# The concept of sustainable development: An evaluation of its usefulness ten years after Brundtland

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## 1. THE ORIGINS OF «SUSTAINABLE DEVELOPMENT»

Few concepts appear to have captured the public and political imagination more than that of «sustainable development». The concept is intended to embrace the idea of ensuring that future generations inherit an Earth which will support their livelihoods in such a way that they are no worse off than generations today. While there are numerous precursors (see, for example, BARRY, 1977; PAGE, 1977), the most celebrated formulation of the concept is that given by the World Commission on Environment and Development (the Brundtland Commission) in 1987:

«development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs» (WCED, 1987).

In economic terms, then, and equating «development» with «increased utility», sustainable development has come to be equated with a development path that ensures non-declining per capita utility over some time horizon.

## 2. THE CAPITAL THEORY BASICS OF SUSTAINABLE DEVELOPMENT

Definitions of sustainable development are not in themselves very interesting, although there is an interesting debate on how «development» might be measured in terms other than per capita GNP (see, for example, ATKINSON et al., 1997). What matters is what has to be done to secure it. PEARCE (1998) suggests that the *conditions* for sustainable development are likely to be invariant with the definition since the conditions will be couched in terms of capacities and capabilities, ie sustainable development becomes an *enabling* concept rather than solely a particular path of change.

What determines the ability of a given set of humans to improve their wellbeing (utility) is the quantity and quality of capital assets available at the time. This notion can be traced back to the economic growth theory of the 1970s. It is elegantly summarised in SOLOW (1992). The concept of capital has widened from the classical approach, with its focus on produced goods or *man-made capital* ($K_M$ in notation), to embrace the skills

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Paper read to the Annual Meeting of the Swiss Society of Statistics and Economics, Stein am Rhein, Switzerland, March 26–27, 1998.

and knowledge embodied in humans, or *human capital* ($K_H$) and *natural capital* ($K_N$). Natural capital refers to traditionally defined natural resources, such as oil or gas, forests and to the stocks of assimilative capacities in the environment. Modern economic growth theory would add another type of capital, *social capital* ($K_S$). Social capital concerns the relationships between individuals, between institutions (including government), and between individuals and institutions. It has been found that different societies can have broadly equal endowments of other forms of capital, but that certain societies perform better in terms of economic and social development. The «missing link» is thought to lie in the fact that the better performing societies have less conflict between social groups, more participatory decision-making procedures, greater trust between economic agents, and so on. Thus PUTNAM (1993) found that one of the factors explaining Northern Italy's better economic performance compared to Southern Italy was the presence of many more voluntary associations. FUKUYAMA (1995) identifies successful communities and companies with the presence of reciprocity and trust. The breakdown of social capital results in more crime, more violence, family breakdown and so on.

To complete the discussion of the capital base for sustainable development we need to add two further factors. The first is the rate of *technological change* which is a disembodied stock of knowledge and skills. If this rate of technological change is positive, then the capital stocks listed above can yield higher and higher flows of services. A declining capital stock may not therefore be of major concern provided the rate of technological progress compensates for the loss of that stock. Of course, some technological change is not «good». Chlorofluorocarbons (CFCs), for example, were thought to be a major technological advance for the development of aerosols, solvents and cooling systems. But today we recognise CFCs as the major source of stratospheric ozone depletion and a risk to human and ecosystem health. The second additional concept is *population change*. It is possible that growth in population can improve human wellbeing by stimulating technological change. There is some evidence for this in historical terms where changes in invention and innovation appear to be linked to increases in population, and there is some modern evidence for this relationship too (BOSERUP, 1981; ENGLISH et al., 1994). But population change is more likely to reduce capital stocks, particularly $K_N$. As population expands, pressure is put on marginal productive land for example, and forests are cut down or burned to make way for agriculture, urban expansion and roads. And if sustainable development is concerned with *per capita* utility, then population growth will mean that more and more output will be needed just to keep pace with additional numbers of people. Whereas technological change is likely to make capital more efficient, population is likely to depress some capital stocks and make sustainable development less feasible.

The *intertemporal* condition for sustainable development, therefore, amounts to each generation leaving the next generation a stock of productive capacity, in the form of capital assets and technology, that is capable of producing more utility or wellbeing per capita than that enjoyed by the current generation. Notationally,

$$dK/dt \geq 0, \quad \text{where } K = K_M + K_H + K_N + K_S \ \ldots \ [1]$$

The World Commission's definition of sustainable development made it clear that the intertemporal feature was only part of the story: concern with the poor now was also important, indeed the highest priority. The analysis above can be applied to this equity issue as well, for the poor cannot improve their lot without access to productive capacity. If their wellbeing is to improve, then they must secure better education ($K_H$), better technology, more man-made capital ($K_M$), and more $K_N$. Social capital will matter as well in the sense of the need for more participation in decisions that affect their lives, and more consultation. Control over resources can be facilitated by establishing secure property rights to land and other resources.

Equation [1] suggests that the intertemporal part of sustainable development can be analysed in terms of the conditions necessary for its achievement, and that those conditions can be interpreted in terms of a *constant capital rule* (CCR). This rule requires modification in so far as:

(a) the rate of technological change results in higher capital efficiency (a higher ratio of generated services to the capital stock). In this case, the constant capital stock rule can be relaxed in favour of one that ensures at least constant capital services;

and

(b) the rate of population growth results in less capital per capita.

Of course, population growth may occur together with exogenous technological change, and this is typically the real world case. If they work in opposite directions, as suggested previously, then a rough rule of thumb will be that sustainable development will require that technological change exceeds the rate of population growth. This intuitive result bears a close resemblance to some of the 1970s growth theory «rules» – e.g. Stiglitz (1979).

## 3. WEAK AND STRONG SUSTAINABILITY

An implicit assumption in the constant capital rule (CCR) is that all forms of capital are substitutable for each other. On this rule, known as the *weak sustainability* (WS) rule, any one form of capital can be run down provided proceeds are reinvested in other forms of capital. Weak sustainability does not imply that substitution is easy or inexpensive – we may have to surrender a great deal to obtain one extra unit of some forms of capital, a feature of weak sustainability that tends to be ignored by those who have criticised it. Moreover, WS requires that the running down of any form of capital is compensated by investment in some other form of capital. It is not consistent with running down capital stocks and «consuming» the proceeds. As a «weak» rule, then, WS is not particularly weak, and empirical tests show that it is quite easy for a country to fail a weak sustainability test (see ATKINSON et al, 1997).

Objections to weak sustainability tend to centre on the assumed substitutability of capital stocks. Indeed, it can be argued that the philosophy of sustainable development arose precisely because there were concerns about the *unsustainability* of forms of economic development that sacrificed the environment in the name of economic growth. The problem can be formalised by saying that the critics regard at least some forms of capital as have no substitutes. Take the ozone layer, for example. Clearly there are some substitutes for its protective functions. Skin cancers and cataracts are one of the risks of exposure to UV radiation in areas where the ozone layer has been »thinned» by CFCs. Individuals can protect themselves against these risks by wearing sun glasses and suitable clothing, as well as by changing behaviour so as to avoid continued exposure. But high levels of UV radiation are also thought to interfere with immune systems and with the functioning of some important ecosystems, especially marine systems. It is far from clear what the substitute is in this context. The ozone layer may therefore have some of the characteristics of an »essential» factor of production. Those who believe in the non-substitutability of natural capital support *strong sustainability* (SS)[1].

SS does not imply that WS is irrelevant, although some writers appear to think this. What SS requires *in addition to* WS is that the stocks of $K_N$ should not decline. «In addition to» is needed because a situation in which natural capital is preserved but other forms of capital are allowed to decline could hardly be called «sustainable development» (it might be »survivable» but even that seems very unlikely). SS implies WS, but WS does not imply SS.

Some writers have criticised the weak sustainability approach because it assumes substitution (see for example, VICTOR et al., 1994). First, they suggest that one should not focus on weak sustainability because it creates a sense of comfort to the effect that the environment can be dispensed with, but it is hard to understand why such a discussion should preclude advocacy of strong sustainability by those who believe in it. More to the point, the preliminary evidence on weak sustainability indicators shows the potential for surprise: a large number of economies fail the weak sustainability test and if they fail that they are likely to fail any strong sustainability test (although not necessarily so) – see ATKINSON et al. (1997). Second, it is suggested that monetary indicators of constant capital fail because they use market prices rather than externality-adjusted prices. But the whole point of valuing capital is to value the externalities. Whether this is done by applying shadow prices to marketed outputs or by valuing the externality, eg air pollution, directly, is immaterial. Moreover, if prices are irrelevant, constant natural capital has no meaning either since it is unclear what numeraire would be used to «value» the stock of natural capital.

We return to the weak and strong sustainability debate later.

1. Strong sustainability has come to characterise «ecological» as opposed to «environmental» economics – see PEARCE 1998(b).

## 4. IS «SUSTAINABLE DEVELOPMENT» A REDUNDANT CONCEPT ?

As an intergenerational equity concept, then, sustainable development is little more or less than the guiding rule that households throughout the world use in determining their savings behaviour and their bequests to their children. If this is a reasonable interpretation of human behaviour we can then ask what point there is to a concept that embodies motivations and behaviour already present in the population. Setting up sustainable development as a *policy objective*, which is how it has come to be interpreted, might be gratuitous.

Two reasons might be advanced as to why sustainable development remains a valid policy concern.

### *Time horizons*

First, sustainable development invites us to consider a *longer term time horizon* than overlapping generations may consider appropriate, and it invites us to seek out *guarantees* that development will be sustainable. Overlapping generations models would suggest that the present can and will take care of the future so long as any one generation cares for the next and ensures that wellbeing in the next period is no less than wellbeing now. Positive discount rates are not a sign that the current generations consumes at the expense of the inherited capital stock for future generations, but rather indicate that capital productivity exists and that this benefits future generations. Similarly, technological change ensures that capital becomes more productive through time, enabling smaller capital stocks to sustain higher per capita wellbeing. This observation that generations *do* care for each other weakens the emotive force of sustainable development as some kind of new and separate objective. But there remains the suspicion that intergenerational bequests between any pair of generations may not be consistent with non-declining utility over long periods of time. Part of the problem is that bequests are bequests of *potential*, not actual, wellbeing, akin to potential welfare improvements in welfare economics (whereby beneficiaries could compensate losers but may not actually do so). The fact is that current generations cannot provide any guarantee that the next generation will in fact utilise its inheritance in such a way that it leaves the right bequest to the following generation. We can only say that past generations behaved this way, and that we need to ensure that current generations behave this way also. No-one can bind the next generation. All we can do is to ensure that they *could* behave that way if they chose, and this is achieved by leaving them a per capita asset stock at least equal to the one we have today. According to some, this inability to bind the next overlapping generation is already in evidence – selfishness and »me now» attitudes have perhaps increased effective discount rates in some countries (OBERHOFER, 1989). Ultimately, any given generation could consume its capital and obey the pairwise generation rising utility rule by simply ensuring that the following generation is better off than it is, but worse off than the preceding generation. Another way of putting it, is that overlapping generations models give us pairwise potential improvements without any guarantee that the path of development over many generations has rising per capita utility.

However, this problem of not being able to guarantee actual rising utility over time is not peculiar to overlapping generations models. The only guarantee would be some overseeing intergenerational authority providing disincentives to break the rising per capita utility requirement. No such authority exists, but, of course, religious precepts provide the best known form of »timeless» rules of behaviour. Perhaps this explains why sustainable development attracts so many moralists to its cause.

### *The composition of capital*

The second reason for thinking that sustainable development is not a redundant concept is that it focuses attention on what exactly it is that should constitute the bequest between generations.

While SS has come to be associated with a constraint on the stock of $K_N$ there may be equal reason to suggest that other forms of capital should be constrained to be non-declining. Believers in *social sustainability,* for example, might argue that the stock of social capital should not decline further because the symptoms of its decline are social unrest, crime, drug abuse and so on. SS might therefore take several forms: *social strict sustainability* and *environmental strict sustainability* would be two examples. Table 1 shows the possibilities. The essential point is that concepts of strict sustainability do raise issues about substitutability between assets, and this focus has greatly sharpened the environmental debate. With development of measures of social capital, it is possible to anticipate that the same will happen to that debate as well.

### *Beckerman's Critique*

BECKERMAN (1995) suggests that weak sustainability adds nothing to conventional economic optimality. If, for example, substitution between forms of capital is to take place the criteria for judging its desirability appears to be the conventional one of what contributes most to economic welfare. The general thrust of this view is correct: WS is indeed an optimality criterion, up to a point. But what it precludes is a persistent declining path of per capita utility over time, which is not what is envisaged by conventional optimisation when translated into rules for maximising the present value of utility over time. The potential contrast between sustainability and optimality was established early on in the sustainability literature – see, for example, PEZZEY (1992).

**Table 1: Weak and strong sustainability rules**

| Form of sustainability | | Requirement |
|---|---|---|
| WEAK | | $dK/dt > 0$ where<br>$K = K_M + K_N + K_H + K_S$ |
| STRONG: | environmental | $dK/dt > 0$ <u>and</u><br>$dK_N/dt > 0$ |
| | social | $dK/dt > 0$ <u>and</u><br>$dK_S/dt > 0$ |

Beckerman's characterisation of strong sustainability is unfortunately a caricature since he interprets it as meaning that one should preserve the environment »in all its forms». While there may be some people who believe this, it is not what SS means in the sustainable development literature. Rather what is intended is either conservation of some overall stock, within which there would indeed be substitution, or conservation of critical non-substitutable stocks. It is, however, possible to sympathise with Beckerman to the extent that the SS advocates have not come up with an empirical justification for their views.

## 5. ENVIRONMENTALLY STRONG SUSTAINABILITY

SS does not require that trees never be cut, or that oil and gas should not be exploited. This is because the «constancy» requirement is expressed as a restriction on the stock of heterogeneous forms of natural capital. That stock can only then be measured by finding some numeraire. The obvious numeraire is money, so that «constant natural capital» would be interpreted as a constant *value* of the natural capital stock. There are problems with a value measure of this kind. One of them is that the individual prices used for valuing capital will change as preferences change. If, for example, future generations do not «value» wetlands, they will implicitly be attaching a shadow price to them of zero. They will not then figure in the measure of natural capital. They might value, say, forests more, so that the requirement for a constant value of $K_N$ to be passed on to the next generation could be met by substituting forests for wetlands. Or they may simply put a higher shadow price on a reduced physical stock of $K_N$, retaining the constant value rule. The idea of running natural resources down in physical terms is almost certainly not what many advocates of SS would claim they mean by SS. How serious a problem is this for the constant value concept?

Much is made of the fact that we cannot know for sure what future generations will want. As such, we may find that they will place very different values on the things we value. As far as sustainable development goes, however, this may not matter. If, for example, a given natural resource is truly »essential», it will be essential for whichever generation is concerned. If other resources are not essential, then the SS rule would ensure that environments in general are conserved, even if there is significant change in the composition of that capital.

What are the reasons for favouring an SS rule ? There are several candidates:
(a) Uncertainty about the value of the elasticity of substitution between natural and other assets should be one reason for a cautious approach to natural capital conservation. That uncertainty remains as long as we are ignorant about the workings of global and local ecosystems.
(b) There is an asymmetry between types of capital with respect to reversibility: once certain critical capital stocks are lost they cannot be re-introduced. That is generally not true of man-made capital. This is the irreversibility problem;
(c) The unknown scale of effects from loss of critical natural capital, particularly where thresholds are thought to be present – witness the divergent views about the effects of global warming. This is the scale problem.

The combination of irreversibility and uncertainty should make us more cautious about depleting natural capital. However, they do not add up to a complete justification for SS.

Finally,

(d) Consumers have an apparent »loss aversion» that arises when certain natural resources are depleted, which means that they value a unit of loss far more than they value a unit of gain (KAHNEMANN and TVERSKY, 1979). It is significant that the resources that appear to produce this phenomenon take the form of amenity and wildlife rather than copper and aluminium. Essentially, this loss aversion suggests non-substitutability in utility functions, or lexical preferences, ie preference orderings which are always dominated by one object of value, just as a dictionary »orders» words according to the first, then second letters of the alphabet, and so on. A few contingent valuation surveys have found that a minority of respondents have indicated intrinsic value as their motivation whilst simultaneously being unwilling to pay anything at all for conservation (STEVENS et al.,1991; FREDMAN, 1993; HANLEY et al., 1995, SPASH and HANLEY, 1995; COMMON et al., 1997).

These studies are open to several criticisms:

(a) they may not have made the trade-off context realistic. A study by HANLEY and MILNE (1996) found that 99% of respondents thought that wildlife and landscape have a right to exist. But this percentage fell to 49% when it was suggested that conservation costs money and jobs, and to 19% when the cost was translated to be 25% of the respondent»s income. While the authors of this study see the remaining 19% as a salutary reminder that not all individuals are willing to trade-off conservation against other things, it might equally be pointed out that 80% of respondents lost their belief in a rights based approach as soon as the reality of trade-offs was presented to them. Arguably, rights may be easily assigned and defended when they cost nothing;

(b) they may not in fact be identifying lexical preferences at all. FOSTER and MOURATO (1997) conduct a contingent ranking exercise on pesticides and bread. Respondents are asked to rank various combinations of attributes (price, health (of consumers) and «birds» (the environmental impact)). A lexical *algorithm* would then rank all options on a single attribute, say «price», and then decide any equally ranked option on the basis of, say, health. 18% of respondents appeared to respond according to a lexical algorithm. While this appears to give support to the presence of lexical preferences, FOSTER and MOURATO note that conformity with the algorithm is not necessarily conformity with *lexical preferences*. They show that the 18% of respondents could simply have utility functions in which there are very strong preferences for a particular attribute of the options.

It must be concluded that the «existence» of lexical preferences remains unproven. The case for or against SS thus tends to rest on empirical issues relating to elasticities of substitution about which little is known. Those that have been estimated tend to relate to conventional natural capital stocks such as aluminium, copper and paper (see BROWN and FIELD, 1979), and not to assimilative capacities. Some very confused efforts have been made to place economic values on *total* stocks of natural capital (see COSTANZA et al., 1997, and, for a critique, PEARCE, 1998c), the overt purpose of which tends to be to demonstrate that $K_N$ is non-substitutable. But a world without any natural capital at all is self-evidently unsustainable. What matters is whether a world with, say, 10% less $K_N$ is sustainable. The issue is akin to minimum critical sizes for ecosystems or populations.

We therefore have a challenge to decide what the relevant elasticities are, and until we have a clearer picture on this issue, the special claims for environmentally strong sustainability must be regarded as unproven (but not unprovable).

## 6. SOCIALLY STRONG SUSTAINABILITY

Because the focus on social capital is comparatively new, it is worthwhile considering in a little more detail what it might mean and whether it necessarily contributes to sustainable development.

PUTNAM (1993) speaks of social capital as comprising certain features of social organisation – norms of behaviour, networks of interactions between people and between institutions, and trust between people. Empirical studies of economic growth have shown that conventional growth accounting models (stressing labour, capital, technology) explain only a limited amount of the difference between growth rates in different economies. World Bank (1997) refers to studies of the »Asia Miracle» economies which suggest that institutional arrangements for cooperation and information exchange may be as, if not more, important than conventional factors. But close interpersonal and inter-institutional arrangements may not always be good for sustainable development. After all, price-fixing cartels are a form of social arrangement, as is the Mafia. This suggests that social capital may have positive and negative aspects.

On the *positive* side it is suggested that social capital contributes to economic development by:

(a) flows of information between economic agents are better and higher if there are closer social relationships. Such flows may relate to anything from price information, information on the availability of materials or labour, through to information on the credit-worthiness of individual agents;
(b) trust reduces the need to search out information in order to make a transaction: ie transaction costs can be reduced. Trust may also result in behaviour which avoids the need to make laws and hence to intervene via government;
(c) social links between individuals and organisations and government also reduce the need for overt public control. Governments may find it easier and more efficient to operate via established social links than to legislate. The rise of «voluntary agreements» as a means to control environmental problems may be a case in point. Polluters simply agree to self-regulate and, in turn, self-regulation will be all the more efficient if the polluters have a social arrangements whereby they trust each other.

Also on the positive side, social capital contributes to environmental improvement by:

(d) substituting for other forms of capital, especially man-made capital. Arrangements to share machinery (eg tractors, harvesters) mean that fewer tractors are needed;
(e) reducing the high discount rates that often imperil the environment. This happens because individual insecurity is reduced by «ganging together» to fight particular causes and by spreading risks among the social group;
(f) reducing external effects, ie the spillover effects of one agent's actions on the well-being of another agent. Effectively, such behaviour is inhibited by the concern for neighbours and third parties arising from social norms of behaviour;
(g) resolving the risks arising from common property. Common property involves a whole community owning and managing a resource, a situation that has risks of environmental destruction if the resulting communal management system breaks down. The stronger the social ties, the less likely the management system is to collapse;
(h) inhibiting anti-social behaviour that damages the environment, whether it is simply the dumping of illicit waste, litter or perverse destruction of wildlife.

Social capital could have *negative* results by keeping contracts to those within the social circle, when those outside are more efficient. Examples include price-fixing, closed contract award systems, and even the requirement that small firms institute some social welfare system to look after those in the social group, imposing costs that impair productivity. One might summarise these problems as the creation of «rent» by restrictive activity and through lobbying of government and others.

Social capital therefore presents a new and challenging dimension of sustainable development. It may, as some have argued, account for the dynamism of some economies and even for lower environmental damage than might otherwise occur. Others suggest that it could easily just as well contribute in a negative fashion by restricting economic interests to specific groups. And, of course, the social group could also be persuaded to destroy the environment in the name of its own group interests.

## 7. TECHNOLOGICAL CHANGE AGAIN

As we saw in the introduction, technological progress offers the opportunity to augment consumption opportunities for a given stock of wealth. Indeed, NORDHAUS (1995) and WEITZMAN and LÖFGREN (forthcoming) have separately argued that the prevalence of *exogenous* technological change effectively absolves the need to undertake accounting for changes in natural assets (presumably, either in a weak or strong sense). WEITZMAN and LÖFGREN (forthcoming) suggest that with a total factor productivity growth of 1.5% per annum in the USA, technological change would swamp genuine savings as estimated by the usual procedures – see below – by adding as much as 41% of GNP to the indicator.

However, in theories of *endogenous* technological change (see for example, ROMER, 1990; and BARRO and SALAH-I-MARTIN, 1995) the creation of new technology uses scarce resources that could otherwise be employed elsewhere in production (and thus do not just fall on the system like «manna from heaven»). Recognition of these opportunity costs of developing new technologies could go some way in dampening some of the more over-optimistic claims that have been made (HAMILTON, 1996b; BARBIER, 1996). Thus, HAMILTON et al. (1998) show that, by contrast, assuming that technological change is not costless but endogenous makes the «technology premium» just 3% of GNP.

Undoubtedly though, a thorough empirical inquiry into the impact of technological change upon prospects for sustainable development is required.

## 8. MEASURING WEAK SUSTAINABILITY: GENUINE SAVINGS[2]

PEARCE and ATKINSON (1993) introduced a measure of sustainable development based on a *net savings criterion.* HAMILTON (1994) has called this measure *genuine savings* and provided a framework for a more consistent treatment of natural asset loss.

Genuine savings is derived as follows. A measure of «green» net national product (NNP) is (see HARTWICK, 1993; MÄLER, 1991; HAMILTON, 1994; ATKINSON et al., 1997)[3]:

$$gNNP = C + Inet - r(R\text{-}G) - p(E\text{-}A)$$

where

| | |
|---|---|
| gNNP | = modified or green net national product |
| C | = consumption |
| Inet | = net investment (ie investment net of depreciation on Km). It is now commonplace to include a measure of human capital *appreciation* in net investment, usually by incorporating current educational expenditures – see World Bank (1997). |
| r | = unit resource rental |
| R | = resource extraction or harvest |
| G | = growth rate of the resource (zero for non-renewables) |
| p | = marginal social damages from pollution |
| E | = emissions |
| A | = natural assimilation of pollutants |
| r(R-G) | = depreciation on natural resources |
| p(E-A) | = net pollution damage |

Rearrangement gives:

$$Sg = GNP - C - DK_M - r(R\text{-}G) - p(E\text{-}A)$$

where

| | |
|---|---|
| Sg | = genuine savings |
| $DK_M$ | = depreciation on made capital |
| GNP-C = S = | gross savings |
| GNP-C-$DK_M$ | = net savings |

2. We have focused solely on this one measure of sustainability, but promising developments include the World Bank's work on measuring total capital stocks – see KUNTE et al. (1998) and World Bank (1997). Ecological indicators have made less progress but those based on the diversity-resilience link are interesting – see PERRINGS (1997).
3. ATKINSON et al. use the term «measure of economic welfare» (MEW) for gNNP plus the value of environmental services, ie gNNP is a special case of MEW.

so that

$$Sg = S - DK_M - r(R\text{-}G) - p(E\text{-}A)$$

Genuine savings is simply gross savings less depreciation on assets. Note that it is an indicator of weak sustainability. If $Sg < 0$ there must be a presumption of non-sustainability.

HAMILTON et al. (1998) show that the genuine savings formula can be modified to account for technological change by adding a term PV(T) to the above equation, where PV(T) is the present value of future economic growth due to technological change in the year in question. Thus the full formula becomes:

$$Sg = S - DK_M - r(R\text{-}G) - p(E\text{-}A) + PV(T)$$

*Criticisms of Genuine Savings*

Several criticisms have been advanced against genuine savings as a measure of sustainability.

(a) positive genuine savings do not necessarily indicate sustainability. The reasons for this assertion can be found in ASHEIM (1994) and PEZZEY (1994). ATKINSON et al. (1997) suggest that genuine saving is a *one-sided* test for (weak) sustainability. What is proposed is a more cautious test for *unsustainable* behaviour rather than sustainability per se. Even so, the empirical evidence that is emerging indicates many countries appear to fail this apparently simple test (ATKINSON et al., 1997).

(b) MARTINEZ-ALIER (1995), VICTOR et al. (1996) and CABEZA-GUTÉS (1996) have pressed the case for indicators that effectively deny the range of substitution possibilities embodied in genuine savings. In other words, their critique is that weak sustainability is not strict sustainability. These are largely negative criticisms in that no actual alternative indicators are presented but perhaps serve to make the important point that genuine savings – or for that matter any single sustainability measure – is not exclusive as a means to evaluate progress towards sustainable development. Nonetheless, these critiques overlook the fact that strict sustainability is not a unique measure of sustainability either. Indeed, SS has to be supplemented with WS, as noted earlier. Nor has empirical evidence been advanced to the effect that the relevant substitution elasticities are zero. The problem for advocates of strong sustainability is that *assertions* of non-substitutability do not constitute evidence on non-substitutability. Those who criticise weak sustainability for assuming substitutability therefore commit at least a parallel fallacy in assuming non-substitution.

(c) MARTINEZ-ALIER (1995) notes that countries failing weak sustainability tests tend to be located in the developing world[4]. Many developing countries are highly dependent on resource extraction activities and the depletion of these assets often means that high levels of savings need to be generated if aggregate real wealth is not to be run down. Given that these resources are often traded with developed countries, a frequent criticism is how does this resource trade affect sustainability and its measurement? Investing the current value of resource rents whether for export or not assumes a constant international resource price. If this price actually varies then a resource exporters» saving requirements are adjusted by a term representing the present value of future resource price changes (HAMILTON, 1996). If the international resource price is increasing then an exporter following the standard Hartwick rule – i.e. invest rents on resource extraction – will be «over-saving». Genuine savings, in other words, should be augmented by the value of this price increase times the amount of resource exported. SEFTON and WEALE (1996), for a two-country model, show that an importer must make a corresponding *debit* to its genuine savings. Hence, in such instances, resource trade does alter the way in genuine savings should be measured. In practice, however, to implement these adjustments, we need to have some idea on the future movements of international resource prices. The economic theory of exhaustible resources predicts these prices *will* rise but long-term historical trends indicate a decline in the price of many resources (including oil). In response to this, HAMILTON (1996) concludes that a balanced and prudent view is that the standard Hartwick rule still offers a useful rule of thumb.

There is a distinct debate running parallel to this theoretical debate focusing on *responsibility* in that developed countries are to a large extent reliant on foreign resources to support their domestic economies. Indeed, several of these developed countries – e.g. the Netherlands and Germany – have expressed concern over their responsibility for resource depletion in other countries. A variety of motivations underlie this concern such as externalities associated with resource extraction or the general instability or evidence of decline in international resource prices over time.

There is, in principle, nothing to stop any importing country assisting a developing country upon whose resource it is dependent in its efforts to avoid persistently non-negative genuine savings via say, bilateral aid (ATKINSON and HAMILTON, 1996). Plausibly, it could be argued that existing schemes to stabilise the export earnings of primary producers by, for example, the European Union indicate that this notion of income compensation is not an entirely naive proposition. However, the rationale would be to secure sustainability in these countries rather than to maintain security of supply. To the extent that assistance has the effect of slowing down overly rapid depletion the latter goal may result. Presumably, any assistance, if forthcoming, would be targeted toward those low-in-

4. As it happens, a number of developed economies fail the test or are perilously close to non-sustainability. See ATKINSON et al. (1997).

come countries where the potential for saving out of income is severely restricted. In this respect, indicators of these dependencies would be useful, such as presented in ATKINSON and HAMILTON (1996).

(d) CABEZA-GUTÉS (1996) has questioned the use of genuine savings where countries such as Japan and United States appear to pass this (weak) sustainability test. Given the earlier comments in (a) above regarding an appropriate interpretation of such results this is a reasonable point. However, genuine savings can still offer new information concerning the non-sustainability of developed countries where environmental damages are recognised as a form of natural asset loss. Such impacts are likely to be associated with significant costs. Hence, not only must the current value of resource rents be debited from genuine savings but also the social costs of emissions of: (a) stock pollutants such as carbon dioxide (HAMILTON and ULPH, 1996) and; (b) flow pollutants with cumulative effects or impacts on stocks (e.g. on human health and hence, human capital) such as sulphur dioxide and particulate matter (HAMILTON and ATKINSON, 1996). On this basis, HAMILTON and ATKINSON (1996) show that the United Kingdom exhibited significantly negative genuine savings in the years 1980 to 1986.

It is worth noting that this indicator is able to capture a significant feature of pollution problems, namely transboundary pollution flows. The rationale for adjusting measures of national income, in the presence of transboundary effects, is an extension of the *polluter pays principle* to the domain of national accounting. This means that the estimates of the unit marginal social costs of pollution in a given country should include all costs, including those in other nations. These unit marginal costs should then by multiplied by the total level of emissions in that country. The argument for this treatment of transboundary pollution in the case of savings rules is, if anything, even stronger. Some portion of a given country's total savings should, at least notionally, be set aside in order to compensate the recipients of the pollution emitted and transferred across international boundaries (HAMILTON and ATKINSON, 1995).

## 9. CONCLUSIONS

While the literature on sustainable development covers many of the issues raised in the early literature on economic growth models, it seems fair to say that, whatever the merits of the original formulation in the Brundtland Report of 1987, one decade later we have greatly advanced both the theoretical aspects of desirable development and the ways in which that development might be indicated. Certainly the concept has given fresh impetus to the measurement of «sustainable» or «green» national income. The suggestion here is that a rearrangement of that concept in the form of genuine savings, originally introduced by PEARCE and ATKINSON (1993), has much to offer for the measurement of sustainability. The other main outcome has been the intense and continuing debate on weak «versus» strong sustainability, and the emerging debate over the role that technological change plays in sustainable development. We have suggested that a good part of the «weak» versus «strong» debate is misguided since weak sustainability is common to both approaches. Nonetheless, crucial issues remain. Perhaps we have reached a stage in human development when additional environmental depreciation does have such high costs that it constitutes de facto non-substitutability. This is what many ecologists have been saying for some time. But advocates of strong sustainability have been strongest in assertion and weakest in offering empirical substance for their views. That does not make them wrong, but it does suggest they have yet to be proved right.

As to technological change, the critical issue appears to be whether that change is endogenous or exogenous. Empirically, the difference for a country like the USA appears to be between «savings premia» or «technology adders», ie percentage GNP additions to the usual calculation of genuine savings, that range from 3% to 41%. In the former case, genuine savings is preserved as an operationally meaningful measure. In the latter case, its relevance would tend to be confined to developing societies where technological change may be very limited. Our own view is that assumptions of costless technological change are not empirically very relevant, but the issue is clearly a debatable one. In the meantime, genuine savings continues to be an important indicator for sustainable development.

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