ADDITIONAL MEASURES OF PROGRESS FOR SCOTLAND: AN ANALYSIS OF THE ISSUES AND PROBLEMS ASSOCIATED WITH AGGREGATE/COMPOSITE MEASURES OF SUSTAINABILITY[1]

Paper for the Additional Measures of Progress Steering Group

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1. Introduction

A central part of the sustainability question is the argument that National Income as currently measured is not *sustainable income*, as it does not aim to capture well-being or quality of life issues, and does not account for environmental assets or the impacts of environmental degradation. This has led to efforts to find ways of adjusting or supplementing conventional measures of national income, in particular GDP, to capture a wider range of issues. However, due to problems of aggregation and valuation of components where markets do not exist, or are imperfect or incomplete, the idea of replacing the conventional system of national accounting with a 'Green GDP' or 'sustainable income' is problematic and controversial and no consensus has emerged on accepted measures of progress in this broad sense.[2]

To deal with this, many countries have introduced systems of satellite accounts, which exist alongside conventional national income accounts, providing information to help manage economic activity in a way that is sustainable. A key element of satellite accounting has been the adoption and use of 'baskets' of individual sustainability indicators, which involves systematic and regular reporting of movements in a number of economic, environmental and social indicators. Where valuation is difficult, as in the case of environmental factors, in contrast to the concept of a fully integrated Green GDP or sustainable income, satellite accounts allow measurement in physical units, with no necessity that these be converted to monetary units.

However, the practice of monitoring and reporting on sometimes very large sets of individual indicators is a complex one and, despite the reservations noted above, the issue remains as to whether it is reasonable to attempt to measure sustainability in a single or composite measure. In the case of Scotland, the question arises in Section 14 of 'Choosing Our Future: Scotland's Sustainable Development Strategy' where the Executive states a commitment to "review the evidence on the options for additional and improved ways of measuring progress, and report by the end of 2006".

As a first step in this process, the purpose of this paper is to consider the broad set of issues and problems associated with adopting aggregate measures of sustainability. We do this by first considering what we mean when we talk about 'sustainable development' in a policy context and the role that we want sustainability indicators to play. Two broad types of sustainability are identified and we argue that the role of sustainability indicators depends on which type we are concerned with. This also proves to have a bearing on many of the problems and issues commonly associated with composite or aggregate indicators. In order to consider these problems and issues systematically we initially abstract from examination of any specific candidate

[2] Of course GDP is an aggregate measure, involving valuing output at prices that, in perfect markets, reflect the valuations of individuals.

indicators. However, in the latter stages of the paper we illustrate our analysis with a number of candidate measures of sustainability.

2. Defining Sustainability

2.1 The Brundtland definition, Hicksian sustainable income, Adjusted Net Savings and Green Net National Product

Brundtland and Hicks

There exists no general agreement on a definitive definition of what is meant by sustainability and sustainable development. Therefore the first step of identifying precisely what is meant when a country states a commitment to sustainability and, consequently, the required role of sustainability indicators, is not straightforward.[3] However, one of the most commonly cited is the 'Brundtland' definition of sustainable development[4] as (WCED, 1987, p.43):

> *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

This allows a definition of sustainability from which practical principles can reasonably derived. A minimum condition for ensuring the ability of future generations to meet their needs (bearing in mind that current policymakers cannot know with any certainty what these needs will be or the technology that will be available) is to maintain the productive capacity of the system. In other words, to preserve for future generations the *potential* to enjoy the same levels of consumption as the current generation has had. Productive potential at any time depends on the stock of productive assets, including the capital stock that is available for use. Thus sustainability involves the maintenance of that stock of assets, which includes both man-made capital (physical/manufactured and human) and natural capital (services offered by the environment that facilitate economic activity and human existence). This would be consistent with a Hicksian definition of sustainable income as being the amount that can be consumed during the accounting period without leaving us worse off at the end of the period than we were at the beginning. Sustainability therefore involves maintaining the capital base of the system, effectively living off the returns to that capital.

[3] The Scottish Executive has identified its sustainability objectives and a set of individual indicators. We do not critique these here.

[4] The concept of sustainable development gained prominence in 1987 with the publication of what is known as the Brundtland Report (World Commission on Environment and Development, 1987). This report is officially titled 'Our Common Future', and was produced by the World Commission on Environment and Development (WCED), a body set up by a UN General Assembly Resolution in 1983. The Chairman WCED was Gro Harlem Brundtland, former Minister for the Environment, and Prime Minister, of Norway, which is how the report gained its popular title.

Adjusted GDP measures

From this perspective, it is appropriate to consider the adjustment of the most commonly adopted measure of national income, GDP, to a basic measure of sustainable national income that is consistent with the Hicksian definition and incorporates the Brundtland definition of sustainable development. Most national accounts already include the adjustment to GDP *net* of depreciation (or consumption) of the capital stock, referred to as Net Domestic Product, NDP, which may be considered a better measure of real income. However, conventional measurement of NDP generally focuses on the depreciation of man-made *physical/manufactured* capital, ignoring the depreciation of human and natural capital. A more appropriate measure of sustainable income may then be one that also accounts for the depreciation of these other forms of capital. Rather than a 'Green GDP', as commonly cited, what we would be attempting to measure would be Green or sustainable NDP. Of course the use of the word 'Green' reflects the focus to date on the depreciation of natural capital and environmental issues rather than human capital. However, this focus also highlights the measurement problems that have so far prevented such adjusted measures of GDP/NDP emerging as viable options in measuring a sustainable income as part of conventional national accounting.

Genuine Savings/Adjusted Net Savings

Despite problems of measurement, there have been noteworthy attempts that consider adjustments to account for the depreciation of a more broadly defined capital stock. The most common focus is on net savings: gross saving/investment minus what is required to offset depreciation of the existing capital stock. Pearce and Atkinson (1993, 1995) define a generic indicator, where they highlight the importance of being able to identify and measure different types of capital. The argument for not eroding the *natural* capital base of the system in particular is based on the argument of limited substitution possibilities between natural and man-made capital. Pearce and Atkinson distinguish between *weak* sustainability, where saving/investment is sufficient to cover depreciation of capital as a whole, and *strong* sustainability, where the latter condition may hold but development is not sustainable because of insufficient replacement of natural capital. Basically, this measure indicates whether a country is following the 'Hartwick rule', which requires that rents from natural resource extraction (price minus marginal cost of extraction) be re-invested to prevent the total amount of capital from declining. Where reinvestment is in man-made capital, this implies substitutability between natural and man-made capital and, thus, weak sustainability. Strong sustainability implies that natural resources can only be used at the rate of technological progress in their usage (i.e. keeping the stock, measured in efficiency units, constant).

Practical application of the Genuine Savings/Adjusted Net Savings index

Jackson and McBride (2005) explain the practical development of this measure, mainly by the World Bank economist Kirk Hamilton, first with the label of the Genuine Savings Index, then as Adjusted Net Savings, with annual calculation of the measure for around 150 countries (including the UK but not Scotland) and reported in the World Bank's 'World Development Indicators' report (e.g. World Bank, 2006). The World

Bank calculates adjusted net savings in four steps that are consistent with Pearce and Atkinson's (1993, 1995) generic measure. They begin with what they refer to as gross domestic saving[5] and first subtract estimates of capital consumption of produced assets (covering depreciation of man-made physical/manufactured capital. This part of the calculation is consistent with standard national accounting (and adjustment from GDP to NDP). Second, public expenditures on education are *added* to net savings.[6] The World Bank (e.g. 2006) explain that this is an attempt to account, albeit imperfectly, for investment in *human* capital and contrasts with standard national accounting, where this would be treated as a current expenditure.[7] Third, estimates of the depletion of a number of natural resources stocks are subtracted, valued at the rent from extraction.[8,9] Finally, deductions are made for carbon dioxide and particulate emissions, representing the depletion of the natural capital from pollution damage, using estimates of unit damage from emissions to the natural environment and the services it provides.[10, 11]

As noted above, Scotland is not one of the countries for which the World Bank regularly calculates Genuine/Adjusted Net Savings (though the UK is). An attempt to measure Genuine Savings for Scotland (over the period 1980-1993) is made by Hanley *et al* (1999). There is some variation from the World Bank methodology: first, it is not clear from the paper exactly how gross savings/investment are defined; second, carbon dioxide is the only pollutant accounted for and depreciation of natural capital from emissions are based on marginal abatement rather than damage costs; third, human capital is not accounted for at all. The natural resources accounted for are forestry, fisheries, aggregates, and North Sea oil and gas deposits.

[5] Preferring to assess sustainability in terms of savings, the World Bank takes gross domestic investment and subtracts net foreign borrowings and adds net official transfers. It can be argued (e.g. Neumayer (2001) that a focus on investment is more appropriate for sustainability.

[6] Spending on education seems to be treated as a net investment in education; depreciation of education, or, more generally, human capital, does not seem to be considered.

[7] The World Bank (e.g. 2006) note that one unit of current expenditure on education does not necessarily yield an equivalent amount of human capital. They also note that the calculation should include expenditure on private education. However, they explain that public expenditure on education is selected as a proxy for which data are available for the largest number of countries.

[8] Note that the World Bank (2006) calculations of unit rents from natural resources, as in many practical calculations, use data on *average* rather than *marginal* extraction costs. This is due to problems of data availability but it is important to note that reliance of average cost data may lead to over or underestimation of natural resource depletion as marginal costs will vary, for example, as resources become more scarce and difficult to extract.

[9] The World Bank (2006) calculations focus on the following natural resources: Oil, natural gas, hard coal, brown coal, bauxite, copper, iron, lead, nickel, zinc, phosphate, tin, gold, silver and forests. All but the last of these are non-renewable resources for which markets exist, with the implication that data is relatively easy to get hold of. Harvesting of forests is the only renewable resource extraction included and the World Bank (e.g. 2006) acknowledges that more would ideally be included in the calculation. Indeed, ALL natural resource stocks should, in principle, be included.

[10] Unit damages from carbon dioxide are calculated as "the marginal social cost per unit multiplied by the increase of the stock of carbon dioxide" (World Bank, 2006. p.187). Details are not given on how the marginal social cost is estimated but the unit damage figure is taken to represent "the present value of global damage to economic assets and to human welfare over the time the unit of pollution remains in the atmosphere" (World Bank, 2006. p.187). Unit damages from particulate emissions are based on the impacts on human heath of exposure to particulate matter pollution in urban areas and are based on willingness to pay to avoid mortality and morbidity from cardiopulmonary disease and lunch cancer in adults and respiratory infections in children that is attributable to particulate emissions.

[11] Note that the World Bank calculations (see previous footnote) do not seem to account for the impact of carbon emissions on global warming. This would seem to be a significant omission.

A final point worth making at this stage, and we return to it in our conclusions, is that the Hanley *et al* (1999) attempt to measure Genuine/Adjusted Net Savings, and other composite measures of sustainability for Scotland, highlights a general issue of data availability for developing such measures. While Scotland is particularly well-served in many aspects (such as the availability of input-output tables), an essential precursor to development of further measures of progress would seem to be an assessment of the availability, quality and compatibility of economic, environmental and social data at the regional level.

GNNP

Though less common than measurement of Genuine/Adjusted Net Savings, some attempts have been made to incorporate depreciation of a more broadly defined capital stock into adjusted measures of GDP. For example, Hanley *et al* (1999) and Pezzey *et al* (2006) attempt to calculate a 'Green Net National Product' (GNNP) for Scotland.[12] One key distinction here that has not been mentioned thus far is a focus on *national* rather than *domestic* product – i.e. using GNP rather than GDP as a starting point. The basis for this is that national product, which measures the income *accruing* to local residents, is commonly argued to be a better measure of welfare than domestic product, which measures the amount of income *generated* in the economy. However, in the case of a regional economy like Scotland, where cross-border flows of income are difficult to measure, it is commonly argued that national product cannot be reliably measured.[13]

The same types of problems encountered in measuring Genuine/Adjusted Net Savings also apply to GNNP (or GNDP) calculations, in terms of measuring/valuing the depreciation of natural capital and identifying which types of natural capital should be measured for the economy in question. However, it is important to note the distinction between Genuine/Adjusted Net Savings and integrated measures such as GNNP. Genuine/Adjusted Net Savings focuses on the capital stock that is available for use by *future* generations, while GNNP focuses on income available to the current generation. In work attempting to establish a measure of sustainable national income for the Netherlands, Gerlagh *et al* (2002) also argue that it is inappropriate to simply introduce the Genuine/Adjusted Net Savings component into NDP or NNP in place of the conventional component (representing depreciation of physical/manufactured capital). Their argument is that this involves hypothetical rather than actual values for the depreciation of natural capital.[14] Instead, Gerlagh *et al* (2002) use an applied/computable general equilibrium model at this stage to account for

[12] Relatively few empirical applications of 'green' national accounting measures such as Green GDP and GNNP have been published. However, the literature search carried out for this study suggests that there may be more policy applications in the not too distant future. For example, the United Nations University web-site is currently advertising a book by Takahiro Akita and Yoichi Nadamura on Green GDP accounting in China, Indonesia and Japan.

[13] This issue does merit further investigation though. For example, Allsopp (2003) argued for the use of income tax data to construct regional income accounts. If such a development were made, these data would be appropriate for use in calculating national product measures for Scotland.

[14] We return to Gerlagh *et al*'s (2002) argument in Section 4 in discussing proposals for 'baskets' of composite indicators.

interaction between economic and environmental variables and to estimate sustainable national income in terms of *the impact on GDP* (or GNP) if a set of environmental constraints must be met.[15]

Adjustment of GDP to account for resource costs of defensive expenditures

While both Genuine/Adjusted Net Savings and GNNP are hampered by the practical problems of valuing and measuring the depreciation of natural (as well as, ideally, human and intellectual capital), such measures are in principle robust and (neo-classical) theory-consistent. Note also that other adjustments to GDP would also be similarly appropriate. For example, in conventional GDP accounting, the costs of defensive expenditures such treating waste are treated as an addition to national income, while no account is taken of the welfare loss caused by the damage in the first place. Allan *et al* (2006) consider the former issue, detailing construction of a 'pollution-adjusted' GDP, where the resource costs of disposing/cleaning up waste or pollution generated in production activities are considered as a negative rather than positive element in the GDP calculation. This analysis focuses on Scotland because of the availability of Input-Output (IO) tables, which facilitate such a calculation. However, again, data limitations of the conventional type of IO tables constructed in Scotland impact on the reliability of the calculation.[16]

Note that the limitations of the measures discussed thus far are practical ones. However, it can also be argued that there are problems in terms of the extent to which such measures can be taken as sufficient indicators of sustainability in practice. There are two broad issues that can be illuminated taking specific examples. First, in terms of global sustainability, Pearce and Atkinson (1993, 1995) note that their generic net savings indicator may take a positive value under strong sustainability conditions (i.e. not running down the natural capital base) in any one country if that country imports the natural resources it requires (directly or indirectly) to meet its consumption demands. This issue of 'importing sustainability' is one of the central concerns of Ecological Footprint measures (originated by Wackernagel and Rees, 1996, 1997). Second, while the measures discussed above do consider welfare, or 'well-being', in terms of consumption levels, where sustainability concerns are broader than those of consumption possibilities and preserving the natural capital stock (the productive capacity of the environment), it is likely to be argued that these are limited as indicators of sustainable development.

The key issue here is what is meant when people talk about sustainability. The Brundtland definition focuses on the impact of development on future generations. Genuine/Adjusted Net Savings focuses on the maintaining the stock of productive assets, particularly natural capital, in any one country for use by future generations of people living in that country. However, the two arguments in the previous paragraph suggest a

[15] Note that, under this treatment, sustainable income is no longer simply an indicator that can in principle be measured. Moreover, any estimates are dependent on the precise nature of the general equilibrium model used.

[16] Issues relating to how the Scottish IO tables could be adapted to better facilitate economy-environment analysis have been raised with both the Scottish Environmental Accounts Working Group and the Input-Output Expert User Group set up by the Scottish Executive.

focus that is wider than the interests of future generations and the stock of natural capital in any one country, with attention to both the sustainability of the global system and to the quality of life enjoyed by current generations in any one country.

2.2 Two broad types of sustainability concern

Global sustainability concerns

This last point in the previous section highlights an important question: what does any one government actually *mean* when it expresses a commitment to sustainability? The possible answer falls into one of two broad categories, but these often get conflated in discussions of sustainability. First there is the type of sustainability that is only really meaningful on a global level: economic development without risk of a global systems collapse due to overuse of natural resources and/or pollution/waste generation beyond the carrying capacity of the environment. This is the type of sustainability concern raised by Meadows *et al* (1972) in 'The Limits to Growth'. Using a formal systems analysis model of the world, Meadows *et al* (1972) predict limits to continued world economic growth within the next one hundred years "if the present growth trends in world population, industrialisation, pollution, food production, and resource depletion continue unchanged" (p.23). Achieving sustainability in this sense implies the requirement of full multilateral co-operation and participation to pursue economic development under a set of *sustainability constraints*, all of which are binding (i.e. if any one of the constraints necessary for sustainability is broken the system becomes unsustainable).

Sustainability agreements, such as international standards, may also be legally binding, or it may be that countries voluntarily choose to meet given targets as binding constraints on their development. Of course, legal commitments, internal commitments/targets and agreements relating to global sustainability concerns may not translate to constraints that, if broken, imply a global system collapse (e.g. EU legislation concerning water quality, commitments to electricity generation using renewable sources etc). However, the argument is similar in that where constraints exist each of these must be tracked separately.

Local quality of life concerns

The other thing that a government may mean by commitment to sustainability is commitment to maintaining the *quality of life* enjoyed in the country it is responsible for. This is of course connected to the issue of global sustainability, since the quality of life in any one country will be affected by the risk of global system collapse. However, while unilateral action on global sustainability is likely to have little effect (especially where the country in question is small, as in the cases of the UK and Scotland), there is a great deal an individual government can do to influence the quality of life in its own country. Moreover when sustainability is interpreted in this way, unlike in the case of global system sustainability, there is no set of jointly binding constraints. Policymakers can made trade-offs between different factors that affect the quality

of life depending on the preferences of the people who live in the region or country they are responsible for.[17] Achieving sustainability in *this* sense implies economic progress according to some *social welfare function*, including all factors that affect the quality of life (including environmental conditions), weighted according to preferences. Of course a key point is that such a function should, in principle, incorporate the preferences of future generations, as well as those of the current generation; a point that would make the construction of such a function very problematic in practice. On the other hand, measures such as Genuine/Adjusted Net Savings do constitute an attempt to take into account the needs (though not the preferences) of future generations. It could be argued that it is appropriate to impose concern for future generations by introducing a constraint that Genuine/Adjusted Net Savings must be positive.

Interaction of local and global concerns

In any one country, the sustainability argument involves consideration of elements of both the quality of life and global sustainability approaches. The state of the global system will impact on quality of life in a given country and commitments to international agreements on global sustainability will place a number of constraints on that country's economic activity. Moreover, there is also a connection to global sustainability in terms of the true impact of any one country's economic activity on the global system. If an economy imports inputs to production and/or goods and services to final demand the issue of 'importing sustainability' arises, since imports are likely to embody resource use and/or pollution generation in the country of origin. As noted above, this is a central concern that Ecological Footprint analyses attempt to address.

A framework for thinking about sustainability

In this section we have identified two different types of sustainability issues: concern for the sustainability of the global system and concern over maintaining the quality of life enjoyed in a particular economy. However we should note these are not categories that all sustainability concerns can be sorted into. Rather they give a *framework* for thinking about sustainability. There will be grey areas between the types of global and local level concerns identified above, and whether sustainability means development under a set of jointly binding constraints, or whether there can be trade-offs according to some social welfare function.

Take, for example, the idea of the sustainability of the global system, meaning that development must take place under a set of binding constraints: this type of sustainability concern could also apply at the local level. An example of this is the case of fish stocks, where over-fishing may lead to the collapse of a local economy.[18] In the case of renewable resources, sustainability means accepting the constraint that the harvest rate must not exceed the regeneration rate of the resource in question. Over-fishing in local waters may not

[17] The notion of different types of sustainability concern implying progress either with or without the possibility of trade-offs may link back to the idea of the substitutability/complementarity of physical and natural capital.
[18] Note that the example of fish stocks is a purely illustrative one. We claim no in-depth knowledge of fishing and the movement of fish stocks and are aware that there may technical problems with the example.

affect the global system, since at the global level the harvest rate may remain within the constraint of being less than or equal to the natural reproduction rate of the type of fish in question. However if the constraint is broken at the local level the local system in question will become unsustainable if it is reliant on the fishing industry. Again, as argued above, this will also affect quality of life in the local economy, and, if the benefits from the fishing industry are considered important to the quality of life in a given local economy, this would be reflected in any welfare function constructed for that economy. However, the point is that if over-fishing means a risk of local system collapse, it becomes a factor that cannot be traded-off against something else, instead constituting a binding constraint on activity.

Another point is that in practice there may be various layers of government concerned with decision-making for sustainability. For example, at the international level greenhouse gases emissions are a global sustainability concern. Conversely, if, for example, at the local level greenhouse gas emissions are mainly in the form of traffic emissions, the main concern is more likely to be the effect on the quality of life (health and well-being) of heavy traffic. The question is whether sustainability constraints are binding at the level in question; for example, if a country is committed to an international agreement on greenhouse gas emissions then this becomes a binding constraint as well as a quality of life issue.

However, as noted above, the key issue is an awareness of the two broad types of sustainability concern. Our argument is that when different types of sustainability concerns are distinguished in this way many of the questions as to the appropriate type and numbers of indicators are resolved by the need to address the relevant issues in a practical manner. Most of the restrictions on how to address the sustainability problem lie in the area of global sustainability (since constraints here are likely to be binding and problems must be addressed on a global scale with multilateral co-operation and co-ordination). However there is more freedom in addressing questions of quality of life, with individual policymakers able to make trade-offs to reflect the preferences of their own people, within the constraints of the economy and of international agreements on global sustainability.

3. The Role of Individual and Composite Sustainability Indicators

3.1 Analysis of common critiques of composite indicators

Individual versus composite?

As the Scottish Executive is doing now, it is common for policymakers to consider the feasibility of (i) sets of individual indicators of different key variables, and (ii) the notion of composite indicators incorporating different factors, including economic, social and environmental inputs, into a single composite indicator (or

basket of composite indicators[19]) of sustainability and welfare/well-being. This is often set up as a question of one versus the other. For example a common argument in the literature (and in the UK 1998 *Sustainability Counts* and 1999 *Quality of Life Counts* consultation documents) is that composite, or aggregated, indicators are not scientifically valid or technically robust. The basis of this argument is what is perceived to be the subjectivity of choice and method of weighting the included components, and of the sensitivity of the index to these choices and weights. A second criticism raised in the literature is that positive and negative effects in different factors can cancel each other out meaning that important problems may be hidden in a composite indicator. Related to this second criticism is the point that the sustainability problem is a complex one and the question must be asked as to whether it is reasonable to attempt to capture the answer to the question "are we behaving sustainably?" in a single number.

The significance of distinguishing the two types of sustainability concern

While the points made in criticism of composite indicators are legitimate concerns, it is not clear that this should rule out their use in favour of individual indicators. One point is that the argument of subjectivity in the choice and weighting of components applies equally to the decision to have a set of individual indicators unless all possible factors are included in the set. This is because choosing a set of individual indicators implicitly involves attaching zero weight to any factors not included (as well as a variable and implicit weighting system in individuals' interpretation of a set of individual indicators). More generally, we would argue that the question of individual and/or composite indicators is not being addressed in the best way. If this problem is considered from the perspective of the two types/interpretations of sustainability identified in Section 2.2, global sustainability and quality of life in any one country, then both individual and composite indicators become relevant depending on the sustainability problem in question.

Global sustainability concerns and monitoring constraints

In terms of global sustainability - where we have argued that this involves economic progress/development under a set of binding sustainability constraints, *all* of which must hold - the criticisms made above of composite indicators are crucially important. In section 2.2 we explain that if one of the constraints necessary for sustainability is broken, then the system will become unsustainable. If this is the case, then missing out something important, under-weighting a component, and/or cancelling effects could lead to the mistaken conclusion that current behaviour is sustainable when in fact it is unsustainable because a binding constraint may be violated. This, however, will also be true of sets of individual indicators if the set is incomplete. Indeed the question could be raised as to whether an exhaustive list of constraints necessary for global sustainability is possible when knowledge is incomplete as to how the global system functions (i.e. we have incomplete knowledge on the working of ecosystems etc). However the argument we are making here is that in the case of global sustainability individual indicators are *necessary* to check that *none* of the constraints on

[19] This may be an important distinction and we return to the issue of 'baskets' of composite indicators in Section 4.4.

behaviour necessary to prevent the risk of system collapse is being violated.[20] (Of course this must be qualified in that such constraints can only be based on current knowledge as to how the global system functions.)

Local sustainability concerns and the concept of a social welfare function

However, the situation is less clear-cut if the sustainability being addressed relates to the quality of life in any one economy. In this case *both* individual and composite indicators are useful, and the criticisms made of composite indicators are less valid than in the case of global sustainability. One criticism that is often made is the subjectivity involved in choosing and weighting components for any welfare index. This *is* an important point and there are two aspects to the issue. First, there is the problem of getting people to reveal their true subjective preference. Second, there is the problem of how to aggregate these preferences.[21] This means that in practice any social welfare function is to some degree a somewhat arbitrary one, in as much as any political process rarely identifies a unique solution that would be unanimously acceptable.[22] Moreover, a social welfare function that is acceptable in one country is unlikely to be ideal for any other. For one thing the political process differs across countries (even across democracies) and this will affect *how* the social welfare function is determined. Secondly, even in countries with similar political processes, preferences will be influenced by history, culture, religious beliefs etc.

However the reality is that policymakers *have* to make welfare decisions for the country or region they are responsible for, and this involves making decisions on trade-offs between different factors. This implies that in making any decision policymakers *implicitly* use a social welfare function, in that they will take into account a number of factors which will be traded off against one another depending on the importance, or weight, they attach to each one.[23] Therefore it can be argued that the explicit statement of a composite indicator(s) is simply focussing on something policymakers have to come to terms with every day, and that rejection of composite indicators on the grounds of subjectivity implies a failure to recognise this point. If an implicit social welfare function already exists, accepting sustainability objectives means accepting some restriction(s) on that function. They key issue is how these restrictions come about. In the case of global sustainability concerns, this will involve the acceptance of some agreed objective. However, in the case of quality of life, the evaluation of the necessary restrictions is less clear. Ideally this will be done through a

[20] One possibility to monitor system sustainability using a composite indicator/social welfare function would be if a non-linear function were used. For example if emissions of some pollutant, p_x, cannot not exceed value p_x^* if the system is to remain sustainable, as p_x approaches value p_x^*, the value of the social welfare function will fall dramatically.

[21] Note that this argument implicitly assumes that the personal preferences of citizens should underpin government decisions. However, not all countries are democracies so this assumption will not be a valid one in all cases.

[22] In a democracy the practical solution to this problem is the requirement of a solution that is acceptable to the majority.

[23] However, in reality, due to the nature of the political process in any country, there is no requirement that policymakers are consistent in terms of what variables are included or in their use of implicit weights. Moreover, policymakers may not wish to make these trade-offs explicit.

consensual process. However, the problem for policymakers is how to interpret, articulate and implement the 'right' thing to do.

Moreover, it should be noted that environmental goods (or 'bads', in the case of pollution) often tend to have the characteristics of *public goods* (or, perhaps more correctly, common resources[24]) and it is difficult to derive an efficient method for determining the 'right' level of public goods.[25] Determining the optimal level for a pollutant, for example, is complicated by information problems regarding the true (social) marginal cost of pollution as compared to the marginal benefit arising from the polluting activity. The situation is further complicated by the fact that in reality a large number of environmental factors are often involved. This means a situation with *multiple* public goods. However, if the country is a democracy, the population elects governments to make welfare judgements and provide public goods on their behalf. The political process can reveal weights to represent what people think are the marginal trade-offs involved between different public goods to report, in the form of an index or welfare function, a composite public good: the quality of life. However, as argued above, in practice, there may be problems in articulating and implementing provision of such a public good, particularly where the political process is imperfect and possibly subject to systematic bias (e.g. as a result of lobbying activity).

3.2 Practical implications

Determining a social welfare function

Determination of a welfare function as an indicator of progress, using components and weightings relevant to the preferences of the people living in the economy in question (and this will vary from country to country), would then seem to be a perfectly valid and useful exercise. Where a consensual process has been used to determine what is important to the population regarding their quality of life, such an exercise to establish a welfare function would seem, in principle, possible. Of course, attention should be drawn to the theoretical problems inherent in aggregating individual preferences to get a social welfare function, as proven in what is known as Arrow's Impossibility Theorem.[26] Nonetheless, while such problems cannot be fully overcome, progress on constructing a useful indicator can be made. Contributions by authors such as Keeney (1974) and

[24] A key problem with natural resources/environmental services is that consumption is rival, with the implication that it may be more correct to refer to a common resource problem rather than public good problem.

[25] It can of course be argued that not all environmental goods have the characteristics of public goods (or common resources) and that markets may be capable of allocating efficient levels of some environmental goods, in particular many natural resources. The point is that it is necessary to recognise the distinction between cases of 'missing markets' (e.g. pollution) and cases where markets *do* exist but might be imperfect (e.g. finite natural resources such as oil). The problem in the second case that is there might be market failure so market prices might not be the 'right' prices for sustainable supply.

[26] Arrow (1951) identified a number of conditions that one could reasonably expect to be met by a collective ordering of preferences. However, his 'Impossibility Theorem' demonstrates how there is no procedure by which to transpose individual preferences into a collective preference ordering that satisfies all these conditions. To date no one has found a satisfactory way to overcome this problem.

Keeney *et al* (1990) offer general advice.[27] Others have made practical attempts to construct composite indicators that focus on quality of life/welfare. These tend to fall under the ISEW umbrella.

The ISEW/Genuine Progress Indicator as a social welfare function

In the sustainability literature, the idea of an Index of Sustainable Economic Welfare (ISEW), also known as a 'genuine progress indicator' (GPI), is the best known suggestion for such a welfare function. However it should be noted that none of the ISEW indices compiled to date appear to use data on preferences elicited through a consensual process. The question of sensitivity to what components are included and assumptions are made *is* an important one (see Perman *et al* 1999, pp.509-511, and Neumayer, 2000, on how the gap between GDP and an ISEW may collapse if certain components are removed[28]). However, this question of sensitivity does not rule out the possibility of using composite indicators like an ISEW, provided that sensitivity analysis is possible so as to explore the impact of different definitions of the indicator (particularly in terms of the weights attached to different components). It is also important to note that ISEW is something of an umbrella term; we would argue that criticisms of specific ISEW applications should not preclude consideration of developing the concept to something that may be more useful (e.g. the approach taken by the New Economics Foundation in developing their 'Measure of Domestic Progress'). We discuss development of the ISEW framework in more detail in Section 4.

Combined use of composite and individual indicators

However, even in considering the case of quality of life, the argument that important factors can get hidden in a composite indicator remains valid. For this reason it would seem important to have a set of indicators for all the individual factors that impact on the quality of life, and that these be monitored as well as the selected composite indicator(s). An important reason for employing both composite and individual indicators is that many individual factors may impact on the quality of life, meaning that the set of individual indicators may be large. The appeal of a composite indicator is that it aids comprehension and is likely to be more digestible and less overwhelming than a large series of individual indicators. These are important considerations to those hoping to inform and involve a wider audience in the question of sustainability, which requires changes in the behaviour of individuals. Moreover, it can be argued that an index would force the *opportunity cost* (including the environmental opportunity cost) of any decision to be taken into account. As argued above, the weights with which different components enter the index represent the marginal trade-off between different factors that affect the quality of life/quality of the environment, which is not the case if a small number of factors are examined individually. These advantages of using composite indicators are set against

[27] Keeney (1974) specifically addresses the issue of quality of life in the context of environmental problems, identifying many of the issues and arguments put forward here (including the inherently subjective nature of people's preferences with respect to the environment). The later work by Keeney *et al* (1990) offers more practical guidance, drawing on an exercise conducted with members of the German public, on eliciting public values and preferences.

[28] Although GDP and ISEW will only become equivalent if zero weights are attached to all (positive and negative) elements included in the ISEW but not in GDP.

the risk of under-informing, but this problem is countered if individual indicators of key factors thought to impact on the quality of life in the economy in question are also available (as they must be for construction of the composite indicator anyway).

International Comparability

Another point that should be made is that while the informational advantages of an index/composite indicator in terms of comprehension are clear, there may be problems if the purpose of the indicator was to *monitor* the government and/or country in question relative to others.[29] This is because, as noted above, different countries may attach quite different weights to different factors (e.g. some may be more concerned than others about further environmental degradation relative to further economic growth), and this may be a source of tension if a government/country is perceived as attaching too much/too little weight to what others regard as the 'wrong' things. If the purpose of having a composite indicator/index is to monitor government/country performance relative to that of other governments/countries, this is likely to involve a trade-off between having an indicator that properly reflects the preferences of the country in question or an indicator that is internationally comparable. In short, the benefits of having an internationally comparable indicator would have to be assessed against the costs of losing components/weightings that reflect country-specific preferences. Of course, it would be possible to use both. The key point is being clear on the role of selected indicators. Are they for the voter to track the government's performance over time or against other countries? Or for government take make consistent micro decisions? Or, for supranational organisations to monitor agreements? The point is that the nature of the indicator may differ depending on which is the case.

4. Some Illustrative Examples of Composite Indicators/Indices

As noted above, there have been some practical developments in the area of composite indicators. Two types of composite indicator in particular seem to have gained the most attention: the concepts of Ecological Footprints and the Index of Sustainable Economic Welfare (ISEW).[30] In this section we consider both of these along with some others, in terms of what appear to be the two main issues in developing a composite indicator or index:

1. Choosing components/variables for inclusion in the indicator

2. How the components are aggregated to form the indicator/weighting of components

[29] The purpose of international comparability may be regarded as the primary reason for constructing composite indicators (e.g. OECD, 2005).

[30] A more recent development that has received quite a lot of attention is the concept of 'happiness' indicators. Much of the work in this area has been carried out by Richard Layard (see, for example, Layard, 2006) and enters our discussion below.

In addition, we would argue that it is important to distinguish between the two broad types of sustainability concern identified in Section 2.2 in assessing whether a given candidate indicator is appropriate for the purpose. For example, in searching for an existing indicator to monitor local quality of life or well-being, something like the Ecological Footprint is likely to be ruled out on the basis that its focus is on the impact of local consumption demands on the global environment and not on local welfare. Methodological or practical concerns are likely to be of secondary importance in these circumstances.

4.1 Indicators that focus on global sustainability concerns

A straightforward example of a composite indicator: the GWP Index

We begin this section by returning to the first type of sustainability concern identified in Section 2.2. This first example of a composite indicator that focuses on global sustainability concerns is one that combines the impact of the science of greenhouse gases on global warming, with no social welfare function underpinning the measure.

In the case of global sustainability concerns such as global warming that have clear scientific underpinning, it is possible to construct very straightforward composite indicators with non-controversial components and weights. For example, it is common to report a Global Warming Potential (GWP) index, which is a composite environmental variable indicating the global warming potential of any one activity by summing emissions of 3 of the main greenhouse gases – CO_2, methane (CH_4) and N_2O – using weights that reflect the global warming potential of each pollutant. These weights are uncontroversial and can be found, for example in the UK Environmental Accounts (UKENA).[31]

A less straightforward example of a composite indicator: Genuine/Adjusted Net Savings

The GWP index is similar to something like Genuine/Adjusted Net Savings in so much as it does not attempt to say anything about who ultimately has responsibility for the change in natural capital due to resource extraction or pollution generation in any one country. Rather, just that it is changing and to try and measure by how much. (Neumayer, 2001). However, Genuine Savings is also an accounting concept that has built into it a minimum target for sustainability (i.e. it must be positive). Recording and reporting indicators such as the GWP Index and Genuine Savings at the national level (and comparing across countries) is consistent with the notion of monitoring binding constraints on economic activity under the type of global sustainability concern identified in Section 2.2.[32]

[31] The GWP weights are 1 for CO_2, 21 for CH_4 and 320 for N_2O.

[32] In the case of the GWP Index, these constraints will at least in part be given by the commitments of governments such as the UK to the Kyoto Protocol.

Global sustainability as a consumption-based problem

We have argued that, in the case of global sustainability concerns, the types of criticism commonly levelled at composite indicators - regarding subjectivity of choice in determining components and weights and of hidden or cancelling effects - are crucially important. However, given the focus on human consumption behaviour (and the unequal patterns of consumption across industrial and developing countries) in much of the sustainability debate, other composite indicators have emerged that focus on global sustainability concerns, but in a more controversial way that invites these types of criticism. The most popular of these is the Ecological Footprint.

An even less straightforward example of a composite indicator: the Ecological Footprint

The composite indicator of global sustainability that has attracted most attention in recent years is the Ecological Footprint (originally developed by Wackernagel and Rees, 1996, 1997). One key distinction that makes the Ecological Footprint much less straightforward relative to Genuine/Adjusted Savings is that where the latter focuses on one issue - the impact of activity on the stock of man-made and natural assets available in the local economy - Ecological Footprints are much more ambitious, attempting to bring a number of scientific environmental constraints into one index.

There have been numerous practical applications of Ecological Footprints, increasingly carried out by specialised commercial companies/consultants, but there has also been considerable academic interest in both applications and the developments of the methodology. Less common are rigorous critiques of the concept itself and of the methodologies adopted. However, a very good example that deserves careful attention is a paper by Van den Bergh and Verbruggen (1999), who point out that "the [ecological footprint] concept and indicator seems to be accepted almost without any critique by many scientists and policy makers, and especially by environmental organisations" (p.62).[33] We draw on Van den Bergh and Verbruggen's (1999) critique here to offer a brief illustrative analysis of the ecological footprint in the context of the two criteria identified at the start of this section.

What is an ecological footprint?

Basically, ecological footprint calculations start from the assumption that every category of energy and material consumption and waste discharge requires the productive or absorptive capacity of a finite area of land or water. The estimated land requirements for all categories of consumption and waste discharge by a defined population are aggregated to give a figure for the ecological footprint of that population, which may not coincide with the population's home region. Therefore the ecological footprint of a specified population

[33] Van den Bergh & Verbruggen (1999) detail some examples of the wide acceptance of the ecological footprint concept and indicator, but note that, beside their own, they have only come across two critical evaluations of ecological footprints. The authors are aware of some subsequent critiques but, if there is serious policy interest in developing the ecological footprint concept for Scotland, we would recommend a thorough literature review.

or economy is defined as the area of ecologically productive land (including land embodied in imports) required on a continuous basis to support consumption. Moreover, the ecological footprint of a given population is the land area needed *exclusively* by that population: flows and capacities used by one population are not available for use by others. This basically implies that one region's resource-based consumption can only be increased through a reduction elsewhere, given a fixed global area of ecologically productive land.

A brief critique of the ecological footprint as a composite indicator

Van den Bergh and Verbruggen (1999) identify a number of problems with ecological footprint calculations that fall into the two categories identified above, such as the appropriateness of focussing on land-use required to support consumption, the lack of distinction between alternative (sustainable and unsustainable) land-uses and the neglect of multiple land-uses. Specific applications are also subject to criticism due to what seem to be arbitrary assumptions in terms of what types of consumption are included and how they are measured and weighted. In terms of the choices of components, problems inevitably arise due to inadequate data, a problem that is common to many environmental indicators. However, it would seem that in the case of ecological footprints, where international comparisons of results are made, differences in methodology due to data problems across applications are crucially important. It should be noted, though, that recent developments in the literature concerning the use of input-output (IO) tables and methodology in calculating ecological footprints are likely to mitigate the component problem in more recent and future applications (see Turner *et al*, 2006, and Wiedmann *et al*, 2006).

However, van den Bergh & Verbruggen (1999) also express concern over the other key problem identified above: how components are weighted. They question the fact the physical consumption-land-use conversion factors are used in the ecological footprint calculation function as implicit weights in both conversion *and* aggregation. They then point out that while the physical weights used may be consistent with ecological principles and thermodynamic laws, they do not necessarily correspond to *social* weights. This means that changes in relative scarcity over time and variation over space are not reflected in the ecological footprint measure. Van den Bergh & Verbruggen (1999) argue that this problem is magnified by a fixed weighting scheme, which means that a fixed rate of substitution is assumed between different categories of environmental pressure. They further argue that some categories receive identical weights even though they have distinctly different environmental impacts. They conclude that all these problems compound to render the ecological footprint a questionable tool for social decision making, such as ranking policy options.

Ecological footprints for Scotland

The reader will be aware that ecological footprint calculations have been carried out for Scotland, initially by Hanley *et al* (1999), and more recently by Best Foot Forward Ltd (2004). Critiques of this latter study are offered in McGregor et al (2004a,b). Here, the reader should note that the Best Foot Forward Ltd (2004)

study is subject to the general critiques noted above. Moreover, the Best Foot Forward application makes no use of the Scottish IO tables, despite the increasing consensus in the literature that, given that the focus of the ecological footprint is to capture the total (direct plus indirect) resource use embodied in final consumption in an economy, IO is the most appropriate accounting framework for this type of indicator (see Turner *et al*, 2006 and Wiedmann *et al*, 2006, for comprehensive reviews of the application of IO data and techniques in calculating ecological footprints).

The above critique of the Ecological Footprint as a composite indicator is intended to be illustrative and we do not attempt a comprehensive analysis here. However, we should reiterate the point made at the start of this section. In comparing different candidate measures, it is important to bear in mind the distinction between the two broad types of sustainability concern introduced in Section 2.2. The Ecological Footprint is concerned with the impact of any one economy on the global environment and does not attempt to directly measure quality of life or well-being. Indeed, probably the most obvious way of reducing a country's ecological footprint is to reduce current consumption, which is likely to have a negative impact on the quality of life enjoyed by the current residents of that country (though this will depend on relative marginal valuations of consumption and environmental quality). Similarly, as the Yale Center for Law and Policy (2005, pp.385-6) point out, a developing country may have a very small ecological footprint "because of a lack of economic activity and persuasive poverty", a situation that "cannot be held out as a policy aspiration".

However, while not appropriate as an indicator of well-being, the ecological footprint may still be a candidate as an indicator of the impact of Scotland on the global environment. In this context, it should be assessed together with other candidate indicators, such as those identified in Moldan *et al* (2004), using the criteria identified at the start of this section (as we have attempted to do here, albeit briefly). [34]

4.2 The Index of Sustainable Economic Welfare (ISEW) and related measures

In this section we return to the second type of global sustainability concern identified in Section 2.2. The most common example of an indicator that gives attention to quality of life concerns is the ISEW (although it encompasses other sustainability issues also – an issue that we return to in Section 4.4). This brings us back to the notion of a social welfare function underpinning the composite indicator.

[34] Moldan *et al* (2004) consider five other 'environmental sustainability composite indicators' that we do not attempt to review here, but may (or may not) be appropriate for monitoring global sustainability concerns in Scotland: the World Economic Forum's 'Environmental Sustainability Index'; the European Union Joint Research Center's 'Dashboard of Sustainability'; the 'Living Planet Index', promoted by the World Wildlife Fund; Eurostat's 'Direct Material Consumption; and their own 'Geobiosphere Load Index'. In assessing these indicators, a key criterion would be whether they get round the problem of binding constraints that seem to be associated with environmental sustainability. That is, if we have a problem with global warming and a problem of resource depletion, both of which are potentially fatal, how do these indicators deal with this?

Background to the ISEW

Since the ISEW concept originated with Daly *et al* (1989) and Cobb and Cobb (1994), studies have been carried out for a number of countries, including Scotland (Moffat and Wilson, 1994, and Hanley *et al*, 1999) and the UK (Jackson *et al*, 1997).[35] With "only slightly changed methodology" (Neumayer, 2000, p.348) the ISEW is sometimes relabelled as a Genuine Progress Indicator (GPI). While identified by some as a potential substitute, or direct comparator, for GDP (e.g. England, 1998), Neumayer (2000) clearly makes the point that the ISEW is not a measure of sustainable or Hicksian income – i.e. of the level of income that can be safely consumed and leave the economy as well off at the end of the accounting period as it was at the start. Rather, due to indexing of inequality to adjust consumption expenditures, it must be interpreted instead as an index of welfare, which can only be compared to GDP in terms of the trends of the two indicators over time. Neumayer (2000, p.358) notes that Daly *et al* (1989) were "clearly aware of this crucial point" in the conception of the ISEW but that "[L]ately, however, this distinction seems to have become blurred".

Basic methodology of the ISEW

Neumayer (2000, p.348) explains that the computation of an ISEW generally starts from personal consumption expenditure as reported in the conventional national accounts, and that this is then weighted with an index of income inequality[36], before adjusting with certain "welfare-relevant" contributions being added and subtracted. Neumayer (2000, also p.348) gives as examples of common additions "the services of household labour and the services of streets and highways" and of subtractions "so-called 'defensive expenditures', costs of environmental pollution, costs of depletion of non-renewable resources and long-term environmental damage costs". Essentially, then, the ISEW is an attempted modification of a standard national accounting measure that covers quite a bit more than environmental issues.

Related measures – e.g. The New Economic Foundation's Measure of Domestic Progress (MDP)

Most of the critiques in the ISEW literature tend to focus on the specific methodology adopted in different studies in identifying and incorporating components in the index.[37] What seems to muddy the waters somewhat is that whenever what are regarded as significant changes to methodology and/or what is included are made, the index is often relabelled. Indeed the ISEW, and specifically Jackson *et al*'s (1997) UK study, provides the basis for the New Economic Foundation's work on developing a Measure of Domestic Progress for the UK. In his NEF briefing note 'Chasing Progress: Beyond Measuring Economic Growth (the Power of Well-being 1)' (Jackson (2004), Tim Jackson explains that the MDP is an 'adjusted' economic indicator that "provide[s] a single performance index by adapting conventional economic measures such as GDP or

[35] See Neumayer (1999, 2000) for fuller reviews of ISEW applications.

[36] The method of adjusting for income inequality differs across studies and a comprehensive literature review is recommended if this concept were to be taken forward. However, note that for the case of Scotland, there is guidance from HM Treasury in the new Green Book about valuing relative income.

[37] The ISEW has been criticised (e.g. Neumayer, 1999) as lacking a sound theoretical foundation. This is disputed by Lawn (2003), who argues that the ISEW is consistent with Fisher's (1906) definition of capital and income.

consumer expenditure to include social and environmental costs and benefits that normally lie outside the accounting framework" (p.5). He explains that the ISEW or Genuine Progress Indicator is one of the main attempts at constructing such an indicator and that the MDP is basically a relabelled ISEW/GPI that incorporates "several additional developments" (mainly focussing on methodology, but also the inclusion of additional components to reflect the costs of crime and family breakdown). The key distinction appears to be a conceptual one: Jackson argues that, in contrast to the common interpretation of the ISEW, a rising MDP neither "guarantees sustainability [n]or ensures 'genuine' progress".

A brief critique of the ISEW and related measures

The fact that most of the critiques in the ISEW literature focus on what components are included and how they are incorporated highlights what seems to us to be the main problem with applications of the broad concept to date. In all of the ISEW applications we have examined (including relabelled ones such as the MDP), the choice of components included (and, importantly, excluded) in the index seems to be wholly that of the authors (indeed, in the initial application by Daly *et al*, 1989, twelve pages are devoted to justifying the authors' selection). In section 3.1 above we have argued that if the index is intended as a measure of quality of life or some type of welfare function, then the choice of components, and the weights attached to them, should be determined by the preferences of the people whose welfare is in question. We have proposed that this could be determined either by some revealed preference technique or through the political process, or both. On this criterion, the choice of components in the ISEW applications to date is somewhat arbitrary and highly questionable, as are the weights assigned, particularly given the accepted measurement problems of components such as environmental degradation, which Daly et al (1989, p.416) themselves describe as "inherently immeasurable" (though this is not true of all components; while perhaps difficult to quantify, a great deal of work has been done on measuring 'intangibles', for example Layard's (2006) work on measuring happiness). Therefore, we would argue that while the idea of an ISEW as a social welfare function is acceptable in principle, the methodology employed in most of the studies to date in choosing and weighting components is unacceptable. Specifically, the ISEW indices compiled to date appear to have failed to tackle the problem that the welfare of the people in any country or region depends on the preferences of those people. That is, with the exception of Clarke and Islam (2005), who make adjustments to the ISEW concept that are specific to the case of Thailand, for which their index is constructed. They argue that the decision to make these country-specific adjustments "is justified by accepting the principles of normative social choice theory" (Clarke and Islam, 2005, p.86).

4.3 A way forward?

A social welfare function based on the preferences of local people

The work to date on the ISEW concept should not, however, be dismissed because it does provide a useful starting point for thinking about developing an index that could act as a sustainable economic welfare

function, or a quality of life index. The fact that much of the ISEW debate has been over what should be included and how suggests that there is no universally correct answer. The best solution to this would seem to be to let the people whose quality of life is in question, and/or the policymakers they have elected to represent them, decide what should be included in the index, and to let them determine the weighting attached to each component. Of course, such an approach carries with it problems of its own:

1. Eliciting people's true preferences: what is being suggested is a *revealed preference* approach, but there are likely to be problems in eliciting people's true preferences and rankings.

2. Even if true preferences and rankings can be elicited, next there is the problem of aggregating across individual revealed preferences as identified in Arrow's Impossibility Theorem (see Section 3.1 above).

3. While it may be possible to evaluate preferences through the political process, there are likely to be further problems for policymakers in articulating the 'right' thing to do and implementing it.

However, even if these problems cannot be fully overcome, the resulting index would be preferable to one whose components have been chosen by individual authors, and weighted solely according to acceptance of monetary valuations of the included components, many of which are factors for which no markets or prices exist.

There is another problem though. Since there do not appear to have been many past attempts to build a composite sustainability indicator of the type proposed here, the more recent literature does not offer a great deal in the way of practical guidance. However, a few useful contributions have been made. First, as noted in Section 3.1, Keeney (1974) and Keeney *et al* (1990) do offer some useful practical guidance on eliciting public values and preferences, specifically in the context of environmental problems. The second, more recent, contribution is by Osberg and Sharpe (2002a,b) in developing their own Index of Economic Well-being.

Osberg and Sharpe's Index of Economic Well-being

Osberg and Sharpe (2002a,b) argue that an index of economic well-being "should be based on indices of consumption, accumulation, inequality and insecurity" (Osberg and Sharpe, 2002b, p.351). However, the key element of this contribution from the current perspective is their underlying hypothesis that "public debate is likely to be improved if issues of fact, analysis and values are as clearly separated as possible" (also Osberg and Sharpe, 2002b, p.351). Specifically, while they identify components for their indicator (under each of the four headings in the opening quote above) and concern themselves with the problem of measuring these components, they specify *explicit* weights for each component (in a "weighting tree") and, as well as testing the sensitivity of aggregate changes to changes in these weights, explain that this is motivated by "the

explicit recognition that the weights attached to each component will vary, depending on the values of different observers" (Osberg and Sharpe, 2002b, p.351).

While one could dispute the components themselves (as Neumayer, 2004, does, on the inclusion of factors relating to environmental sustainability in Osberg and Sharpe's 'accumulation' or 'wealth stocks' category – see below), we would argue that the key contribution here is the separation of problems involved in constructing a composite indicator. We do not offer a judgement on whether Osberg and Sharpe's (2002a,b) Index of Economic Well-being is any more appropriate for Scotland (or any other country) than any other candidate indicator. Rather, it is the approach of explicitly separating problems involved in constructing a composite indicator into those that can be solved by 'experts' and those that are better addressed by policymakers and through public debate. It is our argument that conflation of these problems may lead to 'throwing the baby out with the bathwater' in consideration of candidate indicators, such as the ISEW, where there are several distinct problems that merit separate consideration, both in terms of how they can be overcome and by whom. These are: (a) selecting and weighting factors to be included in an indicator, a problem best addressed by policymakers and through the democratic process; and separately from (b) measuring/valuing those factors that are not marketed, or for which markets are imperfect, which will require the input of experts; as will (c) overcoming technical problems in constructing the indicator/index. The core argument of the current paper is that it is important to be clear on the specific nature of the problem with a given approach or candidate indicator and then decide how it is best solved, and by whom.

4.4 Sets or 'baskets' of composite indicators

In Section 3.1, we identified two basic criticisms of composite indicators. The first of these - the perceived subjectivity of choice and method of weighting the included components, and of the sensitivity of the index to these choices and weights, as well as the relevance of this issue to indicators of global sustainability concerns and quality of life/well-being in turn – has been the focus of much of the discussion in this section so far. The second criticism identified relates to the issue of positive and negative effects cancelling each other out and/or being hidden in a composite indicator, and, thus, the question of whether it is reasonable to attempt the answer to the question "are we behaving sustainably?" in a single number. We have argued that this problem should be addressed by monitoring a set of underlying individual indicators alongside the composite indicator and, indeed, must be in the case of global sustainability concerns.

However, this second issue also arises in some of the critiques of both the ISEW concept and Osberg and Sharpe's (2002a,b) Index of Economic Well-being. Again, while it is not our intention to be prescriptive in terms of what candidate indicators may or may not be appropriate for Scotland, the basic issue, while already raised in Section 2.1, is one worth clarifying here. Gerlagh *et al* (2002) and Neumayer (2004) both argue that it is inappropriate to fully integrate factors relating to the economy, well-being and environmental

sustainability in a single indicator. As noted in Section 2.1, Gerlagh *et al*'s (2002) argument is that hypothetical and actual values should not be integrated. Neumayer (2004) focuses on the distinction between current well-being (involving the use of capital) and environmental sustainability (focussing on the level of capital stock). He argues that "what affects current well-being need not affect sustainability and vice versa - either not at all or at least not in the same way" (Neumayer, 2004, p.4), giving the example of an unequal distribution of income negatively impacting on well-being but not diminishing the total capital stock available to future generations (and cites evidence that an unequal distribution of income may actually be in the interests of future generations if the rich save more).

We are not entirely convinced that in so far as these problems relate to 'hidden' or 'cancelling' effects, they cannot be overcome by the approach of monitoring individual indicators alongside a composite. However, given that one of the key aims of a composite indicator is to simplify communication on the sustainability of development, if the combination of different elements of the sustainability problem in one single indicator does the opposite and is likely to confuse people regarding progress, it makes sense to consider different composite indicators that can be examined separately but alongside one another. For example, Moldan *et al* (2004) identify three 'pillars' of sustainability, suggesting that GDP be examined in the case of the 'economic pillar', the United Nations Development Programme's Human Development Index (HDI) in the case of the 'social pillar' and consider seven candidate composite indicators for the 'environmental pillar'.

Neumayer's (2001, 2004) response to this problem is to propose that, alongside conventional economic measures and in place of a 'fully integrated' measure such as ISEW, the HDI be used as an indicator of well-being alongside Genuine/Net Adjusted Savings (see Section 2.1) as an indicator of environmental sustainability. He acknowledges that there are other proposals and that HDI may not be the best choice of a well-being indicator for developed countries.[38] However, the value of his contribution is in demonstrating a systematic method by which the two can be used together (in this case with Genuine Savings being used to qualify what the HDI says about the sustainability of individual countries).

As we have noted previously, it is not our intention to be prescriptive and we do not offer any judgement on whether the HDI would be an appropriate indicator of well-being for Scotland. Nonetheless, it provides a useful example to close on, as there may be some appeal in the HDI, given that it is a widely recognised and internationally comparable indicator with predetermined components and weightings. However, it is important to note the argument put forward in Section 3.2 above that the benefits afforded by these features should be considered against the cost of the non-inclusion of components/weightings that reflect country-specific preferences. This suggests the need for other indicators that do reflect this. One area worth

[38] If the HDI were to be considered as a candidate in the case of Scotland, we would recommend a comprehensive review of this index. There are a number of what seem to be valid critiques of issues such as how the components are integrated to form the index (see, for example, Neumayer, 2001, and Sagar and Najam, 1998).

considering would be Layard-type 'happiness' indicators. Some review is offered in the Appendix, but the key point to be made here is that while guidance is offered in the literature (e.g. Layard 2006) with respect to measurement and aggregation issues (identified as problems (b) and (c) at the end of Section 4.3), in terms of selecting components and weights (problem (a) above), the same issues apply to happiness indicators as to other composite indicators that incorporate quality of life or well-being.

5. Summary and Conclusions

As noted repeatedly throughout this paper, we do not attempt to assess any particular candidate composite indicators for adoption in the case of Scotland. Nor, indeed, do we argue in favour of the use of composite indicators for Scotland in general. Rather, our intention is to clarify the criteria upon which different options may be systematically assessed. We identify two broad types of sustainability concern, relating to global and local quality of life issues respectively, and argue that it is not valid to dismiss the notion of composite indicators on the grounds of subjectivity in the case of the latter. Even in the case of global sustainability concerns, while the criticism of subjectivity *is* crucially important, we argue that use of composite indicators may still be useful in terms of comprehension and communication, so long as key underlying variables are monitored via appropriate individual indicators to avoid the problems of 'hidden' or 'cancelling' effects.

We argue that in assessing specific options for composite indicators it is important to distinguish between issues that require the input of experts, such as valuation of non-marketed factors and technical aspects of aggregation, and those relating to selection and weighting of factors that, in the case of quality of life or well-being, are best addressed through the political process. However, we also highlight the fact that the intended use of the indicator is another important consideration: where composite indicators are required for the purpose of monitoring government/country performance against that of others there will be a trade off between international comparability and having components and weightings that reflect country-specific preferences.

If the Scottish Executive decide that they want to progress with developing composite indicators, we would make several recommendations. First of all, there should be more comprehensive investigation into what type of indicator is required given Scotland's sustainability objectives (both individually and as a devolved region of the UK), and all candidate indicators should be identified.[39] Finally, it is also crucial to investigate data availability – i.e. if candidate indicators emerge, are data available to construct them to an acceptable standard? Generally, we would argue that there is a requirement to improve the quality and reporting of

[39] In the appendix to this paper we provide an overview of work currently being done in Scotland and elsewhere on composite indicators of sustainability, with specific focus on quality of life/well-being.

economic, environmental and social data in consistent and compatible formats for Scotland (e.g. adopting something like the NAMEA format promoted by Eurostat).[40,41]

[40] NAMEA is an acronym for 'National Accounting Matrix including Environmental Accounts'. See Keuning and Steenge (1999), and Vaze (1999) for the UK.

[41] Another issue is that, even where appropriate indicators can be constructed to an acceptable standard, their measurement and reporting is just that, an entirely descriptive process. If we want to understand *why* indicators move in a given direction, some type of modelling framework will be required to examine the transmission mechanism between changes in economic activity and indicator variables (see Turner, 2002).

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