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ANALYSIS

A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes

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Abstract

For some time now, ecological economists have been putting forward a 'threshold hypothesis'—the notion that when macroeconomic systems expand beyond a certain size, the additional cost of growth exceeds the flow of additional benefits. In order to support their belief, ecological economists have developed a number of similar indexes to measure and compare the benefits and costs of growth (e.g. the Index of Sustainable Economic Welfare, ISEW, and the Genuine Progress Indicator, GPI). In virtually every instance where an index of this type has been calculated for a particular country, the movement of the index appears to reinforce the existence of the threshold hypothesis. Of late, a number of observers have cast doubt over the validity of these alternative indexes. One of the concerns commonly expressed is the supposed lack of a theoretical foundation to support the ISEW, the GPI, and other related indexes. By adopting a concept of income and capital outlined by Fisher (Nature of Capital and Income. A. M. Kelly, New York, 1906), this paper demonstrates that these alternative indexes are theoretically sound but, in order to be broadly accepted, require the continuous development of more robust valuation methods.

Keywords: Index of Sustainable Economic Welfare; Genuine Progress Indicator; Threshold hypothesis; Fisher's concept of income and capital

1. Introduction

Ecological economists have long believed that the continued growth of macroeconomic systems is both ecologically unsustainable and existentially undesirable. Consistent with this belief, ecological economists have put forward a 'threshold hypothesis'—the notion that when macroeconomic systems expand beyond a certain size, the additional benefits of growth are exceeded by the attendant costs (Max-Neef, 1995). In order to support their belief, and in view of the inadequacies of Gross Domestic Product (GDP) as an indicator of human progress, ecological economists have developed a number of indexes to measure and compare the benefits and costs of growth. The first of these was Daly and Cobb's

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(1989) Index of Sustainable Economic Welfare (ISEW). The original ISEW, which Daly and Cobb calculated for the USA, has since been calculated for the UK, most western European and Scandinavian countries, Canada, Australia, and Chile. Over this time, many of the methods used to calculate the index have been revised. In addition, the ISEW has been given a variety of different names—for example, a Genuine Progress Indicator or GPI (Redefining Progress, 1995) and a Sustainable Net Benefit Index or SNBI (Lawn and Sanders, 1999; Lawn, 2000). While there has been a variation in the disparity between GDP and the chosen index calculated for different countries, the trend movement in the ISEW, GPI, and SNBI is very consistent. That is, up to a point, the growth of macroeconomic systems is beneficial to human well-being (see Fig. 1). Beyond this point, growth appears to be detrimental. On the surface at least, the ISEW, GPI, and SNBI offer solid support for the threshold hypothesis and the need for countries to eventually abandon the growth objective and focus on sustainable qualitative improvement, better known as sustainable development (SD).

Some recent articles (e.g. Atkinson, 1995; Neumayer, 1999, 2000) have called into question the validity of the ISEW, GPI, and SNBI as well as the methods used in their calculation. Not surprisingly, the critics of these alternative indicators cast doubt over their capacity to substantiate the threshold hypothesis (e.g. Neumayer, 2000). These are very timely papers since they challenge ecological economists to consider whether their results reflect the trend movement in the sustainable net benefits of growth or a subconscious desire to design an index to vindicate their own threshold hypothesis. Since, as an advocate of these alternative indexes, this challenge extends to me, I will assess the ISEW and other related measures to determine the extent to which they reflect concrete reality or the prejudices of ecological economists. In all, I hope to demonstrate that the ISEW, GPI, and SNBI are theoretically sound indexes, but would be increasingly accepted if a more robust and consistent set of valuation methods was employed in their calculation.

Before outlining the theoretical foundation of the ISEW and other related measures, I will briefly mention something about each of the relevant indexes.

1.1. Gross Domestic Product (GDP)

GDP is a monetary measure of the goods and services annually produced by domestically *located* factors of production (i.e. by the natural and human-made capital located in a particular country). GDP can be measured in *nominal* or *real* values. If GDP is measured in nominal values, it is measured in terms of the prices at the time of production. On the other hand, if GDP is measured in real values, it is measured in terms of the prices of all goods in a particular year—often referred to as the base year. Consequently, annual changes in real GDP merely reflect differences in the quantity of goods and services produced from year to year. It is for this reason that, in conventional terms, real GDP is preferred to nominal GDP as a measure of national income and well-being.

Most readers would have come across Gross National Product (GNP). GNP is much the same as GDP except that it measures the monetary value of the goods and services annually produced by domestically *owned* rather than domestically located factors of production (i.e. by the natural and human-made capital owned by the citizens of a particular country).

1.2. Index of Sustainable Economic Welfare (ISEW) and Genuine Progress Indicator (GPI)

The ISEW and GPI are designed to more closely approximate the sustainable economic welfare or progress of a nation's citizens. The sustainable economic welfare implied here is the welfare a nation enjoys at a *particular point in time* given the impact of past and present activities. The notion of sustainable economic welfare being approximated is critical. For example, imagine two comparable industrialised nations—one that had long ago made the structural adjustment to operate both sustainably and equitably; the other which had not. In view of the notion of sustainable economic

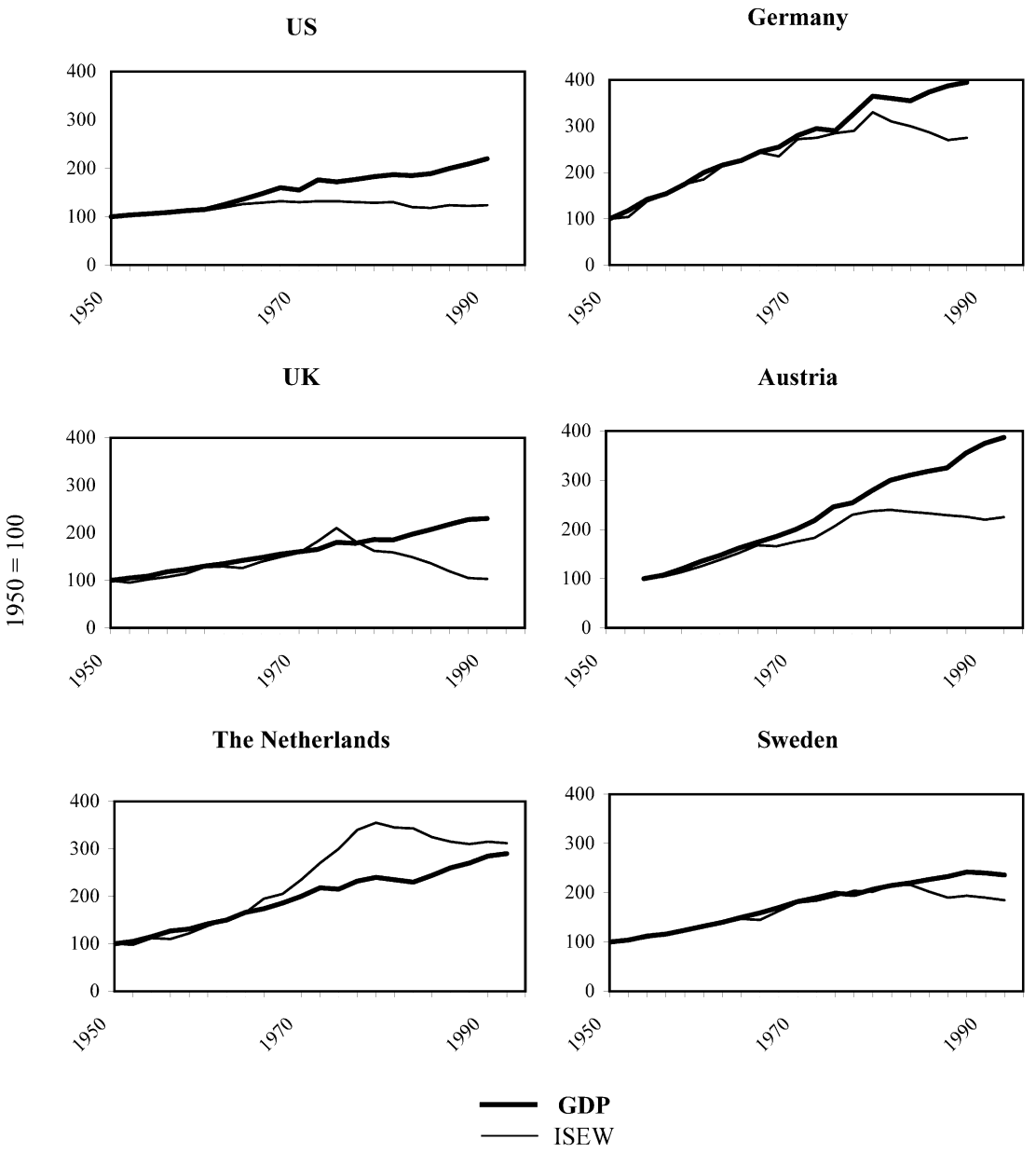

Fig. 1. Comparison of GDP and ISEW for the US, Germany, UK, Austria, The Netherlands, and Sweden (Jackson and Stymne, 1996).

welfare outlined above, the ISEW or GPI of the former would presumably be lower in the past to reflect the cost experienced at the time of structural adjustment, but higher in the present to reflect the ensuing benefits.

As for the calculation of the ISEW and GPI, both indexes begin, not with GDP as their base, but with the extraction from the national accounts of the transactions deemed directly relevant to human well-being (Redefining Progress, 1995).

Further adjustments are made to account for the many benefits and costs of economic activity that GDP ignores. Accordingly, the ISEW and GPI include a number of social and environmental benefits and costs that invariably escape market valuation. The following is a list of the typical items used in the calculation of the ISEW and GPI (Table 1).

Table 1 includes a range of positive and negative items that are summed to obtain a final index number. All items are valued in monetary terms, as are the ISEW and GPI. The final index number is usually calculated in real rather than nominal values. The ISEW and GPI basically differ in name only. It is becoming increasingly common for updated calculations to be referred to as the GPI. If one compares the original ISEW with recent calculations of the GPI, the list of items used to arrive at the final index number has varied over time, as have some of the valuation methods. One also finds a difference in the valuation methods used to calculate the ISEW and GPI for different countries (see, for instance, Diefenbacher, 1994; Moffat and Wilson, 1994; Rosenberg and Oegema, 1995; Jackson and Stymne, 1996; Jackson et al., 1997; Guenno and Tiezzi, 1998; Castaneda, 1999; Hamilton, 1999). The reasons for these differences are usually related to the availability of data and the preference researchers have for specific valuation methods.

Table 1
Items used to calculate the GPI for USA from 1950 to 1995

Personal consumption expenditure (+)
Index of distributional inequality (+/−)
Weighted personal consumption expenditure
Cost of consumer durables (−)
Services yielded by consumer durables (+)
Services yielded by roads and highways (+)
Services provided by volunteer work (+)
Services provided by non-paid household work (+)
Cost of noise pollution (−)
Cost of commuting (−)
Cost of crime (−)
Cost of underemployment (−)
Cost of lost leisure time (−)
The cost of household pollution abatement (−)
The cost of vehicle accidents (−)
The cost of family breakdown (−)
Net capital investment (+/−)
Net foreign lending/borrowing (+/−)
Loss of farmland (−)
Cost of resource depletion (−)
Cost of ozone depletion (−)
Cost of air pollution (−)
Cost of water pollution (−)
Cost of long-term environmental damage (−)
Loss of wetlands (−)
Loss of old-growth forests (−)
TOTAL = sum of all positive and negative items = GPI (valued in dollars)
(+) = positive item
(−) = negative item
(+/−) = item that may be either positive or negative

Source: Redefining Progress, 1995.

1.3. Sustainable Net Benefit Index (SNBI)

The SNBI is much the same as the ISEW and GPI. Where the SNBI differs is in the explanation of the rationale for an alternative index and the presentation of the items used in its calculation. The items, which are similar to those listed in Table 1 (see Lawn and Sanders, 1999), are sorted into separate 'benefit' and 'cost' accounts. The total of the cost account is subtracted from the benefit account to obtain the SNBI. This approach has the advantage of presenting the results in a manner consistent with a concept of income and capital superior to standard definitions of income (more on this later). It also allows one to compare the benefits and costs of a growing macroeconomy. In so doing, it strengthens its own case as well as the case for the ISEW and GPI.

2. The theoretical foundation of the ISEW and GPI

While the development of the ISEW and GPI has been motivated by the inability of GDP to serve as a measure of sustainable economic welfare, surprisingly little effort has been devoted towards the establishment of a theoretical foundation to support them.[1] This is why a colleague and I put forward the SNBI (Lawn and Sanders, 1999).

[1] Perhaps the best attempt so far is that of Stockhammer et al. (1997).

Apart from wanting to find out whether Australia had exceeded the welfare-increasing threshold of continuing growth, we wanted to highlight the theoretical foundation underlying the existing ISEW and GPI.

Contrary to some opinions, the ISEW and GPI are soundly based on a concept of income and capital first advanced by Irving Fisher (1906) that is far superior to standard definitions of income. In order to explain the theoretical foundation underlying the existing ISEW and GPI, I will begin by outlining the inadequacies of GDP. I will do this by adopting the Hicksian definition of income—the definition of income invariably used to calculate adjusted measures of GDP (sometimes referred to as a measure of sustainable net domestic product or SNDP). I will then outline the Fisherian view of income and capital and explain why it is preferable to the Hicksian definition. Following this, I will adopt the Fisherian view of income and capital to reveal the shortcomings of both GDP and the SNDP as well as the logical superiority of an economic indicator based on this alternative perspective. Finally, I will show how and in what way the ISEW and GPI are consistent with Fisher's concept of income and capital.

2.1. The shortcomings of Gross Domestic Product (GDP)

Many of the shortcomings of GDP have been outlined in past justifications for the ISEW and GPI. The most obvious one is that GDP does not constitute a measure of national income. Some time ago, Hicks (1946) pointed out that the practical purpose of calculating income is to indicate the maximum amount people can produce and consume without undermining their capacity to produce and consume the same amount in the future. From a national income perspective, it is necessary to answer the following question: "Can a nation's entire GDP be consumed without undermining its ability to produce and consume the same GDP in the future?" For a number of reasons, the answer is an obvious no. First, some of the annual GDP must be set aside to replace worn out producer and consumer goods. Second, production and consumption involves activities that are, in many cases, ecologically unsustainable. Thus, even if one was to subtract from GDP the depreciation value of all existing producer and consumer goods and, in doing so, obtain a measure of net domestic product (NDP), the resultant NDP would still overestimate the maximum net product that a nation could sustainably produce and consume. Finally, the output of many economic activities is not directly consumed but specifically set aside to defend a nation's citizens from the side-effects of past and present economic activities. Yet a measure of GDP commits this accounting error by treating all defensive and rehabilitative expenditures as income. In all, a better measure of national income can be calculated by adhering to the following formula (Daly, 1996):

$$\mathrm{SNDP} = \mathrm{GDP} - \mathrm{depr}^{n} \text{ of } \mathrm{Kh} - \mathrm{depl}^{n} \text{ of } \mathrm{Kn} - \text{def.andrehab. expenditures} \quad (1)$$

where: SNDP = sustainable net domestic product; GDP = gross domestic product; Kh = human-made capital in the Irving Fisher (1906) sense of all human-made items that directly or indirectly yield benefits to possessors (all producer and consumer goods); Kn = natural capital.

By making the necessary subtractions from GDP, the SNDP is able to provide a better measure of the maximum amount a nation can produce and consume without undermining its capacity to do so in the future. The above adjustments to GDP are significant in that they reflect the basic need to avoid long-term impoverishment by keeping intact a stock of income-generating capital. However, the need for capital intactness leads to a further concern, that is, should a combined stock of human-made and natural capital be kept intact or are the two forms of capital sufficiently unique to necessitate their individual maintenance? The answer to this question depends on whether human-made capital and natural capital are substitutable. If human-made capital is able to serve as an adequate substitute for declining natural capital, there is only a need to keep intact a combined stock of both forms of

capital. In this situation, the SNDP constitutes a measure of 'sustainable' income provided enough goods have been produced to offset the combined depreciation of human-made and natural capital. The final measure of the SNDP in this instance is often referred to as a *weak* sustainability measure of national income.

Should, on the other hand, natural and human-made capital be complements, merely subtracting the depreciation of human-made capital and the depletion of natural capital from GDP cannot give rise to a measure of 'sustainable' income unless the estimated depletion value of natural capital reflects the cost of whatever is required to keep natural resource stocks intact. To do this, it is necessary to determine the portion of the proceeds from resource exploitation that must be set aside to cultivate additional renewable resource stocks or, in the case of non-renewable resources, to cultivate a renewable resource substitute. A simple but ingenious formula has been put forward by El Serafy (1989) to calculate the set aside amount. This set aside amount constitutes the 'user cost' or, as I shall later argue, the replacement cost of resource depletion. The remainder constitutes legitimate income. To calculate the SNDP, the former is subtracted from GDP but the latter is not. So long as the user cost subtracted from GDP approximates the amount that must be invested to keep the stock of natural capital intact, this second measure of SNDP is equivalent to a *strong* sustainability measure of national income.

Growing evidence from ecological economists indicates that natural and human-made capital are complements for the very reason that natural capital provides a range of services that human-made capital cannot. For instance, natural capital is the sole source of low entropy resources (the availability of which is necessary for human-made capital to exist); is the sole repository and assimilator of high entropy waste; and is the sole generator of critical life-support services. There are, however, claims that substitution between the two forms of capital exists because the technological progress embodied in human-made capital can reduce the natural capital needed to fuel the economic process. For three good reasons, it is wrong to call this substitution. First, the technological progress embodied in human-made capital does not 'take the place of' natural capital. Technological progress merely reduces the high entropy waste generated in the transformation of natural to human-made capital. Because of the first and second laws of thermodynamics, there is a limit to how much production waste can be reduced—i.e. there is no 100% production efficiency; there can never be 100% recycling of matter; and there is no way to recycle energy at all. Hence, the production of a given quantity of human-made capital will always require a minimum resource flow and, therefore, a minimum amount of resource-providing natural capital (Lawn, 1999). Second, when a production function adhering to the first and second laws of thermodynamics is used to derive the elasticity of substitution between human-made capital and natural capital, the value is less than one for all relevant values of the human-made capital/natural capital ratio (Lawn, 2001).[2] Furthermore, the elasticity of substitution tends towards zero as attempts are made to augment human-made capital to offset the impact of declining natural capital. Third, the quantity of natural capital required to maintain the life-support services it provides far exceeds the quantity needed to sustain the economic process alone. For these reasons, ecological economists prefer the calculation of the SNDP to be based on a strong sustainability measure of national income.

2.2. The shortcomings of Sustainable Net Domestic Product (SNDP)

While the SNDP is a better measure of Hicksian income than GDP, it has its deficiencies too. To begin with, the calculation of the SNDP overlooks a number of important welfare-related factors. These include the cost of reduced leisure time, the cost of commuting, the cost of crime and family breakdown, the value of volunteer and non-paid household work, and the welfare effect of a change in the distribution of income. Often overlooked,

[2] A value of at least one is required to demonstrate adequately substitutability.

the redistribution of income from the low marginal benefit uses of the rich to the higher marginal benefit uses of the poor can lead to an overall increase in the economic welfare enjoyed by society as a whole (Robinson, 1962; Easterlin, 1974; Abramowitz, 1979). Thus, while the SNDP of a nation can increase over time, it will not accurately reflect the increase in a nation's economic welfare if the rise in the SNDP is accompanied by a growing income disparity between rich and the poor.

Second, there is the issue of whether the SNDP is in fact a good measure of national income—a key factor underpinning the theoretical strength of the ISEW and GPI. Very early on in the consideration of national income, Fisher (1906) argued that the national dividend consists not of the goods produced in a particular year, but of the services enjoyed by the ultimate consumers of all human-made goods. Fisher called the services enjoyed by ultimate consumers as 'psychic income'. Most economists refer to psychic income as 'utility satisfaction'. Because the economic process involves many irksome activities, the concept of psychic income can be extended to include the 'psychic outgo' of the economic process (e.g. the cost of noise pollution, commuting costs, and the cost of crime and family breakdown). This allows one to obtain the theoretical notion of 'net psychic income'—the sum total of all the psychic income-yielding aspects of the economic process less the sum total of its irksome or psychic outgo-related aspects.

The implications of adopting Fisher's view of income are significant. To begin with, any durable producer or consumer good manufactured during the current year is not part of this year's income. It simply constitutes an addition to the stock of human-made capital.[3] Only the services rendered this year by non-durable consumer goods and durable producer and consumer goods manufactured in previous years are part of this year's income. Unfortunately, since the calculation of the SNDP counts all additions to human-made capital as current income, it wrongly conflates the services rendered by capital (income) and the capital that renders them. It is therefore questionable whether the SNDP is a true measure of income, although one's view on this boils down to their preference for the Hicksian or Fisherian definition of income. The Fisherian view of income is superior in that the former wrongly associates economic welfare with the rate of production and consumption. The Fisherian perspective is different in that it takes the view that economic welfare depends on the psychic enjoyment of life—a view strongly supported elsewhere (e.g. Georgescu-Roegen, 1971; Daly, 1979). While it is true that the psychic enjoyment of life cannot be experienced without the existence of physical goods, it is certainly not determined by the rate at which goods are produced and consumed. It is determined primarily by the quantity of human-made capital (at least up to a certain amount), the quality of the stock, and its ownership distribution—all of which can be favourably adjusted without the need for an increased rate of production and consumption. It is also interesting to note that one of the forefathers of national income accounting, Pigou (1932), believed Fisher's approach was both attractive mathematically and logically correct. Pigou opted not to follow Fisher's approach because he believed "the wide departure it makes from the ordinary use of language involves disadvantages that seem to outweigh the gain in logical clarity." This was probably acceptable at a time when the rise in production benefits clearly exceeded the rise in production costs. But, as the ISEW, GPI, and SNBI have shown (Fig. 1), this point in time has long been surpassed and so the great weight of disadvantage now rests with the maintenance of the present system of national accounts.

Fisher's concept of income and capital has one further implication. By keeping capital and income separate, it forces one to recognise that since the stock of human-made capital depreciates and

[3] In the Irving Fisher (1906) sense, capital is regarded as any physical object that is subject to human ownership and capable of directly or indirectly satisfying human needs and wants. Hence, human-made capital refers to all producer and consumer goods. Although not subject to ownership other than by the individual who possesses productive knowledge and skills, labour can also be included as part of the stock of human-made capital.

wears out through use, its continual maintenance is a cost not a benefit. It constitutes a cost because the maintenance of human-made capital requires the production of new goods and production can only occur if there is an ongoing throughput of matter-energy (the input of low entropy resources and the output of high entropy wastes). To obtain the throughput, it is necessary to exploit natural capital which, in turn, results in the inevitable loss of some of the source, sink, and life-support services provided by natural capital (Perrings, 1986). As Eq. (1) showed, the calculation of the SNDP overcomes the problem of counting lost natural capital services as income by subtracting from GDP the cost of natural capital depletion. However, it is because Fisher's concept of income and capital treats the production of replacement goods as the cost of keeping human-made capital intact that the SNDP effectively stands as an index of sustainable cost. While an index of sustainable cost is preferable to an index of unsustainable cost, such as GDP, it scarcely serves as an index of sustainable economic welfare. Indeed, as an index of sustainable cost, it makes sense to minimise not maximise a nation's SNDP.

3. The theoretical superiority of the ISEW and GPI

Contrary to some opinions (e.g. Neumayer, 1999), the ISEW and GPI do not lack a theoretical foundation. The ISEW and GPI serve as very good indicators of both income and sustainable economic welfare precisely because they are consistent with Fisher's concept of income and capital. The best way of demonstrating this is to focus on the individual items used to construct the ISEW and GPI.

3.1. Personal consumption expenditure

Unlike the SNDP, which starts with GDP as its initial reference point, the ISEW and GPI begin with personal consumption expenditure. This is important because it provides an approximate estimate of what Fisher described as the services or psychic income enjoyed by the ultimate consumers of human-made goods. Using consumption expenditure as the initial reference point does not imply that consumption is itself good—a theoretical failing of the SNDP. It implies that consumption is a 'necessary evil'. That is, it is necessary to consume goods to gain the services they yield. Of course, if the same level of service can be enjoyed from less consumption, this would be a gain because it would necessitate less production to maintain the stock of human-made capital intact. Such a gain, if it were made, would not be reflected in this particular item but would instead be reflected in other items due to a smaller cost of pollution or resource depletion or both. Thus, if a given level of service from consumption was accompanied by a reduction in the rate of production (due, for example, to an increase in the durability of human-made capital), this would lead to a rise in the ISEW and GPI. However, it would lower the SNDP.

3.2. An index of distributional inequality/weighting of personal consumption expenditure

As I mentioned earlier, the distribution of income can have a significant impact on a nation's economic welfare. If personal consumption expenditure does not change from one year to the next but the distribution of income deteriorates, the economic welfare enjoyed by society as a whole is likely to fall because the marginal benefit uses of the rich is less than the marginal benefit uses of the poor. Unless personal consumption expenditure is weighted according to changes in the distribution of income, it will inaccurately reflect its true contribution to a nation's economic welfare. This adjustment is made in the calculation of the ISEW and GPI but not so in the case of the SNDP.

3.3. The cost of consumer durables

Included in personal consumption expenditure is the amount paid in the current year on consumer durables such as cars, refrigerators, and household furniture. This amount constitutes an addition to the stock of human-made capital. It does not constitute current income in the Fisherian sense. In the calculation of the ISEW and GPI, the cost of consumer durables is subtracted from weighted

personal consumption expenditure. It is not done so in the calculation of the SNDP.

3.4. Services yielded by existing consumer durables

Not included in personal consumption expenditure is the value of the services annually yielded by previously purchased consumer durables. As Fisher argued, these services constitute current income. In the calculation of the ISEW and GPI, the annual value of these services is added to the running total. It is overlooked in the calculation of the SNDP. The service value is usually calculated as a percentage of the total value of the entire stock of consumer durables. Ideally, the percentage rate chosen should reflect the estimated depreciation rate or 'rate of consumption' of consumer durables.

3.5. Services yielded by publicly provided human-made capital

Consumer durables are not the only form of human-made capital that yields services. Publicly provided human-made capital such as libraries, museums, roads and highways do likewise. To be consistent with the Fisherian concept of income and capital, these services are treated as income and added in the calculation of the ISEW and GPI. They are again overlooked in the calculation of the SNDP. The service value is usually calculated in the same way as it is for consumer durables, that is, as a percentage of the total value of the existing stock of publicly provided human-made capital. Consistent with the Fisherian concept of income and capital, current expenditure by governments on human-made capital is not included because it merely constitutes a current addition to the stock.

3.6. Services provided by volunteer and non-paid household work

Not all benefit-yielding services are provided by market-based economic activity. The initial reference item of personal consumption expenditure overlooks the services provided by volunteer and non-paid household work. To obtain a better indicator of the psychic income enjoyed by a nation's citizens, the ISEW and GPI include these services. The SNDP does not.

3.7. Disservices generated by economic activity

The items so far discussed make a positive contribution to the psychic income of a nation. As I mentioned earlier, the economic process involves a range of irksome activities while it also generates many undesirable side-effects. To extend the concept of psychic income to that of 'net psychic income', the cost of irksome and psychic outgo-related aspects must also be included. The ISEW and GPI do this by deducting the following:

- the cost of noise pollution
- the cost of commuting
- the cost of crime
- the cost of underemployment
- in some cases, the cost of unemployment
- the cost of lost leisure time

3.8. Defensive and rehabilitative expenditures

A large portion of the human-made capital produced each year does not contribute to the psychic income of a nation. It is produced to prevent the undesirable side-effects of the economic process reducing the psychic income enjoyed in the future. In calculating the ISEW and GPI, the following defensive and rehabilitative expenditures are subtracted from the running total:

- the cost of household pollution abatement
- the cost of vehicle accidents
- the cost of family breakdown
- in some cases, a certain percentage of private health expenditure assumed to constitute a form of defensive expenditure

3.9. Net capital investment

The inclusion of this particular item is contentious. One of the key implications of the Fisherian

concept of income and capital is that additions to the stock of human-made capital should not be counted as income. The ISEW and GPI go a long way towards ensuring this by subtracting current expenditure on consumer durables and by not adding current government expenditure on human-made capital. However, the calculation of the ISEW and GPI includes the net investment in the stock of producer goods (plant, machinery, and equipment). If the calculation of this item was based on an estimate of the net increase in the total stock of producer goods, as it is in the calculation of SNDP, the inclusion of this item would be inconsistent with Fisher's concept of income and capital. It is not, however, calculated in this manner. Rather, net capital investment is calculated as the increase in the stock of producer goods above the amount required to keep the quantity of producer goods per worker intact. As contentious as this item is, there is some justification for its inclusion. To recall, because of the complementarity between human-made and natural capital, *sustainable* economic welfare requires both forms of capital to be non-declining. In terms of human-made capital, this implies that the quantity of producer goods per worker must not fall. Therefore, should the stock of producer goods be greater than the necessary minimum requirement, the difference constitutes an increase in a nation's productive capacity. This, of course, is a clear benefit.

3.10. Net foreign lending/borrowing

This item is included because a nation's long-term capacity to sustain the psychic income generated by the economic process depends very much on whether natural and human-made capital is domestically or foreign owned. Evidence clearly indicates that many countries with large foreign debts have difficulty maintaining the investment levels needed to keep their stock of human-made capital intact. Furthermore, they are often forced to liquidate natural capital stocks to repay debt (George, 1988).

3.11. Cost of sacrificed natural capital services

As I explained earlier, one of the major implications of Fisher's concept of income and capital is its recognition of the continual maintenance of human-made capital as a cost. The cost is eventually borne out by way of the natural capital services lost in obtaining the throughput required to keep the stock of human-made capital intact. To be consistent with the Fisherian concept of income and capital, it is necessary to deduct the cost of the lost source, sink, and life-support services provided by natural capital. The ISEW and GPI do this by deducting the following:

- loss of farmland and the cost of resource depletion (lost *source* services of natural capital)
- cost of ozone depletion and air and water pollution (lost *sink* services of natural capital)
- cost of long-term environmental damage and the loss of wetlands and old-growth forests (lost *life-support* services of natural capital)

All up, the ISEW and GPI have a sound theoretical foundation based on Fisher's concept of income and capital. This makes the ISEW and GPI far superior indicators of both income and sustainable economic welfare than GDP and the SNDP. Moreover, provided the benefits and costs of the economic process can be measured with some of accuracy, it is reasonable to believe that the ISEW and GPI can serve as a valuable means of assessing whether, at the national level, the additional benefits of growth are being exceeded by the additional costs.

There is, however, a theoretical weakness associated with the ISEW and GPI that also extends to the SNBI. All three indexes merely count the cost of lost natural capital services. While it is important to obtain a better measure of economic welfare by subtracting the cost of environmental damage, it is equally important to know when a nation's stock of natural capital has declined to such an extent as to render the economic welfare it enjoys ecologically unsustainable. The ISEW, GPI, and SNBI do not directly provide this information and thus require supplementation.

Given the need to keep natural capital intact, it is advisable to undertake biophysical assessments of a nation's resource stocks and critical ecosystems and present the information in something akin to a natural capital account. For example, in Lawn (2000), a natural capital account has been compiled for Australia as well as the benefit and cost accounts described earlier to calculate the SNBI. The diminution of Australia's natural capital over the same period in which the SNBI has been calculated indicates that the falling level of economic welfare (a consequence of the decline in the SNBI) is also becoming increasingly unsustainable. That is, the additional benefits of growth in Australia are not only being overtaken by the additional costs, but the Australian macroeconomy has probably exceeded its maximum sustainable scale. As a back-up to the natural capital account, a comparison between a nation's ever-changing ecological footprint and biocapacity could also be provided (e.g. Wackernagel et al., 1999) as well as a number of ecosystem health indexes proposed by the various contributors in Costanza et al. (1992).

4. The need for a more robust and consistent set of valuation methods

The validity of the criticism levelled at the ISEW, GPI, and SNBI is probably greatest in relation to the valuation methods used in their calculation (see Maler, 1991; Atkinson, 1995; Hamilton, 1994, 1996; Neumayer, 1999, 2000). The majority of criticism has been directed at the valuation of the following items listed in Table 1—the index of distributional inequality and the weighting of personal consumption expenditure; defensive and rehabilitative expenditures; the cost of resource depletion; and, finally, the tendency to deduct the cumulative cost of ozone depletion, long-term environmental damage, and lost old-growth forests. Since an assessment of the contentious valuation methods requires each to be thoroughly examined, I will leave such a task to a future paper.[4] Having said this, I would like to raise a number of aspects regarding the ISEW and related measures that must eventually be addressed in order for these alternative indexes to gain broader acceptability.

First, as I have already pointed out, the ISEW and GPI must be supplemented by a satellite account of natural capital to determine whether the changing level of economic welfare is ecologically sustainable. Second, the list of items used to calculate the ISEW, GPI, and SNBI is not exhaustive—there are many welfare-related factors unaccounted for (e.g. the disutility of certain forms of work and the existence values of natural capital). Quite obviously, it is impossible to incorporate all welfare-related factors into a single index. Nevertheless, it may be beneficial to replace some of the lesser items currently included in the calculation of the ISEW, GPI, and SNBI with items that can be clearly identified as having greater welfare significance.

Third, as Neumayer (1999) has pointed out, some items dominate others such that it is possible for a small variation in dominant items to overwhelm large variations in the remainder. Overcoming this problem may require decomposition of the dominant items into a number of smaller items. Fourth, it is assumed that all personal consumption expenditure contributes to human well-being. Since this item includes the consumption of junk food, tobacco products, alcohol, and guns, it is unlikely that all consumption expenditure will boost the psychic income of a nation's citizens. To date, this issue has been largely avoided by ISEW and GPI advocates. One possible way of dealing with this problem is to conduct a sensitivity analysis by excluding some of the components of personal consumption expenditure. For example, personal consumption expenditure in the SNA includes a category for 'cigarettes and tobacco' and another for 'alcoholic drinks'. The

[4] I would just like to point out that I am currently updating the SNBI for Australia and, as part of the process, have been reassessing the valuation methods employed and the nature and make-up of the various items used to compile the benefit and cost accounts.

full amount of the former could be omitted and half of the latter. There might also be a justification for excluding a small percentage of expenditure on 'food'. Given the magnitude of the consumption expenditure item, omissions of this nature could lead to a small variation in the overall index which would then allow analysts to make their own conclusions regarding its impact on sustainable economic welfare. This having been said, the existence of this problem in no way undermines the legitimacy of the ISEW and other like indicators since subjective judgments about what contributes to human well-being are common to all indicators.[5] As it is, these alternative indicators already include items to capture some of the costs of undesirable forms of consumption (e.g. the impact of additional health costs and reduced productivity).

Fifth, while the ISEW, GPI, and SNBI convey useful information about the current manifestations and immediate effects of past and present activities, they reveal much less about the future impact of current activities—a consequence of the definition of sustainable economic welfare being measured. This weakens the policy-guiding relevance of these alternative indexes. It might, therefore, be expedient to accompany the ISEW, GPI, and SNBI with a second index that incorporates the probable future benefits and costs of current actions (i.e. attributes future benefits and costs to the present calculation of the ISEW, etc.). This could be achieved by employing the forecasting techniques put forward by Asheim (1994, 1996), Pezzey (1993), and Pezzey and Wiltage (1998). Ideally, the accompanying measure of 'adjusted' economic welfare would be higher than the standard ISEW, GPI, or SNBI to reflect the forecasted net benefits of moving toward a more just and sustainable mode of operation. A lower accompanying measure of economic welfare would reflect the failure of present policies. Thus, if the threshold hypothesis is valid, growth-based policies should lead to a lower measure of 'adjusted' economic welfare and, moreover, to a widening of the gap over time between the standard and adjusted indexes.

Finally, there is little doubt that some of the valuation methods employed to calculate the ISEW, GPI, and SNBI are extremely crude and often involve the use of very heroic assumptions. Hence, the values of some items are likely to be, at best, distant approximations of their correct value. Clearly, the advocates of the ISEW, GPI, and SNBI must continue to strive for more robust valuation methods. There is also a genuine need for a standardised set of items and valuation techniques to allow for a more meaningful welfare comparison of different nations. Indeed, unless a robust and consistent set of valuation techniques can be established along similar lines to the way in which the United Nations System of National Accounts is used to calculate GDP, the results of the ISEW, GPI, and SNBI will forever be open to criticism.

5. Conclusion

As imperfect as the ISEW, GPI, and SNBI might be, I believe the illumination of a sound theoretical foundation and the evolution of more robust valuation methods will strengthen the case for these alternative indexes. In doing so, it should lead to a wider acceptance of the threshold hypothesis. I believe this to be of major importance and a continuing challenge to ecological economists at a time when the world's richest nations urgently need to make the transition away from growth to that of sustainable qualitative improvement, better known as sustainable development.

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[5] If nothing else, the exclusion of some forms of consumption is likely to reduce the final value of the ISEW, GPI, and SNBI and, in doing so, reinforce the threshold hypothesis.

comments. The responsibility for any errors rests solely with the author.

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