harm human character not because of what they do to other beings. (O'Neill, 1998; Hargrove, 1989; Passmore, 1980)

184 Early in the twentieth century similar anthropocentric trends continued in the West, perhaps because many environmentalists were aligned with wealthy governmental-industrial interests. Attempts were made to conserve wilderness, but largely for human benefit. Non-human beings were viewed to have predominantly instrumental value and not intrinsic value in themselves. Thus plants or rivers were valuable, for instance, mainly because of their contributions to medicines or to the nature experiences of backpackers, birdwatchers, and Boy Scouts. Western environmentalists thus forgot Locke's warning. (Hargrove, 1989; Schrader-Frechette, 1993)

185 In the latter half of the twentieth century, environmental ethics emerged as a separate philosophical discipline. Practitioners debated whether animals, trees, and rocks had moral or legal "rights," whether there were duties to them, and whether they had

“interests.” Attorney Christopher Stone likewise questioned the defensibility of contemporary recognition of the legal standing of human-made corporations when natural beings such as trees have no such standing. (Stone, 1972) Because natural beings appear to be ends in themselves and to have intrinsic worth, independent of human wants and needs, philosophers argue that humans have at least *prima facie* duties not to harm these natural beings. (O’Neill, 1992; Jamieson, 2002; Callicott, 1989; Norton, 1982; Stone, 1972)

186 For thinkers such as Peter Singer, however, humans have not only *prima facie* duties to avoid harming non-human beings but also *prima facie* duties to avoid as much suffering as possible, whether human or non-human. He concludes that anthropocentrism arguably errs because of speciesism. Akin to racism and sexism, speciesists focus on the welfare of “rational” beings, not all beings who experience pain or pleasure. Tom Regan goes further, claiming animal subjects have rights not to be harmed insofar as they have such things as sense perceptions, beliefs, desires, and psychological identity over time. (Regan, 1983) Paul Taylor extends non-anthropocentric concerns by arguing for biocentrism, respect for the equal intrinsic value of each human, animal, or plant, as a “teleological-center-of-life” whose good can be enhanced or damaged. (Regan, 1983; Singer, 1975; Taylor, 1986).

187 As debates such as those among Regan, Singer, and Taylor reveal, one of the thorniest ethical issues is how to balance human and non-human welfare. What to do when feral or overpopulated animals ravage a fragile ecosystem? Or when HIV threatens human health? Obviously treating non-human nature as a mere instrument for human welfare is wrong. Obviously it also is wrong to make all human rights to life subservient to the good of the biosphere, through the “environmental fascism” of which Baird Callicott has been accused. Yet the precise human-non-human tradeoffs remain a matter of controversy. Robin Attfield, for instance, argues for a hierarchical, consequentialist balancing. He says humans have greater intrinsic value than non-humans but argues for balancing the conflicting goods of different beings. Onora O’Neill argues that obligations and not rights are basic. She claims that many human-non-human conflicts can be addressed by following the Kantian dictum: Never act in ways in which others in principle cannot act. (O’Neill, 1997; Callicott, 1989)

188 Whatever the ultimate theoretical account of human-non-human balancing, in many cases human-and-non-human goods are aligned. For instance, eating vegan arguably is healthier for humans than eating meat, especially meat that includes food-chain contaminants, and it serves animal-welfare and climate-change goals. Similarly, preservation of forests and other carbon sinks serves both biotic,

climate, and long-term human welfare. Reducing use of fossil fuels likewise would serve atmospheric, climate, and human welfare by reducing airborne particulate matter that prematurely kills millions of people throughout the world.

189 Of course, some situations embody genuine conflict between human survival and biotic or abiotic welfare, as when indigenous people have caused desertification because they had to cut down trees for firewood. Yet because both humans and nonhumans rely on the same biotic and abiotic systems for survival and well-being, many cases of human-environment conflict are avoidable. As Thomas Pogge suggests, many such conflicts have arisen from colonialism, greed, imperialism, and the desperation and human inequality that they cause. (Pogge, 2002) If governments followed more egalitarian ethics that avoided environmental justice and protected all human rights to life, thus to a livable environment, they also might end much unwise resource depletion and pollution. Greening the ghetto arguably would green the entire society. (Blackstone, 1974; Shrader-Frechette, 2007; Singer and Mason, 2006; Pogge, 2002; Bob and Bronkhorst, 2010)

#### 190 **4.3.1.8 Political stability and legitimacy**

191 A further criterion for the evaluation of economic growth concerns its impact on political stability and legitimacy. Some authors have explored whether economic growth furthers political stability (Paldam 1998), and there is an established literature on how economic growth – and the rate of change of growth – impacts both political stability and political legitimacy (Hirschman 1973; Huntington 1968; Przeworski, Alvarez, Cheibub & Limongi 2000). There is, in addition to this, a literature on whether political stability promotes economic growth (Alesina, Özler, Roubini & Swagel 1996), but the focus here is on the evaluation of economic growth, and so, in this context, the focus is on the effects of economic growth on political stability and legitimacy (and not vice versa).

192 In order to evaluate economic growth on this basis it is important (i) to have clear definitions of the two terms, and (ii) to evaluate their value and importance.

193 On the former: Przeworski, Alvarez, Cheibub & Limongi argue that political instability should not be confused with mere “political change” (Przeworski, Alvarez, Cheibub & Limongi 2000, p.188), and so political stability should not be understood as a lack of political change. Political stability can instead be understood as an absence of major “political upheavals” (Przeworski, Alvarez, Cheibub & Limongi 2000, p.189ff). In their survey of competing definitions of political stability, Keith Dowding and Richard Kimber provide a more precise



formulation (1983). They write: “political stability is the state in which a political object exists when it possesses the capacity to prevent contingencies from forcing its non-survival” (Dowding and Kimber 1983, pp.238-239).

194 Political legitimacy is distinct from political stability. It is common to distinguish between ‘normative’ notions of political legitimacy (which claim that an political institution has political legitimacy if it meets some moral standards) and ‘descriptive’ notions of political legitimacy (which claim that a political institution has political legitimacy if those subject to it recognize it as being entitled to govern) (Peters 2010). A paradigmatic account of political legitimacy in the descriptive sense is given by Max Weber in *Economy and Society* (Weber 1978 [1922]).

195 Turning now to the evaluative question, two points are worth noting. The first is that the value of political order and political legitimacy is, to some extent, a derivative value. That is, they have value, in part, because, and to the extent that, the social and political institutions that are in place are valuable ones that should be stabilized and legitimized. So before knowing whether stabilizing and legitimizing a regime is valuable it is necessary to know whether it is worth preserving, or whether there is a more just and less oppressive alternative available.

196 Bernard Williams has argued that the question of how to secure order and political stability is the “first political question”, meaning that “the securing of order” is necessary to pursue other ideals (like social justice) (Williams 2005, p.3). However, this is consistent with thinking that its value derives from the realization of these other goals. An evaluation of the effect of economic growth on stability and legitimacy must therefore be conducted together with its effects on justice and the standard of living.

#### 197 4.3.2 How is it distributed?

198 The previous section considered some of the metrics that might be used to evaluate economic growth, and specified various benefits (happiness, preference satisfaction, capabilities, meaning of life, etc) and various burdens (pollution) that need to be borne in mind. There is a further question concerning how the goods in question (whether happiness or capabilities or some other good) should be distributed. This section turns to those questions.

##### 199 4.3.2.1 Global commons

200 [Note to reviewers: Section to be amended to reduce overlap with Section 4.5 below]

- 201 The “global commons” have been defined as follows:
- 202 “...resource domains or areas that lie outside of the political reach of any one nation State. Thus international law identifies four global commons namely: the High Seas; the Atmosphere; Antarctica; and, Outer Space. These areas have historically been guided by the principle of the common heritage of humankind” (UNEP, 2016)
- 203 These four phenomena – the high seas (including the sea bed), Antarctica, the atmosphere, and space – have also been identified as the four constituent elements of the global commons by Susan Buck in her book *The Global Commons* (Buck 1998, p.xiii).
- 204 Economic growth bears on the “global commons” in at least two ways. First, economic growth can impact on the global commons. For example, economic growth has historically involved high emissions of greenhouse gases and thereby brought about the prospect of dangerous anthropogenic climate change (UNFCCC Article 2). This will have adverse effects on health and access to food and water, and it can lead to severe weather events. In addition to this, economic growth can lead to high emissions of CFCs which damage the ozone layer, and thus increase the prospects of skin cancer and eye cataracts. Other impacts of economic growth include pollution of the high seas and the depletion of resources. (See Sections 4.3.1.6 and 4.3.1.7) In short, then, economic growth can have adverse effects on the global commons.
- 205 It is likely that all the accounts of how to conceptualize benefits and burdens that were mentioned in 3.1 will converge, to a large extent, in their evaluation of these effects. Notwithstanding some differences between the various metrics (3.1) we can expect them to agree on deeming increased threats to health or food or water as ‘bads’, which should, other things being equal, be minimized and distributed equitably.
- 206 A second way in which the “global commons” and economic growth are interrelated is that the global commons can also be a source of resources and environmental services which in themselves can facilitate economic growth. The global commons thus enables economic growth. For example, the sea beds are rich with resources such as cobalt, copper, manganese and iron (Buck 1998, p.90 and, more generally, pp.88-91). In addition, Antarctica contains mineral resources (such as copper, gold, iron, silver, and petroleum) (Franck 1995, pp.401-405).
- 207 Given that economic growth impacts on the global commons, and given that the global commons facilitates economic growth, there is a need, first, for principles of justice to protect the global commons and

ensure that any use is sustainable over time. There is also a need, second, to regulate access to the natural resources and environmental services contained within the “global commons” (Caney 2012). In particular, since the atmosphere, Antarctica, the high seas and space exist beyond the confines of states there is a need for principles of global justice. Furthermore, since current economic behaviour affects the standard of living of future generations there is a need for principles of intergenerational justice to regulate the global commons.

208 This raises a methodological question of how to treat the global commons within a theory of justice. Some propose principles designed to treat the global commons on their own (Risse 2012, Part II), whereas others argue that the issues surrounding the global commons (like the use of the atmosphere) should be treated in light of people’s overall rights (such as their rights to develop and promote a reasonable standard of living) (Caney 2012).

#### 209 4.3.2.2 Maximizing the good

210 Having discussed the kinds of domains that should be regulated by principles of justice, we can turn now to consider various distributive criteria. One familiar view is that the good should be maximized. The best-known version of this is utilitarianism, which takes utility (understood either as happiness or as preference satisfaction) as its good and then calls for its maximization (Sidgwick 1981 [1907]). Utilitarianism is also endorsed by some contemporary economists (Layard 2011). It is important to note that it is possible to adopt a maximizing view and not apply it to utility but to another good, such as the enjoyment of capabilities or a perfectionist account of the good life.

211 Views that call for the maximization of a total good are vulnerable to several well-known objections. One is that it is indifferent to the distribution of benefits (however they are defined) and can sanction outcomes that would be thought to be unjust (Rawls 1999, pp.19-24, especially p.23). It might, for example, justify inflicting great hardship on a few if that produced sufficiently great benefits for others. Related to this, approaches which maximize some benefits might ride roughshod over the rights of individuals and minorities, and justify illiberal policies (Nozick 1974). (See Scheffler 1988 for a good overview).

212 Since our focus is on economic growth and thus the standard of living of people in the future, it is worth noting that an additional set of questions arise when we apply a maximizing approach to future generations. Derek Parfit has argued that if the aim is to maximize total utility then this might lead to what he calls “the repugnant

conclusion” – a world with very many people all of whom have a low (but positive) standard of living (Parfit 1984, chapter 17). Others object that applying a maximizing approach might impose very demanding obligations on current generations who are required to sacrifice their consumption in order to create greater benefits for future generations. This has led some to embrace ‘discounted utilitarianism’ (which applies a positive pure time discount rate), and for others to abandon maximizing views (Parfit 1984, pp.484-485; Rawls 1999 p.262).

#### 213 4.3.2.3 Equality

214 An alternative distributive principle by which to evaluate economic growth would be to assess it in terms of its impact on the realization of equality. As Chapter Two has discussed, there are different kinds of egalitarianism. Some endorse what has been called luck egalitarianism and hold that “it is bad – unjust and unfair – for some to be worse off than others through no fault of their own” (Temkin 1993, p.13; Cohen 1989). Others condemn economic inequalities for other reasons. In his influential ‘The Diversity of Objections to Inequality’, Thomas Scanlon draws attention to five reasons that have been given in defence of greater equality.

- 215
1. It is needed to reduce suffering;
  2. Economic inequality can lead to stigma, and feelings of inferiority;
  3. economic inequality can enable some to exploit and control others;
  4. economic inequality undermine the fairness of procedures; and,
  5. economic equality is a fair principle to regulate relations between members of a joint scheme of cooperation (Scanlon 1997, pp.2-10)

216 Martin O’Neill has built on this analysis arguing, like Scanlon, that inequality results in suffering, stigma, and domination, but also arguing that it generates a lack of self-respect on the part of the disadvantaged, attitudes of servility and deference, and social fragmentation and a lack of community across society (O’Neill 2008, pp.121–23). Furthermore, there is now an extensive empirical literature that concludes that economic inequalities within societies lead to stigma, anxiety, and poorer health for all (Marmot 2004; Wilkinson 2005, Wilkinson and Pickett 2009).

- 217 One question that is very relevant when evaluating economic growth is whether the focus should be just on inequality within a country or whether it should concern global inequalities. The issue at stake is that of the scope of egalitarian justice. Given that economic growth often has implications beyond the borders of any given state, it is important to consider whether egalitarian principles apply globally or not (for a discussion see Chapter Two).
- 218 On one view, inequality matters only within a state. This view holds that there is something special about the state that it entails that egalitarian principles apply there but not elsewhere. This might be because the state exercises coercion over its citizens (Blake 2013) or because the state is a scheme of cooperation (Sangiovanni 2007). A contrasting, cosmopolitan, view maintains that it is arbitrary to apply equality within one country. Luck egalitarians, for example, will hold that egalitarian principles should apply at the global level, and thus criticize global inequalities as unjust (Caney 2011).
- 219 A second question concerns the application of this principle over time. Given the effects of economic growth on future generations it is necessary to enquire whether egalitarian principles – or some other principles – should be applied over time. One concern about maintaining that equality should apply across time is that it would seem to prohibit one generation from making future generations better off. As such it seems vulnerable to a particularly acute version of the ‘leveling down’ objection (Parfit 1997, pp.210-211). It would seem implausible to limit growth if and because it would result in an intertemporal inequality.
- 220 In light of this, one might consider an alternative view, voiced by Brian Barry, who argued that “those alive at any time are custodians rather than owners of the planet, and ought to pass it on in at least no worse shape than they found it in” (Barry 1991, p.258: emphasis added). A similar view is expressed by James Woodward: “each generation ought to leave for succeeding generations a total range of resources and opportunities which are at least equal to its own range of resources and opportunities” (Woodward 1986, p.819). On this view, one generation may not leave future ones worse off but may leave them better off. Another option is to adopt a pluralist view and hold that equality is one value but not the only one (Cohen 1989; Temkin 1993). Finally, one might endorse what Paula Casal calls “Leveling up Egalitarianism”, which holds that “reducing inequality has value only if it benefits individuals” and so would not require leveling the future down (Casal 2007, p.309: also Mason on “conditional egalitarianism”: 2001).

221 Related approaches have been developed by Humberto Llavador, John Roemer, and Joaquim Silvestre in *Sustainability for a Warming Planet* (2015) (as well as in earlier papers by Roemer (2011, 2013) and they receive further analysis by the economist Geir Asheim (2016). The core idea expressed by Llavador, Roemer and Silvestre is that members of each generation have a right to an equal standard of living on the grounds that it is objectionable for some to have less or more purely because of when they are alive: that is a morally arbitrary fact about that. However, they argue, each generation has a right to leave future generations better off, and in line with this preference governments should maximize the standard of living of current generations subject to leaving future generations better off (thereby honouring what they term “growth sustainability” (2015, pp.4 & 34)). For this argument see Llavador, Roemer and Silvestre (2015, pp.1-5 & 34-38; also Roemer 2011, 2013).

#### 222 4.3.2.4 Sufficiency/meeting core needs

223 As noted above, one rationale for reducing inequalities is that it is necessary for reducing human misery and suffering. As Scanlon observes, this argument is not deeply committed to equality (Scanlon 1997, p.2). It implies that inequality is acceptable so long as people’s standard of living is above some designated level. This takes us to sufficientarianism. This is “the doctrine that what is morally important with regard to money is that everyone should have enough” (Frankfurt 2015, p.7). Sufficientarianism insists that there is a threshold standard of living, below which no one should fall. This could be quite a minimal standard, calling for meeting everyone’s basic needs. Or it could be something more demanding, requiring a higher standard of living.

224 As before, when evaluating economic growth it is worth considering the global and the intertemporal applications of a proposed principle. At the global level, many endorse a sufficientarian threshold. One version of this, for example, is couched in terms of rights and it holds that all persons throughout the world have rights to have their basic needs met. Such a view is powerfully defended by Henry Shue in *Basic Rights* (1996). This approach contrasts with purely aggregative approaches which seek to promote the good of the whole, and it emphasizes the rights of everyone not to fall beneath a minimum standard.

225 Such a sufficientarian approach can also inform intergenerational justice and thus be employed to judge the value of economic growth over time. On one widely held view, current generations have a duty not to act in ways which result in future generations being unable to enjoy a basic standard of living. An important and influential example of this kind of sufficientarian approach is the Brundtland

Commission which holds that “[s]ustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development 1987, p.43).

226 A sufficientarian approach commands considerable support. Nonetheless some issues remain. One difficult issue surrounds the question of how to define the sufficiency threshold and where to draw the line (Casal 2007, pp.312-313). It is also unclear why differences just below any designated threshold have immense moral significance but benefits above it lack any. As Paula Casal has argued, it would be implausible to insist on a policy that improves the standard of living of someone below the threshold at the cost of imposing considerable losses on everyone else leaving them just above the threshold (Casal 2007, pp.298-299). As she notes, a sufficientarian approach to evaluating economic growth – whilst important – cannot be the full story: it needs to be supplemented with additional principles, such as equality or prioritizing the least advantaged (Casal 2007:).

#### 227 4.3.2.5 Priority for the least advantaged

228 This takes us to a fourth distributive principle that might be applied when evaluating economic growth – the principle of prioritizing the least advantaged. An important statement is given by Parfit, who defines what he terms “the Priority View” as follows: “Benefiting people matters more the worse off these people are” (Parfit 1997, p.213). (See also Adler (2012, chapters 5-7) and Holtug (2010, chapter 8).) As Parfit brings out, this is importantly distinct from egalitarian views for whereas egalitarian views are concerned with how people fare relative to others, prioritarian views, by contrast, are concerned only with people’s absolute level, and not with how well one person does in comparison to another. As Parfit puts the point:

229 “on the Priority View, benefits to the worse off matter more, but that is only because these people are at a lower absolute level. It is irrelevant that these people are on a lower absolute level than others (Parfit 1997, p.214).

230 As with the preceding principles, it is instructive to note that some apply prioritarianism to the global level, and thus would evaluate global economic growth in light of Parfit’s Priority View. The reasons given in defence of the Priority View, if sound, would seem to apply with equal force at the global level as well as within the state (Caney 2005, chapter 4). Similarly, to the extent that it is a valid principle at all there is no reason to think that it should apply solely within one

generation. An intertemporal priority view would thus evaluate economic growth in terms of its effects on current and future generations, giving more weight to persons the worse off they are (though it would have to address the complicated issues raised by population ethics (Holtug 2010, chapter 9)).

231 Having noted the claims made on its behalf and its implications, we should note that the Priority View is not without critics. Some, such as Roger Crisp, have argued that whatever appeal it has, it has none when all are above a high sufficiency threshold. In a society where some have very high levels of wealth but others have even more, there seems, he argues, little reason to attribute greater weight to the interests of the first group (Crisp 2006, p.157). Rather, he maintains, it gets its force from cases where people are severely disadvantaged.

#### 232 4.3.2.6 Environmental justice

233 [Note to reviewers: Section to be amended to make application to economic growth more explicit.]

234 The previous sections have discussed the general principles of distributive justice normally applied to the economy as a whole. In this section, a specific focus is given to environmental justice, or injustice, which occurs whenever a vulnerable group of people faces disproportionate environmental risks such as hazardous-waste dumps, has less-than-equal access to environmental goods such as clean air, or has less opportunity to participate in environmental decision-making.

235 Partly because of globalization and the reach of multinational corporations, within every nation of the world children, minorities, poor people, or blue-collar workers bear environmental injustice (EIJ). In some cases, those responsible for EIJ are not corporations but nations themselves, as in the case of climate change. While the developed countries of the world are responsible for the bulk of historical greenhouse gas emissions, developing nations are now enduring far greater climate vulnerabilities. (Claudio, 2007; Schrader-Frechette, 2007; Schlosberg and Collins, 2014)

236 Children represent a minority victimized by EIJ because they are more sensitive to the same doses of virtually all forms of environmental pollution. Blue-collar workers dealing with hazardous chemicals and radiation also are frequent EIJ victims partly because English-speaking countries, following Adam Smith, typically allow workers to receive up to 50 times higher pollution doses than members of the public. The government rationale is that the workers freely took the jobs and receive extra pay for doing them. However,



workers rarely freely consent to hazardous jobs but take them because they have no other options. Moreover, at least for non-skilled, non-college-educated, non-unionized workers, hazardous work typically involves no additional hazard pay. (Schrader-Frechette, 2007)

- 237 Studies consistently show both that socioeconomically deprived groups are more likely than affluent whites to be employed at risky occupations, to live near polluting facilities, to eat contaminated fish, and to be less able to prevent and to remedy such inequities. Social scientists also have found that race is an independent factor, not reducible to socioeconomic status, in predicting the distribution of air pollution, contaminated fish consumption, municipal landfills and incinerators, toxic waste dumps, and lead poisoning in children. Members of communities facing such threats typically are too poor to "vote with their feet" and move elsewhere. E.g., Boer, Kastor and Sadd, 1997; Ringquist, 1997; Maher, 1998; and NAACP, 2016.
- 238 People in developing nations usually face far worse EIJ than in the developed world. For example, chlorinated hydrocarbons pesticides banned in the US were shipped for use abroad, mostly to developing nations. (Newton, 1996) The 1984 Bhopal, India chemical spill killed nearly 4,000 people and permanently disabled another 50,000. The company later settled, with survivors and the disabled, for only several thousand dollars per person.
- 239 Apart from the lax standards that US and multinational corporations employ in their plants in poor areas and developing nations, groups in the industrialized world also often intentionally dump toxic wastes in the third world. Each year companies and local governments offer nations in the Caribbean and in West Africa hundreds of dollars for every 55-gallon barrel of toxic waste that can be dumped legally. Although the United Nations 1989 Basel Convention on Hazardous Wastes requires exporters to obtain written permission from the importing nation, corruption and lack of information often keep the citizens of waste-receiving countries from knowing what their leaders have accepted in exchange for payment. Something similar happens with the hazardous materials in e-waste, much of which is shipped to developing nations where it causes environmental catastrophes in places like Guiyu, China and Agbogbloshie, Ghana. (Schue, 1981; Kuehr, Balde, Wang and Huisman, 2015)
- 240 A chief economist from the World Bank, later President of Harvard, Larry Summers created a massive controversy when he wrote a memo explaining the economic rationale for shipping developed-nation toxic waste to LDCs or less-developed countries: "Shouldn't the World Bank be encouraging MORE migration of the dirty industries to the LDCs?" He argued that their citizens already had a

lower life expectancy, were relatively "under-polluted"; and that impairing the health of the people with the lowest wages made the "greatest economic sense." (Rosen, 1997)

241 Since Summers made his questionable remark, many studies have documented the fact that polluters in developed nations appear to be following his advice. Indeed one way the developed-nation shippers get away with dumping hazardous waste in developing countries is by sending it on end-of-life vessels, destined for breakdown and recycling. (Hull, 2010; Sangeeta, Sonak and Giriyan, 2008)

242 Critics of environmental justice typically respond in one of two ways. Either they try to excuse environmental injustice by saying that, on balance, victims of alleged environmental insults may benefit from living near noxious facilities because of factors such as cheaper housing costs. Or they try to excuse the environmental injustice by saying that minorities likely moved to risky areas because housing was cheaper. (Starkey, 1994; Baker, 1993; Hayward, 2013)

243 Both objections are questionable. The first ignores the fact that those living amid environmental injustice likely have not consented to it, but instead can afford nothing better. This supposed consent is not genuine consent if people have no other options. The objection also forgets that everyone, especially poor and innocent potential victims, have rights to life. The second objection fails because it misses the point. The issue is not whether people, corporations, or governments deliberately discriminate against poor people or minorities in siting decisions and therefore cause them to live in polluted areas. Even if minorities move to an area after it is polluted, the issue is whether some citizens ought to have less-than-equal opportunity to breathe clean air, drink clean water, and be protected from environmental toxins. If they do have less-than-equal opportunity, although no one may have deliberately discriminated against them, the situation needs to be remedied, at least in part because people have rights to life and to equal treatment. Environmental injustice need not be deliberate.

#### 244 4.3.3 Welfare and wealth: theory and practice

245 Section 4.2 pointed out important determinants of economic growth, including the different forms of capital such as physical, human, natural and social capital. Section 4.3.1 and 4.3.2 have reviewed the different normative criteria that can be used to evaluate growth. This section discusses how growth factors can be used to evaluate welfare and human development.

- 246 The factors described in Section 4.2 were chosen for their important role in increasing GDP. When the objective of society is defined in a different way, the relevant factors may differ as well. Their relative importance may change and there may be factors that contribute to welfare, but not to GDP. For example, Llavador et al. (2011) define a utility function that includes three more variables in addition to the usual consumption. In addition to the state of the climate these are education and knowledge, “because an understanding of how the world works and an appreciation of culture are intrinsic to human well-being”.
- 247 Leisure is an additional factor that may also need to be accounted for. Fleurbaey and Gaulier (2009) include it into an international comparison of living standards. This is meaningful, because between two societies with equal GDP, the one enjoying more leisure has higher welfare.
- 248 GDP is not necessarily a good guide to determine the welfare of a society or to guide decisions of its actors. So what could guide the decisions of a society that aims to fulfill one or more of the objectives identified in Section 4.3.1? Fleurbaey (2009) identifies four approaches to measure welfare: monetary aggregates, Gross National Happiness, the capability approach and synthetic indicators.
- 249 For preference satisfaction, the theory of dynamic optimization provides an answer and has led to the development of net national product (NNP) (Weitzman, 1976, 2003). NNP is an example of monetary aggregates. As an important and early welfare measure we will use it to show how consumption and economic growth can be included in a welfare measure without dominating it.
- 250 The calculation of net national product (NNP) requires preferences to be determined in a first step. Utility may, for example, be derived from consumption, leisure and the state of the environment. Second, the optimization problem is set up, including the constraints on the capital dynamics. There will be constraints for both private and natural capital. Third, the shadow prices for the constraints can be obtained from the first order conditions and inserted back into the optimization problem to obtain NNP (see Edenhofer et al. (2014) for a more detailed example).
- 251 The NNP example shows that welfare concepts can be used to derive comprehensive measures of wealth. Deriving a measure of wealth (“social worth of the economy’s capital assets”, Dasgupta, 2004) from a concept of welfare (“value someone attaches to his personal circumstances in a social state”, Dasgupta, 2004) is helpful to obtain a basis for comparison. A detailed discussion on different ways to

measure wealth is provided in Section 4.4.3. The comprehensive measures of wealth make it explicit that the wealth of society consists of far more than private capital and includes all the different kinds of capital identified in Section 4.2, each of which can be used as a basis for political decision making.

- 252 The shadow prices for the different capital stocks are derived from their role in contributing to utility or preference satisfaction. If, for instance, climate change is a concern, then the marginal utility from mitigating greenhouse gas emissions is high. This translates into a high price for the quality of the climate. A society guided by NNP would invest into this highly valuable form of capital. In addition to deriving the relative prices of the different components of welfare, NNP also identifies all components required to enhance welfare as defined by society. If there is a preference for leisure, the amount of leisure enjoyed will end up in the equation for comprehensive wealth.
- 253 NNP is theoretically neat and has inspired some practical approaches to define wealth in a broader way, see Section 4.4.3.1. However, NNP has several shortcomings and two major lines of criticism have emerged: The first is the difficulty of implementing it in practice. The second is that it suffers from some of the same conceptual shortcomings as GDP like ignoring the unequal distribution of wealth in society and not considering the possibility of changing preferences.
- 254 Putting NNP into practice requires determining the value of variables other than consumption. In simple cases the value of capital stocks other than private capital is given by the marginal rate of substitution between consumption and the other variable. How many units of consumption would society be willing to sacrifice for one unit of improvement in the state of nature for example? The marginal rate of substitution is difficult to measure with precision.
- 255 Fleurbaey and Blanchet (2013, Section 3.5) identify two additional difficulties in measuring the prices required for the calculation of NNP. The first is that many individuals cannot freely choose the exact consumption bundles they would prefer, in particular concerning exactly how many hours they would like to work. In this case market prices (like wages) do not reflect the true appreciation for goods (like leisure). The second is that individuals appreciate goods like leisure differently so that there is no unique market price for these goods. In order to replace market prices, which do not reflect the value of a good in society when markets work imperfectly, Fleurbaey and Blanchet (2013) propose the use of the willingness-to-pay, which reflects the true appreciation of individuals for a good.

256 NNP thereby offers an improvement over GDP in two important ways. It identifies variables other than consumption that contribute to the wealth of society and it gives a guideline on their importance relative to GDP. Like GDP, however, it does not address inequality. NNP is concerned only with aggregate values and is blind to the distribution of wealth in society. Monetary aggregates often implicitly assume that the measured aggregate quantities are distributed equally. If this condition is not met, welfare can be improved by improving the allocation without changing the aggregate quantities. Refinements to monetary aggregates such as presented in Jorgenson (1990) can take inequality into account, but even those lead to problematic results when personal abilities and needs are unequal (Fleurbaey, 2009, Section 2.4).

257 On a fundamental level, Fleurbaey and Blanchet (2013) argue that “putting a price on everything is not a promising way of going beyond GDP”. One reason is the “futuraity” problem raised by Samuelson: correct accounting would require knowledge on how the relevant assets matter in the future for well-being. Market prices, which are assumed by theory to reflect such knowledge, can clearly be shown to fail this role in practice.

258 Monetary aggregates can be compared within a country over short time spans or policy alternatives. More general comparisons are conceptually not meaningful (Fleurbaey, 2009, Section 3.3).

#### 259 4.3.4 Evaluation of growth – a summary

260 This section has shown that there is widespread recognition that Gross Domestic Product (GDP) in itself only matters in that it contributes to other goods, such as preference satisfaction (4.3.1.1), happiness (4.3.1.2), capabilities to function (4.3.1.3) and the meaning of life (4.3.1.4). Status consumption (4.3.1.5) has been linked to preference satisfaction, happiness and to an extent also to capabilities to function, and is therefore also a tool to evaluate economic growth. On the counter side, economic growth has also been linked to industrial-technological pollution (4.3.1.6) and harmful impacts to nature and animals, which are argued to have an intrinsic value in themselves (4.3.1.7). One final measure of economic growth concerns its impact on political stability and legitimacy (4.3.1.8).

261 Having reviewed what matters above and beyond GDP, the section discussed the distribution of those goods - if economic growth should be judged in terms of its contribution to maximizing the good (4.3.2.2), ensuring equal amounts of it (4.3.2.3), raising people above a certain threshold (4.3.2.4), or giving priority to the least advantaged (4.3.2.5), each of which has arguments pro and against.

Environmental pollution linked to economic growth has been shown to negatively impact certain more vulnerable groups than others – environmental injustice – which argues for the right of each individual to have equal opportunity to breathe clean air, drink clean water and be protected from environmental toxins (4.3.2.6).

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## 262 4.4. Social and natural wealth

263 The previous section discussed evaluations of economic growth, including benefits and burdens to both people and planet. This section builds on that basis to place economic growth into a broader discussion of wealth, first presenting different components of social wealth (4.4.1) then natural wealth (4.4.2), and finally different ways of measuring wealth (4.4.3).

### 264 4.4.1 Social wealth

265 Traditionally, economists have predominantly focused on the concept of economic output to measure the extent to which socially desirable goods and services can be provided. For this reason, this sub-section examines differences in per-capita incomes across as well as within countries and discusses the relationship between economic growth and poverty reduction. It then proceeds to discuss the social, political and structural economic changes as well the changes in consumption pattern occurring during process of economic growth.

#### 266 4.4.1.1 Regional growth rates over time, convergence/divergence of per-capita incomes and global division of labor

267 For the largest part of human history, per-capita income has been largely stable and close to the subsistence level. According to Maddison (2003), before the year 1820 average global per-capita income only grew by about 0.05% per year and did not exceed US\$ 670. This constellation of 'Malthusian stagnation' changed drastically with the onset of the industrial revolution (Mokyr 1992), first in Great Britain, then followed by other European nations. The industrial revolution led not only to increasing per-capita incomes, but fundamental transitions in the way societies are organized, including changed fertility patterns, increasing investment in education, and rapid urbanization (Galor 2005) (see Section 4.4.1.4). Industrialization also implies structural change in economic activity with increased specialization and division of labor (see Section

4.4.1.6). As a consequence, the emergence of new constituencies and interest groups also results in fundamental changes in the political system, such as an expansion of the franchise (Acemoglu and Robinson 2000) (see Section 4.4.1.5).

268 This increase in economic activity in one part of the world has led to what has been described as “the Great Divergence” (Pomeranz 2000). Countries that successfully embarked on a course of industrialization, i.e. Europe and its offshoots (the US, Canada, Australia, and New Zealand) dominated the global economy, giving them geo-political weight to shape global institutions to their advantage. After the Second World War, Japan was the first Asian country to industrialize. Only recently, coinciding with the acceleration of the ‘second wave of globalization’ (Baldwin and Martin 1999), industrialization has become more widespread in poor countries.

269 Economic integration into global market by means of trade and investment across national borders gives poor countries the opportunity to specialize in activities for which they enjoy a comparative advantage (e.g. labor-intensive activities, such as textiles and assembly of electronic products.). Hence, trade openness has often been a central feature of newly industrializing countries’ development strategies (Rodrik 2005). China’s spectacular growth performance is a salient case in point for such ‘export-led growth’ (Rodrik 2006). Yet, these countries did not simply liberalize trade and foreign direct investment, but also employed an array of specifically tailored industrial policies to overcome market failures, such as financial frictions and coordination failures (Rodrik 2005).

270 Whereas successful growth take-offs have occurred predominantly in Asia (Hausmann, Pritchett, and Rodrik 2005), it has been argued that about one billion people are still mired in extreme poverty, especially in Sub-Saharan Africa. It seems rather unlikely that this ‘bottom billion’ living in resource rich, land-locked, badly governed and conflict-ridden countries will achieve decent living standards in the near future (Collier 2008).

271 As discussed in the following sub-sections, economic growth has by and large reduced global poverty (Section 4.4.1.3). However, with rising within-country inequality in a large number of countries, the gains of economic growth have not been evenly distributed, such that there is no automatic link between growth and poverty alleviation (Section 4.4.1.2). Further, the emergence of a middle-class in developing economies implies shifts in consumption patterns that put additional pressures on natural resources and the environment (Section 4.4.1.7).

#### 272 4.4.1.2 Development of inequality on regional and country levels

273 Is global inequality increasing? The answer depends partly on how one measures inequality. Oxfam may answer yes; the richest have been controlling more and more global income/wealth. World-Bank economists may answer no; mean incomes within different nations have been converging.

274 In 2015, 62 people in the world owned as much as the 3.5 billion people at the bottom. The gap has widened alarmingly; in 2010 the fortunes of 388 global high-earners equaled the wealth of the bottom half. In both developed and developing nations workers have been getting a smaller and smaller share of the economic pie. The result is that the planet is now more economically unequal than at any time in history, more unequal than ancient Rome or any dictatorship (Oxfam, 2016).

275 Within-nation inequality has grown, says Oxfam, because of several factors. These include (1) tax havens such as Switzerland and the Cayman Islands that allow rich people offshore wealth, (3) deregulation, (4) privatization, and (5) financial secrecy---all of which enable the rich to control policy and tax structures and to shape both society and government. Currently individuals hold \$ 7.6 trillion offshore in tax havens, more than the combined GDP of the UK and Germany. (Oxfam, 2016) However, among-nation inequality dwarfs within-nation inequality. An American with the average income of the country's bottom 10 percent is better off than two-thirds of the world's population (Oxfam, 2016).

276 Among-nation or international inequality may have begun because of variations---in climate, environment, and geography, including different amounts of natural resources and available farmland---that contributed to western European agricultural, technological, and immunological advantages. (Diamond, 1997) As a result of these disparities in natural advantages, international gaps in economic development increased. These gaps, in turn, made possible colonialism, slavery, and imperialism, which includes the murder or socioeconomic, political, or military subjugation of millions of people. (Bartolome de las Casas, 1992, Cooper, 2005, Hobsbawm, 2008, Howe, 2002)

277 As a result, the income of the average Angolan or Ethiopian is only 2 percent of that of the average American. Indeed the economy of the state of California is much larger than that of all Africa, and the average American living in poverty has an income three times larger than the average African. An American with the average income of the bottom 10 percent in the country is nevertheless better off than two-thirds of the world's population. Hence within-nation inequality



is dwarfed by among-nation inequality (World Bank, 2005, Branko Milanovic, 2002, Frieden, 2001) although both within and among nations, similar feedbacks among poverty, disease, poor education, unemployment, and crime exacerbate inequality. (e.g. Garchitorena A, Ngonghala CN, Guegan J-F, Texier G, Bellanger M, Bonds M, Roche B. 2015 , Michele Lamont, Stefan Beljean, and Matthew Clair, 2014; Milanovic, 2013).

278 Among-region inequality increased partly because of colonialism, as Western Europe has been mainly a colonizer and not its victim, whereas Latin America and Africa have been predominantly victims and not perpetrators of colonialism. Some regimes likewise tend to have victimized regions rich in natural resources and hence created and exacerbated regional inequalities.

279 On the question of whether trade-openness increases regional and international inequality, the answer depends largely on the regions and nations involved and their specific circumstances. For instance, the answer may be yes for India but no for Brazil, given their respective economic differences. Answering this question requires a case-by-case analysis. (Daumal, 2013)

280 Recently scholars have given compelling ethical, economic, and democratic grounds for justice-based duties to aid the poor. (See Sections 4.3.1 and 4.3.2 as well as Chapter 2 (Social Progress: A Compass))

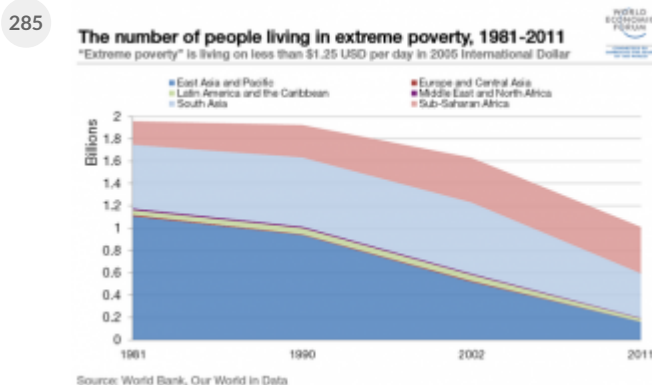
#### 281 **4.4.1.3 Growth and poverty reduction**

282 As discussed in Sections 4.1.2 and 4.4.1.1, recent decades have witnessed unprecedented growth in numerous countries. Yet, as shown in Section 4.4.2.2, the additional national income has in many cases not been evenly distributed. What does this mean for the incomes of the poorest members of society? Has economic growth contributed to lifting people out of poverty?

283 In an update on their seminal study, Dollar et al. (2016) argue that overall, “growth is good for the poor”. That is, even though the relationship between countries’ growth performance and poverty reduction shows quite some variance, on average every percentage point of economic growth increases the income of the two poorest quintiles by about one percent. The finding that economic growth seems to ‘lift all the boats’ is confirmed by more recent developments. Absolute poverty, defined as the number of people with daily income below US\$ 1.25 (measured in year 2005 international US\$)[8], has roughly been halved over the three decades from 1981 to 2011, from about 2 billion to 1 billion people. Most of this decline can be attributed to East Asia and the Pacific, i.e.

the region that displayed the highest rate of economic growth during the respective period (See Figure 4.5). However, it should also be noted that even though poverty rates have fallen considerably in all regions of the developing world (from 11.4% in 1981 to 2.3% in 2011), the progress when measured by the number of people in absolute poverty is less impressive. For example, the number in poverty has increased in Sub-Saharan Africa, and now stands at about 400 million, even though the poverty rate has fallen slightly from 13.0 percent in 1981 to 10.4 percent in 2011. And, despite a considerable drop of its poverty rate, South Asia still displays about the same number of absolute poor today as it did in 1981 and more than does Sub-Saharan Africa.

- 284 The responsiveness of poverty to economic growth differs substantially across regions, with a lower level of initial inequality associated with a higher rate of transformation (Fosu, 2010). In particular, Sub-Saharan Africa (SSA) has generally exhibited less impressive progress on poverty, compared to the rest of the developing world, even during the more recent period of substantial growth resurgence. This is not only due to relatively high levels of inequality, but also to the low levels of income, which tend to reduce the rate at which growth is translated into poverty reduction (Fosu, 2015). Nevertheless, on average, economic growth has been the main force behind the recent progress on poverty in SSA (Fosu, 2015).



- 286 Figure 4.5: Development of absolute poverty (defined as disposable income below 1.25 US\$ per day) over the period 1981-2011. Source: <http://www.weforum.org/agenda/2016/01/poverty-the-past-present-and-future> (<http://www.weforum.org/agenda/2016/01/poverty-the-past-present-and-future>)

- 287 Growth therefore doesn't automatically reduce poverty. The disconnect is due to weak institutions, policy-making, and research capacity and to insufficient public investment.

288 Another major reason, in particular in SSA, is slow agricultural growth and rural development (Diao et al 2012). Most of the poor are to some degree dependent on farming and so fostering agricultural growth is often seen as a strategy to support pro-poor development (Thriddle, Lin, and Peisse 2003). Agricultural growth rates in many African countries are less than a third of the nonagricultural sector's growth rates, and per capita agricultural income increased at less than 1% per year from 2000 to 2015 (World Bank 2016).

Consequently, the rural-urban divide in Africa continues to widen. Diao et al (2012) found that improving agricultural productivity in most African countries is essential to achieving inclusive, pro-poor growth. Staple-food crop and livestock production must be expanded because they have the scale and linkages to poor households needed to reduce national poverty within a reasonable period of time.

289 Poverty alleviation is not exclusively a matter of disposable income, but a matter of development possibilities in a broader sense. This includes access to physical and social infrastructures necessary to satisfy basic human needs (see Section 4.6.1.). Examples include health, education, and social security, as well as expansion of physical infrastructure (Alkire 2002a). This view is further buttressed by the recent finding that poverty is persistent, in that the level of poverty prevailing in an earlier period tends to promote further poverty in the future (Ravallion, 2012).

290 Economic growth can therefore support poverty alleviation and provide the means to physical foundation for human well-being, such as basic infrastructure. Yet, there is no automatic link between economic growth and access to development opportunities. In order to ensure that growth is indeed good for the poor, accompanying policies can support societal transformations during the process of industrialization (Drèze and Sen 2013). Vice versa, even with low rates of economic growth, governments can take measures to address poverty by strengthening social inclusion. For instance, the Indian state of Kerala is often cited as a good example of how good development outcomes can be achieved even with comparatively low per-capita incomes (Kannan 1995).

#### 291 4.4.1.4 Social transitions

292 Urbanization, i.e. the increase in the proportion of households living in cities, is a phenomenon as old as the Neolithic revolution and the transition from hunting-gathering to agriculture. (See Chapter 5: Cities) Through the centuries, cities developed specific functions: administrative centers, trade hubs, religious sites. Each interacted with development in its own way, depending on its function (see Bairoch, 1988), trade hubs being more beneficial than cities devoted to consumption by the elite or by the masses. With the take-off to

modern growth in the nineteenth century, Europe witnessed never seen before urbanization rates. High urbanization levels always accompany high income per person. Urbanization is necessary for growth, but not sufficient to spur growth in itself. Indeed, we do not observe advanced societies without a large proportion of their members living in cities. But we may well observe poor or stagnant societies with high urbanization rates (from the Roman Empire to some developing countries today). Gollin, Jedwab and Vollrath (2015) develop the idea of premature urbanization, which arises in particular in resource-exporting countries, with “consumption cities” having a larger fraction of workers in non-tradable services, high poverty rates, and extensive slums.

293 Urbanization directly contributes to growth by moving people from low efficiency sectors to more productive ones (McMillan and Rodrik, 2011). Part of the growth observed in developed countries today came from this reallocation. Now that this movement is coming to an end, one of the "engine" of growth is no longer operating.

294 Beyond its direct effect on productivity, urbanization is also very much related to the increase in human capital. Indeed, cities are the place where people acquired secondary and tertiary education, and where upper tail human capital was developed, through institutions tightly linked to cities, such as academies, museums, universities, libraries, etc... More generally, cities generate agglomeration externalities, by allowing private resources to generate social benefits (Fujita and Thisse, 2002).

295 Urbanization is also an inevitable component of "modernization", and is related to many other features of development, such as democratization, secularisation, individualisation, rising standard of living and the emancipation of women. This movement has important consequences for demography, and is intrinsically linked to what demographers call the second demographic transition (van Bavel and Kok, 2010).

#### 296 **4.4.1.5 Political change**

297 [Placeholder]

#### 298 **4.4.1.6 Economic change**

299 Based on seminal work by Kuznets (1973) there is a rich literature on economic structural change in the analyses of economic growth. Patterns of sectoral structural change in the form of increasing shares of manufacturing and service sectors in growing economies have remained largely robust over time and across countries (Herrendorf et al. 2014).

- 300 Industrialization processes in particular are recognized to play a key role for development, which is supported by most recent patterns of economic growth: Asian countries' growth in the last decades has largely been built on increasing shares of their manufacturing sectors. While unconditional convergence (as expected by neoclassic growth theory) for countries that have built sufficient manufacturing capacities can be observed, in other regions, such Latin America and Sub-Saharan African countries, a pre-mature deindustrialization is feared to limit future growth opportunities (Rodrik 2015). At the same time, McMillan et al. (2014) identify structural change towards increasing shares of manufacturing sectors to be an important driver of future economic growth in today's poor countries.
- 301 The literature basically distinguishes between two drivers for structural change (for a detailed review, see Herrendorf et al. 2014): non-homothetic preferences and differences in sectoral productivities. High differences in sectoral productivities, however, do not necessarily lead to structural change. A lack of infrastructure, for example, can impede labor to be available in more productive manufacturing sectors (Gollin et al. 2014).
- 302 This raises a more general question how non-tradable inputs and societal capabilities interact with structural change and industrialization processes. Various strands of the literature have identified positive spillovers of industrialization on societal development as they induce technological (Lall 1992) and social capabilities (Fagerberg and Srholec 2016). Some authors have argued that increasing complexity in a more general way holds implications for institutional change and economic performance (Murphy et al. 1989; North 1990). The fact that economies become more diversified with increasing affluence, but specialize again when they get richer (Imbs and Wacziarg 2003) is explained by a changing elasticity of substitution between modern sectors and in the relation between traditional and modern sectors (Zeira and Zoabi 2015). Recent conceptual efforts empirically show the complexity of national exports to be predictive for economic growth (Hidalgo et al. 2007; Hidalgo and Hausmann 2009) and can be used to assess the capabilities that are available in a particular economy (Hausmann and Hidalgo 2011).
- 303 Yet, structural change still needs to be coupled with better wealth redistribution policies and mechanisms as until now, and despite the impressive growth of the global economy in the last decades (since the 1960s, world GDP has increase 57 times (World Bank, 2015b), there are profound asymmetries between developed and developing countries and, in general, between rich and poor. (See Section 4.4.1.2)

#### 304 4.4.1.7 Development and consumption patterns in the process of economic growth

- 305 Modern economic growth has led to entirely new and intense forms of consumption, being the top 600 richest urban settlements at the forefront of such dynamic nowadays. They generated about 60% of world GDP in 2007 (McKinsey Global Institute, 2011) and represented the greatest share of total urban energy consumption which has been estimated at about 76% of global final energy consumption; IPCC, 2014a).
- 306 The rising use of fossil fuels, the emergence of novel technologies, the expansion of infrastructures, and industrialization, constitute the backbone of such consumption trend. Standardization process, mass production, just-in-time production and more recently the outsourcing of production within a context of a globalized market, are particularly to be mentioned, as well as the expansion of urban infrastructure, transportation and logistics, and of technologies such as the automobile, air transportation, petrochemicals, electronic communications, among others.
- 307 Because of the just said, the amount, variety and intensity of goods and services consumption has indeed changed drastically in the course of economic development. Analyses of historical consumption patterns of energy and materials show an increasing use of resources over time. The “metabolic profile”, or the energy and material average consumption patterns in biophysical terms, for hunter-gathers has been estimated in about 10-20 GJ/cap/yr of energy and 0.5-1 ton/cap/yr of materials; for agrarian societies within 40-70 GJ/cap/yr and 3-6 ton/cap/yr; and for the industrial society between 150 to 400 GJ/cap/yr and 15 to 25 ton/cap/yr (Haberl et al, 2009).
- 308 The metabolic intensity of industrial societies, mainly, since the second half of the XX century, has resulted in a growing transgression of planetary boundaries, taking us further apart from the Holocene-like conditions which support human life, as well as other forms of life (Steffen et al, 2015). Data show that during that period, material and energy use increased 5.6 times faster than population (Schaffartzik et al, 2014). Yet, per capita consumption patterns were asymmetrical as they are associated to purchasing power and therefore to income levels. Hence, by the year 2000, 10% of world population consumed about 40% of energy and 27% of materials (Steinberg, Krausmann and Eisenmenger, 2010).
- 309 Energy and material consumption patterns have been coupled with economic growth during the last century (Csereklyei and Stern, 2015); while the human population increased fourfold and the economy grew about twenty times, material and energy use

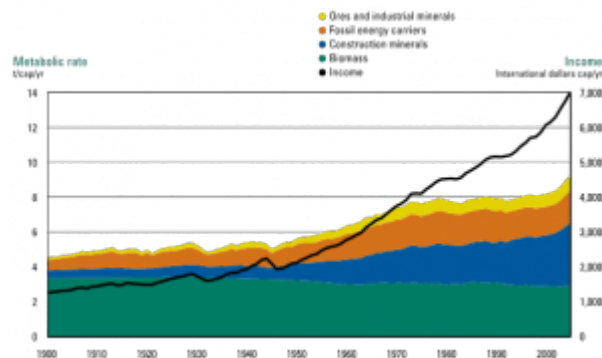
increased an average of tenfold: biomass consumption increased 3.5 times, energy consumption 12 times, ores and industrial minerals 19 times and construction minerals up to 34 times (case of cement) (Krausman et al, 2009; UNEP, 2011a). (See Figure 4.6).

310 Figure 4.6

311

Source: UNEP, 2011a.

312



: Global metabolic rates 1900 – 2005 and income

313 For the reasons mentioned above, decoupling growth from material and energy consumption has been identified as an environmental and climate imperative (IPCC, 2014b; UNEP, 2011a), even more when noticing that a business as usual scenario may lead to an extraction of about 140 billion tons annually by 2050 or almost three times the amount of the year 2000 (UNEP, 2011a).

314 Decoupling opportunities are already being explored through, for example, more efficient production technologies and practices, renewable energies, urban sustainable planning and development, behavioral adjustments, or the reuse and recycling of materials (two key actions to additionally confront material supply risk and reserves depletion).

315 Yet, even when some fruitful outcomes have been attained from such decoupling efforts in relative terms (UNEP, 2011b; Yadong et al, 2013; Schandl et al, 2015; Kalmykova, Rosado and Patrício, 2015), absolute efficiency, or material and energy efficiency at the level of the whole global economy, is still to be probed; specially as emerging and growing economies might more than compensate any material saturation point reached in mature economies (Graedel et al, 2015).

## 316 4.4.2 Natural wealth

### 317 4.4.2.1 Growth and resource use: a safe operating space?

318 The Industrial Revolution stimulated unprecedented economic growth. (See Section 4.1.2) Since that time, human activities have become the main driver for earth system changes, pushing the system beyond a stable natural state and introducing substantial environmental problems such as air and water pollution (Section 4.4.2.3 and 4.3.1.6), climate change (Section 4.4.2.2), soil pollution by heavy metals, a hole in the ozone layer, wetland retreat, and loss of biodiversity (Section 4.4.2.5) (Crutzen, 2002; Steffen et al., 2007; Hudson, 1992 and Rockström, 2009a). There are also many examples of inter-connections among impacts. For instance, adverse impacts on biodiversity can impact earnings at various levels from household incomes to national budgets, lead to loss of agricultural productivity through multiple channels such as reduced soil fertility and insect pollinators, and have implications for food security across scales, ranging from small farmers to international markets (Dasgupta, Morton et al 2014).

319 Although development has caused inevitable problems, as one of the basic human rights it remains an important goal and challenge, especially for developing countries. (African Charter on Human and Peoples' Rights, 1981). Nonetheless, the damage to environment and resources threaten both current and future generations. Therefore, there is an inevitable conflict between short-term and long-term development as well as local development and global development. In response, in 1992 the UN Conference on Environment and Development published the Earth Charter, which outlines a sustainable society in the 21st century and emphasizes the necessity to shift to cross-sectoral coordination.

320 Rockström et al., (2009a, b) proposed a framework to quantify the planetary boundary within which we can safely operate. This framework identifies nine biogeochemical classes: climate change (Section 4.4.2.2), ocean acidification, stratospheric ozone depletion, nitrogen (N) cycle, phosphorus (P) cycle, global freshwater use (Section 4.4.2.3), land system change, biodiversity loss (Section 4.4.2.5), atmospheric aerosol loading and chemical pollution. The baseline of all the calculations is the beginning of Industrial Revolution. Among these classes, three have transgressed their limit: climate change, nitrogen cycle and biodiversity loss. Global P and N cycles, atmospheric aerosol loading, freshwater use and land use change are close to their limits. It is worthwhile to note that if one boundary is transgressed, other boundaries are under serious risk. For example, land use in the Amazon could change water resources on Tibetan Plateau (Cynder et al., 2004). Change of the nitrogen-phosphorus boundary can influence ecosystems, absorb of CO<sub>2</sub> and therefore impact the climate boundary (Rockström 2009). Climate



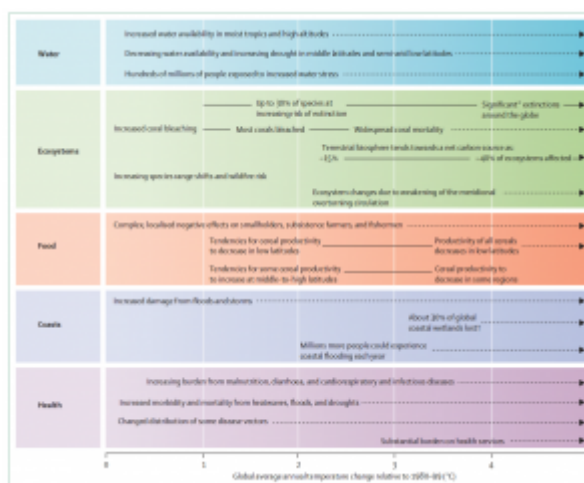
change will influence the local monsoon climatic system, subsequently altering local energy and precipitation patterns, and eventually freshwater accessibility and ecosystems services.

321 This framework of planetary boundary gives us a clear and grand  
blue print of where human beings' position is in different dimensions  
of natural boundaries. This can also guide us to take measurements  
to maintain and support sustainable development. Within these nine  
planetary boundaries, humanity can continue to develop and thrive  
for generations to come -- while crossing them could generate abrupt  
or irreversible environmental changes.

#### 322 4.4.2.2 Climate change

323 Climate change poses risks to economic growth as it is likely to have  
far reaching consequences across sectors, impacting human well-  
being in multiple ways. (See Figure 4.7) The currently observed  
impacts, the projected risks for the future, and the challenges and  
opportunities for adaptation and mitigation under alternative  
scenarios have been documented in the recently published IPCC  
reports (IPCC 2014: Summary for Policy Makers WG II and WG III,  
Synthesis Report). Impacts occur across components of natural  
wealth including biodiversity, water, and land, with adverse  
consequences for ecosystem services, whether regulatory,  
provisioning or cultural. Social and economic consequences arise for  
food security, human conflict, and loss of economic assets (MEA  
2003, MEA 2005, Atkinson et al 2012) Expert judgments are  
required about the elasticity of substitution between natural wealth  
and other modes of wealth for long-run sustainability and innovative  
methods for economic valuation of the ecosystem assets and  
services that would get adversely impacted due to climate change  
(Atkinson et al 2012)

324 Figure 4.7



: Effects of climate change on health and natural wealth. Source: Watts et al., 2015.

325 For resource constrained, low and middle income economies, where multiple co-stressors such as poverty, malnutrition, lack of basic amenities and health care services exist, accounting for climate change implies new demands on resources and prioritization within a development agenda, to ensure that the gains from sustainable development are not eroded in the near or longer term due to climate change impacts. Conventional ways of understanding the relationship between economic systems and ecosystems are no longer adequate and create challenges for the long-run sustainability of the process of economic growth. It reinforces the idea that economic systems and ecosystems are both complex adaptive systems, and the need for economic policy interventions that can lead to increased resilience and robustness (Arrow et al 2014, Chopra and Dasgupta 2016).

326 Human health is impacted adversely by climate related occurrences, and many of these impacts are seen to be distributed unequally, often disproportionately affecting the poorest and those facing current deficits in water, sanitation and basic health care services (Watts N, et.al 2015, Dasgupta 2016, Smith, et al 2014). Several studies and initiatives have established the association between different climate drivers and prevalence of selected diseases, the key risks due to exposure and vulnerability, and more recently, the challenges and opportunities for reducing these risks through appropriate actions for adaptation, mitigation and health sector responses to ensure that health gains are not eroded and, subsequent social and economic impacts are avoided (Dasgupta, Ebi et al 2016, Haines et al 2006, Dasgupta 2016) .

327 Climate change impacts health in direct and indirect ways: direct ones on morbidity and mortality include the impacts from floods, droughts, extreme heat, and cyclones while indirect impacts can occur from disruptions and changes in ecological processes impacting spread of disease vectors, food production and under nutrition, and displacement of populations, disruptions in provisioning of health care services and damages to health infrastructure among others. There is sufficient evidence that the impacts of climate change are likely to be severe and require adequate responses to avoid economic and social consequences. (Table 4.2)

328 Table 4.2 Economic analysis of health impacts of climate change in Europe. Source: Hutton and Menne 2014.

DISASTERS	COVERAGE	YEAR	ECONOMIC MODEL <sup>a</sup>	ANNUAL COST OR SAVINGS	REFERENCE
<b>Health impact cost studies (attributed to climate change)</b>					
Cards-respiratory	EU	2050	CGE	€38 billion savings	Bonville et al. <sup>13</sup>
	FDU <sup>b</sup>			€4 billion savings	
Heat-related, Salmonellosis, Flooding	EU	2080	Bottom-up	€86–167 billion cost	Kovats et al. <sup>14</sup>
Heat-related, Salmonellosis, Flooding	EU	2080	Bottom-up	€50–118 billion	Wolke et al. <sup>4</sup>
Salmonellosis		2011–40		€70–140 million	
Heat-related	Skagge, FYRM <sup>c</sup>	2005–10	Bottom-up	€1 million	WHO-Regional Office for Europe <sup>15</sup>
Heat-related	Rome, Italy	2020	Bottom-up	€281 million	Albertini et al. <sup>14</sup>
Heat-related	Germany	2011–2100	Bottom-up	€360–€750 million (hospital admissions) €2.5–€10.3 billion (productivity)	Hübner et al. <sup>11</sup>
Cards-respiratory	EU	2080	Bottom-up	€129 billion	Holland et al. <sup>16</sup>
Pollution <sup>d</sup>	OECD Europe, Eastern Europe	2100	CGE	8.92% of GDP	Nordhaus and Boyer <sup>17</sup>
<b>Adaptation cost studies (attributed to climate change)</b>					
All health-related adaptations	Europe and Central Asia	2010–2050	Bottom-up	€1.18 (CSFRC) – €4.32 billion (NCAR) <sup>e</sup>	World Bank <sup>18</sup>
Diarrhoeal cases	WHO European Region	2030	Bottom-up	€140 million <sup>f</sup>	Etz <sup>19</sup>
Disease treatment	Western Europe	2050	Bottom-up	€0.68 billion savings	Agnoletti et al. <sup>20</sup>
	Eastern Europe			€0.06 billion savings	

#### 330 4.4.2.3 Water

331 Water is used for producing food, domestic consumption, producing energy (hydropower), manufacturing, transportation (e.g. ships in rivers and lakes) and much more. Freshwater ecosystems also provide other crucial goods and services such as habitats for aquaculture, mitigation of floods, buffering wastes (e.g. wetland), and maintenance of biodiversity. Water ecosystems provide vital services of enormous global value, on the order of several trillion US dollars, according to some estimates (Postel and Carpenter 1997, p.210). There is enormous temporal and spatial variation as well as variations in quality that completely govern its value to people and ecosystems. Water may be both disastrous (during flooding) and lifesaving (during droughts) – both conditions may occur in the same year in the same location (Rijsberman 2006).

332 Population growth, urbanization, rapid economic development and climate change have put increasing stress on our planet's water resources. Economic development and urbanization greatly increase water consumption. As shown in the previous section, climate change has not only affected rainfall quantity but also the rainfall distribution for many regions in the world. Such changes have profound impact on local water resources. Both water scarcity and declining water quality are global concerns. Many regions of the world face severe water scarcity problems, making water shortage one of the world's most pressing challenges. It links issues as diverse as food security, poverty, public health, conflict, energy production and ecosystem management (WWAP, 2015). 2.4 billion people worldwide, more than one third of humanity, don't have access to safe, affordable sanitation. An estimated 645,000 children younger than 5 years of age perish every year from -a preventable, sanitation-related disease (WHO, 2016). The poor are most affected by lack of access to water for productive purposes (e.g. irrigation), resulting in a vicious cycle of malnutrition, poverty and ill health. To complicate the issue, global water demand is expected to increase by 55% by 2050. Though agriculture is anticipated to remain the largest user of water (currently around 70%), water demand for manufacturing is expected to increase by 400%, for electricity by 140% and for domestic use by 130% (OECD, 2012; UN-Water, 2015).

333 Water quality has been impacted by human activities, which impact Biochemical Oxygen Demand (BOD), as well as Nitrogen (N) and Phosphorus (P) levels. Globally, 1 in 8 people are at high risk of water pollution from organic compounds, affecting BOD; 1 in 6 people are at high risk of N pollution and 1 in 4 people are at high risk of P pollution. Most of these people live in developing countries in Asia (Veolia and IFPRI, 2014).

334 The frequency and intensity of local water crises have been increasing, which have had severe impacts on food security, economic development and environmental sustainability. Solutions to these potential crises are available, including enhancing the resilience of the water system for irrigation, domestic, and industrial purposes through highly selective and efficient investments in infrastructure and in water governance. Even more important are water conservation and water use efficiency improvements in existing irrigation and water supply systems through water management reform, policy changes, and investment in advanced technology. The investments, policy reforms, and the water institutions must be tailored to local conditions, both ecologically and socio-economically (Rosegrant, Cai and Cline, 2005). There is enough water available to meet the world's growing needs, but not without dramatically changing the way water is used, managed and shared. The global water crisis is one of governance, much more than of resource availability. To allow water resources to enable rather than limit economic growth and sustainable development, this is where the bulk of the action is required. (WWAP, 2015).

#### 335 4.4.2.4 Food security

336 [Note to reviewers: Section to be amended to make application to economic growth more explicit.]

337 Food security has been theorized, analyzed and measured in different ways. It is a contested, evolving and multidimensional construct (Foran et al, 2014). Its early conceptualization relates to the "right to food". Within the context of the Green Revolution, the idea evolved to "food self-sufficiency" (Chaifetz and Jagger, 2014), meaning the improvement of infrastructure, innovation and institutional governance. A Malthusian approach was installed when warning about the imbalance between population growth and food availability. Consequently, since the 1970s agricultural productivity has been a priority for the international community - a 70% expansion of global crop area is projected to be needed to feed the global population in 2050 (Kastner et al, 2012).

- 338 A much broader understanding of food security was adopted by the World Food Summit in Rome in 1996, which included in addition to availability, access to affordability and utilization of food. The “stability” dimension was later added to the definition, given the recognition of resource scarcity (such as for phosphorus; Cordell and Neset, 2014) and the exacerbation of the environmental and climate change crises. The implications of which include crop productivity reduction, food safety, incidence and prevalence of foodborne diseases, rising food costs, and the potential unrest for land and resources (Ericksen, Ingram and Liverman, 2009; Tirado et al, 2010; Lobell and Burke, 2010; Rockström et al, 2011; Lin, 2001; Allouche, 2011; Brooks and Loevinsohn, 2011; McCann, 2011; Smith et al, 2014).
- 339 The Summit committed “...to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015” (FAO, 1996). The means to achieve it would be a more productive and efficient domestic production and imports (assisted by a major liberalization of trade).
- 340 Established in the year 2000, the First Millennium Development Goal has not yet been achieved as 10.9% of world population or 795 million people are undernourished; 98% of living in the developing world, mostly in the rural Africa (29.2%) and Asia (64.3%) (FAO, IFAD and WFP, 2015). In addition, about 26% of world’s children are stunted (low height for age), 2 billion people has micronutrient deficiencies and 1.4 billion are overweight, of whom 500 million are obese (FAO, IFAD and WFP, 2013).
- 341 Progress has been however attained. Globally, the percent of undernourished has gone from 18.6% in 1990-92 to 10.9% in 2014-16 – equivalent to an absolute decline of about 216 million during a time when the population increased by 1.9 billion (FAO, IFAD and WFP, 2015).
- 342 Hunger it is not related merely to the agricultural/food sector. It includes nutritional and health aspects (human right to adequate and healthy food), which in turn can be associated to income and other socioeconomic and political aspects, including personal endowments, individual agency, migration and gender issues (Carney, 2014; Babu, Gajanan and Sanyal, 2014; Burchi and De Muro, 2015). This has been described as Amartya Sen’s entitlement approach (Burchi and De Muro, 2015). Entitlement failure, as stated by Drèze and Sen (1989: 24) points to possible remedies and helps to understand the forces that generate hunger and sustain it. This integral approach advocates for a complex and inter- and transdisciplinary analysis not just of food systems (Foran et al, 2014) and R&D (Sumberg and Thompson,

2012), but also of human flourishing within limits (, 2009), and thus the need of economic change by placing a clear differentiation between means and ends of development (see section 4.4.1.6).

343 Food insecurity under existing socioeconomic and environmental conditions could be reduced through a portfolio of policies and interventions, from improving transport, storage and communications infrastructure, to market incentives, trade regulation, social protection programs, resource efficiency, resilience increasing and coping strategies strengthening. Urban and peri-urban agriculture may be an additional strategy for food security and climate change mitigation, particularly in low-income countries (Barthel and Isendahl, 2013; Magnusson and Bergman, 2014; Poulsen et al, 2015).

#### 344 **4.4.2.5 Biodiversity**

345 Species extinction is a natural process, and would occur without human actions. However, biodiversity loss has accelerated massively (Mace et al., 2005). The fossil record shows that the background extinction rate for marine life is 0.1-1 extinctions per million species per year (Pimm et al., 1995; Mace et al., 2005). The rate of extinction of species now is estimated to be 100 to 1,000 times more than what could be considered natural (Mace et al., 2005).

346 [Note to reviewers: Section to be expanded to make application to economic growth more explicit.]

#### 347 **4.4.2.6 Depletion of exhaustible resources and resource curse**

348 Empirical evidence has established a so-called curse from natural resources. (Sachs and Warner, 2001; Frankel, 2010). The ‘curse’ refers to an observation that countries endowed with richer natural resources systematically grow slower than resource-poor countries. Isham et al. (2005) provide empirical evidence that many oil, mineral, and plantation crop-based economies experienced a substantial deceleration in growth following the boom and bust of the 1970s and 1980s. The literature has examined the validity of the claim, exploring alternative ways of measuring resource abundance, and considering the potential for omitted variables in cross-country studies that may be correlated with natural resource endowments. However, study after study, as surveyed by Frankel (2010), the curse survives any empirical tests, and there is little to no evidence that omitted variables, such as geographical or climatic variables, can explain the curse alone. Others have argued that resource abundant countries may have miss-out on export led growth, since they are high-price economies. Frankel (2010) speculates about possible links that lead to the curse, and examined the effects of resource

endowments on long-term trends in world commodity prices, volatility, crowding out of manufacturing, civil war, poor institutions, and the dutch disease. Isham (2005) further attributes the curse to the fact that in resource rich countries economic activity is developed along a narrow geographic and economic base, and is predisposed to social divisions and weak institutions. As a consequence, these countries don't have the ability to respond to shocks. Bilion (2001) examined theories of relationships between resources and armed conflicts, and puts forwards a clear argument where, in the presence of rich natural resource endowments, capital is misallocated towards the production of criminal-style activities.

349 While the literature that discusses potential channels that lead to a curse is fairly developed and robust, there is limited evidence on policies that could prevent the curse. Frankel (2010) speculates about some of these, and considers the indexation of oil contracts, hedging of export proceed, denomination of debt in terms of oil, chile-style fiscal rules, a monetary target that emphasizes product prices, transparent commodity funds, and lump-sum distribution.

#### 350 4.4.2.7 Sustainable development

351 The concept of sustainable development came into prominence with the publication of the Brundtland report (see section 4.3.2.4). The concept, definition and indicators of sustainable development have evolved over time, with the United Nations playing a central role in the process. Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED 1987), and assumes the conservation of natural assets for future growth and development.

352 The Millenium Development Goals (MDGs) became widely interpreted as sustainability indicators (UN 2006 and UN 2012). Several other indicators have also emerged, ranging from measures of green GDP (See section 4.4.3.1 for discussion on green accounting) to measuring footprints such as those of carbon or water. An early attempt at getting at a better measure of sustainability than conventional GDP, was the Measure of Economic Welfare (MEW) (see Section 4.1.1; Nordhaus and Tobin 1972) which took note of the damages to the environment. Beginning in the eighties, there were a number of parallel developments including the extension of the system of national accounts (SNA) to incorporate the use, augmentation and depletion of natural resources through building satellite accounts (SEEA), and the extension of the concept of capital to include natural capital.

- 353 The Sustainable Development Goals (SDGs), recently adopted by the UN, call for action to tackle climate change and its impacts, but also for the conservation of and sustainable use of natural resources. Such goals relate to the availability and management of water and sanitation, access to affordable and modern energy for all, ensuring a quality education, achieving gender equality, and ending poverty and hunger, while achieving food security and improved nutrition. (UN, 2016).
- 354 The phrase 'sustainable development' has thus evolved in a way that articulates and embodies international processes. However, implementational challenges exist in terms of meeting the specific needs of regions and sub-groups of populations. The problem of *social and economic inequality* for instance is not a concern in this approach for economic growth or development (See section 4.3.2.3). Issues of access to basic rights and resources gets marginalized in the discussion, and the role of society and socio-environmental rights is operationalized in the narrow sense of ensuring sufficiency in terms of a pre-determined set of indicators of threshold level of quality of life.
- 355 The inherent problems with the structure of the economic system do not get addressed in this functional view of sustainability. The *lack of structural transformation* implies that the rationale of capital as the basis for economic growth remains valid with all its attendant problems (see section 4.1.4), and can lead to situations that promote social inequality.
- 356 Much would also depend on the *political will* of leaders and policy-makers, who would not normally be expected to integrate long term concerns for sustainability of human development, given that under capitalism the role of political influence can be disruptive for redistribution and long term development (See section 4.1.4). Political voice is part of well-being and is integral to understanding social progress and sustainability (See section 4.4.3.2) as is the role of global governance and international agreements. Appropriate tax and incentive structures can influence outcomes positively in this respect (See Section 4.1.4).
- 357 Thus, some strong socio-economic tensions exist that could slow implementation of sustainable development in its true spirit of enhancing welfare and social progress. Critics of a sustainable development approach (e.g. by ecological economists and development experts. Joan Martínez Alier) ask *why we grow so much if we are destroying everything* and how *green growth and sustainable development are a contradiction; there can be no economic growth that is green. It is falsely green. The current economy is based on more oil, more coal, more palm, more copper ...* (Alier 2015). Amartya Sen proposes a



more complex and multidimensional perspective (see sections 4.3.1.3, 4.4.3.2) that would lead to a development that guarantees freedom, and focuses on human rights (Sen 2000). Thus, an integrative approach calls for more complexity in operationalization of the concept of sustainable development, which recognizes the multiple linkages between growth, development and social welfare as emphasized through the different sections of this chapter. An alternative view on sustainability is the recognition that both socioeconomic systems and ecosystems are complex adaptive systems, and have linkages that assume significance in terms of increased resilience and robustness (Arrow et al 2014).

#### 358 **4.4.3 Measuring wealth**

359 This section gives an overview of different methods for measuring wealth. Section 4.4.3.1 begins with aggregate measures such as GDP and GDP-based indicators, including a description of their shortcomings, in particular as indicators for welfare. Various approaches to measure welfare by including non-marketed assets into the calculation of a GDP-like indicator, such as NNP and genuine savings are then summarized. The advantages of a whole dashboard of indicators for well-being are discussed in Section 4.4.3.2. Section 4.4.3.3 shows how public policy decisions can be drawn from such a dashboard of economic and well-being indicators by using the welfare diagnostics approach.

##### 360 **4.4.3.1 Aggregate indicators**

361 The history of the gross domestic product (GDP) goes back to Kuznets (1934), who proposed a predecessor of GDP as a measure of national productivity in order to better understand the workings of the Great depression.<sup>[9]</sup> (See Section 4.1.2) The general definition of GDP is the sum of private consumption, investment, government spending and exports less imports (Auerbach and Kotlikoff, 1998). It can be calculated in three ways, which, in theory, should yield the same outcome: First, the expenditures approach is simply the sum of all expenditures on goods and services by final users measured in consumer prices (not counting purchases of intermediate goods and services which serve as inputs in later stages of production). Second, the factor incomes approach adds up the income firms pay for all factors used in production. Finally, the value added approach calculates the value of all sales minus the payments made for intermediate inputs (Auerbach and Kotlikoff, 1998; Pritzker et al. 2015).

362 There are several measures of national productivity that are closely related to GDP. First, the gross national product (GNP) counts production by all citizens of a country, at home and abroad, while

GDP counts all production occurring within a country. Second, gross domestic income (GDI) is basically GDP measured by the income method. Third, GNI is GDI plus income received from outside the country, minus income payments leaving the country. Fourth, the previous measures are all gross indicators which means that they do not account for depreciation. Both, the net domestic product (NDP), and the national income (NI) factor in depreciation. The NI metric additionally subtracts indirect taxes such as sales taxes. Finally, some authors argue that gross output (GO), i.e. the sum of all sales both final and intermediate, is a “natural measure for the production sector” that is complementary to GDP (Jorgenson et al., 2006).

363

In spite of its wide acceptance, measuring economic activity through GDP has several drawbacks. Since GDP is an indicator of economic activities which lead to monetary transactions it cannot act as an accurate measure of welfare (Fleurbaey, 2009; Stiglitz et al., 2009). [10] The reasons for this can be structured into three groups (Afsa et al., 2008; Fleurbaey, 2009): First, being an aggregate monetary measure, GDP neglects distributional issues as well as determinants of well-being which have no direct or indirect market value such as health, longevity, social relations and personal safety. Second, it is a measure of productive flows and hence by design does not account for the impact of economic activities on stocks, in particular on stocks of natural capital. Third, it does not include household production of services. In some cases, events generally considered detrimental to well-being can lead to an increase in GDP. For instance, an increase in traffic jams may lead to higher gasoline consumption which increases GDP, but reduces well-being and has adverse effects on the environment (Stiglitz et al., 2009).

364

Several improved welfare measures have been developed over the last decades. Roughly, they can be classified as monetary and non-monetary measures. The monetary measures can be seen as a generalization of GDP, which take national income as a starting point and then correct it for factors such as non-market aspects of well-being and sustainability. Non-monetary approaches aim at including more subjective factors such as happiness (see Section 4.3.1 for a definition of non-monetary measures). Non-monetary measures may capture determinants of well-being which are difficult to conceive with a monetary approach. However, one of their major shortcomings is the arbitrary weighting of different determinants of well-being. Due to this subjectivity they are not able to provide a comprehensive measure of well-being, but they can be valuable components of synthetic indicators. In the following we thus focus on monetary measures.

- 365 Green accounting is a form of accounting that extends national income measures to include different concepts of sustainability, with a focus on the environment (Smulders, 2008). It develops a broader welfare base and allows welfare to depend on factors such as health, pollution levels or environmental quality. Altruistic preferences that account for inter- (and to a lesser extent intra-) generational inequality are also allowed. Several monetary measures for green accounting have been developed such as the (green) net national product (NNP), genuine savings (GS) and the index of sustainable economic welfare (ISEW).
- 366 The net national product has been developed by Weitzman (1976) using the theory of dynamic optimization to maximize a given objective function. It hence takes the intertemporal component into account and factors in depreciation of physical capital and depletion of natural capital stocks. Non-marketed goods such as health and the environment are assigned values by using their shadow prices. These shadow prices can be interpreted as the opportunity cost in foregone consumption of investing in a non-marketed good. Section 3.3 describes in further detail how it is calculated.
- 367 The theoretical result that, if there are no externalities, or if all externalities are internalized by appropriate policy instruments, NNP is proportional to social welfare is sometimes called the Weitzman principle (Weitzman 1976, 2003).[\[11\]](#) Some sustainability concepts are related to this principle, such as the Hartwick (1977) rule that states that investing all profits and rents from exhaustible resource extraction into physical capital allows a society to maintain a constant level of utility. This is equivalent to green net investment being zero (Smulders, 2008). In reality, however, several externalities are likely to be uninternalized and factors such as exogenous technological change and changing global prices invalidate the finding that zero green net investment implies sustainability (Asheim et al., 2007).
- 368 In order to find an improved measure of sustainability, several investment measures have been proposed which separate consumption from net investment and which correct prices whenever necessary and feasible. In these frameworks different methods are used to impute prices on non-marketed goods and services. Genuine savings (GS) is among the most common such measures and its development goes back to Hamilton (1994) and Pearce et al. (1996). Hamilton and Clemens (1999) demonstrate that GS are negative in many developing countries, in particular in sub-Saharan Africa, while they tend to be positive in high-income industrial countries.

369 GS as a measure of sustainability has been extended as well as criticized on several aspects: Considering extensions, Arrow et al. (2003) analyze the role of varying population in measuring genuine savings and find that including population as a type of capital is the only consistent approach. Pillarisetti (2005) argues that GS is flawed as a measure of sustainability and can lead to erroneous policy implications for several reasons: (1) GS is GDP-based and industrialized countries appear to have positive GS, even though they have a substantial ecological footprint, (2) many externalities manifest themselves on a global scale and national indicators are hence futile, (3) it is empirically redundant since education expenses have a strong influence on the numerical value of GS, (4) it is based on the concept of weak sustainability, which assumes a perfect substitutability between different types of capital such as health, physical and natural capital.

#### 370 4.4.3.2 A disaggregate dashboard of welfare indicators

371 In 2008, Joseph E. Stiglitz, Amartya Sen and Jean-Paul Fitoussi created a commission, the “Commission on the Measurement of Economic Performance and Social Progress” (CMEPSP), to assess how to improve statistical information about the status of the economy and the society.

372 The commission’s report comes to several important conclusions, which can be summarized as follows (Stiglitz et al. 2009): First, the perspective should shift from production-based indicators to indicators of well-being. Second, well-being is multidimensional (and in large parts subjective), it includes material living standards, health, education, personal activities including work, political voice and governance, social aspects, environment (present and future conditions) and insecurity (economic and physical). Third, measuring sustainability involves the future and hence always requires taking normative assumptions. Sustainability is complementary to well-being and thus should be examined separately. In order to measure sustainability several indicators are needed that measure changes in the quality and quantity of stocks that matter for future well-being such as natural, human and physical capital.

373 Regarding the third point, the measurement of sustainability, (Stiglitz et al. 2009) discuss the advantages and the shortcomings of using a set of indicators, instead of aggregating the indicators into one number. Both, monetary and non-monetary measures would be necessary for deriving sound policy advice from such a dashboard of indicators. Such a set of indicators can be interpreted as analogous to a car’s dashboard: If all the indicators in the dashboard of a car such

as gasoline level, speed and revolutions per minute would be aggregated into one single indicator, this indicator would not be very helpful.

#### 374 4.4.3.3 Welfare diagnostics

375 The CMEPSP made great process in providing tools for the measurement of social progress, it did not, however, develop recommendations on how to draw public policy decisions from such a set of indicators.

376 As discussed in the previous sections, there is a broad spectrum of possible perspectives on how one can define well-being. Should public policy aim to make people happy, or should it aim to allow them to satisfy their preferences? How should non-human beings and the natural environment be reflected in normative decisions? And how should the things society values be distributed? A consensus on these questions can never be achieved by all members of society. For this reason, a flexible approach that encompasses the concept of social welfare from the perspective of multiple policy objectives is required as a basis for policy-making.

377 Following Sen's (2009) analysis of how to reconcile different theories of justice, Jakob and Edenhofer (2014) argue that even though public policy cannot optimize social welfare, it can nevertheless aim at removing the most serious obstacles to human well-being. This so-called 'welfare diagnostics' aims to identify factors that are essential for human well-being—i.e. basic needs—and correcting deficiencies. From this perspective, welfare diagnostics is closely related to the provision of 'primary goods' in the sense of Rawls (1971), namely 'things that every rational man is presumed to want' (p. 62). As it crucially depends on public deliberation with regard to which factors matter for social welfare, how basic needs are to be defined, and how trade-offs between them should be assessed, welfare diagnostics is also closely related to the capabilities approach discussed in Section 3.1.d

378 Welfare diagnostics as envisioned by Jakob and Edenhofer (2014) identifies determinants of well-being which are considered essential (basic goods such as access to clean water and hygiene). It then aims at increasing the supply of these basic goods. Large groups of individuals with potentially different views about social welfare could agree to such policies. The main argument put forward in their study is that, similar to the growth-related argument by Hausman et al. (2005), not all factors of well-being have to be at their optimal levels to enhance welfare. Therefore, a more pragmatic approach which aims at correcting major deficiencies already leads to large increases in welfare.

379 Jakob and Edenhofer (2014) relate their proposal of welfare diagnostics to a recent debate on growth vs. degrowth. They argue that the debate should shift away from a growth-centered towards a welfare-centered perspective. The authors propose a pragmatic approach that establishes minimum thresholds (so-called ‘guardrails’) for capital stocks essential to welfare. The UN’s sustainable development goals (SDGs) can be seen as such a guardrails approach. It includes goals such as ending poverty and hunger, as well as improving health and combating climate change (for more details see UN, 2015). The central task for public policy is then to ensure the attainment of these minimum thresholds for sustainable development. It might be more demanding to agree on how to allocate available resources once these minimum thresholds are satisfied. However, public policy could then still play an important role by outlining feasible options and the trade-offs between different objectives. Jakob and Edenhofer (2015) conclude that “economic growth cannot be a societal goal in itself, but can only be useful if it helps to achieve other objectives.”

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## 380 4.5. Governing the commons

381 [Note to reviewers: Section to be amended to reduce overlap with 4.3.2.1.]

### 382 4.5.1 Tragedy of the commons and the neo-classical solutions: Pigouvian taxes or Coasian property Rights

383 “Commons” is a non-technical term for a variety of non-private goods shared by a group of different size and vulnerable to enclosure, overuse, under-provision or other social dilemmas. Given the classical economic classification of goods according to ‘rivalry’ and ‘excludability’ (Table 4.1) commons-problems usually relate to rival and non-excludable resource systems, that is, common-pool resources (CPRs). Some commons problems also relate to underprovided and impure public goods, such as so called knowledge commons like science, education or the internet.

384 **Table 4.1:** Classification of Goods according to ‘rivalry’ and ‘excludability’

385	Excludable	Hard to Exclude
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<b>Rival</b>	Private Goods	Common-Pool Resources
<b>Non-Rival</b>	Club Goods	Public Goods

- 386 Most classical literature on the commons examines natural CPR systems like fishing grounds, fresh water basins, or pasture land. Garrett Hardin's (1968) influential analysis of the "tragedy of the commons" had established the perception that common pool resources (CPRs) are prone to overuse and collapse unless either private property or central state solutions are implemented. However, subsequent research particularly by Elinor Ostrom (1990) clarified that Hardin's analysis more specifically addressed a "tragedy of open-access". Ostrom finds empirically that humans routinely devise complex governance arrangements to transform open-access situations into regulated commons regimes. Strategies for ensuring the sustainable use of CPR systems often focus on strengthening the degree of excludability, i.e. assigning property rights to ensure enclosure of the resource system or parts of its output. Successful commons governance in these cases works through establishing a private good or club good, often including decisions on distribution or exclusion. Commons management also often involves the provision of public goods, such as technologies that reduce the costs of protecting the commons (for example, low-carbon energy technologies in the case of protecting the atmospheric commons). It is important to clarify that there is no single "right" governance or property regime for goods or resource systems with CPR- or public good characteristics. An unregulated forest has the characteristics of a CPR, but its sustainable use can be organized via privatization, state property or any other form of mixed property rights assignment including common ownership.
- 387 Governance of commons is not about a blunt call for implementing common property regimes wherever possible, but a specification of complex rules and property rights. In the context of commons governance property rights refer to a bundle of rights including the authority to undertake particular actions, including rights of access, withdrawal, management, alienation (i.e. sale), appropriation of value, or exclusion from a resource (Ostrom 2000, Barnes 2006). The private owner of a forest, for example, may choose to delegate access- or harvesting rights to other individuals or group agents. Addressing questions of commons governance often includes addressing highly controversial questions of inclusion and exclusion, of initial entitlement and legitimate ownership.

388 Global commons are areas and resources the utilization of which is rival at least in some of the global functions or services they provide. Classical examples like the high seas and deep seabed, the Antarctica, the outer space as well as the atmosphere are beyond sovereign jurisdiction making them initially open-access (Buck 1998; Edenhofer et al. 2014). Other resource systems – such as forests or land – do fall within sovereign jurisdiction of states, but also show global commons properties, e.g. as carbon sinks connected to the atmosphere through the global carbon cycle (Brousseau et al. 2012).

389 A key challenge of global commons governance is that they are either situated outside national jurisdiction or their conservation and sustainable use conflicts with national sovereignty and regulation. Their use may affect different levels of governance in distinct ways, often requiring global cooperation. Yet, policies to govern the global commons will often conflict significantly with existing patterns of resource use, sovereignty rights and other related well-established interests. Additionally, most global commons interact with other global resource systems, i.e. management of one common will most likely also impact the use of others.

#### 390 **4.5.1.1 Neoclassical solutions: Pigou, Coase & Co**

391 The neoclassical economic tradition has long since come up with solutions for a strong central state to prevent an overuse of commons. Overuse of commons is driven by the social costs of utilizing a commons exceeding the individual costs. Taxing the individual for accessing the commons at the marginal social costs, as suggested by Arthur C. Pigou, will therefore align individual and social interests. The so-called Pigouvian tax will thus trigger the socially optimal utilization of the commons (Pigou 1920).

392 The same can, however, be achieved with (arguably) less intervention by the state: If the state merely establishes property rights, i.e. access rights to the commons, and if these permits can be traded at no cost, then bargaining among private agents for these permits will achieve the same socially optimal utilization (Coase 1960).

393 Although theoretically equivalent in the outcome, the Coasean perspective has emphasized the benefits of a smaller role of the state and the informational problems for the state to know the socially optimal utilization. By contrast, the Pigouvian perspective has pointed out that trading permits is hardly without costs, and thus Coasean bargaining is therefore likely inefficient in situations with large numbers of agents (Hovenkamp 2009).



- 394 Beyond arguments of political economy and transactions costs, the equivalence of price and quantity instruments (here: Pigouvian tax vs. Coasean bargaining) frequently breaks down when the restrictive idealized assumptions are relaxed. Weitzman (1974) showed that under uncertainty, the ration of marginal costs and marginal benefits of accessing the commons is distinctive for the superiority of one instrument over the other, sparking a branch of literature on “prices vs. quantities” (cf. Hepburn 2006 for a survey). For the specific case of the uncertainties associated with climate change, for example, a price instrument has been shown to be superior (Newell and Pizer 2003).
- 395 Contrary to the intuition that additional instruments improve welfare, the efficiency of Pigouvian taxes is undermined if private actors additionally engage (uncoordinated) in Coasean bargaining (Buchanan and Stumblebine 1962, Turvey 1963). But again, this result is turned on its head if (ex ante) transaction costs of bargaining are high (MacKenzie and Ohndorf 2016). Lehmann (2012) identifies a range of situation where a mix of multiple instruments improves over the outcome with a single pricing instrument.
- 396 Applied to global commons, the choice between price or quantity instruments translates to choosing between a global tax on the utilization (e.g. harvesting or polluting) or a global trading scheme for rights to utilize or pollute (Stavins 2010). According to Stavins, in the final analysis only few differences between a tax and a permit trading scheme remain, and even among environmental economists preference for one instrument over the other is unsettled. There is, however, overwhelming consent that it is essential to (a) establish a price for accessing commons, and (b) in doing so, rely on one of the market based instruments, i.e. a tax and a permit trade system.
- 397 One asymmetry between tax and trading identified in recent research with particular relevance in the context of polycentric global commons management concerns their different properties in enabling heterogeneous actors to express diverging preferences for the commons (Goulder and Stavins 2011; Williams 2012; IPCC 2015, Chapter 15): In the context of a greenhouse gas (GHG) cap-and-trade system unilateral efforts to enhance mitigation efforts by states or other actors, e.g. via additional policies such as renewable feed-in tariffs, have no impact on carbon emissions, as these remain determined by the overall cap. Still, additional policies can be merited to address other externalities, such as those related to learning-by-doing in new technologies. Instead of contributing to overall emissions reductions, such unilateral efforts re-shift emissions to other emission sources under the cap, and reduce the allowance price as (more expensive) abatement options that otherwise would not have been used contribute to meeting the quantity target. By

contrast, with a price instrument (e.g. a GHG tax or minimum price in an ETS[12]) unilaterally-enhanced abatement can increase the overall amount of emission reductions, if the price signal for other covered emission sources remains unchanged. While finding agreement on a common price (floor) among agents with heterogeneous preferences can be challenging, transfers can facilitate finding such agreement (Edenhofer et al. 2016).

#### 398 4.5.1.2 Global perspective without world government

399 The management of global commons, however, cannot be delegated to a central authority but involves negotiation and agreement by up to 200 sovereign states. Managing global commons thus become a collective action challenge: while it is in everybody's interest that some management scheme is implemented, there are strong free riding incentives for the individual state not to comply (cf. Sandler 2004, Barrett 2007).

400 Thus a key approach to manage global commons has been establishing multilateral institutions through international agreements (Barrett 2007), and to make participation as broad and as ambitious as possible. However, achieving this turns out to be difficult. For the case of environmental commons, Barrett (2003) reviews more than 300 treaties but observes that most of the treaties do not succeed to make a difference. The academic game theory literature that investigates the underlying causes for this cooperation failure was initiated in the early 1990s (Heal 1992, Carraro and Siniscalco 1993, Barrett 1994), pinning down strong free riding incentives as the culprit for low cooperation and/or little ambition of international environmental agreements. What followed was an extensive body of literature exploring designs of environmental treaties to overcome the cooperation failure, summarized in Benchekroun and Van Long (2012) or Carraro (2014). For example, this literature explores treaty mechanism (such as minimum participation clauses, Carraro et al. 2009, or emission permit trading, Lessmann et al. 2013), sanctions (e.g. on international trade, Nordhaus 2015), and rewards (e.g. transfer payments, Lessmann et al. 2015). Despite the fact that some treaty designs indeed show promise of improving environmental treaties, these game theoretic studies have confirmed time and time again that protecting global environmental commons is a hard problem.

#### 401 4.5.2 Successful management of the commons: complex institutions and Ostrom's design principles

402 Empirical and conceptual work examining whether local CPRs can be managed efficiently via self-organization of local communities has offered a more optimistic perspective on the prospects of commons

management even in absence of a central state (Ostrom 1990; Ostrom 2009). Based on meta-analyses of multiple local CPR case studies, Ostrom (1990) challenged the conventional neoclassical wisdom and particularly Garrett Hardin's (1968) claim that successful CPR management requires either the definition of private property rights enforced by a central state (e.g. Coasean solution), or direct top-down central state management (e.g. Pigouvian taxation) to enable collective action. Central to the empirical and theoretical claim of her work is that while there is indeed a tragedy of open-access CPRs – that is, CPRs for which no effective governance regime is in place – human beings are able to self-organize and to devise complex governance regimes to avoid the “tragedy of open-access” and transform it into a “drama of the commons” where outcomes are open and not determined a priori (Ostrom et al. 2002).

403 While Ostrom and collaborators convincingly argued that successful local CPR management via different forms of cooperative management regimes is possible, they also showed that success depends on a number of design principles that are conducive for successful CPR governance (Table 4.2). Humans do self-organize and succeed in problem-solving even in situations with weak individual incentives for cooperation – but not always. Facilitative formal and informal institutions enable people to carry out their management roles (Ostrom 2010b), including mechanisms such as effective monitoring, conflict-resolution or sanctioning for non-compliance, and devising rights to organize and to participate in rule-setting (Dietz et al. 2003).

404 Table 4.2: Design Principles for stable small-scale CPR management, based on Ostrom 2000.

405

Defined boundaries	Clearly defined boundaries of the CPR itself and the group of appropriators
Congruence	Devise rules congruent with local conditions and setting
Collective-choice arrangements	Allow most users to participate in developing rules
Effective monitoring	Hold monitors accountable to users
Graduated sanctions	Apply graduated sanctions

Conflict-resolution mechanisms	Develop local low-cost conflict resolution mechanisms
Minimal recognition of rights to organize	Ensure that external authorities permit local users to devise their own rules
Nested Enterprises	Build larger institutions for the management of CPRs in larger systems

406 Game theoretic analyses of CPRs tend to narrow down the solution space and conceptualize the problem setting as consisting of homogenous, profit-maximizing individuals in a fixed setting, where open access is given and the possibilities to cooperate, to build trust in repeated interactions over time, or even to communicate are severely limited or neglected. Ostrom's research questions the empirical validity of these assumptions in pointing to the diversity of human behavior and individual interest as well as to the relevance of a reliable institutional setting for effective regulation of local usage claims in a participatory framework.

407 Findings in experimental (behavioral) economics in recent decades have provided the empirical and theoretical underpinnings for this understanding of human capacities for successful cooperation in CPR and public good games despite pervasive incentives for free-riding by self-interested agents (Ostrom and Walker 2002; Carlsson and Johansson 2012; Fehr and Fehr 2016). It can be shown that humans are conditional cooperators, especially in reciprocal settings. Many humans are not purely self-interested but have other-regarding preferences. Face-to-face communication and trust are particularly conducive to such behavior. As the perception of fairness matters for the agents' willingness to cooperate, burden-sharing and transfer mechanisms among asymmetric players can further facilitate cooperation. This is in stark contrast to the neoclassical perspective on the homo economicus and explains the divergence of neoclassic pessimism and the optimistic message from Ostrom's research.

### 408 4.5.3 Up-scaling to the global level: polycentric governance of global commons?

#### 409 4.5.3.1 Global Commons Problems

410 Sustainable governance of global commons is increasingly important to maintain global prosperity and human well-being in the 21st century, e.g. related to problems of climate change (see Section 4.4.2.2), biodiversity-loss (see Section 4.4.2.5) or access to and conservation of other ecosystem services. Compared to local

commons, global commons problems face a set of additional difficulties, especially due to challenges of scale (global commons may concern the entirety of all human beings), diversity (of actors as well as of economic, political or cultural preconditions), and complexity (resource dynamics of interlinked CPRs, global externalities across places and generations)(Ostrom 1999, Stern 2011, Ostrom 2014). Given the challenges of international treaty making discussed before, research following Ostrom can offer at least two useful directions to mitigate and partly overcome global collective-action challenges: applying lessons to international negotiations (Section 4.5.3.2) and taking a polycentric perspective for global problems (Section 4.5.3.3).

#### 411 **4.5.3.2 Upscaling local lessons to the international level**

412 Up-scaling lessons learned from successful local commons management one-to-one to the structurally different challenges of global commons governance is difficult (Stern 2011). Nevertheless lessons may be used to enhance cooperation among states on the international level. Some have argued that the community of international negotiators may exhibit dynamics similar to CPR settings with low number of participants (“small-N”), and applying lessons from smaller scale CPR and experimental research may be applicable in this context (Messner et al. 2013; LeVeck et al. 2014). For example, research has shown that repeated communication affects trust levels, which themselves substantially determine levels of cooperation (Cole 2015). Positive experience of cooperation can further enhance mutual reputation and trust, potentially resulting in even higher cooperation levels. Graduated sanctions and rewards through transfers, and monitoring and compliance mechanisms can also catalyze trust-building and help deter free-riding. It remains an open question if lessons from small-N settings can indeed be applied to the international level where negotiators are embedded in principal-agent relationships with their governments and population (Putnam 1988) that are critical for structuring their behavior.

413 The 2015 UNFCCC agreement in Paris exhibits some features reminiscent of successful CPR design principles, in particular a regular monitoring and verification scheme and a global stock take mechanism identifying the gap between existing efforts of all countries and the global mitigation goal of limiting global warming to 2°C. These mechanisms should enhance transparency over the action of countries thus enabling to build trust over time. They also provide leverage points for informal “naming and shaming” of countries with low levels of policy ambition or not living up to their promises (e.g. by civil society groups as sanctioning mechanism), as formal sanctions were not politically feasible in Paris.

#### 414 4.5.3.3 A polycentric approach

415 Local lessons may also be applied where the harsh dichotomy between top-down and bottom-up approaches to global commons governance is transcended in efforts that include the broad array of sub-international actors (Ostrom 2010a; Ostrom 2010c). Many problems with global commons properties need some kind of international action to be properly addressed - they all are also dependent on implementation, compliance, or even structural changes on several subsidiary policy levels. As there is no first-best monocentric governance architecture for global commons problems, polycentric theory stresses the benefits and needs of an adaptive and decentralized system of multiple self-governing and interacting units of different scale across policy levels (Dorsch and Flachsland 2016). Recognizing site-specific conditions, i.e. heterogeneous preferences as well as heterogeneous competencies and constraints of different actors, enables policy design to realize site-specific co-benefits and to mitigate costs (Dalmazzone 2006). Participation in smaller units fosters self-organization and trust-building, while the interaction between units fosters mutual learning and diffusion of norms (Shobe and Burtraw 2012; Hoffmann 2011; Hulme 2009). Externalities between subsidiary groups can be addressed in larger organizational settings, i.e. to avoid conflicting policies. This is also reflected in Ostrom's eighth design principle (see table 1), suggesting multiple layers of 'nested enterprises' for the management of CPRs in larger systems (Ostrom 2000).

416 The prevalent task for real-world multi-level governance arrangements is then to mobilize collective action at several scales by organizing this interplay of interests, capabilities and externalities productively. As outlined in Section 4.5.1, reducing GHG emissions by implementing appropriate price instruments at higher levels enables jurisdictions and other agents to express their preferences for more ambitious policy more effectively than under a cap-and-trade system. Also, transfer schemes among different groups with asymmetric preferences can be used to enable higher levels of ambition by providing compensation for increased policy ambition on behalf of those particularly able and willing to provide such compensation (e.g. in the climate context via international climate finance and the Green Climate Fund).

#### 417 4.5.3.4 Polycentric climate governance architecture

418 Empirically, most global commons problems like climate change mitigation are to a large extent already addressed via polycentric policy approaches, encompassing international agreements as well as a multitude of subsidiary policies, institutions and civil engagement on the local, national and regional level all over the globe (Jordan et

al. 2015; Paavola 2011). These arrangements include traditional state-led and market instruments as well as other forms of climate action by different state and non-state actors.

- 419 Still, national governments remain key actors not only for international multilateralism. Many nation states adopt a growing number of unilateral climate policies and strategies (Dubash et al. 2013, Nachmany et al. 2015), coordinate and mutually foster their climate policies in bi- and minilateral agreements (like US-CHN, G7/G20, EU; see Falkner 2015), but also provide various support functions for non-state initiatives (Hickmann 2016; Hale and Roger 2014).
- 420 In many cases, regardless of the specific interests of their national governments, sub-national entities such as states and cities can also be policy drivers (e.g. for California, Rabe 2010 and Urpelainen 2009, for cities, Hakelberg 2014). In transnational networks such as the C40 Cities Climate Leadership Group, the ICLEI Local Governments for Sustainability network or the World Mayors Council, sub-national governments as well as non-state actors self-organize to commit to specific climate and energy targets, introduce review schemes and foster policy transfer through information sharing or capacity building (Hoffman 2011, Bulkeley et al. 2014). Additionally, a broad range of climate action by non-state actors is evident – from business self-regulation, civil society groups, universities, foundations or individuals (e.g. UNEP 2015, Partzsch and Ziegler 2011). Given the encyclical intervention *Laudato Si* by Pope Francis, even religious groups contribute to the eclectic but increasingly meaningful emerging global climate governance landscape (Edenhofer et al. 2016).
- 421 Contrary to the classical intuition that collective action on global commons such as the atmosphere is hindered through pervasive free-riding incentives, mitigation action is observable worldwide – even though the level of ambition of current global action is not yet overall sufficient to achieve the objectives set out in the 2015 Paris Agreement (as notably stated in the Agreement itself, UNFCCC 2015). Efforts at achieving such international agreements remain necessary to address international free-riding incentives. But they are already characterized and complemented by polycentric governance structures aiming not only at ensuring implementation but also at harnessing decentralized potentials for mitigation.
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## 4.6. Societal transformations, policy options and trade-offs

### 4.6.1 Welfare diagnostics

This sub-section examines how the concept of welfare diagnostics, which has been introduced in Section 4.4.3.3., can be put into practice.

A common concern for sustainable development is the question of how to reconcile concerns for environmental quality with poverty reduction. Welfare diagnostics can provide some guidance on how to simultaneously address over-use of natural resources and under-provision of access to infrastructure services (such as water, sanitation, electricity, health, education...) that are fundamental for human development. Welfare diagnostics can be understood as a process that includes the following three steps:

1. Identify the relevant dimensions of welfare (e.g. consumption possibilities and their distribution, or capabilities) as well as the trade-offs between them. Define minimum thresholds for environmental quality and human development. The policies that ensure that all thresholds are met constitute the set of feasible public policies.

2. Establish limits regarding the use of natural resources in line with the feasibility set from step 1 by means of fiscal policies, such as Pigouvian taxes, tradable permit schemes, or resource rent taxes. Appropriate the associated rents to the public budget.

3. Use the revenues from step 2 to invest in infrastructure required to meet the minimal thresholds for human development defined in step 1. That is, revenues from e.g. carbon pricing could be used to finance water or electricity access.

As practical examples, Jakob et al. (2015) show that phasing out environmentally harmful subsidies for fossil fuels would not only benefit the climate, but would also raise substantial means to invest in basic infrastructure. Currently, about 80 of the world's countries lack universal access to water, sanitation and electricity. Redirecting current fossil fuel subsidies over a period of 15 years towards infrastructure would enable about 70 of them to achieve universal water access, about 60 could achieve universal access to sanitation, and about 50 universal electricity access. Similar results are obtained



for the potential revenues from carbon pricing in scenarios that are compatible with the aim of the international community to limit global warming to 2°C (Jakob et al. forthcoming).

430 In order to successfully carry out welfare diagnostics, policy-makers need accurate scientific information on environmental limits as well as the economic, technological and institutional requirements to remain within these boundaries. For instance, for the case of climate change, the benefits of slowing down global warming would need to be compared with mitigation costs and potential risks of key technologies to reduce emissions, such as use of bio-energy, carbon capture and sequestration, or nuclear power.

431 However, defining thresholds and deciding what constitutes a socially acceptable risk is an inherently normative question that cannot be answered by scientists but requires public deliberation (Edenhofer and Kowarsch 2015). For this reason, participative democracy is a fundamental cornerstone to express social preferences and guide policy decisions aiming to find the right balance between short term exigencies of human development and long-term considerations to safeguard environmental quality.

432 Measures as such proposed above will have important distributional impacts across time and income groups. For instance, if infrastructure access will likely be granted only after a certain time period needed for construction, but higher energy prices are experienced immediately. In a similar vein, fossil fuel subsidies mainly benefit richer households who consume considerably more energy than poorer ones (Arze del Granado, Coady, and Gillingham 2012), such that they have an incentive to resist subsidy reform. For this reason, well-designed policy packages that prevent adverse distributional impacts and compensate political losers need to be devised (IMF 2013). This issue will be addressed in the next section.

#### 433 **4.6.2 Public policy institutions and trade-offs between growth and distributional impacts: political economy and rent-seeking**

434 [Placeholder]

#### 435 **4.6.3 Adjusting to the possibility of slowed future growth, implications of stagnating societies**

436 [Placeholder]

#### 437 **4.6.4 Robust and context specific policies**

438 [Placeholder]

#### 439 **4.6.5 Narratives**

- 440 Capitalism has been credited with unprecedented economic growth, while at the same time it has also been severely critiqued for many ills in human society, including the biases in distribution of gains and rise in inequality among stakeholders.
- 441 Capitalism may be described as an economic system characterized by the ongoing accumulation of physical capital, growing labor productivity, growing capital/labor ratio and a stable real interest rate. There are two major narratives about contemporary capitalism: the first emphasizes the benefits, the second is concerned with the detrimental effects. Both have influenced current theories and debates on economic growth. This section provides an overview of these two narratives and then discusses the synthesis - or “third way”- proposals, which attempt to find pathways to move ahead, bringing together the positives of both narratives.
- 442 In the first narrative, economic growth is viewed as a process of liberation. Capitalism allowed for unprecedented economic growth which provided an abundance of material goods after centuries of life at the subsistence level for almost the entire population. It brought along dramatic improvements in life expectancy, health care, education and cultural development. As capitalism works best when individuals have rights and freedom, it spread these benefits to increasing numbers of people.
- 443 In the second narrative: economic growth is viewed as a process of alienation or exploitation. Capitalism’s success in efficiently providing goods and services for individual consumption created a mindset that tends to under estimate the negative externalities created, biasing distribution of gains towards owners and managers of resources and against other stakeholders such as workers; and creating uncompensated harm to nature while at the same time omitting long term sustainability concerns. When left unregulated capitalism can create exploitation, large inequalities and injustices and neglect common objectives like environmental quality.
- 444 The popularity of the narratives of capitalism as “liberation” and “exploitation” (Randazzo and Haidt, 2015) with different segments of society raised a concern about finding a more integrated perspective in order to forge a welfare enhancing and socially progressive pathway for economic growth.[\[13\]](#) In recognition of this, third way approaches emerged to highlight the potential of capitalism (and its limitations) in order to move the discussion forward. It was felt that such a broad theoretical framework would not only allow for an evaluation of the costs and benefits of capitalism but also provide pathways for the transformation of contemporary capitalism. The common idea is to maintain the driving forces of capitalism for innovation, cultural diversity and democratic institutions and to

address inequality and social anomalies by suitable policies like redistribution, social inclusion and protecting the interests of society through the regulation of economic activity.

#### 445 **4.6.5.1 Economic Growth as a Process of Liberation**

446 Thomas Malthus described economic developments up the 18th century as an endless cycle of small technological improvements and ensuing small increases in population (Malthus, 1798). Towards the turn of the 19th century, however, the previous pattern of stagnation changed into a quite stable process of exponential economic growth which still continues today. Solow (1956) and Swan (1956) solved the riddle of the driver of economic growth and identified it to be technological change. Capital accumulates as a result of technological change, but is not itself the driver of growth.

Accordingly, accelerated technological change and the resulting shift of investment from a large number of children towards the education of children allowed the escape from the Malthusian “trap” (Galor and Weil, 1999 and 2000, Hansen and Prescott, 2002).

447 Technological change then makes the difference between life at subsistence level and ever increasing material wealth for the largest part of the population. What allowed technology to start improving much faster in the late eighteenth century and what keeps it improving today? Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992) pioneered economic research which went beyond the Solow model by making technology endogenous. The central idea is that individuals develop technology when they are rewarded for it by receiving a share of the additional production that can be realized with the new technology.

448 Exponential growth could thus take off once inventors would be rewarded adequately. This link between the effort and the reward was established with the first modern patent system in England in the 16th century (MacLeod, 1988). It developed from medieval Venetian origins and introduced the concept of intellectual property. The patent system granted a new individual right to the general population. It is no coincidence that this occurred in England, the country which pioneered the development of democracy. Acemoglu and Robinson (2012) describe the development of democracy as a process which started with the signing of the Magna Carta in 1215 and very gradually transferred power from a very small elite towards an increasingly large part of the population.

449 The patent system is an important example for the general pattern that good institutions foster economic growth. Acemoglu et al. (2005) uses the Korean peninsula as an example. When the Korean peninsula gained independence after World War II it was extremely

homogeneous. The political division into a northern and a southern part, however, installed very different types of institutions. The democratic South Korea embarked on a process of rapid growth while the repressive North Korea stagnated. This illustrates what Hall and Jones (1999) find with a sophisticated econometric analysis: differences in productivity can be explained by differences in institutional quality.

450 What is it about institutions that make them so powerful in generating economic growth? Easterly (2013) argues that their decisive element is granting individual rights. Individuals with rights can essentially solve their own problems, in particular that of poverty. Rights, enforced by functional institutions, help individuals to claim the benefits of their work. Ultimately, they provide incentives to innovate and develop technology, which create a positive externality. This externality allows the economy as a whole to grow.

451 The remarkable stability and persistence of economic growth was famously observed by Kaldor (1961). While Capital per worker had increased, the real interest rate and the ratio of capital to output were stable in the long run. Most remarkably, however, labor productivity grew at a sustained rate, implying that inventions and productive new ideas had not run out so far. Jones and Romer (2010) extend and refine the original Kaldor facts and confirm the stability and persistence of economic growth. They show that while the evolution of institutions is the subject of research, their central role for economic growth is undisputed.

452 The recognition that freedom generates wealth fueled a process of liberalizing international trade, which was actively advocated by the Bretton Woods institutions as part of the “Washington consensus” (Williamson, 1993). Over time it was realized that globalization requires careful regulation (Rodrick, 1997; Stiglitz, 2002, Cetorelli and Goldberg, 2012), but the idea that trade as a whole is beneficial proved right empirically (Wacziarg, 2001; Winters, 2004). Even concerns about higher unemployment and brain drain turned out to be unfounded (Felbermayr et al., 2011; Docquier and Rapoport, 2012). In fact, once countries start opening up to trade, they converge towards the most developed economies (Sachs and Warner 1995; Ben-David, 1996).

#### 453 **4.6.5.2 Capitalism as Alienation or Exploitation**

454 The previous section demonstrates that capitalism has, without doubt, brought great advances in living standards over the last centuries. However, capitalism also has several adverse effects which threaten to destroy some of its greatest achievements. The second

narrative, which is described in this section, focuses more on these adverse effects. In the following we describe four major inherent problems of growth-focused capitalism which we consider to be most relevant: (1) increased wealth inequality, (2) overuse of natural capital, (3) unrestricted corporate power, (4) a too narrow focus on material consumption.

455 A relatively recent strand in the empirical literature reports a strong increase in wealth inequality in several industrialized countries: the gap between the top 1% and the rest of the population has increased significantly over the course of the last three decades (Piketty, 2014; Piketty and Zucman, 2014). Regarding capital income in the U.S., Alvaredo et al. (2013) demonstrate that the share going to the top 1% increased from 17% to 27% in the period between 1980 and 2000. This development also results in an increasing ratio between wealth and income during the same period (Piketty and Zucman, 2014).[\[14\]](#)

456 The increase in wealth inequality can be attributed to different drivers. Stiglitz (2015) sees political changes that facilitate the appropriation of economic rents[\[15\]](#) by wealthy economic agents among the main drivers of wealth inequality. Network externalities, such as those occurring in large social networks such as Twitter and Facebook (Haucap and Heimeshoff, 2013), give market power to only a handful of big firms, which then derive monopoly rents [Citation?]. Political rents can occur when economic agents also have political influence, for instance through lobbyists. Several types of exploitation rents occur in the financial sector, for instance through predatory lending practices and market manipulation (Stiglitz, 2015). Stancheva et al. (2012) confirm the relation between changes in politics which lead to a growth in different types of rents and increasing wealth inequality. The existence of rents furthermore diverts investment away from physical capital towards rent-generating fixed factors like land (Feldstein, 1977).

457 Section 4.1.4.1 demonstrates that technological change is the main driver behind economic growth. However, some authors argue that technological change can have adverse distributional effects, since it is biased towards high-skill workers ("skill polarization", Autor, 2015; Brynjolfsson and McAfee, 2014). Autor (2015) argues that technological change is a two-edged sword: there is both a substitution effect between machines and human labor (which contributes to skill polarization) and a complementary effect between the two (which leads to higher demand for labor). He shows that the substitution effect outweighed the complementary effect in the last decades to some extent, but states that this will not prevail in the longer term. Furthermore he argues that journalists and even expert commentators tend to overstate the substitution effect.

Mokyr et al. (2015) attribute this focus on the negative aspects of technological change to a form of technological anxiety that prevails since the early days of capitalism.

458 Piketty (2014, see chapter 11 in particular) identifies reduced growth of economic output and population as a further driver of inequality. He argues that slower growth means that less wealth is newly created than it would be in a high growth scenario. Therefore, a higher share of total wealth was created in the past. The wealth created in the past, however, is more concentrated than newly generated wealth due to inheritance. While the individual's right to retain created wealth provided the basis for growth it, also causes increasing inequality in a situation of slow growth.

459 Growth-focused policy makers ignored for a long time that, if natural capital stocks are left unregulated, they tend to be overexploited. Greenhouse gases are a global concern today. Many other forms of environmental degradation have occurred over the years, affecting the sustainability of economic growth and welfare of regions and sub-populations within countries, such as through increased soil degradation and water overuse, desertification and deforestation, adversely affecting productivity (see section 4.2 for a detailed discussion on the role of natural wealth). The link with economic growth can be illustrated with the example of fossil fuels. Fossil resources are an important economic input. Burning of fossil fuels, however, releases greenhouse gases into the atmosphere, which causes climate change (Stocker et al., 2013).[\[16\]](#) An individual's use of fossil fuels enhances total output, but has an impact on the economic activity of others. The release of greenhouse gases is hence an externality which cannot be addressed if the market is left to its own devices.

460 The strong correlation between economic growth, greenhouse gas emissions (Edenhofer et al., 2014a) and natural capital depletion in general has led some authors to the conclusion that economic growth causes more harm than good. Schneider et al. (2010), Jackson (2009) and Kallis (2011) argue that economic growth is so strongly associated to the destruction of natural capital that de-growth, the deliberate halt or reversal of economic growth, is the only feasible approach to maintain the natural capital. This line of reasoning has been questioned mostly for the premise that the depletion of natural capital and economic growth are inseparable (Jakob and Edenhofer, 2014), but has gained significant popular support.

461 A major concern behind a more globalized economy is the enormous market power and political influence of large (multi-national) corporations, which often exceeds the protective power of nation states. These corporations exercise their power through lobbyism,

trade regulations and liberal financial markets (Stiglitz, 2006). Large corporations can move abroad to avoid strict local regulations such as environmental policies and labor rights (Stiglitz, 2006). They can even erode beneficial health, environmental and labor regulations by suing governments in front of international courts (see e.g. Sud et al., 2015).<sup>[17]</sup>

462 The drive for private profit, which is at the heart of capitalism, has also been identified as a threat to economic growth and thus to the ability of the society to free disadvantaged citizens from economic hardships. Tollison (1982) identifies two forms of rent-seeking, rent-seeking for natural rents, which is a productive search for profitable activities, and rent-seeking for artificial rents, which is the unproductive competition for existing rents. The second type of rent-seeking has been identified as harmful for economic growth by Murphy et al. (1993) and Mohtadi and Roe (2003) since it consumes resources, but does not create additional value for the society.

463 Schumpeter (1942) predicts that over time capitalism will lead to corporatism, which will end economic competition. Similarly, Olson (1982) argues that lobby groups will use their political influence to achieve protectionist policies and thus cause a decline in economic growth. Neumann (1997) believes that economic development will form long cycles, in which society will alternate between focusing on redistribution and capital accumulation. Galbraith (1967) by contrast expects the formation of large companies to be beneficial since they are most likely to succeed in long term planning. Modern economic analysis finds that monopolists with strong political influence can stop development altogether (Parente and Prescott, 1999).

464 A final criticism of current growth patterns concerns the usefulness of growth in consumption for increased well-being. Hirsch (1977), for instance, points out that there may be “social limits to growth” if people use their income predominantly to pursue status seeking behavior. Further, Frederick and Loewenstein (1999) and Layard (2011) show that consumers overestimate the pleasure they will derive from new purchases, misjudging the rapid psychological adaptation to new goods. Both effects explain a rather weak positive effect of personal income on subjective well-being (Kahneman and Deaton 2010).

#### 465 4.6.5.3 The “Third Way” Alternatives

466 Economic policies that allow for a “third way” (preserving the benefits of capitalism as mentioned in Section 4.6.5.1 while addressing its inherent problems outlined in Section 4.6.5.2) are focused on four essential elements: (i) increased public investment which promotes equity either directly, or by offsetting the

distributional effect of skill polarization and which allows for human development beyond a narrow focus on growth, (ii) environmental policy, (iii) international cooperation to reduce corporate power and address the global externality of climate change, (iv) redistribution without harming growth.

- 467 First, public capital, in a broad sense that includes energy, transport, health and education infrastructure, is crucial for both economic growth and equity, but tends to be underfinanced in most developed economies (Bom and Ligthart, 2014; Estache and Fay, 2007; Romp and Haan, 2007). Increasing public investment has the potential to address several of capitalism's inherent problems: First, an increase in education investment can supply low-skill workers with the skills necessary to flourish in a labor market that increasingly focuses on skills which are complementary to machines (Autor, 2015). This increased public investment should be financed preferably through non-distortionary taxes on externalities and less distortionary taxes on rents or bequests to reduce adverse growth effects. Third, depending on the financing mechanism, public investment has the potential to decrease inequality (Chatterjee and Turnovsky, 2012; Klenert et al. 2016).
- 468 Second, the destruction of natural capital can be countered, conceptually, by investing in natural capital. In a market economy this can be achieved in a straightforward manner by obliging individuals to pay the social cost for natural capital. The alignment between individual and social costs can be achieved by Pigouvian taxation. By increasing Pigouvian taxes to very high or prohibitive levels even concepts of strong sustainability can be realized (Edenhofer et al. 2014b). Problems such as biodiversity loss can also be addressed in this way, for example through prohibitive taxes on deforestation. In addition to Pigouvian taxes, complementary measures such as subsidies for renewable technologies (Acemoglu et al., 2012, Mattauch et al., 2015) and public investment into sustainable infrastructure (Guivarch and Hallegatte, 2011) are needed for transition towards an environmentally sustainable economy.
- 469 Third, the problems generated by abusive corporate power can be addressed by global governance (Finkelstein, 1995). The tendency for pollution intensive firms to produce in countries with the weakest regulation can be addressed through international environmental agreements like the 2015 Paris Agreement (UNFCCC, 2015). Similarly, the race to the bottom in social protection and labor standards can be addressed through the International Labour Organization (ILO). Strengthening international cooperation between governments can generally reduce the risk of corporations playing countries off against each other. To address the ability of



corporations to start well-funded legal attacks, Stiglitz (2006) suggests that "advanced industrial countries finance strong legal assistance for the developing countries"

470 Fourth, we conclude that the two narratives and some economic models that promote them are too single-minded about inequality. On the one hand, inequality in returns to efforts motivates households to work harder (Roemer, 1993) and has a generally positive effect on growth (Marrero and Rodriguez, 2013). On the other hand, inequality in factors that go beyond the personal responsibility ("inequality of opportunity") can have detrimental growth effects (Marrero and Rodriguez, 2013). It should hence be addressed by economic policy. We propose three pathways towards reducing inequality of opportunity: (1) inheritance taxation (Piketty and Saez, 2013), (2) public investment, as proposed in point one and (3), policy changes to reduce rent income. Other ways of reducing inequality such as the taxation of aggregate wealth might have adverse growth effects and are hence less desirable (Judd, 1985; Chamley, 1986).

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## 471 4.7 Action Toolbox

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Goals/values	Policy-makers	International org	NGOs	Citizens
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Economic growth that leads to social well being is <i>good</i>	Act to persistently raise the threshold of quality of life for: (a) the less advantaged (b) in terms of alternatives such as adaptive capabilities, and meaning of life alongside preference satisfaction.	<p>Push for even distribution of the gains from economic growth: such as more use of welfare diagnostics and multidimensional indicators of economic growth</p> <p>Enhance global understanding on local context for improving social welfare on issues such as climate adaptation, environmental justice, international trade.</p>	<p>Create awareness of the benefits and ways of achieving sustainable and social well being</p> <p>Focus on key areas of change: such as food security, pollution, water security.</p> <p>Facilitate enforcement of rights, labour laws.</p>	<p>Create pressure for distributional improvements/ reduce inequities with economic growth on other actors: demand for appropriate taxes, safety nets, employment.</p> <p>Protect local and global commons through their action</p>
Economic and Social well being depends on inclusiveness of actors in the process of development and growth	Focus on enhancing rights, political stability and legitimacy	Keep polycentric approaches to governance in mind; increase the capabilities for participation in international processes	Contribute to bringing in more actors at the grass roots level	Focus on preserving safety and security (law and order, institutions, governance) in local and regional growth and development context
Enhanced Institutional capability alongside inclusiveness leads to economic stability and sustainability	Mainstream multiple criteria into measures for evaluating economic growth for instance, environmental justice, reduced regional and social inequities in the economy, and poverty alleviation.	Urge policy thrust on less of particularized and more of generalized institutions that involve all economic agents	<p>Focus on geographies, environmental disabilities, remote areas;</p> <p>Create conditions for greater transparency at various levels of public policy and governance</p>	Execute civil and social responsibilities to ensure positive change

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- 994 [2] Affiliations LAs : Universidad Pedagogica y Tecnologica de Colombia, Cornell University, Oxford University, University of Louvain-la-Nueve, University of Ghana, MCC, ZEW, University of Notre-Dame, Stanford University, IFPRI
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- 996 [4] KMS Research and Consulting
- 997 [5] Sweden is the only country with more than 250 years of population censuses.
- 998 [6] The obvious social and economic changes of the late twentieth century have initiated a rethinking the global notions of these concepts. Economic analysts such as Thomas Piketty (Piketty 2014), agree that in the last three decades, social and economic inequality has increased (See Section 4.1.3)
- 999 [7] The European Union has funded a project, led by the Autonomous University of Barcelona (ICTA-UAB), titled the Environmental Justice Organizations, Liabilities and Trade (EJOLT), which receives contributions from 100 professors from 23 universities and environmental justice movements in 18 countries.
- 1000 [8] The 1.25 US\$ threshold has frequently been criticized as constituting a mere subsistence level (Pritchett 2006), suggesting that poverty itself may go much beyond this measure.
- 1001 [9] Less formal definitions of GDP even go back to 17th century England (Coyle, 2014).

- 1002 [10] Even though some say that it actually can be used as a proxy for welfare (see e.g. Jorgenson et al., 2006).
- 1003 [11] Asheim and Weitzman (2001) evaluate under which conditions the Weitzman principle holds when NNP is measured in monetary rather than utility terms.
- 1004 [12] Minimum prices in cap-and-trade systems have e.g. been implemented in California, Quebec, the Northeastern US RGGI trading system, and some Chinese provincial ETS (ICAP 2016).
- 1005 [13] Mattauch (2015) recently argues that neoclassical growth theory is dominated by the narrative that capitalism is liberation, and proposes building a public economic theory that unifies both narratives. Here, our focus is on suggesting policy reforms instead of reforms to economic theory.
- 1006 [14] A large part of this increase, however, can be attributed to a change in land prices (Homburg, 2015).
- 1007 [15] An economic rent is the share of income received by a factor owner that exceeds the cost of providing the factor in production (Wessel, 1967; Segal, 2011).
- 1008 [16] The global mean temperature already rose by 0.89 °C over the last 160 years (Stocker et al., 2013).
- 1009 [17] For instance, Philip Morris, a large tobacco producer with an annual revenue of \$80bn, successfully sued the country of Uruguay, which has a GDP of \$53bn (The Independent, 2014). As a result, Uruguay reduced the size of health warnings on cigarette packages (de Zayas, 2015). Other examples include the law suit of Vattenfall against Germany's decisions to fade out nuclear power, the lawsuit of several investors, among them Daimler and Hochtief, against Argentina, and the lawsuit of Chevron against Ecuador, by which Chevron tries to avoid paying for massive pollution it caused the Ecuadorian rainforests.