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Review

What is Sustainability?

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Abstract: Sustainability as a policy concept has its origin in the Brundtland Report of 1987. That document was concerned with the tension between the aspirations of mankind towards a better life on the one hand and the limitations imposed by nature on the other hand. In the course of time, the concept has been re-interpreted as encompassing three dimensions, namely social, economic and environmental. The paper argues that this change in meaning (a) obscures the real contradiction between the aims of welfare for all and environmental conservation; (b) risks diminishing the importance of the environmental dimension; and (c) separates social from economic aspects, which in reality are one and the same. It is proposed instead to return to the original meaning, where sustainability is concerned with the well-being of future generations and in particular with irreplaceable natural resources—as opposed to the gratification of present needs which we call well-being. A balance needs to be found between those two, but not by pretending they are three sides of the same coin. Although we use up natural resources at the expense of future generations, we also generate capital (including knowledge) which raises future well-being. A major question is to what extent the one compensates for the other. This debate centres around the problem of substitutability, which has been cast into a distinction between ‘weak’ and ‘strong’ sustainability. It is argued that these two do not need to be in opposition but complement one another.

Keywords: sustainability; well-being; welfare

1. Introduction

The term sustainability has become popular in policy-oriented research as an expression of what public policies ought to achieve. The principal inspiration came from the Brundtland Report of 1987 [1]. Since then the concept has shifted in meaning. This paper argues that the shift is unfortunate in that it obscures the real contradiction which exists between long-term sustainability and short-term welfare. Moreover, the distinction between three ‘pillars’ of sustainability is conceptually fuzzy. We propose a definition that reverts to the original sense in which the concept was intended.

However, this paper does not pretend to offer a comprehensive view of the problem of sustainability. It presents a critical view of how the term is used in policy debate and in impact assessment—the set of methods used in applied research to appraise policies and projects.

2. History of the Concept

The concept of sustainability was originally coined in forestry, where it means never harvesting more than what the forest yields in new growth [2]. The word *Nachhaltigkeit* (the German term for sustainability) was first used with this meaning in 1713 [3]. The concern with preserving natural resources for the future is perennial, of course: undoubtedly our Palaeolithic ancestors worried about their prey becoming extinct, and early farmers must have been apprehensive about maintaining soil fertility. Traditional beliefs enjoined thinking in terms of stewardship and concern for future generations, as expressed in the oft-quoted words of a Nigerian tribal chief who saw the community as consisting of “many dead, few living and countless others unborn” [4,5]. Perhaps there have always been two opposing views of the relation between humankind and nature: one which stresses adaptation and harmony, and another which sees nature as something to be conquered. While this latter view may have been rather dominant in Western civilization at least in recent centuries, its counterpoint has never been absent.

Sustainability (without necessarily using the word) is a natural topic of study for economists: after all, the scarcity of resources is of central concern to the dismal science. A famous example is the work of Thomas Malthus, who published his theory about looming mass starvation (due to the inability of available agricultural land to feed an expanding population) in 1798. A theory on the optimal rate of exploitation of non-renewable resource which is still relevant today was formulated by Harold Hotelling, an American economist, in 1931 [6]. We shall have more to say about his views later.

A milestone in capturing the attention of global public policy was the report of the Club of Rome [7], which predicted that many natural resources crucial to our survival would be exhausted within one or two generations. Such pessimism is unbecoming in public policy which is, after all, supposed to be about improving things. Therefore, the report of the UN World Commission on Environment and Development, better known as the Brundtland Report after its chairperson, was welcomed for showing a way out of impending doom. It was this report which adopted the concept of sustainability and gave it the widespread recognition it enjoys today.

The question which Brundtland and her colleagues posed themselves was: how can the aspirations of the world's nations for a better life be reconciled with limited natural resources and the dangers of environmental degradation? Their answer is sustainable development, in the Commission's words:

development that meets the needs of the present without compromising the ability of future generations to meet their own needs [1].

Thus, environmental concerns are important, but the basic argument is one of welfare, seen in a context of inter-generational equity. We should care for the environment not because of its intrinsic value, but in order to preserve resources for our children.

Since that time, there have been two major developments in the concept of sustainability: one, its interpretation in terms of three dimensions, which must be in harmony: social, economic and environmental. Two, the distinction between 'strong' and 'weak' sustainability. These two developments are discussed critically in the Sections 3–4 and 5–6, respectively.

3. People, Planet, Profit

The Brundtland report speaks of two concerns that should be reconciled: development and the environment. They can also be interpreted as needs *versus* resources, or as the short *versus* the long term. Today, however, sustainability is almost always seen in terms of three dimensions: social, economic and environmental [8-11]. This is embodied in the definition of sustainability adopted by the United Nations in its Agenda for Development:

Development is a multidimensional undertaking to achieve a higher quality of life for all people. Economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development [12].

But what are economic and social development and how are they different? Robert Gibson, a political scientist, says that the distinction is needed because "material gains are not sufficient measures or preservers of human well-being" [13]. The same author also suggests that the three dimensions or 'pillars' reflect the disciplines of those who study sustainability, adding for good measure that a cultural and a political pillar could also be included [13]. Gibson himself, by the way, rejects the idea of pillars altogether and instead formulates seven principles on which sustainability could be based.

The idea of sustainability having three dimensions stems from the Triple Bottom Line concept, coined by Elkington [14]. As the term bottom line suggests, it originates from the world of management science, and Elkington intended it as a way to operationalize corporate social responsibility. To the conventional bottom line (profit) should be added care for the environment (the planet) as well as being good to people, for instance by providing facilities for the handicapped and hiring minorities (the social dimension).

The goals of business, however, are very different from those of public policy. Although, as in business, revenue is needed to cover government expenditure, maximizing the excess of revenue over expenditure is not normally considered an appropriate goal for government policy. Government is not supposed to be a profit-making venture. The 'profit' pillar is therefore translated as the money made by the entire country, expressed as gross domestic product (GDP). This then is the economic dimension, and the social dimension ('people') is everything else connected with human aspirations: equity

(translated as income distribution), inclusion (commonly operationalized as employment) and health (expressed by an indicator such as life expectancy or access to medical services). However, the equation of 'economic' with money is a very limited view of economics. Moreover, the view is further restricted if we confine ourselves to the aggregate amount, and not with its distribution or with what the money can buy.

GDP is intended as a measure of welfare, and as such it is a very useful but also a very incomplete and biased one. It is useful for measuring the amount of economic activity and because there are relatively good data for it; but it needs to be complemented by other indices, such as the Human Development Index. These are subjects of study for both economics and sociology, and there is no good reason to call one aspect economic and the others social. The sociologist would ask what welfare is and how it can be measured (an issue discussed in the next section), whereas the economist's task would be to assess, given human aspirations and the scarcity of resources, what course of action is likely to produce the highest degree of satisfaction of those aspirations.

If there is good reason from a conceptual point of view to prefer a single socio-economic dimension, what of its usefulness to policy analysts? Let us consider a hypothetical project which scores very well on the environmental dimension but rather poorly on both the social and the economic one. This might easily lead a policy-maker to conclude that the project is, on the whole, not a good idea. A two-dimensional approach might bring about the opposite judgment: its environmental benefits come at a cost in terms of welfare. The environmental dimension may thus receive less weight in a three-dimensional approach. Indeed, some authors explicitly state that the three dimensions should receive equal weight [15]. Since socio-economic aspects are mostly about the well-being of the present generation and environmental ones are about caring for the future, this means the former become twice as important as the latter—which violates the Brundtland requirement that development should not take place at the expense of future generations.

Worse, perhaps, is that the contradiction between our desire for a better life and our concern for what this may do to the environment is obscured by conceptualizing these two concerns into three dimensions, and then suggesting that a solution is possible where all three are in harmony. Sustainability then becomes a concept that is equivalent to 'good' and thus devoid of any specific meaning—a blanket concept to assure stakeholders of the policy's good intentions. The strength and relevance of the original Brundtland concept was precisely that it posed the question of how to reconcile one goal 'development' with another 'sustainability'. The two goals are often in tension.

Therefore, we propose to use the word sustainability in the sense as it was intended by the Brundtland Commission, and not as it has been coined later by corporate types and policy-makers. In the words of Robert Solow [16]:

If 'sustainability' is anything more than a slogan or expression of emotion, it must amount to an injunction to preserve productive capacity for the indefinite future.

Such a concept must be confronted with the socio-economic dimension of human aspirations for a better life: welfare, well-being, development or some similar concept. Which of these concepts it should be is the topic of the following section, before returning to our exploration of sustainability.

4. Happiness, Well-being and Welfare

Any of the above words may be used to express a primary goal of government policy: to improve people's lives. In dictionaries (e.g., Merriam-Webster [17]), well-being, welfare and happiness are commonly seen as synonyms, and offering any one of these three words is deemed sufficient to explain the meaning of any other. We propose to consider happiness the broadest concept. A policy that would make everybody happy would surely be considered a good one. It would also generally be considered impossible to design. This is because it is very hard to know what makes people happy. Happiness is a subjective state of mind which only partially depends on objective conditions [18]. It may even be at variance with those conditions: a person may live in objectively very unfortunate circumstances, yet manage to feel happy [19]. That is why 'gross national happiness' (a term coined by the former King of Bhutan) has to be measured either by asking people how they feel [20] which is difficult to connect with concrete policies; or, if measured by objective standards, turns out to be equivalent to what we call well-being [21].

We propose to view happiness as a basic goal of human behaviour [22] but not of policy. Individuals are responsible for their own happiness. Governments cannot make people happy. However, to the extent that happiness does depend on objective conditions external to the individual, policy can and indeed should promote them [23]. What, then, are those conditions and should we call them well-being or welfare?

Of these two terms, well-being is commonly used in a broader sense than welfare [24]. If happiness can be equated with 'subjective well-being' [18,19], then well-being refers to the objective conditions that help to make people happy. It is equivalent to 'livability of the environment' in Veenhoven's scheme of 'qualities of life' [25], and it covers what policy can do to advance happiness. In Amartya Sen's view, well-being ought to be not about material goods or 'basic needs', but about capabilities to achieve one's potential [26]. If well-being is to be a policy goal, this means it should incorporate such intangible needs as freedom, education, security, democracy and justice.

Welfare is then a more limited concept denoting prosperity in terms of material needs such as food, water, health, and shelter. It tends to be easier to measure than well-being and can therefore serve as a useful proxy—as long as we keep in mind that it does not cover all aspects [27]. Other 'social' indicators, often harder to quantify, refer to issues such as participation and cultural values [28]. These fit perfectly into the concept of well-being.

Thus, we propose to replace the social and economic dimensions of sustainability as conventionally used with a single dimension called well-being, which is a policy goal that must be balanced with another one called sustainability. Measuring well-being and sustainability separately will enhance the transparency of the policy formulation process, by bringing out in the open the two issues and clarifying rather than obscuring the choices that have to be made. Of course this does not solve all problems of policy evaluation: well-being has many aspects that need to be weighed against one another.

5. Sustainability: Resources and the Future

Sustainability may then be defined as maintaining well-being over a long, perhaps even an indefinite period. This covers largely the environmental dimension of the triple bottom line, but environment and sustainability are not synonymous. On the one hand, some forms of environmental degradation are both relatively easily reversed and highly noxious in the present—many forms of air and water pollution, for instance. These have a strong well-being aspect. Indeed, in the EU Guidelines for Impact Assessment [10] they appear both under the environmental and the social dimension. On the other hand, what we bequeath to future generations also includes cultural heritage: art and cultural landscapes as well as infrastructure, technology and institutions.

Some of this heritage consists of resources needed for production or, to put it differently, for our survival. It is not always easy to know which ones these are, as resources essential today may be substituted by others tomorrow; and genetic resources potentially useful for medicine may be lost before we have even identified them. Other resources are appreciated for their esthetic, scientific or ‘intrinsic’ value (such as the existence of orangutans, Picasso paintings, or knowledge of black holes). Some of these are not easily lost or are well protected (knowledge, works of art); others are more difficult to preserve (cultural-historical landscapes). Since man does not live by bread alone, there is no fundamental reason to separate the two types. It makes more sense to distinguish between natural and man-made resources, and between renewable and non-renewable ones [29]. Renewable man-made resources are equivalent to what economists call capital, and we shall use the term capital in that sense (Table 1).

Table 1. A Fourfold Classification of Natural and Cultural Resources.

	Non-renewable	Renewable
Natural	e.g., soil, biodiversity, fossil fuels	e.g., water, forest, clean air
Man-made	e.g., paintings, landscapes	capital

As Robert Solow [16] has pointed out, we cannot avoid using up some non-renewable natural resources, but this does not mean that these will necessarily become completely exhausted. In Solow’s view, natural resources (whether renewable or non-renewable) can always be substituted by capital [30]. This can take the form of new materials (say, plastic for steel) or smaller amounts of the natural resource for the same amount of end product (e.g., energy efficiency). New natural resources are harnessed while others become obsolete before they are depleted. An example is the substitution of coke for charcoal in the iron industry as wood for charcoal was becoming scarce, or the transition from hunting and gathering to agriculture in tandem with increasing population densities. In any case, capital continues to increase as natural resources become scarcer.

We do not know, of course, whether technology will always be able to solve our resource problems, and moreover there are resources that we just do not want to lose—such as the blue whale or the Amazon forest. The question is, how much of our natural resources can we sacrifice? More precisely, we should pose two questions: what resources should we preserve at all cost, and to what degree? And, for those that can be substituted for by capital, how much capital should be created to compensate for the loss of how much in terms of natural resources?

The first question is beyond the purview of the economist. It is a decision of society what resources are to be considered essential. Economic analysis can, of course, estimate the cost of their conservation in terms of well-being foregone, to help in the decision-making process. The second question was first analyzed by Harold Hotelling in 1931. Hotelling considered that the depletion of a natural resource may be too slow as well as too fast: the present generation would probably not be better off if our ancestors had limited the extraction of coal to 10% of what they actually used; the progress of manufacturing would have been much slower, and even as it is we are not short of coal for a couple of centuries yet. There is an optimum rate of exhaustion, in which the social cost of losing the resource is outweighed by the social benefit which it yields over the period of use. This benefit can be expressed as rent, which in economic theory means the payment for a production factor above what is needed to keep it operating. In an ideal situation, where a mineral is freely accessible, the rent is the excess of the price of the mineral over the cost of extracting it. Hotelling shows that this rent is maximized if the increase in rent is equal to the discount rate [6]. That rate is an important quantity in welfare economics: it expresses how the value of a future benefit compares to the same benefit in the present. Social discount rates as used for public investments tend to be of the order of a few percentage points per year; if we place a high value on caring for the future, we would use a low discount rate.

Hotelling's theory was taken up taken up by Robert Solow in a lecture in 1974, where he proposes that these resource rents (or Hotelling rents) must be invested in productive capital so as to compensate future generations for their loss of the natural resource. This is also known as Hartwick's rule [16]. Such thoughts are at the basis of funds that some resource-rich countries set up to invest the proceeds of their resource for the future. The big unknown here is, of course, whether capital (including technical progress) can indeed substitute for natural resources indefinitely [31]. While we do not know this, technical progress may provide us with an objective basis for the social discount rate, *i.e.*, the rate that we should use as a society to discount future as compared to present well-being. That basis, according to Randall [31] should be the marginal efficiency of capital, which in the long run is equal to the productivity of society. That brings us closer to measuring sustainability—but not close enough. The productivity of society can be measured only in terms of GDP, which as we saw is not a reliable indicator of well-being. However, Randall is right in pointing out that artificially keeping the discount rate low for the benefit of future generations may actually do those generations a disfavor by misallocating resources today and bequeathing them a lower standard of well-being than they might have enjoyed.

It will by now be clear how crucial the discount rate is for intergenerational equity, which we propose to equate with sustainability. It could be argued that this rate should be zero, in which case the welfare of future generations would be of equal importance to our own. The difficulty with this view is that we do not know what the value of today's natural resources (or of some of them, in any case) will be in the future. A distinction should therefore be made between those resources which we are convinced will always be important (biodiversity is a case in point) and those which depend on the state of technology (for example, the need for oil).

Sustainability can now loosely be defined as a state of affairs where the sum of natural and man-made resources remains at least constant for the foreseeable future, in order that the well-being of future generations does not decline. Ideally, when we assess the potential impact of a proposed policy, programme or project, it should both lead to higher well-being and to a positive or at least neutral

effect on the overall state of resources for the future—in which case we can speak of sustainable development [32].

6. Weak and Strong Sustainability

Sustainability, then, is a matter of what resources—natural resources, quality of the environment, and capital—we bequeath to coming generations. As we saw, some loss of natural resources is inevitable, but this may be compensated for by increased capital—at least in the view of Robert Solow and his ilk. Others, however, oppose the idea that capital can substitute for natural resources and feel that sustainability is a matter of preserving natural resources essential for our survival [33]. The two views are eloquently stated in Pearce *et al.* [32]:

- (i) That the next generation should inherit a stock of wealth, comprising man-made assets and environmental assets, no less than the stock inherited by the previous generation;*
- (ii) That the next generation should inherit a stock of environmental assets no less than the stock inherited by the previous generation.*

These two views have been called ‘weak’ and ‘strong’ sustainability, respectively [34]. Although the difference between them led to a heated debate [35,36], there is a place for both of them. Some resources must fall under the requirement of strong sustainability, others under the weak variety. Which of the two it is will depend on the degree to which they can be substituted by capital. The depletion of fossil fuels, for instance, is an issue of weak sustainability: provided other sources of energy are developed instead, we are not obliged to leave our descendants an undiminished stock of petroleum. An extinct species, on the other hand, cannot, at the current state of scientific knowledge, be recovered, and must therefore be considered a loss in terms of strong sustainability.

Strong sustainability can be seen as a series of thresholds that must not be crossed. In impact assessment, any outcome of a proposed intervention must fall within those thresholds. Setting such thresholds is largely a matter of socially and politically determined preferences, but also a matter of resilience: to what extent is a system (for instance an ecosystem) able to recover from shocks and stress?

We may think of strong sustainability as a space delimited by such thresholds. Weak sustainability is then the yardstick by which policy outcomes within that space are judged. Given that the conditions of strong sustainability are met, the most sustainable outcome will be that which leads to the largest amount of both natural and man-made resources, *i.e.*, environmental assets, valuable landscapes and other forms of cultural heritage, science and technology, infrastructure, *etc.* Such an approach is familiar to economists: in economic analysis, one of the constraints is always the legal system governing an economy, by whose rules an economic agent must play. Strong sustainability is an aspect of such rules.

Thus weak and strong sustainability each have a role to play in impact assessment. However, having such a framework does not mean that there are no more disagreements. For each environmental issue there can be arguments about its substitutability. Generally, ecologists and other natural scientists will favour a larger role for strong sustainability (emphasizing non-substitutable ecosystem functions), whereas economists tend to like weak sustainability as this gives them leeway to use their models.

Strong sustainability puts them out of work. The strongest argument in favour of weak sustainability is that it allows the calculation of the cost of preserving an environmental asset as well as its benefit. For instance, if the cost of mitigating climate change is very high (say, hypothetically, sacrificing 1 percentage point of world economic growth annually in order to avoid 0.05° of temperature increase over 50 years), one might decide to allocate resources to buying land for nature reserves instead. The most crucial variables in sustainability assessment will be the thresholds of strong sustainability, the social discount rate to be used, and the valuation of material benefits *versus* those of 'intrinsic' value.

Strong sustainability has two principal arguments, which we may call ecosystem services and stewardship. According to the former, human life exists only by the grace of nature, which provides a number of essential services termed ecosystem services [37]. We damage these systems at our peril. The second argument is an ethical one, namely that we do not have the right to destroy the right to life of other species, or that we must preserve the beauty and diversity of our natural environment for our own enjoyment as well as for future generations. It is of course not possible for any policy-maker to prevent completely the extinction of species, the decrease of natural habitats or the disappearance of valuable landscapes; but this is not the point of strong sustainability. The point is that any action the policy-maker considers can be assessed in advance for its impact on any aspect of natural resources. The policy-maker can decide in advance what types of impact are tolerable, and for those that are, to ascertain that a permissible negative impact is compensated for in terms of well-being [38].

7. Conclusions

Having reached this point, the reader may feel we have come no closer to solving the practical problem of how to measure sustainability. Indeed we have aimed more at exploring the theoretical basis for defining sustainability than providing a practical manual for measuring it. In spite of the large body of literature on sustainability, we feel that there is still need for clarifying the concept. Since sustainability is a topic of both policy appraisal and scientific study, its definition must be useful for both fields of work.

We believe that separating the needs of the present from the needs of those who will come after us is a sensible way to analyze scenarios and assess the impact of policies, because it clarifies the choices that need to be made. We propose to call the former well-being and the latter sustainability. This prevents sustainability from becoming an empty phrase indistinguishable from 'goodness'. Well-being mostly corresponds with the social and economic dimensions of the 'triple bottom line', sustainability with the environmental dimension.

When assessing the impact of a policy on well-being, the distinction between social and economic dimensions is not helpful and often impossible to make in practice. It is better to use sociological insights to assign values to the different aspects of well-being, and economics to combine those values into an overall assessment. In arriving at actual measurements (inevitable for comparing different possible outcomes), some important but imponderable costs and benefits may have to be left out because they cannot be expressed in quantitative terms. However, they should be left out only from the measurement, not from the assessment. In this way, decision-makers can at least see how much an unmeasured benefit will cost, or what has to be sacrificed for a certain increase in measured well-

being. The concept of welfare may be useful as a subset of well-being—namely, that part of well-being that can be quantified and valued in money terms.

When assessing sustainability, a distinction should be made between strong and weak sustainability. Both can have a place in impact assessment: strong sustainability as thresholds that should not be crossed, weak sustainability for those environmental amenities, natural resources or ecosystem services (these three terms are more, or less, interchangeable) that are in principle substitutable for others. The setting of the thresholds is a matter of policy, but must be informed by scientific knowledge on the resilience of ecosystems. The thresholds can be set so restrictively that no sustainable outcome is possible, and all that policy can do is to minimize the extent by which thresholds are exceeded. The less restrictive they are, the larger the ‘sustainability space’, within which analysts can model and compare different outcomes. Potschin’s and Haines-Young’s notion of sustainability choice space [39] is a way of articulating this.

In such analysis the participation of natural and social scientists (including economists) is needed.

We see this as a possible way to resolve the perennial conflict between economists and ecologists about sustainability, or at the very least a method to handle that conflict. The latter tend to balk at cost-benefit analysis in which natural resources may be substituted by man-made ones, pointing out that natural resources can become lost forever and that such loss should therefore be prevented at all cost. They therefore tend to prefer other tools of decision support, such as multi-criteria analysis. Social cost-benefit analysis has one great advantage, however: once goals have been stated clearly, it shows up the best choice among alternatives. This forces policy-makers to show their hand and put their money where their mouth is, so to speak. Qualitative tools leave them the freedom to choose one alternative over another more or less arbitrarily, though there are of course examples of political decisions being made contrary to cost-benefit indications. The major disadvantages of cost-benefit analysis are our ignorance of the future (especially technical progress) and the difficulty of quantifying many variables. Hence we propose to identify some natural resources as belonging outside the domain of cost-benefit analysis. That tool should be restricted to those resources where substitutability is believed to be applicable. Which resources can be so treated remains, of course, a matter of debate and, ultimately, of politics.

Those resources which we deem irreplaceable and which must therefore be preserved at all costs are the domain of strong sustainability. Here we must ask ourselves not only what degree of well-being we should bequeath to other generations, but even more profound questions relating to the long-term survival of our species as well as our responsibilities towards other species [40]. This, however, is beyond the scope of this paper.

The ideas advocated in this paper are not new. Indeed we have been inspired by the authors quoted, last but not least by the Brundtland Report [1], which in the literature is generally recognized as the initiator of the sustainability debate and to which we hark back. We believe, however, that the particular way we propose to combine the various dimensions into well-being and sustainability is more precise as well as more comprehensive than the way the concept of sustainability is commonly used at present. Ultimately, the point of sustainability appraisal must be that a balance is sought between the requirements of stewardship on the one hand and the desire for a better life on the other—or even, the extent to which these can be reconciled.

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22. Although not necessarily the only goal. A person may strive not for her own happiness, but for the good of her community, the prestige of her family, or some other ideal; or she may wish to adhere to a moral code superseding the pursuit of personal happiness. One might say that such a person still strives for happiness, since these goals apparently make her happy. However, that would be a tautology, implying that happiness is whatever a person strives for; it would render the concept of happiness meaningless. Instead, we may say that everyone strives for what he considers ‘the good life’, and one form of this is happiness.
23. On the empirical relation between those objective conditions and happiness, see Johns, H.; Ormerod, P. *Happiness, Economics and Public Policy*; Institute of Economic Affairs: London, UK, 2007.
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27. Economists often use the term utility to express the satisfaction people get from goods and services. It is theoretically equivalent to well-being, although the way it is normally measured in practice makes it more similar to welfare.
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29. It is not always evident when a resource can be considered renewable. We propose that a resource is non-renewable if it cannot be recovered or replenished with today’s technology neither at a practicable cost nor within a reasonable time. It will be clear that renewable or non-renewable is often a matter of degree—some renewable resources are replenished more easily than others.
30. This is not true in an absolute sense, of course. It is not possible to produce (or indeed to live) without any natural resources at all [33] Solow’s point is that we need to study only those situations where such substitution remains possible.
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38. The question may be asked whether human well-being is all that counts in policies. Is there not something in the stewardship argument that goes beyond our own well-being? To this it could be replied that “man is the measure of all things”, a statement ascribed to the Greek philosopher Protagoras. However a policy is judged, it can only be judged by humans on the basis of values attached by humans. If we think the great panda should not disappear, this is based on the scientific, esthetic or ethical value we place on it.
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