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Has Australia surpassed its optimal macroeconomic scale? Finding out with the aid of 'benefit' and 'cost' accounts and a sustainable net benefit index

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Abstract

The sustainable economic welfare of a nation depends largely on the sustainable net benefits the macroeconomy confers to its citizens. For this reason, an optimal macroeconomic scale can be considered one where the physical scale of the macroeconomy and the qualitative nature of the stock of wealth it comprises maximises a nation's sustainable net benefits. The corollary of this definition is thus: the physical scale of the macroeconomy should grow only if, in the process, the sustainable net benefits of a nation increase. It should cease to grow once sustainable net benefits are maximised. Whilst it is one thing to promote an optimal macroeconomic scale, it is another entirely to gain an appreciation of the sustainable net benefits yielded by the macroeconomy. Gaining such an appreciation constitutes the central aim of this paper. With the assistance of two separate 'benefit' and 'cost' accounts to replace gross domestic product (GDP), a sustainable net benefit index is constructed for Australia for the period 1966–1967 to 1994–1995. The index, particularly at the per capita level, indicates that economic welfare in Australia is declining (i.e. the average Australian is getting 'poorer') despite per capita real GDP increasing. The index therefore suggests that the scale of the Australian macroeconomy has probably well exceeded the optimum. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Optimal macroeconomic scale; Sustainable economic welfare; National accounts; Australia

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1. Introduction

This paper is structured in the following manner. First, the importance of having to separate benefits and costs at the macroeconomic level is emphasised. Second, the case for an optimal macroeconomic scale is put forward. Third, it is explained why gross domestic product (GDP) is unable to suffice as a measure of sustainable net benefits and, therefore, as an indicator of sustainable economic welfare. In response, two separate accounts are recommended. The first is designed to measure the 'uncancelled' benefits (net psychic income) of economic activity. The second account seeks to measure the 'uncancelled' costs of economic activity—in effect, the source–sink and life-support functions of natural capital sacrificed in the process of producing and maintaining the stock of benefit-yielding wealth. The two accounts are briefly explained and discussed. With the use of these two accounts, a sustainable net benefit (SNB) index is calculated for Australia for the period 1966–1967 to 1994–1995. As an alternative macroeconomic 'barometer' to GDP, the SNB index enables one to appreciate whether the Australian macroeconomy is nearing or has surpassed its likely optimum.

2. Why is an optimal scale of the economic system a macroeconomic desideratum?

Economists are entirely familiar with the notion of optimal scale. Indeed, microeconomics is virtually an expanded variation on the theme (Daly, 1996, p. 60). Whether it be a firm in production or an individual making decisions concerning consumption choices or the number of hours they should work, it is customary to identify, define, and often mathematically formalise a benefit and cost function. In so doing, the microeconomist is at pains to separate benefits and costs. The two basic economic laws of diminishing marginal benefit and increasing marginal cost are incorporated into the analysis to reflect the usual way that benefits and costs vary in accordance with an increase in the scale of any given activity. In every instance, the recommended microeconomic course of action is the same. That is, expand the scale of activity until marginal benefits equal marginal costs. Once achieved, net benefits are maximised and an optimal scale of activity is attained.

Strangely, macroeconomics ignores the notion of an optimal scale almost completely. No attempt is ever made to compare the benefits and costs of a growing macroeconomy, nor, furthermore, is there an attempt to seek and attain, or at least move closer to, an optimal macroeconomic scale. The continued physical expansion of the macroeconomic subsystem is deemed desirable simply because it involves an increase per capita output. To wit:

> The growth of total output relative to population means a higher standard of living because an expanding real output means greater material abundance and implies a more satisfactory answer to the economising problem (Jackson et al., 1994, p. 414).

Why should an increase in the scale of economic activity imply a more satisfactory answer to the economising problem when, at the microeconomic level, operating at maximum capacity is not necessarily the desirable solution? One can only suggest that in moving from the microeconomic to the macroeconomic sphere, most economists continue to celebrate the benefits of a growing macroeconomy while forgetting or ignoring the attendant costs. Yet, it is because of this oversight and the failure to properly account for the costs of growth, that it is presently impossible to ascertain whether any given macroeconomy is nearing or has surpassed its likely optimum. Clearly, to appreciate how well an economic system is performing, the most basic of microeconomic concepts—the concept of constrained optimisation—must be incorporated into macroeconomics and the System of National Accounts.[1] In other words, for any single macroeconomic indicator to be reliably used as a measure of

[1] Two macroeconomic constraints that ought to at least be in place are: (a) an ecologically sustainable rate of resource throughput, and (b) a fair and equitable distribution of income and wealth.

sustainable economic welfare, it must be constructed on the basis of identifying, separating, and comparing the benefits and costs of economic activity. Only then is it possible to appreciate whether an increase in the physical scale of the macroeconomy is either beneficial or detrimental to the sustainable economic welfare of a nation's citizens.

How then does one set about identifying the optimal macroeconomic scale? In particular, what are the relevant benefits and costs of economic activity that need to be identified and measured? To begin with, imagine the natural environment as humankind's initial dowry from which three main categories of service are freely provided. These are its ability to: (a) provide a source of natural resources (low entropy matter-energy); (b) to absorb and assimilate high entropy wastes; and (c) to provide the amenities which support life—in all, its instrumental source–sink and life-support functions. Human beings have the onerous task of transforming a portion of the natural resource endowment into human-made wealth to satisfy their additional needs and wants. This task is never ending because the capacity of an individual item to satisfy human desires is eventually lost. Individual commodities are either consumed or, through use, wear out. Consequently, human beings are forever required to produce physical commodities simply to maintain the stock of human-made wealth intact.

Given, firstly, that resource scarcity ensures wealth creation always comes at a cost, and secondly, that there is a limit to the benefits yielded by a given stock of wealth, the following question needs to be considered. That is: 'to what extent should a nation continue to increase the rate of production and expand the scale of the macroeconomy?' Since achieving an optimal macroeconomic scale requires the maximisation of a nation's sustainable net benefits, there are two aspects to consider in answering this question. The first deals with the benefits of wealth creation and maintenance. The second deals with the cost of maintaining the stock of wealth in terms of environmental services sacrificed.

Strictly speaking, the satisfaction of human needs and wants depends on the stock of natural capital—the original source of all economic activity. This is because natural capital is the sole source of low entropy matter-energy and the ultimate repository of all high entropy wastes. Nevertheless, the intensity with which human needs and wants are satisfied is largely a function of the quality as well as quantity of human-made wealth, that is, of the 'psychic income' that the stock of wealth yields through its consumption. Psychic income constitutes the true benefit of economic activity because, as Fisher (1906) pointed out long ago, the external world is only made effective to human beings as a consequence of final satisfactions derived from commodity consumption eventually residing in the human mind.

It is an unfortunate fact of life that, in the process of creating wealth, human beings must also endure a considerable array of psychic disservices (e.g. the disutility of work, of commuting, and of noise pollution). It is the cancelling out of these psychic disservices or 'psychic outgo' from psychic income that enables one to obtain a measure of *net psychic income*—the final or 'uncancelled' benefit of economic activity. Net psychic income is the uncancelled benefit of economic activity because, in tracing the course of economic activity from its source (natural capital) to its final, psychic conclusion, every intermediate transaction involves the cancelling out of a receipt and expenditure of the same magnitude. Only once an item of wealth is in the possession of the final user or consumer is there no additional exchange and, therefore, no further cancelling of transactions (Daly, 1979, p. 81).

In dealing with the second aspect concerning the above question, it is important to recognise that whenever human beings extract useful resources (low entropy matter-energy) from the natural-environment, it inevitably returns, in the same quantitative mass, as useless waste (high entropy matter-energy).[2] Perrings (1986) has shown that

[2] It returns in the same quantitative mass because of the first law of thermodynamics—the law of the conservation of matter and energy—which stipulates that both matter and energy cannot be either created nor destroyed. However, it returns as high entropy waste, that is, in a qualitatively degraded condition, because of the second law of thermodynamics—the so-called Entropy Law.

no matter how benignly human beings conduct their activities, the subsequent disarrangement of matter-energy always has some deleterious impact on the natural environment. Consequently, human beings have no option but to acknowledge and accept some loss of the free source–sink and life-support services provided by natural capital as some portion of the low entropy it provides is transformed into physical commodities and returns, once they have been consumed, as high entropy waste.

Since natural capital is the original source of all economic activity, the loss of natural capital services constitutes the final or 'uncancelled' cost of economic activity. That is, if one traces economic activity from its final, psychic conclusion (net psychic income) back to its original source, all intermediate transactions are cancelled except, finally, the natural capital services sacrificed in obtaining the low entropy required to produce and maintain the stock of wealth.

In the end, sustainable net benefits can be calculated by subtracting the uncancelled costs of economic activity from the uncancelled benefits. The extent to which a nation should increase the physical scale of the macroeconomy depends on whether its physical expansion leads to an increase in sustainable net benefits. In the event that it does, growth is 'economic' and therefore desirable. However, once a nation's sustainable net benefits are maximised and the optimum is attained, the macroeconomy should cease to grow (unless the optimum scale, which is not static, increases over time). Growth beyond the optimum, even an expanding optimum, becomes 'anti-economic'.

The notion of an optimal macroeconomic scale is diagrammatically illustrated in Fig. 1.

Assume, for a moment, that technological progress is static. The uncancelled benefits (UB) curve in Panel 1a represents the net psychic income yielded by a growing macroeconomy. The characteristic shape of the UB curve is attributable to the law of diminishing marginal utility which, barring technological improvements, is equally applicable to the total stock of wealth as it is to individual items. It is as a consequence of this law that the marginal uncancelled benefit (MUB) curve in Panel 1c is downward sloping.

The cost of increasing the physical scale of the macroeconomy is represented in Panel 1a by the uncancelled cost (UC) curve. It represents the free instrumental services—the source–sink and life-support functions—lost in the process of transforming natural resources into physical commodities. The shape and nature of the UC curve is attributable to the law of increasing marginal costs—a reflection of the increase in costs arising from the macroeconomy growing relative to a finite natural environment.[3] For instance, as the macroeconomy grows and non-renewable resources are progressively depleted, human beings are forced to go to much greater lengths and expend more energy to discover and extract new and often poorer grade resources. Also, in a world where the scale of the macroeconomy relative to the natural environment is small, wealth creation has only a minimal impact on the source–sink and life-support functions of natural capital. As the macroeconomy gets bigger and its relative scale becomes more considerable, undesirable ecological feedbacks increase in their significance such that, with every new disruption of natural capital, the opportunity cost is generally greater than the previous disruption. It is because of the law of increasing marginal costs that the marginal uncancelled cost (MUC) curve in Panel 1c is upward sloping.

Both the UC and MUC curves are vertical at the macroeconomic scale of S_S. This is because S_S denotes the maximum *sustainable* macroeconomic scale—what is, for given levels of human know-how, the largest macroeconomic scale that any nation can maintain at the maximum sustainable rate of resource throughput. Both the UC and MUC curves are vertical at this point to indicate that any wealth created beyond S_S is not permissible (at least from a sustainability perspective) since, in the long run, the larger stock of wealth cannot be ecologically sustained. Whilst S_S is therefore equivalent to a sustainability threshold,

[3] Since the natural environment can erratically respond to novel events, the UC curve is not always as well behaved as is shown in Fig. 1.

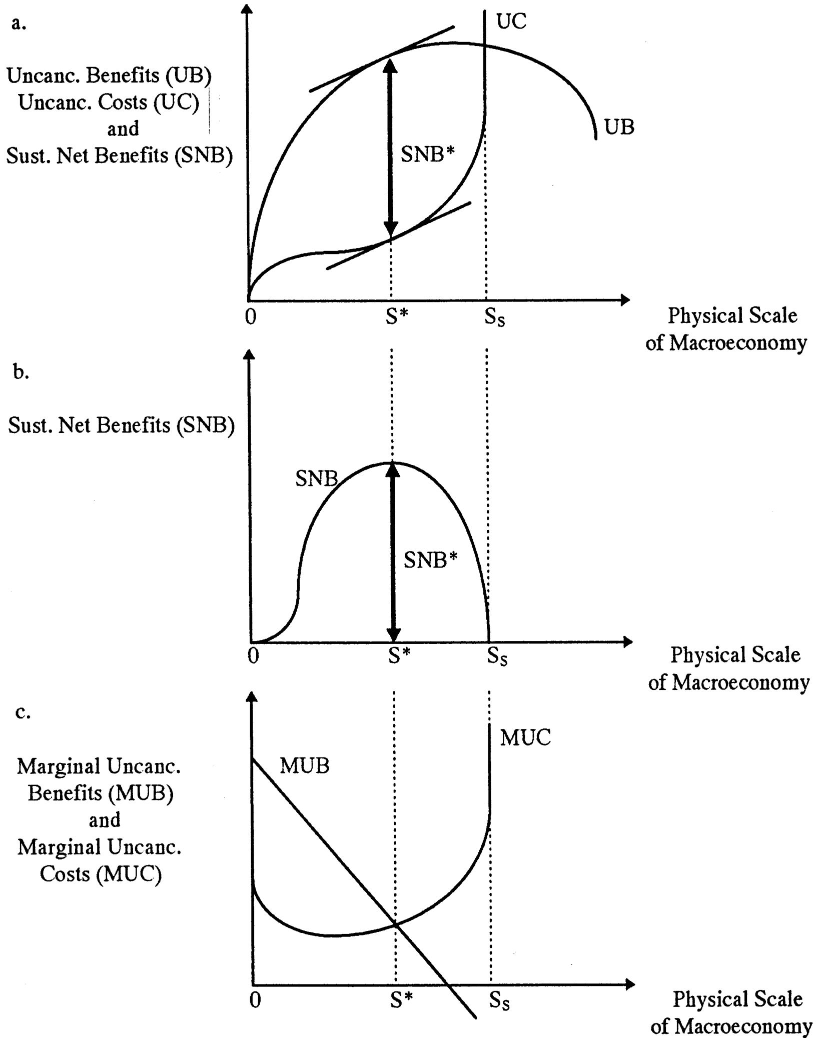

Fig. 1. A diagrammatic illustration of an optimal macroeconomic scale.

it should always be understood that a threshold of this nature is both indistinct and, for many uncontrollable reasons, highly variable. For this reason alone, the maximum permissible scale should always be limited to something less than the estimated maximum sustainable scale.[4]

For any given macroeconomic scale, sustainable net benefits (SNB) are measured by the vertical difference between the UB and UC curves. This difference is represented by the SNB curve in Panel 1b. An optimal macroeconomic scale is obtained at and denoted by S^*. It represents the physical size and qualitative nature of the macroeconomy that maximises the vertical difference between the UB and UC curves (SNB*). In Panel 1c, this is where the MUB and MUC curves intersect.

Fig. 1 demonstrates that growth is a desirable

[4] This is best achieved by consciously setting quantitative limits on the annual rate of matter-energy (throughput) cros ing the natural environment–macroeconomy boundary. See Daly (1996), Chapter 2.

macroeconomic objective only in the early stages of the development process. Continued physical expansion of the macroeconomic subsystem, which is equivalent to moving along the UB and UC curves, eventually leads to a decline in sustainable net benefits and thus becomes anti-economic, indeed, anti-development.

3. Technology and the optimal macroeconomic scale

The role of technology cannot be ignored at this point. Technological progress can increase the net psychic income gained while also decreasing the natural capital services sacrificed in maintaining a given macroeconomic scale. This is because technological progress can beneficially shift the UB curve upwards and the UC curve downwards and to the right. In doing so, technological improvements can permit, over time, an increase in the overall size of the optimal macroeconomic scale. Furthermore, by also reducing the loss of natural capital services, technological progress can also increase the maximum sustainable scale.

To explain how the two curves can be positively shifted, consider a couple of instructive examples, beginning with uncancelled benefits. If a technological innovation increases the capacity of the stock of wealth to yield benefits, a higher level of net psychic income can be enjoyed even if the macroeconomy comprises the same physical magnitude, though never the same population, of wealth. This can be achieved by improving the technical design of newly produced commodities. It can also be achieved by improving the way in which human beings organise themselves in the course of producing and maintaining the stock of wealth (thereby reducing such things as the disutility of labour and the cost of commuting and unemployment). Conversely, of course, downward pressure on the UB curve can also be exerted if, in the process of producing commodities to maintain the stock of wealth intact, unemployment and other psychic outgo costs increase.

What about uncancelled costs? New technologies that increase the efficiency of resource use—i.e. that reduce the requirement for resource input, that lead to more ecologically benign wastes, and result in resource extraction activities having a lessened impact on the environment, shift the UC curve by reducing the loss of natural capital services associated with the creation of human-made wealth.

There is considerable debate surrounding how much and for how long human beings can rely on technological progress to respectively shift the UB and UC curves. This paper is not the place to debate such issues. However, ecological economists believe the limits to technological progress, particularly with respect to uncancelled costs, are probably not that far away. In any case, one thing is irrefutably clear. Regardless of the rate of technological progress, and moreover, how distant the limits to such progress indeed are, there is, at any given point in time, a physical macroeconomic scale which constitutes the optimum. If the rate of growth of the macroeconomy exceeds the rate at which technological progress beneficially shifts the UB and UC curves, the macroeconomy eventually overshoots the optimum. In doing so, sustainable net benefits must eventually decline—something a rigorously constructed index of sustainable net benefits should have little problem in revealing.

4. Real GDP—an inadequate measure of sustainable economic welfare

GDP is measured in both nominal and real terms. At a simplistic level, nominal GDP is the monetary value—at current or going market prices—of the annual flow of goods and services produced by domestically located factors of production. Real GDP, on the other hand, eliminates the effect that inflation (deflation) has on the nominal measure of GDP by approximating the annual *physical* flow of production in terms of a constant price level. Since the 1940s, real GDP has been the foremost indicator of economic welfare throughout the world. Comparisons over time in real GDP are made on the grounds that it illuminates changes in economic welfare and, therefore, changes in the standard of living. In addition, real GDP is used to assess the relative state of economic welfare of different countries.

As previously explained, an efficacious welfare indicator needs to identify, separate, and compare benefits and costs in order to properly reflect the changing net benefits conferred by a growing macroeconomy. With this in mind, it is suggested that, for the following reasons, real GDP is unable to suffice as a measure of sustainable economic welfare. First and foremost, GDP fails to separate benefits and costs. It treats many costs as benefits yet fails to include some benefits altogether. For example, it falsely includes as benefits a range of defensive and rehabilitative expenditures (e.g. some medical and dental expenditures, the cost of vehicle repairs, crime prevention measures, and efforts to both rehabilitate and protect the natural environment from the impacts of economic activity). GDP also fails to include a number of significant welfare-related benefits. These include more than just the usually indicated oversights such as non-paid household work, volunteer work, and the value of leisure time. With the exception of owner-occupied residential dwellings, GDP also excludes the annual services yielded by owner-used assets (consumer durables such as furniture, white-goods, and cars) and publicly provided assets—public buildings (such as art galleries, museums, and libraries) and roads and highways (Daly, 1996, p. 111). Overlooked, also, is the annual value of natural capital services which appear to have greater welfare significance than any human-made capital (Costanza et al., 1997).

Second, and in view of the last point, the calculation of GDP falsely counts the consumption of natural capital as income. Income is properly defined as the maximum amount that can be consumed without undermining the capacity to maintain the same level of consumption into the future (Hicks, 1946). Because of the complementarity of human-made and natural capital (Daly, 1996, pp. 76–79), sustaining a given consumption stream requires the stock of both forms of capital to be kept intact. Preliminary evidence indicates the stock of natural capital of most countries is being consumed despite GDP increasing (Pearce and Atkinson, 1993). When GDP is adjusted to take account of natural capital depletion, it is often dramatically affected (e.g. Repetto et al., 1989). In many cases, increases in GDP become decreases following an adjustment for natural capital consumption. Hence, by counting as benefit the consumption of natural capital, GDP is in many ways a faulty measure of income.

Third, the calculation of GDP assumes that an extra dollar of income to the rich adds as much to the nation's economic welfare as an extra dollar of income to the poor. However, this assumption runs counter to the principle of diminishing marginal utility where, as Robinson (1962) once pointed out, 'so much of the good juice of utility is allowed to evaporate out of commodities by distributing them unequally'. Of course, one cannot assume that a nation's economic welfare would be maximised by ensuring each citizen received the same income. It clearly would not. Income inequality is necessary to provide the incentive structure required to reward individual effort and to assist in generating a nation's income to begin with.[5] Nevertheless, given that changes over time in the distribution of income are likely to affect the aggregate economic welfare of a nation, an adjustment of some description should be made to reflect this welfare implication. Current measures of GDP do not incorporate an adjustment of this type.

Finally, GDP does not include the social cost of unemployment, in particular, long-term unemployment, nor the potential unsustainability of a growing foreign debt. Does, for instance, a steady increase in GDP represent an increase in economic welfare if: (a) a growing percentage of the labour force becomes unemployed and (b) if, in servicing a growing foreign debt, a nation is forced to liquidate much of its natural capital? The answer would seem to be an unambiguous no although, again, one cannot rely on GDP to reflect such impacts on the welfare of a nation's citizens.

[5] All the same, the degree of income inequality should not exceed what is deemed to be ethically acceptable.

5. A sustainable net benefit (SNB) index for Australia, 1966–1967 to 1994–1995

In order to gain an appreciation of the sustainable net benefits yielded by the Australian macroeconomy, two things are required. In the first instance, the deficiencies inherent in conventional measures of GDP must be overcome. Second, an SNB index needs to be constructed on the basis of having to identify, separate, and compare the benefits and costs of economic activity.

5.1. Account No. 1—the uncancelled benefits (net psychic income) account

In view of the aforementioned, a clearer picture of sustainable net benefits is obtained via the compilation of two separate accounts. The first is an 'uncancelled benefits' account. The primary aim of this account is to calculate a pecuniary measure of net psychic income. The construction of such an account involves a number of steps. To begin with, there is a need to identify and measure the psychic income enjoyed from either the use and–or consumption of wealth as well as from the process of wealth creation itself. Second, the disservices deplored but nonetheless experienced from economic activity—psychic outgo—also need to be identified and valued. Having achieved both, the latter are subtracted from the former to obtain a measure of net psychic income.

To assist in the measurement of both psychic income and outgo, a number of the items used in the calculation of both the Index of Sustainable Economic Welfare (Daly and Cobb, 1989) and the Genuine Progress Indicator (Cobb et al., 1995) have been separated into the two respective categories.[6] The following items constitute the psychic income items which make up the uncancelled benefit account for Australia. The means by which they are calculated are, in most instances, briefly explained. The respective values of each item are based on 1989–1990 prices.

- *Private consumption expenditure*. Private consumption expenditure serves as the initial reference point for the uncancelled benefit account. (Data source: Foster, 1996, Table 5.2a, p. 220).
- *An index of distributional inequality*. As previously explained, psychic income depends very much on the distribution of income. Consequently, an index of distributional inequality is used to weight consumption expenditure. This index is based on the change in the Gini coefficient with the initial year, 1966–1967, given a base index value of 100.0. Any improvement–deterioration in the distribution of income since 1966–1967 results in a smaller–larger Gini coefficient and, therefore, a smaller–larger index value. (Data source: Australian Bureau of Statistics, Income Distribution in Australia (various). Catalogue No. 6523.0).
- *Distributional weighting of private consumption expenditure*. Consumption expenditure is weighted to reflect annual changes in the distribution of income. This is achieved by: (a) dividing consumption expenditure for each year by the respective index value, and (b) multiplying by 100.
- *Annual services yielded by stock of consumer durables*. Consumer durables are not wholly consumed over an annual accounting period. Hence there is a need to impute the value of the services (psychic income) derived from their part 'consumption'. It has been assumed that the value of these services is equal to an annual depreciation value of 15% per year. (Data source: Commonwealth Treasury of Australia, 1996, Table 1(a), p. 49 and Table 1(b), p. 50).
- *Annual services yielded by stock of public dwellings*. As per the previous item except, in this instance, the annual imputed rental rate was assumed to be equal to that of owner-occupied private dwellings. (Data source: Foster, 1996, Table 5.23, p. 274).
- *Annual services yielded by stock of roads and highways*. As per the previous item. (Data source: Australian Bureau of Statistics, Australian National Accounts: National Income, Expenditure and Products (various). Catalogue No. 5204.0).

[6] A few additional items have been added in this study. In addition, there is a slight variation in the means by which some of the items have been calculated.

- *Non-paid household labour*. Significant benefits are derived from non-paid household labour activities such as household cleaning, cooking, child care, household maintenance and renovation, and gardening. To calculate the annual value of non-paid household labour, the gross opportunity cost method was used. An hour of unpaid household work was assumed to be equal to the average hourly real wage. (Data source: Foster, 1996, Table 4.18, p. 209).
- *Volunteer labour*. Volunteer labour contributes significantly to the psychic income enjoyed by Australians. Calculated as per non-paid household labour. (Data source: Australian Bureau of Statistics, Voluntary Work in Australia. Catalogue No. 4441.0).
- *Public expenditure on health and education counted as consumption*. Not all public expenditure on health and education directly benefits a nation's citizens. Much of it is simply for defensive measures. This item includes the estimated portion of public expenditure which contributes to the improvement of a nation's health and vitality (assumed to be half of all public health and education expenditure). (Data source: Foster, 1996, Table 2.12, p. 83).
- *Net capital growth*. To sustain net benefits over time, the quantity of productive capital per worker must be maintained. Net capital growth constitutes any increase in productive capital above this requirement. (Data source: Foster, 1996, Table 4.3, p. 180 and Table 5.23, p. 274).
- *Change in net international position*. This item was included because a nation's long-term capacity to sustain net benefits over time depends very much on whether capital is domestically or foreign owned. (Data source: Foster, 1996, Table 1.20.c, p. 55).
- *Imputed value of leisure time*. Leisure is an important component of any nation's well-being. To calculate this item, the number of leisure hours was estimated by calculating the average daily number of non-leisure hours of Australians aged 15 years and above (the minimum school-leaving age) and deducting it from the number of hours in a day. It was assumed that the real value of an hour of leisure time remained unchanged over the study period. (Data source: Department of Employment, Education, and Training, 1995; Foster, 1996, Table 4.12, p. 198; Australian Bureau of Statistics, Survey of Motor Vehicle Usage (various). Catalogue No. 9208.0; Australian Bureau of Statistics, Education and Training in Australia (various). Catalogue No. 4224.0).
- Item A—*Total psychic income*. Equal to the sum of all psychic income items. The value of Item A for each year over the period 1966–1967 to 1994–1995 appears in Table 1.

The following items serve as the psychic outgo items which, when cancelled against the above, provide a measure of uncancelled benefits (net psychic income). These, too, are based on 1989–1990 prices.

- *Annual expenditure on consumer durables*. Because the life of consumer durables exceeds one year, one cannot record current expenditures on consumer durables as an act of personal consumption. In other words, the amount paid for consumer durables reflects the psychic income consumers expect to enjoy over the full time it takes to consume, degrade, or depreciate consumer durables. As such, it is necessary to subtract current expenditure on consumer durables. (Data source: Australian Bureau of Statistics, Australian National Accounts: National Income, Expenditure and Product (various). Catalogue No. 5204.0).
- *Defensive private health and education expenditure*. There is a need to subtract those portions of private education and health expenditures which are clearly defensive (assumed to be half of all private health and education expenditure). (Data source: Australian Bureau of Statistics, Australian National Accounts: National Income, Expenditure and Product (various). Catalogue No. 5204.0).
- *Cost of private vehicle accidents*. The cost of vehicle accidents is a form of expenditure that reduces a nation's psychic income. However, only the cost of private vehicle accidents was included because much of the total cost of all vehicle accidents is incurred by the business sector which does not directly affect psychic income. (Data source: Paterson, 1973; Bureau of Transport and Communications, 1979; Atkins, 1981; Steadman and Bryan, 1991).

Table 1
Sustainable net benefit (SNB) index for Australia, 1966–1967 to 1994–1995

Year	Total psychic income A	Total psychic outgo B	Uncancelled benefits (net psychic income) (A–B) C	Uncancelled costs (loss of natural capital services) D	Sustainable net benefit (SNB) index (C–D) E	Australian population ('000s) F	Per capita SNB index (E–F) G
1966–1967	284 439	21 893	262 546	108 960	153 586	11 799	13 017
1967–1968	304 990	22 083	282 907	112 799	170 108	12 009	14 165
1968–1969	317 954	23 007	294 947	117 334	177 613	12 263	14 484
1969–1970	330 721	24 129	306 952	122 239	184 713	12 507	14 769
1970–1971	358 793	26 588	332 205	126 206	205 999	13 067	15 765
1971–1972	379 532	31 901	347 631	130 709	216 922	13 304	16 305
1972–1973	405 065	29 510	375 555	135 219	240 336	13 505	17 796
1973–1974	435 574	34 488	401 086	140 640	260 446	13 723	18 979
1974–1975	444 339	46 167	398 219	145 806	252 413	13 893	18 168
1975–1976	453 211	49 243	403 998	150 275	253 723	14 033	18 080
1976–1977	447 315	54 081	393 324	155 267	238 057	14 192	16 774
1977–1978	447 552	57 857	389 695	159 688	230 007	14 359	16 018
1978–1979	441 762	56 779	384 983	166 132	218 851	14 516	15 077
1979–1980	424 111	58 593	365 518	171 632	193 886	14 695	13 194
1980–1981	460 080	59 083	400 997	176 448	224 549	14 923	15 047
1981–1982	477 267	66 496	410 771	181 733	229 038	15 184	15 084
1982–1983	475 321	86 244	389 077	186 462	202 615	15 394	13 162
1983–1984	483 943	80 892	403 051	190 692	212 359	15 579	13 631
1984–1985	482 004	78 495	403 509	196 907	206 602	15 788	13 086
1985–1986	493 386	81 271	412 115	201 932	210 183	16 018	13 122
1986–1987	511 237	82 718	428 519	206 552	221 967	16 264	13 648
1987–1988	533 839	79 516	454 323	211 238	243 085	16 532	14 704
1988–1989	526 865	74 947	451 918	215 992	235 926	16 814	14 032
1989–1990	530 409	85 827	444 582	224 046	220 536	17 065	12 923
1990–1991	535 645	103 874	431 771	228 639	203 132	17 284	11 753
1991–1992	556 953	113 783	443 170	232 987	210 183	17 489	12 018
1992–1993	556 281	116 700	439 581	239 802	199 779	17 656	11 315
1993–1994	559 036	108 834	450 202	243 189	207 013	17 838	11 605
1994–1995	577 869	103 405	474 464	247 396	227 068	18 054	12 577

All items in $millions (1989–1990 prices) except column F.

- *Cost of noise pollution*. The cost of noise pollution is based on a 1972 World Heath Organisation estimate (OECD, 1986). This estimate was adjusted in accordance with changes in a constructed noise pollution index. (Data source: Fabricius, 1994).
- *Direct disamenity cost of air pollution*. Along with many other forms of pollution, air pollution costs reflect the loss of the ecosphere's sink function. However, some portion of all air pollution costs includes the direct impact it has on a nation's psychic income. These include the impact of air pollution on: (a) urban property values and wages, and (b) urban aesthetics (Freeman, 1982). It was assumed that these two impacts constitute 40% of the total cost of air pollution. (Data source: Australian Bureau of Statistics, Cost of Environmental Protection, Australia: Selected Industries, 1991–1992. Catalogue No. 4603.0; Fabricius, 1994).
- *Cost of unemployment*. In the same way leisure time constitutes a benefit, so unemployment constitutes a psychic outgo cost to the unemployed. (Data source: Foster, 1996, Table 4.3, p. 180; Table 4.12, p. 198; Table 4.15, p. 202; and Table 2.25, p. 108).
- *Cost of underemployment*. As per the previous item. Underemployment occurs when the number of hours worked by those employed is less than the amount desired. (Data source: Australian Bureau of Statistics, Employment, Underemployment, and Unemployment, 1966–1983 in Australia. Catalogue No. 6246.0; Kryger, 1993).
- *Cost of commuting*. As cities and towns grow, the length of time spent commuting increases thereby reducing the nation's net psychic income. This item was calculated by adopting the formula used by Daly and Cobb (1989), pp. 424–425, in their estimation of commuting costs as part of their calculation of the Index of Sustainable Economic Welfare. (Data source: Australian Bureau of Statistics, Australian National Accounts: National Income, Expenditure and Product (various). Catalogue No. 5204.0).
- *Cost of crime*. The cost of crime was assumed to be the sum of: (a) the theft of privately owned property (excluding the cost of crime inflicted upon the business and public sector); and (b) the cost of being confined indoors at particular times of the day or to particular places. The latter was assumed to be equivalent to the amount spent by all forms of government on public order and safety. (Data source: Walker, 1992; Australian Bureau of Statistics, National Crime Statistics. Catalogue No. 4510.0; Foster, 1996, Table 2.12, p. 83).
- *Cost of family breakdown*. This item reflects the loss of psychic income arising from the breakdown of the family unit. The method used here is the same as that used by Cobb et al. (1995), pp. 19–21, in the estimation of the Genuine Progress Indicator. (Data source: Australian Bureau of Statistics, Australian Yearbook (various). Catalogue No. 1301.0).
- Item B—*Total psychic outgo*. Item B is equal to the sum of all psychic outgo items. The value of Item B for each year over the period 1966–1967 to 1994–1995 appears in Table 1.

The total psychic outgo (Item B) is subtracted from total psychic income (Item A) to obtain an measure of net psychic income (uncancelled benefits). The final estimate of net psychic income for Australia appears in Table 1 (Item C).

Net psychic income for Australia generally rose over the study period, indicating that psychic income rose more than the increase in psychic outgo. The steepest rise occurred during the period 1966–1967 to 1973–1974. Between 1973–1974 and 1986–1987, Australia's net psychic income increased only marginally. This can be explained by the fact that net psychic income is particularly sensitive to changes in unemployment, changes in income distribution, net capital growth, and changes in the net international position. All of these items deteriorated significantly either throughout this entire period or over most of it. Interestingly, neither of these factors have any affect on conventional measures of GDP. Apart from the recessionary period of 1988–1989 to 1990–1991, net psychic income generally increased beyond 1986–1987. However, the rate of such an increase is considerably smaller than that experienced between the years of 1966–1967 to 1973–1974.

5.2. Account No. 2—the uncancelled cost account

The principal objective of an uncancelled cost account is to estimate a pecuniary measure of the natural capital services sacrificed in the process of conferring uncancelled benefits via economic activity. To construct an uncancelled cost account, it is first necessary to ascertain the extent to which the natural environment's source–sink and life-support functions have been lost during each accounting period. This involves a number of steps. The first of these relates to the environment's source function. To deduce the extent to which the source function has been sacrificed, it is necessary to determine: (a) the rate at which both renewable and non-renewable resources have been harvested or mined; (b) the regeneration rate of renewable resources; and (c) the extent to which renewable resources have been cultivated to offset the depletion of non-renewable resources. Having achieved this, the extent to which the source function has been lost requires comparison between (a) and (b) with allowances made for variations in (c).

With the above in mind, the following items are included to measure the diminution of the natural environment's source function. The respective values for each financial year are based on 1989–1990 prices.

- *User (depletion) cost of metallic mineral stocks*. The extraction of non-renewable resources constitutes a direct decline in the natural environment's source function. El Serafy (1989) user cost method was employed to calculate the cost of non-renewable resource depletion. (Data source: Australian Bureau of Statistics, Mining Production, Australia (various). Catalogue No. 8405.0; Australian Bureau of Agricultural and Resource Economics. Commodity Statistical Bulletin (various). AGPS, Canberra).
- *User (depletion) cost of coal stocks*. As per the previous item.
- *User (depletion) cost of oil and gas stocks*. As per the previous item.
- *User (depletion) cost of non-metallic mineral stocks*. As per the previous item.
- *Loss of agricultural land (soil loss)*. This item was calculated by assuming the value of the annual productivity loss of agricultural land is equal to 6% of the annual value of agricultural production (State of the Environment Advisory Council, 1996). Also included in this calculation were the losses attributed to the encroachment of urban areas onto agricultural land. (Data source: State of the Environment Advisory Council, 1996; Australian Bureau of Statistics, Census of Population and Housing (various). Catalogue No. 2822.0).
- *Net change in timber stocks*. As a renewable resource, the impact of timber harvesting on the environment's source function depends critically on the rate at which it is harvested; its regenerative rate; and the extent to which additional timber stocks have been cultivated. Separate values were assigned for native forest timber, woodland forest timber, plantation timber–broadleaved, and plantation timber–coniferous. (Data source: Australian Bureau of Statistics, National Balance Sheets for Australia: Issues and experimental Estimates, 1989–1992. Occasional Paper, Catalogue No. 5241.0, Table 4.2, p. 72; Table 4.3, p. 73; Table 4.4, p. 73; Table 4.5, p. 74; Table 4.7, p. 79; Table 4.8, p. 80; Table 4.9, pp. 81–82; and Department of Primary Industries).
- *Net change in fishery stocks*. Calculated as per the previous item. Fishery stocks included prawns, rock lobster, abalone, scallops, oysters, fish (excluding tuna), and tuna. (Data source: State of the Environment Advisory Council, 1996, Fig. 8.4, pp. 8–14; Table 8.11, p. 8–29; Australian Bureau of Agricultural and Resource Economics. Commodity Statistical Bulletin (various). AGPS, Canberra).
- *Cost of lost or degraded wetlands, mangroves and saltmarshes*. Wetlands, in this instance, included all areas of land that are flooded annually or are inundated or waterlogged on a permanent, seasonal, or intermittent basis. Separate values were assigned to each of these landscape types. (Data source: Galloway et al., 1984; Paijmans et al., 1985; State of the Environment Advisory Council, 1996, Tables 8.6 and 8.7, pp. 8–22)

The second major step involved in the compilation of an uncancelled cost account relates to the natural environment's sink function. The sink function is sacrificed, to some degree, when the quantity and qualitative nature of the high entropy wastes generated by the economic process exceeds the capacity of the natural environment to assimilate them. With a good deal of reliability, one can say that the waste assimilative capacity has been exceeded whenever the emission of pollution imposes discernible costs. For this reason, the following items have been chosen to reflect the loss of the natural environment's sink function.

- *Cost of water pollution*. The cost of water pollution was calculated by using a constructed water pollution index to adjust the estimated 1991–92 cost of water pollution. (Data source: Australian Bureau of Statistics, Cost of Environmental Protection, Australia: Selected Industries, 1991–1992. Catalogue No. 4603.0; Fabricius, 1994).
- *Cost of air pollution*. It was assumed that 60% of the total cost of air pollution reflects the waste assimilative capacity of the natural environment having been exceeded (the remaining 40% was assumed to be equal to the direct disamenity cost of air pollution). (Data source: Australian Bureau of Statistics, Cost of Environmental Protection, Australia: Selected Industries, 1991–1992. Catalogue No. 4603.0; Fabricius, 1994; State of the Environment Advisory Council, 1996).
- *Cost of solid waste pollution*. An index of solid waste pollution was calculated by assuming the full impact of solid waste is a function of the quantity of waste which makes its way to landfill sites. The index was then used to adjust the 1991–92 estimated cost of solid waste pollution. (Data source: Fabricius, 1994; National Greenhouse Gas Inventory Committee, 1996, Table A2, p. 73; Australian Bureau of Statistics, Cost of Environmental Protection, Australia: Selected Industries, 1991–1992. Catalogue No. 4603.0).
- *Cost of ozone depletion*. The cost of ozone depletion was calculated by multiplying the cumulative production of CFC-11 and CFC-12 by a value of $1.00 per kilogram produced. The cumulative figure is equivalent to the amount needed to compensate future generations for the effects of excessive pollutants in the Earth's atmosphere (in particular, 'Greenhouse' and ozone-depleting gases and substances). (Data source: Cobb et al., 1995).

The completion of an uncancelled cost account requires the estimation of two important aspects related to the ecosystem's life-support function. The first of these relates to the cost of long-term environmental damage. The second involves the calculation of an Ecosystem Health Index. An uncancelled cost account is consequently finalised by the inclusion of the following items:

- *Cost of long-term environmental damage*. The cost of long-term environmental damage largely reflects the natural environment's diminishing life-support services. To calculate this item, Australia's annual consumption of energy was converted to a crude oil barrel equivalent and multiplied by a cost value of $2.50 per barrel. Like the previous item, the cumulative figure is equivalent to the amount needed to compensate future generations for the excessive use of energy resources. (Data source: Australian Bureau of Statistics, Energy Accounts for Australia, 1993–1994. Catalogue No. 4604.0, Table 3.4, p. 21; Bureau of Resource Economics, 1987, Table E1, p. 73).
- *Ecosystem Health Index*. Many sacrificed life-support services are exceedingly difficult to measure. To overcome this, the above running total of uncancelled costs is weighted by an index reflecting the health of Australia's ecosystems. This is necessary given that the items used to account for lost source and sink services do not account for impacts on the life-support function of natural capital (e.g. mining not only diminishes the source function of natural capital but, through the disruption of ecosystems, its life-support services). The index was based on the rate of native vegetation clearance with 1966–1967 given a base value of 100.0. The index constantly falls to a value of 90.0 by the year 1994–1995, which represents a 10% reduction in native vegetation cover over the study period. The running total of uncancelled costs was weighted by: (a) dividing the uncancelled costs for each year by the respective index value; and (b) multiplying by 100. (Data source: Biodiversity Unit, 1995).

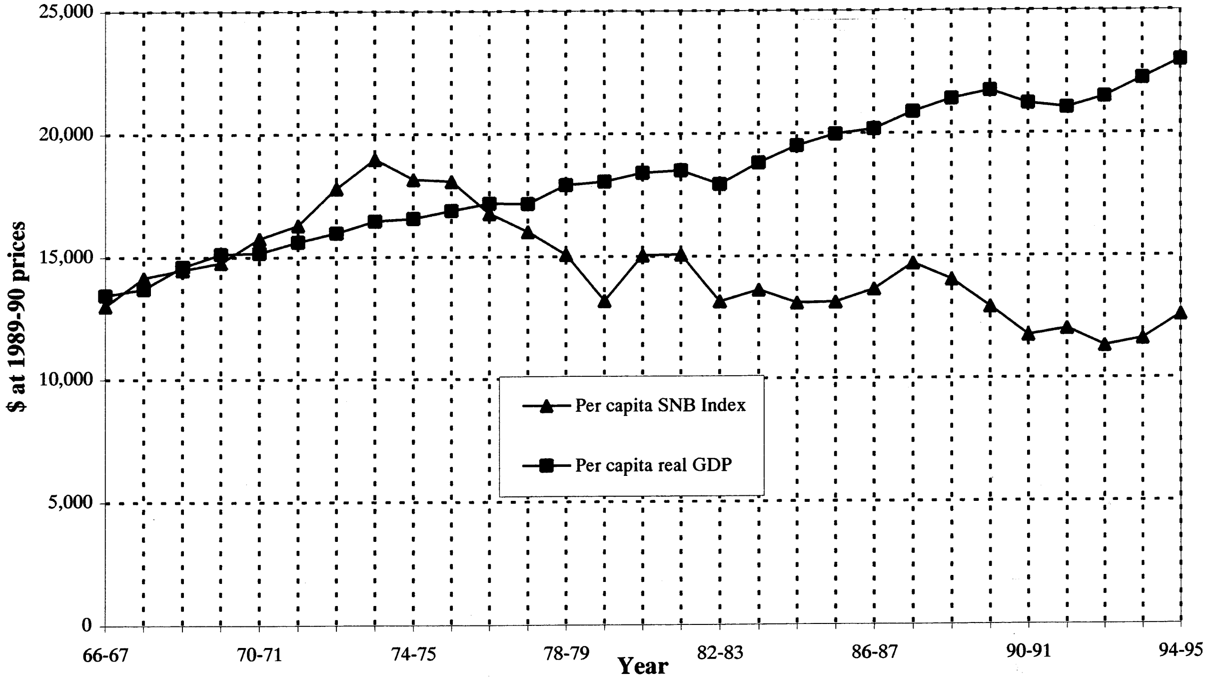

Fig. 2. Per capita sustainable net benefits and per capita real GDP for Australia, 1966–1967 to 1994–1995.

- Item D—*uncancelled costs*. The value of Item D for each year over the period 1966–1967 to 1994–1995 appears in Table 1.

Overall, the final uncancelled costs for Australia rose throughout the entire study period. Similarly, per capita uncancelled costs also increased in all but the financial year 1970–1971. Of the items included in the uncancelled cost account, the biggest rises occurred in the user cost of non-renewable resources, the loss of agricultural land, and in the cost of ozone depletion and long-term environmental damage. It is clear that Australia is failing to invest a sufficient amount of the proceeds from non-renewable resource depletion into the cultivation of additional renewable resource substitutes. Whilst pollution costs generally increased over the study period, such increases were moderated by improvements in waste treatment, pollution abatement technologies, and tighter legislative controls on waste emissions. Due largely to extensive native vegetation clearance in the states of Queensland and New South Wales (about one-third of the Australian continent), the health of Australia's ecosystems deteriorated over the study period despite a small net increase in timber stocks.

6. Calculating the SNB index for Australia, 1966–1967 to 1994–1995

Having estimated the pecuniary value of final uncancelled benefits and costs, the results were simply combined to establish the SNB index. This was accomplished by subtracting uncancelled costs from uncancelled benefits (Item C less Item D). A raw SNB index and a per capita SNB index were calculated for Australia. Both appear in Table 1 (Items E and G). All estimates were based on 1989–1990 prices. In Fig. 2, a comparison is drawn between the per capita SNB index and Australia's per capita real GDP.

The SNB index increases steadily from 1966–1967 until peaking in 1973–1974. It then steadily declines through to 1979–1980. The index recovers slightly in 1980–1981 and continues to fluctuate up to 1986–1987. In 1987–1988 there is a sharp increase in the SNB index. The index then proceeds to gradually but marginally decline to 1992–1993. In the last 2 years of the study period, the SNB index increases slightly. By 1994–1995, the SNB index is less than its 1973–1974 peak ($227068 million in 1994–1995 as opposed to $260446 million in 1973–1974).

As for the per capita SNB index, the trend is similar but of greater interest. The per capita SNB index begins at $13016 per Australian citizen. The per capita SNB index steadily rises before peaking in 1973–1974 at $18979. It eventually declines to $12577 per Australian citizen by 1994–1995—less than its initial value. Both the raw and per capita SNB indexes indicate a general decline in Australia's sustainable economic welfare since 1973–1974. This is despite per capita real GDP rising virtually throughout the entire study period. More particularly, the SNB index indicates the strong likelihood of the Australian macroeconomy having already exceeded its optimal scale. Given the continued increase in uncancelled costs, that is, in the loss of natural capital services, Australia may well have surpassed its maximum sustainable scale.

From the evidence provided, it is not possible to ascertain with any reliability the extent to which the Australian macroeconomy has: (a) expanded in a physical sense via increases in resource throughput—that is, has simply moved along the UB and UC curves; and–or (b) developed in a qualitative sense—that is, has evolved due to shifts in the UB and UC curves arising from technological progress or improvements–deterioration in the manner in which Australians organise themselves in the process of producing physical commodities. Assume there has been a shift upwards of the UB curve and a downward shift of the UC curve. Nevertheless, the observed decline in sustainable net benefits indicates that the rate of such progress has been exceeded by the rate of physical growth of the macroeconomic subsystem. This, alone, calls into question macroeconomic policies geared primarily towards increasing levels of resource throughput and the continued expansion of the Australian macroeconomy. Indeed, it suggests Australia requires policies to facilitate the qualitative improvement in the stock of wealth (development) and not its quantitative increase (growth). Achieving this will require Australian policy makers to think creatively about the design of institutional structures and arrangements and to place greater emphasis on a range of non-economic factors and the maintenance of natural capital. Above all, it will require the GDP-employment and GDP-poverty links to be severed, particularly given that both constitute key forces underpinning the currently perceived growth 'imperative'.

7. Conclusion

The gradual decline in per capita sustainable net benefits since 1973–74 suggests Australia has probably surpassed its optimal macroeconomic scale. Because uncancelled costs (lost natural capital services) are increasing at a faster rate than uncancelled benefits (net psychic income), the continued physical expansion of the Australian macroeconomy is making the average Australian poorer, not richer. However, in making such a claim, there are a few aspects that must be taken into account. First, the list of items used to compile the uncancelled benefit and cost accounts is in no way fully comprehensive. For reasons essentially related to measurement difficulties or a lack of appropriate data, many welfare-related factors are excluded from their compilation. As for a number of the items included, a great deal of subjective judgement was required to make monetary estimates. Moreover, where data for some years was unavailable, both extrapolation and interpolation techniques were required.

Second, one cannot be certain that the uncancelled benefit account reflects a true measure of net psychic income. For instance, consumption expenditure (Item A) includes junk food, tobacco products, and alcohol, which may or may not be of benefit to the consumer. Third, a per capita measure of sustainable net benefits does not reveal much about the distribution of net benefits. Who is best able to experience the benefit-yielding qualities of physical goods and services is a very important welfare consideration. Whilst the index of distributional inequality helps to deal with this issue to some degree, it does not provide a transparent indication of the spread of net benefits enjoyed by Australian citizens, nor does it indicate whether the distribution of net benefits is fair and equitable.

Finally, from a sustainability viewpoint, a raw SNB measure does not indicate whether the macroeconomy has exceeded the maximum sustainable scale (i.e. S_S in Fig. 1). Whilst the SNB index incorporates the natural capital services sacrificed in the process of conferring benefits to Australian citizens, one can never be certain whether the total loss has exceeded a sustainability threshold. This suggests the SNB index may be more effective if accompanied by a satellite account to indicate the state of natural capital and the health of important ecosystems.

Clearly, as with any aggregate measure or index, the SNB index must be treated with caution. Not for one moment should the index be seen as a precise measure of Australia's sustainable economic welfare. However, from a policy-guiding perspective, it would seem preferable to have a somewhat inaccurate but conceptually sound indicator than a performance indicator which is relatively accurate but conceptually flawed (Daly, 1996, p.115). GDP belongs to the latter category. A measure of sustainable net benefits belongs to the former. For this reason, the SNB index serves as a much better means of measuring the welfare-related performance of the macroeconomy than does GDP. With this in mind, it is high time that the System of National Accounts be revised. The SNB index and the compilation of separate benefit and cost accounts may not, by themselves, be the answer, but they would seem to be a step in the right direction.

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