

Wealth as a Criterion for Sustainable Development

by

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0 Motivation and Summary

In recent years, debates on how to measure the quality of life have been influenced by two dichotomies: (1) the constituents vs. the determinants of well-being, and (2) current vs. sustainable well-being.¹ In publications from international organizations, much has been made of the former dichotomy (e.g., UNDP, 1994), but nothing specific has emerged there on the latter. It is the case that the most well-known indices of social well-being - Gross National Product (GNP) per head and the United Nations Development Programme's Human Development Index - are for all practical purposes measures of current well-being. Given the attention "sustainable development" continues to receive in international discourses, we need an index with which to check if current policies are consistent with sustainable development.

In this article we argue that the correct index for checking if development is sustainable is wealth. The index is based on the determinants of well-being. We show that when it is estimated on the basis of accounting prices, wealth measures not only current, but also future well-being, including whatever distributional concerns one would wish to see embedded in our ethical deliberations. Accounting prices reflect the tradeoffs among present and future well-beings, and among contemporaries too. Adam Smith may have had other things in mind when he inquired into the wealth of nations, but he was correct to do so. Of course, wealth per se has no meaning, but wealth comparisons do, and sustainable development involves intertemporal comparisons of well-being.

The plan of the paper is as follows: Section 1 distinguishes the constituents of well-being from its determinants. Section 2 contains a discussion of UNDP's Human Development Index (HDI). We show that it does not reflect any of the tradeoffs that are involved in ensuring that economic development is sustainable. In Section 3 we argue that the concept of sustainable development invites us to identify an economy's productive base, consisting as it does of the economy's institutions and its capital assets. Wealth is defined to be the accounting worth of an economy's capital assets. The notion of wealth we advance here is a comprehensive one, including not only the social worth of manufactured capital, but also knowledge, human, and natural capital. The change in wealth over a (short) period of time, measured at constant accounting prices, is called genuine investment. In Section 4 it is shown that, subject to certain qualifications, if genuine investment per head is positive, well-being is sustainable. This finding is the touchstone with which other suggested criteria ought to be judged. In Section 5 we argue that a recent suggestion that growth in total factor productivity is a reliable index of economic progress is defective. Section 6 contains a discussion of why Net National Product (NNP) too cannot serve as an index of sustainable development. We show that excepting under unbelievable circumstances, NNP is not a return on wealth. A country's NNP can rise even while its wealth declines.

In Section 7 the findings in Sections 3 and 4 are put to work on some crude data from the poorest countries in the world. The picture which emerges about recent development experiences and the problems poor countries now face is substantially different from the one portrayed in the contemporary literature on economic development. Countries which would be regarded as having performed well if judged on the basis of such indices as GNP per head or the Human Development Index are found to have grown poorer, a few alarmingly so. The estimates we offer are very crude, but they suggest that the poorest countries of the world have "developed" by depleting natural capital relative to their high population growth rates. This finding is at variance with current thinking among development economists that in poor countries high population

¹ In what follows we use the terms "quality of life" and "well-being" interchangeably.

growth hasn't been a hindrance in the recent past.²

1 Constituents or Determinants?

There are two ways to measure social well-being (henceforth well-being). One is to study its constituents, including health, happiness, freedom to be and do and, more broadly, basic liberties. The other is to value its commodity determinants, which are commodity inputs in the production of well-being, such as food, clothing, potable water, shelter, access to knowledge and information, and resources devoted to national security. The former procedure measures "output" (health, the exercise of one's abilities, and civil and political liberties), whereas, the latter values and then aggregates the required "inputs" (expenditure on food, clothing, education, potable water, shelter, and resources deployed for the protection and promotion of civil and political liberties). If undertaken with sufficient precision and care, either on its own would do the job: changes in a suitable measure of either the constituents, or the determinants, can serve as a measure of changes in the quality of life in a society.³ Along the former route we would measure the constituents directly and aggregate them in a suitable way, using social weights to reflect the relative worth of the various constituents. Along the latter route we would need to estimate accounting prices of the determinants of well-being in order to arrive at a suitable index for the purpose in hand. Roughly speaking, the constituents and determinants of well-being can be thought of as being ends and means, respectively. Moral and political philosophers regard the constituents to be the obvious objects of study, in contrast to economists and statisticians, who gravitate toward the determinants. There is a cultural divide here.

The cultures often clash. Consider education and skills. Are they constituents or determinants? They are in fact both. The acquisition of education is partly an end in itself and partly a means to increasing future income by improving skills. Aristotelian ethics emphasizes the former, while the economics of "human capital" stresses the latter. That education has both flavours doesn't pose problems so long as we are able to track the two and their contributions to well-being. Double-counting is a virtue when a commodity offers joint benefits. Education ought to be counted twice.

Those who pioneered the economics of human capital contributed greatly to our understanding of the process of economic development by drawing attention away from Aristotelian virtues.⁴ If governments in today's poor countries were persuaded that education doesn't increase productivity, but is solely an end in itself, they would have an excuse to neglect it even more than they currently do. Governments could argue that poor countries cannot afford luxuries.

2 Current vs. Sustainable Well-Being

To fix ideas, we consider the simplest possible world that captures the tensions between current and future people.⁵ Suppose population is constant and the economy is deterministic. Time is discrete and is denoted by t ($= 0, 1, 2, \dots$). Let C_t denote aggregate consumption and $U(C_t)$ current well-being at t . We are to imagine that C_t is a composite index of consumption goods and services, having been estimated with whatever distributional concerns that are to be reflected in the valuation exercise. U is a flow.

² Bauer (1981, 2000), Kelley (1988), Simon (1989), Sen (1994), and Temple (1999).

³ This is shown formally in Dasgupta (1993, ch. 7*).

⁴ Schultz (1974) and Becker (1983).

⁵ For extensions, see Dasgupta and Mäler (2000, 2001).

Consider an arbitrary date t . Let (C_t, C_{t+1}, \dots) be a consumption stream, which is a sequence of aggregate consumption from t onward. Denote intergenerational well-being at t by V_t . Presumably, V_t is a function of (C_t, C_{t+1}, \dots) . A commonly assumed form for V is,

$$V_t = \sum_t^{\infty} \beta^{(t-t)} U(C_t), \text{ for } t \geq 0, \text{ where } \beta \equiv 1/(1+\delta), \text{ with } \delta > 0. \quad (1)$$

In words, intergenerational well-being is the present discounted value of the stream of current well-beings. In equation (1) $\beta^{(t-t)}$ is the discount factor and δ is the corresponding discount rate. δ is often called the pure rate of time preference.⁶

The phrase sustainable development was introduced by the International Union for the Conservation of Nature and Natural Resources.⁷ The publication drew attention to the role played by the natural environment in our economic life. But the phrase became a commonplace only after the publication of a report by the World Commission on Environment and Development, widely known as the Brundtland Commission Report, where sustainable development was defined as "... development that meets the needs of the present without compromising the ability of future generations to meet their own needs".⁸ The idea is that, relative to their respective demographic bases, each generation should bequeath to its successor at least as large a productive base as it inherited from its predecessor. If it were to do so, the economic possibilities facing the successor would be no worse than those it faced when inheriting productive assets from its predecessor.

The above definition is based on well-being's determinants. What would the corresponding definition be if sustainable development were to be defined in terms of well-being's constituents?

Consider then the following definitions:

(X) The consumption stream $\{C_0, C_1, \dots, C_t, \dots\}$ corresponds to a sustainable-development path at t if $U(C_{t+1}) \geq U(C_t)$; that is, if $C_{t+1} \geq C_t$.

(Y) The consumption stream $\{C_0, C_1, \dots, C_t, \dots\}$ corresponds to a sustainable-development path at t if $V_{t+1} \geq V_t$.

It is clear that Y nails the idea of sustainable development, while X fails to do so. Being concerned only with comparisons of current well-being (U), criterion X could be satisfied at t even as the economy's productive base is allowed to shrink, jeopardising life in the future. It could even be that current well-being increases between t and $t+1$ only because prevailing policies discourage the accumulation of manufactured capital and are also rapacious in the use of the natural environment. Criterion X would be unable to detect this. Such measures of the quality of life as the Human Development Index of the United Nations Development Programme suffer from this weakness (see Section 3). In contrast, criterion Y is able to detect if existing policies are myopic, precisely because it involves a comparison of intergenerational well-beings (V). So we adopt Y as the definition of sustainable development and refer to V_t as social well-being, or well-

⁶ The formulation is so well known that we do not elaborate on it here. The interested reader will find a non-technical account in Dasgupta (2001).

⁷ IUCN (1980).

⁸ WCED (1987: 43).

being for short.

The consumption stream the economy faces at any date depends on a myriad of factors, among which are the capital assets the economy has inherited from the past, the institutions which govern the allocation of resources, people's preferences, and technological possibilities. We focus here on the dependence of V on the existing capital assets. That dependence is the link between well-being and wealth.

3 The Human Development Index: Development as What?

Gross national product (GNP) is known to be more a measure of aggregate economic activity than of social well-being. Nevertheless, it has become the touchstone by which economists, historians, politicians, journalists, and commentators judge the progress of nations. Its use has also been criticized on a regular basis by economists, historians, politicians, journalists, and commentators. While some historians construct time series on GNP and wages, others unearth mortality and anthropometric statistics.⁹ Reflecting the same kind of professional schizophrenia, it is routine practice in economics to use growth in GNP per head as the criterion for judging the progress of nations, even while some in the profession complain that GNP is insensitive to the incidence of poverty, and yet others argue that the complaint is unwarranted because growth in GNP per head is typically accompanied by a reduction in poverty (the "trickle down effect"). Despite these differences in perception, GNP has become so much a part of our collective consciousness, that when someone says "growth" in an economic context, it is understood that they mean growth in GNP. People would seem to be comfortable adopting a stance of critical allegiance to the measure.

The United Nations Development Programme (UNDP) is an exception. Since its inception in 1990, UNDP's annual Human Development Report has engaged in a campaign against the use of GNP as an index of the quality of life within nations. In its stead, the organization has proposed what it calls a Human Development Index (HDI). Over the years, however, the Report's increasingly overexcited prose has served to detract from what HDI does not deliver. So much so, that many who find GNP unduly limiting are drawn to HDI for comfort. It will pay to study the index here.¹⁰

Imagine that countries are assessed on the basis of M attributes (indexed by i), each of which is deemed to be desirable. There are N countries, indexed by j . Let X_{ij} (a cardinal number) be the index of attribute i in country j . UNDP defines country j 's "performance gap" in attribute i to be,

$$I_{ij} = [\max_j \{X_{ij}\} - X_{ij}] / [\max_j \{X_{ij}\} - \min_j \{X_{ij}\}].$$

The average performance gap for country j is defined as,

$$I_j = \sum_i [I_{ij}] / M.$$

UNDP's Human Development Index for country j is then defined to be,

$$(HDI)_j = (1 - I_j).$$

Notice that $(HDI)_j$ is a number lying in the interval $[0, 1]$. The higher is $(HDI)_j$, the better is j in terms of the M attributes. HDI is a simple and seemingly appealing index of the average quality of life in a country.

In practice, HDI has been based on three attributes: life expectancy at birth, GNP per head, and adult literacy. What aspects of life's quality do they reflect?

Life expectancy at birth is the expected length of life of a randomly chosen new-born if the prevailing age-specific mortality rates persist. We stress the conditionality, because it is a reminder that life

⁹ Among the others are Fogel et al. (1983) and Floud, Wachter and Gregory (1990).

¹⁰ HDI has been refined in a number of ways. We ignore the refinements here because they do not meet the criticisms that we will make of the index.

expectancy at birth is a constituent of current well-being. But life expectancy at birth this year says nothing about life expectancy at birth next year. It could be that expectancy of life has been rising in recent years but is about to decline, owing to institutional decay and increased resource scarcity. Indicators of current well-being, such as life expectancy at birth, would be unable to signal this. The decline would catch everyone by an unpleasant surprise.

GNP (in a closed economy) is the sum of aggregate consumption and gross investment. Consumption is a determinant of well-being. But what about investment? As current practice goes, national income statisticians measure investment in manufactured capital with the greatest care, but play fast and loose with economic theory when they come to the other measurable forms of capital, namely, human capital and natural capital. For example, expenditure on school buildings and equipment is recorded as investment, but salaries of teachers are not. Similarly, the construction of scientific laboratories is regarded as investment, but scientists' salaries are not so regarded. Moreover, for the most part, natural capital is ignored.

If these lacuna were removed, net investment in the overall productive base would measure the social worth of the flow of additional consumption that would become available over time if the investment were made.¹¹ By "net" we mean net of depreciation of assets. It is the "gross" bit that makes GNP wholly unsuitable as a measure of intertemporal well-being, no matter how carefully and extensively one measures it. GNP is a component of neither current well-being, nor future well-being.

Of the three components of the Human Development Index, it is adult literacy that reflects something about future possibilities. Typically, it is defined as the proportion of the adult population that are literate. In this context, adults are frequently defined as people aged 15 or more. Adult literacy is a stock, not a flow. Even though crude, it is a measure of human capital. Like other forms of capital, it depreciates. When people die, they take their literacy with them. A country has to invest in it continually to prevent the stock from declining.

Literacy is a constituent and a determinant of well-being. The theory of human capital focuses on literacy's role as a determinant. UNDP (1995) stresses that it is also a constituent. Literacy is a component of both current well-being and well-being through time.

As a measure of social well-being, the Human Development Index is therefore three-thirds current and one-third intertemporal. But because adult literacy is only one type of capital asset, the one-third isn't adequate for reflecting intertemporal concerns. If we are interested in both the present and future, neither GNP per head nor the Human Development Index is satisfactory. The reason is that neither measure is derivable from a coherent view of human well-being. In Section 4 we identify a measure that is implied by ethical thought.

3 Capital Assets and Accounting Prices

An economy's productive base includes not only manufactured capital, human capital, and knowledge, but also natural capital and the economy's institutions. Together, they determine the production, allocation, and use of goods and services. A society's productive base is the source of its well-being.

The base itself is a diverse collection of durable objects, some tangible and alienable (buildings and machinery, land and animals, trees and shrubs), some tangible but non-alienable (people, the oceans), some intangible but alienable (codified pieces of knowledge, such as patentable ideas), some intangible and non-alienable (air, skills, the legal framework, and cultural coordinates), and some that are yet to be defined in

¹¹ Dasgupta and Mäler (2001).

an acceptable way (social capital).¹² This heterogeneity poses a problem. No doubt it serves heuristic purposes to refer to all but people as capital goods and then to say that output is produced by people and capital goods, but explaining that to economic statisticians is not much use. They ask how all the bits and pieces called capital goods are to be measured and valued.

The objects they seek to measure are accounting prices, which reflect the social worth of goods and services. The accounting price of something is the improvement in the quality of life that would be brought about if a unit more of that thing were made available costlessly (or, alternatively, the deterioration in the quality of life that would occur if there were a unit less of that thing).¹³

If the good isn't a "good", but is instead a "bad" (sulfur emission), its accounting price is negative. But even if a good is a "good", its accounting price could be negative if the economy's institutions are bad: offering an extra unit of the good to someone could lower social well-being. Examples include common-property resources suffering from the tragedy of the commons. To illustrate, consider that carbon is emitted into the atmosphere when fossil fuels are burnt. The use of fossil fuels by motorists yields not only private benefits, but also collective losses (enhanced greenhouse effect). If emissions are untaxed, private benefits would not include the collective damage caused by the combustion of fossil fuels. Imagine now that the collective damage arising from a marginal increase in the use of fossil fuels exceeds private benefits. An additional unit of fossil fuels awarded to a motorist would then lower social well-being. The accounting price of fossil fuels in a motorist's vehicle would be negative.

Ways of estimating accounting prices have been devised by economists for various types of assets, including natural capital. As we would expect, at one extreme are some that are relatively easy to estimate (e.g., because market prices are a good approximation), while at the other, there are those that are impossible to estimate.¹⁴

Conceptually, the most problematic is social capital. Economists have come down hard on the concept.¹⁵ In his work on Italy, Putnam (1993) pursued an interesting route for measuring social capital. Putnam's unit of analysis was a region, and in cross-regional data he found a strong positive relationship between economic performance and measures of "civic engagement", such as membership in unions and choral societies.¹⁶ From this finding to the thought that civic engagement matters for economic performance is a natural step. It is a step Putnam took with relish.

Economists do not question that move. What bothers them is a measurement problem. The form of civic engagement evolves over time. Even when choral societies are hard-pressed to attract new recruits, it could be that citizens are discovering new ways to connect with one another (e.g., via the internet), which itself could be the reason why choral societies are hard-pressed. Measurement problems abound in the search

¹² On social capital and the difficulties surrounding its definition, see the essays in Dasgupta and Serageldin (2000).

¹³ An alternative name is shadow price.

¹⁴ For a summary account, see Dasgupta (2001).

¹⁵ See, especially, Arrow (2000) and Solow (2000).

¹⁶ Inter-village data from poor countries have revealed similar relationships. See, for example, Narayan and Pritchett (1999).

for social capital. Nor were matters helped by the fact that Putnam defined social capital to be "... features of social organization, such as trust, norms, and networks that can improve the efficiency of society by facilitating coordinated actions".¹⁷ As a characterization this appears beguiling, but it suffers from a weakness: it encourages us to amalgamate in turn beliefs, behavioural rules and such forms of capital assets as interpersonal networks, without offering a hint as to how they are to be amalgamated.

A large contemporary literature on social capital interprets the concept as an economy's institutions.¹⁸ Admittedly, a name is but a name, but some names can mislead. To call a society's institutions "capital" is less helpful than may seem. Institutions are distinct from other forms of capital, in that they guide the allocation of resources (among which are the capital goods themselves!). Institutions are better seen as resource allocation mechanisms, a familiar enough term in economics. Economic forecasts can only be made on the basis of an understanding of an economy's resource allocation mechanism¹⁹

It is easy to appreciate why economic statisticians left social capital aside from their accounting scheme. But they did not have to neglect as much of natural capital as they have. Current accounting practices have been shaped partly by developments in economic theory and partly by internal dynamics in accounting. For example, while the value of agricultural land is included in accounting systems, watersheds aren't valued in their entirety. Of course, bits of watersheds are valued, namely, those supplying commercial products. However, most of the myriad of non-commercial services they provide are excluded. Nor are the commercial benefits bestowed on enterprises outside a watershed included.

One explanation for the bias is that, until recently there was little theory to guide economic statisticians in the direction of the natural environment. But the necessary theory is now in hand. There is no reason why national accounting systems should remain confined in the way they have been so far.

4 What Does Productivity Growth Measure?

Some have located signs of economic progress in a statistic very different from GNP or UNDP's Human Development Index. In seeking to interpret the expansion of the United States economy during the decade of the 1990s, the Economist has recently exclaimed:

"In judging an economy's prospects, what is the most important measure? Growth in GDP? Inflation? The size of the budget surplus? The level of the stockmarket? None of the above. Far more important is growth in productivity, which is crucial in itself and which affects all of those things and more."²⁰

We take the passage to refer to total factor productivity. But what does growth in total factor productivity (which is also called the residual) measure? The passage quoted above implies that it reflects an economy's prospects. But does it?

Traditionally, labour-force participation, manufactured capital, and marketed natural resources have been the recorded factors of production. In recent years human capital has been added. Attempts have been

¹⁷ Putnam (1993: 167).

¹⁸ See, for example, the Special Issue of the Journal of Interdisciplinary History, 1999, 29(3), on "Patterns of Social Capital: Part I".

¹⁹ Formally, a resource allocation mechanism is a mapping from an economy's stocks of capital assets to a complete future history of resource allocation in the economy. The mapping depends, among other things, on the character of the economy's institutions. The competitive market-equilibrium mechanism is an example of a resource allocation mechanism.

²⁰ Economist (2001, February 10-16: 22).

made also to correct for changes in the quality of manufactured capital owing to research and development. But national accounts mostly still don't include the use of non-marketed natural resources, nor for that matter, non-marketed labour effort. They do not, for the understandable reason that accounting prices of non-marketed natural resources are extremely hard to estimate. Moreover, how do you estimate unrecorded labour effort? Now imagine that over a period of time the economy makes increasing use of the natural-resource base, or of unrecorded labour effort. The residual would be over-estimated. In fact, a simple way to increase the residual would be to "mine" the natural-resource base at an increasing rate. But this would be a perverse thing to do if we seek to measure economic prospects.

What if it is possible to decompose the growth of an economy's aggregate output in a comprehensive manner, by tracing the growth to the sources originating in all the factors of production? To assume that over the long run the residual could still be positive would be to imagine that the country enjoys "free lunch" (like manna from heaven). Is the latter a possibility? One way to enjoy free lunch, for poor countries at least, is to use technological advances made in other countries without paying for them. The residual would then reflect increases in freely available knowledge. However, adaptation is not without cost. To meet local conditions, adjustments need to be made to product design and to the processes involved in production.

For rich countries, the residual could reflect serendipitous growth in knowledge. It has been observed by historians of science though that serendipity is the good fortune of prepared minds. As preparation involves engagement, time, and resources, we are led back to the factors involved in the production of knowledge. Once we take into account the contribution of those factors of production, the residual could well be negligible.

Leaving aside these doubts, imagine that serendipity can be reliably expected to be the source of the residual. It would still be only one component of the sources of growth in GNP. Moreover, GNP is not a measure of social well-being. These are reasons why the residual should not be viewed as an indicator of an economy's prospects. It is all too possible for country A to record a higher residual than country B even as social well-being in B increases, while that in country A declines.

Total factor productivity can have short bursts in imperfect economies. Imagine that a government reduces economic inefficiencies by improving the enforcement of property rights, or by reducing centralised regulations (import quotas, price controls, and so forth). We would expect the factors of production to find better use. As factors re-align in a more productive fashion, total factor productivity would increase.

In the opposite vein, the residual could become negative for a period. Increased government corruption could be a cause. The cause could also be civil strife, which destroys capital assets and damages a country's institutions. When institutions deteriorate, assets are used even more inefficiently than they had been previously. The residual declines. This would appear to have happened in sub-Saharan Africa during the past forty years.

As the name suggests, the residual reflects our ignorance of the sources of change in aggregate output, be the change positive or negative. The originators of the concept didn't interpret it as a measure of an economy's prospects, and they certainly didn't mean it as a measure of prospects over the long run.²¹ They were right not to have done so.

Table 1, taken from Collins and Bosworth (1996), gives estimates of the annual rate of growth of GNP per head and its breakdown among two factors of production (manufactured and human capital) in

²¹ Abramovitz (1956) and Solow (1957).

various regions of the world. The estimates are given in the first three columns. The period was 1960-94. The fourth column of figures represents the residual in each region. They are simply the difference between figures in the first column and the sum of the figures in the second and third columns.²² Collins and Bosworth did not include natural capital as factors of production. If the use of environmental services has grown during the period in question (a most likely possibility), we should conclude that the residual is an overestimate. Even so, the residual in Africa was negative (-0.6 percent annually). The true residual was in all probability even lower. The residual in South Asia, the other really poor region of the world, was 0.8 percent annually, but as it is undoubtedly an overestimate, we are unclear if there has been any growth in total factor productivity in that part of the world. One can but conclude that two of the poorest regions of the world (the Indian sub-Continent and sub-Saharan Africa) have not improved their institutional capabilities over four decades, nor were they able to improve productivity by making free use of knowledge produced in advanced industrial nations.

5 Wealth and Genuine Investment: Theory

Taken together, investment in manufactured capital, human capital, the natural environment, and expenditure on research and development change the capital base of an economy.²³ It is in the nature of things that the mix of the base varies across space, time, and circumstances. Possibilities of substituting one type of capital good for another in production affects the way the mix changes. Although seemingly innocuous, enlarging our conception of an economy's capital base has significant implications for the way development processes are viewed. We confirm this below.

UNDP (1994: 14-15) castigates those who regard GNP to be an index of social well-being on grounds that it is a measure of a country's opulence. The criticism is faulty in two ways. First, opulence is a stock concept, and GNP is not a return on any index of opulence that we are aware of.²⁴ Secondly, and more importantly, the connection drawn in Section 1 between the constituents and determinants of well-being tells us that it is not a mistake to seek to measure a society's well-being in terms of an index of opulence. The point isn't that opulence misleads, but rather that we should search for the right measure of opulence.

A country's wealth is the social worth of its capital assets. It is a measure of the nation's opulence. It can be shown that, subject to a well-defined set of qualifications, it is simultaneously a measure of social well-being.

At date t , let K_{it} be the quantity of the i^{th} manufactured asset, H_{jt} the quantity of the j^{th} form of human capital, S_{kt} the quantity of the k^{th} natural capital, and Z_{mt} the stock of the m^{th} type of knowledge.²⁵ Next, let well-being at t (V_t) be the unit of account, and let p_{it} , h_{jt} , r_{kt} , and q_{mt} , respectively, denote their accounting prices. They are spot prices. The economy's wealth at t can then be expressed as:

$$W_t = \sum_i (p_{it} K_{it}) + \sum_j (h_{jt} H_{jt}) + \sum_k (r_{kt} S_{kt}) + \sum_m (q_{mt} Z_{mt}). \quad (2)$$

The notion of wealth being advanced here is a comprehensive one, being the social worth of an

²² Subject to rounding-off errors.

²³ In their monograph on the character of economic growth, Thomas *et al.* (2000) have this as their opening point.

²⁴ One can even argue that, because it doesn't take note of capital depreciation, GNP cannot be a measure of opulence.

²⁵ It may appear contrived to talk of a measurable stock of knowledge, but as we will see presently, we don't need to measure stocks, only the social worth of changes in stocks.

economy's entire capital base. But what do we mean by the i^{th} manufactured asset or the k^{th} natural capital at t ? How should we decide that a pair of assets should be regarded as distinct, rather than the same? We should of course include physical and chemical properties in an asset's attributes. But we should include more. For example, transport costs for traditional manufactured goods are a reason why location matters. Transport costs can assume an extreme form in the case of natural capital. The ecological role of a species of plants is site-specific. A species in one location is a different asset from that same species elsewhere.

In imperfect economies the institutions governing the use of an asset matter too. Even if they possess similar ecological properties, a private fishery is a different asset from a fishery to which there is free access. For classifying assets, ownership matters.²⁶

A country's wealth is the sum of the social worth of all the bits and pieces of manufactured capital, human capital, natural capital, and knowledge. Of course, a figure for wealth is meaningless in itself, but differences in wealth is meaningful. We may ask, for example, if, correcting for demographic differences, a country is wealthier now than it was earlier. It is useful to ask the question because, as we shall see, wealth can be used as a measure of a society's well-being.

As an index of well-being, wealth has the merit of being linear in assets, the accounting price of an asset being the weight awarded to a unit of the asset. A country's wealth in a given period is its wealth in the previous period plus net investment made during the previous period. Wealth increases if, and only if, there is net investment in the capital base.

It helps to formalize this. For convenience, regard time to be continuous. We then define net investment at time t to be:

$$I_t = \sum_i (p_{it} dK_{it}/dt) + \sum_j (h_{jt} dH_{jt}/dt) + \sum_k (r_{kt} dS_{kt}/dt) + \sum_m (q_{mt} dZ_{mt}/dt). \quad (3)$$

We will call I_t genuine investment at t . I_t is the social worth of the change in the capital base at t . I_t measures the change in wealth at t , in spot prices.

Let us assume for the moment that population remains constant. Assume too that the acquisition of knowledge is not costless. Imagine also that, being an imperfect economy, there are no significant institutional changes under way. It can be shown that under these circumstances genuine investment is equal to the rate of change in social well-being. This means the quality of life improves if genuine investment is positive, not otherwise. To put it formally,

$$I_t = dV_t/dt. \quad (4)$$

Equation (4) says that genuine investment measures change in social well-being. Moreover, if genuine investment is positive, a country becomes wealthier; contrariwise, if it is negative, the country becomes poorer (equation (3)). So, the accumulation of wealth amounts to an increase in social well-being.²⁸

Of course, if the population is too large and the natural environment overly depleted, it may not be possible to increase wealth. The finding we are describing here are of the "if and only if" kind, they don't say on their own if substitution possibilities between the natural environment and other forms of capital are

²⁶ Thus for theory. In practice, refined partitioning isn't feasible. Economic statisticians are compelled to lump together what are often different assets.

²⁷ See Dasgupta and Mäler (2000).

²⁸ These ideas have recently been put to use in assessing various long-term forecasts of world food production. See Dasgupta (1998) and Daily et al. (1998).

sufficiently large for wealth to increase at the expense of Nature.²⁹ Imagine, for example, that substitution possibilities are limited, and the economy's institutions are profligate in the use of natural resources. The quality of life will then not be sustainable. This would be signalled by the fact that, at some future date, accounting prices will assume such values as to make it impossible for genuine investment to be positive: natural capital will have to be run down if there is to be any consumption. Social well-being declines when genuine investment is negative. So, movements in social well-being and genuine investment are two sides of the same ethical coin.

The assumption that the size of the population is constant is wrong. Suppose then that population is projected to increase (or, for that matter, decrease). Since numbers should matter, an adjustment needs to be made to estimates of genuine investment. It can be shown that, as an approximation, changes in wealth per head reflect changes in social well-being: If genuine investment per head is positive, social well-being increases, whereas, if it is negative, social well-being declines. The criterion for sustainability is therefore genuine investment per head.

6 Why Not NNP?

GNP is insensitive to the depreciation of capital assets, while wealth is the social worth of those very assets. So there is little reason to expect movements in GNP to parallel those in wealth. But, subject to the qualifications made earlier, wealth and social well-being are equivalent. It is then possible that GNP increases for a time even while the country becomes poorer and social well-being declines. The moral is banal: GNP is not a measure of the quality of life.

What about net national product (NNP)? What ethical significance does NNP have?

NNP looks promising because it is consumption plus genuine investment. To formalise, let us return to the base case, where population is constant. Let v_t be the accounting price of consumption.³⁰ On using equation (3), we may express NNP at date t as,

$$NNP_t = v_t C_t + I_t = v_t C_t + \sum_i (p_{it} dK_{it}/dt) + \sum_j (h_{jt} dH_{jt}/dt) + \sum_k (r_{kt} dS_{kt}/dt) + \sum_m (q_{mt} dZ_{mt}/dt). \quad (5)$$

Equation (5) says that genuine investment would be positive if the value of consumption were less than NNP, but that it would be negative if it exceeded NNP. If wealth is to increase, consumption must not exceed NNP. This is the ethical significance of NNP, a fact noted by those who originally explored the concept of NNP.³¹

In recent years though, far more has been claimed on behalf of NNP. It has been said that NNP is the "interest" on social well-being.³² If δ is the rate at which future well-being is discounted, the claim would read,

$$NNP_t = \delta V_t. \quad (6)$$

Solow (1992: 17) has gone further. He has suggested that NNP is the return on wealth: "Properly defined and properly calculated, this year's net national product can always be regarded as this year's interest on society's total stock of capital."

²⁹ Dasgupta and Heal (1979, chs. 8 and 10) offer a technical account of substitution possibilities.

³⁰ Well-being is the unit of account.

³¹ Lindahl (1934), Hicks (1940), and Samuelson (1961).

³² Weitzman (1976, 1998). In their important early work on green accounting, Repetto *et al.* (1989) also interpreted NNP to be an index of well-being, while observing that genuine investment must be positive if consumption is to be sustainable.

As we understand it, this interpretation would read as,

$$\text{NNP}_t = \delta[\sum_i(p_{it}K_{it}) + \sum_j(h_{jt}H_{jt}) + \sum_k(r_{kt}S_{kt}) + \sum_m(q_{mt}Z_{mt})]. \quad (7)$$

But equations (6) and (7) are true only under very restrictive circumstances. Equation (6) holds if well-being is linear in the flow of consumption goods and services, but not otherwise, while equation (7) is true if well-being is linear and accounting prices are constant over time, but not otherwise. There is every ethical reason for rejecting the former condition.³³ The latter condition, that accounting prices are constant over time, holds only if the flow of goods and services, relative to one another, remains the same, year in and year out. In the world as we know it, neither assumption should be acceptable.

What is the intuition behind these results? Why isn't NNP adequate? The problem lies in price changes. It can be shown that,

$$dV_t/dt = v_t dC_t/dt + dI_t/dt. \quad (8)$$

Using equation (3) in equation (8) we may conclude that social well-being increases during a brief interval of time if, and only if, the value of changes in consumption services plus the change in the value of net changes in capital assets is positive.

Notice the transposition of "change in" and "value of" in the previous sentence. The requirement is that the change in consumption is valued at its current accounting price, but changes in the structure of capital assets are not so valued, movements in the assets' accounting prices are also included. It is possible for NNP to grow for a time even while a country becomes poorer and the quality of life declines. As an index of social well-being, not only GNP, but NNP too is inadequate.³⁵

8 Wealth and Genuine Investment: Applications

Reporting studies undertaken at the World Bank, Hamilton and Clemens (1999) have provided estimates of genuine investment in a number of countries. They call it "genuine saving". The authors included in a country's capital base its manufactured, human, and natural capital. There is a certain awkwardness in some of the steps the authors took to estimate genuine investment. For example, investment in human capital in a given year was taken to be public expenditure in education. It is an overestimate, because each year people die and take their human capital with them. This is depreciation, and should have been deducted.

Among the resources making up natural capital, only commercial forests, oil and minerals, and the atmosphere as a sink for carbon dioxide were included (not included were water resources, forests as agents of carbon sequestration, fisheries, air and water pollutants, soil, and biodiversity). So there is an undercount, possibly a serious one. Nevertheless, one has to start somewhere, and their's is a useful compendium of estimates.

³³ For example, because it is wholly insensitive to distributional matters.

³⁴ Dasgupta and Maler (2000).

³⁵ NNP comparisons over time can be made to reflect changes in social well-being by a sort of deus ex machina. A way to do it is to make use of the changes in the structure of accounting prices over time to re-estimate consumption and genuine investment, and to re-estimate them in such ways that comparisons of the re-estimated NNP correspond to changes in social well-being. Asheim and Weitzman (2001) have explored this route and have found a way of doing this which makes the re-estimated NNP proportional to social well-being. The problem is that their device is dependent on the numeraire they construct. In the text, we are talking of properties of indices that do not depend on the numeraire, for the reason that those that do are in effect contrivances, they don't reflect deep underlying properties.

Being a global commons, Earth's atmosphere poses an intriguing problem. When a country adds to the atmosphere's carbon content, it reduces the value of the common. In calculating the value of the change in the country's capital assets, how much of the reduction should we include?

Two possibilities suggest themselves.³⁶ One is to attribute to each country the fraction of Earth's atmosphere that reflects the country's size relative to the world as a whole, using population as a means of comparison, or GNP, or whatever. The other is to regard the global common as every country's asset. In that case, the entire cost of global warming inflicted by a country would be regarded as that country's loss. Hamilton and Clemens (1999) follow the latter route.³⁷ They use US \$20 as the figure for damages caused by a tonne of emitted carbon dioxide.³⁸

The accounting value of forest depletion is taken to be the stumpage value (market price minus logging costs) of the quantity of commercial timber and fuelwood harvested in excess of natural regeneration rates. This is an awkward move, since the authors don't say what is intended to happen to the land being deforested. If the deforested land is converted into an urban sprawl, the new investment in the sprawl would be accounted for in conventional accounting statistics. But if it is intended to be transformed into farmland, matters are different: the social worth of the land as farm should be included as an addition to the economy's capital base.

Despite these limitations in the data, it is instructive to put the theory to work in the context of the world's poorest regions. Table 2 does that. The account that follows covers sub-Saharan Africa, the Indian sub-continent, and China. Taken together, they contain nearly half the world's population. They also comprise pretty much all the world's poorest countries.

The first column of figures in Table 2 contains estimates of genuine investment, as a proportion of GNP, in Bangladesh, India, Nepal, Pakistan, China, and sub-Saharan Africa over the period 1970-93. Notice that Bangladesh, Nepal, and sub-Saharan Africa have disinvested: their capital base has shrunk during the period in question. In contrast, genuine investment was positive in China, India, and Pakistan. This could suggest that the latter countries were wealthier at the end of the period than at the beginning. But when population growth is taken into account, the picture changes.

The second column of figures in Table 2 contains the annual percentage rate of growth of population in the various places over the period 1965-96. All but China have experienced rates of growth in excess of 2 percent per year, sub-Saharan Africa and Pakistan having grown in numbers at nearly 3 percent per year. We now want to estimate the average annual change in wealth per capita during 1970-93. To do this, we multiply genuine investment as a proportion of GNP by the average output-wealth ratio of an economy to arrive at the (genuine) investment-wealth ratio, and then compare changes in the latter ratio to changes in population size.

Since a wide variety of capital assets (human capital and various forms of natural capital) are unaccounted for in national accounts, there is an upward bias in published estimates of output-wealth ratios, which traditionally have been taken to be something like 0.30. In what follows, we use 0.25 as a check

³⁶ Dasgupta, Kriström and Mäler (1995).

³⁷ Under optimum global management, the country would be required to pay the total cost in the form of an international tax.

³⁸ The estimate is due to Fankhauser (1994).

against the upward bias in traditional estimates. This is almost certainly still a conservatively high figure.

The third column in Table 2 contains our estimates of the annual percentage rate of change in per capita wealth. The procedure for this has been to multiply genuine investment as a proportion of GNP by 0.25, and then to subtract the annual percentage rate of growth of population from the product. This is a crude way to adjust for population change, but more accurate adjustments would involve greater computation.

The striking message of the third column is that all but China have decumulated their capital base during the past 30 years or so. This may not be a surprise in the case of sub-Saharan Africa, which is widely known to have regressed in terms of most socio-economic indicators. But the figures for Bangladesh, India, Nepal, and Pakistan should cause surprise.

How do changes in per capita wealth compare with changes in conventional measures of the quality of life? The fourth column of the table contains estimates of the annual percentage rate of change in per capita GNP during 1965-96; and in the fifth column we have compiled figures for the average growth rate in UNDP's Human Development Index (HDI) over the period 1987-1997.

Notice how misleading our assessment of long-term economic development in the Indian sub-continent would be if we were to look at growth rates in GNP per head. Pakistan, for example, would be seen as a country where per capita GNP grew at a healthy 2.7 percent per year, implying that the index doubled in value between 1965 and 1993. In fact, the average Pakistani became poorer by a factor of nearly two during that same period.

Bangladesh too has disinvested in her capital base. She is recorded as having grown in terms of per capita GNP at a rate of 1 percent per year during 1965-1996. In fact, at the end of the period the average Bangladeshi was less than half as wealthy as she was at the beginning.

The case of sub-Saharan Africa is, of course, especially sad. At an annual rate of decline of per capita wealth of 3.5 percent, the average person in the region becomes poorer by a factor of two every 20 years. The ills of sub-Saharan Africa are routine reading in today's newspapers and magazines. But the ills aren't depicted in terms of a decline in wealth. Table 2 reveals that sub-Saharan Africa has experienced an enormous decline in its capital base over the past three decades. It will take years for the region to recover, if it is at all able to do so.

India can be said to have avoided a steep decline in its capital base. But she has been at the thin edge of economic development, having managed not quite to maintain her capital base relative to population size. If the figures are taken literally, the average Indian was slightly poorer in 1993 than in 1970.

Even China, so greatly vaunted for her progressive economic policies, has just managed to accumulate wealth in advance of population increase. For a poor country, a growth rate of 0.8 percent per year in wealth per head isn't something about which one gets too excited. In any event, a more accurate figure for output-wealth ratio would almost surely be considerably lower than 0.25. Moreover, the estimates of genuine investment don't include soil erosion or urban pollution, both of which are thought by some people to be especially problematic in China.³⁹

What of HDI? In fact it misleads even more than per capita GNP. As the third and fifth columns show, HDI offers precisely the opposite picture of the one we should obtain when judging the performance

³⁹ Hussain, Stern and Stiglitz (2000) contains an analysis of why China has been the economic success it is widely judged to have been in recent years. There is no mention though of what may have been happening to China's natural-resource base in the process of her economic development.

of countries. We do not have an intuitive feel for what may or may not be a healthy growth rate for HDI, but for sub-Saharan Africa the index grew during the 1990s, at 0.9 percent per year. Bangladesh and Nepal have been exemplary in terms of HDI. However, both countries have decumulated their assets at a high rate.

These are all rough and ready figures, but they show how accounting for human and natural capital can make for substantial differences in our conception of the development process. The implication should be depressing: the Indian sub-continent and sub-Saharan Africa, two of the poorest regions of the world, comprising something like a third of the world's population, have over the past decades become even poorer. In fact, some of the countries in these regions have become a good deal poorer.

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Table 1
Sources of Economic Growth, 1960-94

	g(Y/L)	g(K)	g(H)	g(A)
East Asia	4.2	2.5	0.6	1.1
South Asia	2.3	1.1	0.3	0.8
Africa	0.3	0.8	0.2	-0.6
Middle East	1.6	1.5	0.5	-0.3
Latin America	1.5	0.9	0.4	0.2
United States	1.1	0.4	0.4	0.4
Other industrial countries	2.9	1.5	0.4	1.1

Key: g(Y/L): annual percentage rate of change in GNP per head

g(K): share of GNP attributable to manufactured capital multiplied by annual percentage rate of change in manufactured capital

g(H): share of GNP attributable to human capital multiplied by annual percentage rate of change in human capital

g(A): percentage rate of change in total factor productivity (residual)

Source: Collins and Bosworth (1996).

Table 2
Genuine Investment and Capital Deepening in Selected Regions: 1970-93

	I/Y ^a	g(L) ^b	g(W/L) ^c	g(Y/L) ^d	g(HDI) ^e
Bangladesh	-0.013	2.3	-2.60	1.0	3.3
India	0.080	2.1	-0.10	2.3	2.2
Nepal	-0.024	2.4	-3.00	1.0	5.3
Pakistan	0.040	2.9	-1.90	2.7	1.8
Sub-Saharan Africa	-0.028	2.7	-3.40	-0.2	0.9
China	0.100	1.7	0.80	6.7	-0.2

^a I/Y: genuine investment as proportion of GNP. (Source: Hamilton and Clemens (1999, Table 3).

^b g(L): average annual percentage rate of growth of population, 1965-96. (Source: World Bank (1998, Table 1.4).

^c g(W/L): average annual percentage rate of change in per capita wealth.

^d g(Y/L): average annual percentage rate of change in per capita GNP, 1965-96. (Source: World Bank (1998, Table 1.4).

^e g(HDI): average annual percentage rate of change in UNDP's Human Development Index, 1987-97. (Source: UNDP (1990, 1999)).

Assumed output-wealth ratio: 0.25.