Using the Fisherian concept of income to guide a nation's macro-investment policy

Philip Lawn

School of Business Economics, Flinders University, GPO Box 2100, Adelaide, SA, 5001, Australia
Fax: 61 8 8201 5071 E-mail: phil.lawn@flinders.edu.au

Abstract: A relatively new group of economists called 'ecological economists' believe that continuing macro-economic expansion eventually leads to a decline in sustainable economic welfare. Ecological economists have therefore called for a halt to the high-growth policies being widely adopted by many governments. To support their belief, and to demonstrate how Fisherian income can serve as a useful guide to a nation's macro-investment policy, a relatively simple formula for calculating Fisherian income is introduced and calculated for Australia for the period 1967–1997. The empirical evidence suggests that Australia may have surpassed its optimal or sufficient macro-economic scale in the mid-1970s. While, around this time, Australia began a transition to a lower rate of growth that arrested the steep decline in per capita Fisherian income, Australia had reverted back to a high-growth policy by the end of the study period. It chose not to continue the deceleration towards a steady-state economy. By 1997, per capita Fisherian income had increased to mid-1970s levels; however, the recent change in Australia's macro-investment policy is likely to have a detrimental long-term impact on the sustainable economic welfare enjoyed by its citizens.

Keywords: Fisherian income; Hicksian income; growth; macro-investment policy; Australia.

Reference to this paper should be made as follows: Lawn, P. (2004) 'Using the Fisherian concept of income to guide a nation's macro-investment policy', *Int. J. Environment and Sustainable Development*, Vol. 3, Nos. 3/4, pp.339–352.

Biographical notes: Philip Lawn is a Lecturer in Environmental and Ecological Economics at the Flinders University of South Australia. Over the past five years, Philip has published a number of papers on ecological economics issues as well as a book entitled Toward Sustainable Development. Philip is currently working on environmental macro-economic models and a comprehensive set of sustainable development indicators to assess Australia's sustainable development performance.

1 Introduction

This paper involves a newly devised policy application of Fisherian national income [1]. Its emergence follows the calls by the so-called 'ecological economists' to halt the continuing obsession that governments have with high-growth policies and the need to establish a simple but more meaningful measure of national income [2]. To achieve its desired effect, the paper is structured as follows. In Section 2, the difference between Hicksian and Fisherian national income is elucidated, as is the logical superiority of the latter approach. In Section 3, it is explained what constitutes, quantitatively, the difference between a rapid-growth, high-growth, low-growth, and steady-state investment policy. Third, the circumstances under which a particular macro-investment strategy should be adopted are rationalised. Fourth, Hicksian and Fisherian income are calculated for Australia for the period 1967–1997. In the final section of the paper, conclusions are drawn regarding the desirability of Australia's macro-investment policy.

2 Hicksian vs. Fisherian national income

In the introductory paper of this special issue [3], income was defined in the Hicksian sense as the maximum amount that can be produced and consumed in the present without comprising the ability to do likewise in the future [4]. The appealing aspect of Hicksian income was its recognition that sustaining the production of a particular quantity of physical goods requires the maintenance of income-generating capital. To ascertain a measure of Hicksian national income, it was suggested that various deductions be made to gross domestic product (GDP) (see equation (1) in [3]). This, in turn, led to a measure of Hicksian national income often referred to as sustainable net domestic product (SNDP).

However, it was also argued that Hicksian national income possessed an inherent weakness. The weakness lay not with the failure of SNDP to capture the capital maintenance requirement (although potential problems do exist in this regard), but with the fact that SNDP includes all additions to human-made capital as current income. In doing so, Hicksian national income conflates the services rendered by capital (income) with the capital that renders them. Moreover, since the monetary value of the physical goods produced in a given year is effectively the cost of keeping human-made capital intact, Hicksian national income stands as an index of sustainable cost rather than an index of sustainable economic welfare.

Fisherian national income overcomes the inherent deficiency of Hicksian national income by attempting to measure the annual services or net psychic income enjoyed by a nation's citizens [5]. It does this by confining consumption benefits to both the services rendered by the non-durable goods consumed in the current year and the durable goods used over the current year that have been manufactured and accumulated in previous years. Unlike SNDP, it does not include this year's additions to the stock of human-made capital as current income. Fisherian national income, as with Hicksian income, also takes account of the natural capital services lost in providing the throughput of matter-energy needed to keep the stock of human-made capital intact. All in all, Fisherian national income is much closer to a measure of sustainable economic welfare than the Hicksian national income.

In their most basic form, Hicksian and Fisherian national income can be denoted by the following simple identities [6]:

$$\text{Hicksian national income: } Y_H = CON + INV - DEP - LNCS \tag{1}$$

$$\text{Fisherian national income: } Y_F = CON + DEP - LNCS \tag{2}$$

where:

CON = private + public consumption expenditure

INV = gross fixed investment in human-made capital (producer goods)

DEP = depreciation of human-made capital (producer goods)

LNCS = lost natural capital services.

The merit of equations (1) and (2) lies in the simplicity with which they reveal the logical superiority of the Fisherian concept of national income. For example, while Hicksian national income as defined in equation (1) correctly includes current consumption as income, it wrongly counts as current income all newly produced human-made capital (i.e., that which has been produced now in order to provide welfare benefits in the future). Furthermore, Hicksian income erroneously subtracts the depreciation or 'consumption' of previously accumulated human-made capital (i.e., welfare benefits currently being enjoyed as a consequence of past production). Measuring national income as per equation (1) is tantamount to saying that investing rather than consuming now involves no sacrifice in the present and that sacrifices in the past yield no current benefits! Fisherian income as defined in equation (2) overcomes this perversity.

2.1 Increasing the policy-guiding value of Hicksian and Fisherian measures of national income

Being examples of Hicksian and Fisherian national income in their most basic algebraic form, equations (1) and (2) are limited in terms of their informational content. Both equations require modifications to bestow them with greater policy-guiding value. Let us begin the modification process with a more thorough examination of Hicksian national income. First, equation (1) differs to the equation for SNDP in [3] in the sense that it does not include the deduction of defensive and rehabilitative expenditures. These expenditures should, of course, be subtracted to obtain a better estimate of a nation's sustainable productive capacity. Given that we wish to keep the equation for Hicksian national income as simple as possible, an uncomplicated adjustment to equation (1) is required. For the purposes of this paper, it is assumed that 10% of all private and public consumption expenditure constitutes spending of a defensive and/or rehabilitative kind. As such, only 90% of private and public consumption expenditure is assumed to be making a contribution to a nation's Hicksian income. Compared to studies conducted elsewhere, this is a very conservative downward adjustment.

Some people may have noticed that equation (1) starts with consumption expenditure as the base item whereas SNDP in [3] starts with GDP. Is this a case of being inconsistent? Not entirely, since two of the main items of GDP are private and public consumption and investment expenditure. Thus, the addition of consumption and investment expenditure in equation (1) is just another way to denote GDP. Nevertheless, this still leaves out the third major item of GDP – namely, net exports (exports less imports). A more comprehensive measure of Hicksian national income must include the addition of net exports to equation (1).

As for Fisherian national income, a number of basic adjustments to equation (2) are necessary. To begin with, private consumption expenditure includes current spending on consumer durables (ECS). Because this expenditure constitutes an addition to the stock of human-made capital – albeit consumer goods – it must be subtracted from equation (2). To be consistent with Fisher's distinction between income and capital, the depreciation of previously accumulated consumer durables must be added to reflect the service they yield in the current year (SCS).

Second, equation (2), just like equation (1), does not include the deduction of defensive and rehabilitative expenditures. As such, these expenditures need to be deducted in much the same way as they should when modifying Hicksian national income. But there is a need to go somewhat further in relation to Fisherian national income. Why? Deductions in relation to Hicksian national income are confined to whatever part of the annual product must be set aside to maintain a nation's sustainable productive capacity. But Fisherian income is concerned with more than sustaining productive capacity – it is also concerned with the net psychic income enjoyed by a nation's citizens. There is little doubt that the consumption of many items that make up private and public consumption expenditure is unlikely to contribute to a nation's net psychic income even though it may have little detrimental impact on productive capacity. Consequently, a simple adjustment to equation (2) is required that does not need to be made to equation (1). For the purposes of this paper, an additional 10% of all private and public consumption expenditure is assumed to be non-welfare enhancing. This means that only 80% of private and public consumption expenditure (net of recommended ECS and SCS adjustments) is assumed to be making a contribution to a nation's Fisherian income. This, again, is a very conservative adjustment when compared to similar studies.

Third, it was pointed out in [3] that a redistribution of income from the low marginal service uses of the rich to the higher marginal service uses of the poor can increase the net psychic income enjoyed by society as a whole. Clearly, a welfare adjustment must be made to equation (2) to account for changes over time in the distribution of income. Again, an adjustment of this nature need not be made to equation (1) because a change in the distribution of income is unlikely to have a significant impact on a nation's sustainable productive capacity [7]. For the purposes of this paper, the contribution made to Fisherian income by the previously adjusted value of private and public consumption expenditure is weighted by an index of distributional inequality. The index of distributional inequality is assigned a base value of 100.0 for the first year of the study period and is adjusted in accordance with changes over time in the Gini coefficient. Private and public consumption expenditure is then divided by the index value and multiplied by 100. An improvement/deterioration in the distribution of a nation's income results in the upward/downward weighting of private and public consumption expenditure. This type of adjustment is commonly used in the calculation of the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI). The benefit of this approach is that it avoids having to make a subjective judgement about the prevailing distribution of income at the beginning of the study period [8]. All that is assumed is that an improvement/deterioration in the distribution of income has a positive/negative impact on the overall welfare of a nation's citizens – an assumption with strong empirical support [9,10].

Fourth, and as explained in [3], the cost of lost natural capital services subtracted from equations (1) and (2) must include the full range of source, sink, and life-support functions sacrificed in supplying the throughput of matter-energy needed to keep the stock of human-made capital intact. While it is a relatively simple exercise to estimate the cost of sacrificed source and sink functions (e.g., the cost of resource depletion and pollution), it is much more difficult to estimate the cost of losing some of the life-support services provided by critical ecosystems. To assist in this regard, the sum total of the cost of lost natural capital services is weighted in line with changes in an ecosystem health index. The rationale for this is simple. The impact of most resource extractive and pollutive activities is not confined to the erosion of the ecosphere's source and sink functions. It also extends to ecosystem degradation. A good example is strip mining – a resource-extraction practice requiring the initial removal of terrestrial fauna and flora. Another is agriculture – again, an activity first requiring the clearance of native vegetation. With this in mind, an ecosystem health index is calculated on the premise that remnant vegetation loss constitutes the 'greatest threat to biodiversity' and, therefore, to ecosystem functioning [11]. A base index value of 100.0 is assigned to the first year of the study period and is adjusted in line with the annual changes in the area of relatively undisturbed land. The annual cost of lost natural capital services is then divided by the index value and multiplied by 100. A decrease/increase in the area of relatively undisturbed land results in an upward/downward weighting of lost natural capital services.

Finally, while net exports need to be added to equation (1) to obtain a more comprehensive measure of Hicksian national income, they must not be added to equation (2). Why? Both private and public consumption and investment expenditure includes current spending on imported consumer and producer goods. Not included are, for obvious reasons, the exported consumer and producer goods purchased by foreigners. It is because exports but not imports help in the determination of a country's productive capacity that net exports are added when calculating Hicksian national income. But, again, Fisherian national income is not about sustainable productive capacity. It is about net psychic income or sustainable economic welfare, and the goods that a nation exports do not contribute directly to a nation's net psychic income. They are not counted in equation (2) to begin with and, appropriately, are not added. Conversely, the goods that a nation imports do make a direct contribution to its citizen's net psychic income. Some of these goods make their positive contribution now (e.g., imported non-durable consumer goods plus the imported durable goods accumulated in the past), while some make their contribution later (e.g., imported durable goods currently being added to the existing stock). Since equation (2) already includes current import expenditure on both non-durable and durable consumer goods, it is necessary to retain the import expenditure on all non-durable consumer goods but subtract the import expenditure on consumer durables. Provided that the first of the recommended modifications to Fisherian income has been followed, this deduction will have already been made.

In view of the aforementioned, and without compromising the relative simplicity afforded by equations (1) and (2), the following identities and sub-equations will henceforth be used to conduct an empirical analysis of Australia's macro-investment policy:

$$\text{Hicksian national income: } Y_H = CON_H + INV - DEP + NX - LNCS \text{ (weighted)} \quad (3)$$

$$\text{Fisherian national income: } Y_F = CON_F + DEP - LNCS \text{ (weighted)} \quad (4)$$

where:

$$CON_H = 0.9CON \quad (5)$$

$$CON_F = \left[0.8\left(CON - ECS + SCS\right)\right] \text{(weighted)} \quad (6)$$

and where:

CON_H = private + public consumption expenditure adjusted as per the Hicksian income concept

CON_F = private + public consumption expenditure adjusted as per the Fisherian income concept and then weighted in accordance with changes in the distribution of income

INV = gross fixed investment in human-made capital (producer goods)

DEP = depreciation of human-made capital (producer goods)

NX = net exports (exports – imports)

LNCS (Weighted) = lost natural capital services weighted in accordance with changes in the ecosystem health index

ECS = current expenditure on consumer durables

SCS = service yielded by the accumulated stock of consumer durables.

It should be pointed out that a measure of Fisherian income could also include items such as the value of volunteer and household labour, the value of leisure time, the cost of unemployment, the cost of noise pollution, commuting, crime, and family breakdown, and the change in a nation's foreign debt position [12]. As important as these items can be, they have been omitted both to avoid over-complicating the calculation of Fisherian national income, and to permit more meaningful comparisons with Hicksian national income.

2.2 Making a quantitative distinction between the various macro-investment strategies

Given the desire to assess the macro-investment policy of Australia, it is necessary to make assumptions regarding the distinction between a rapid-growth, high-growth, low-growth, and steady-state investment policy. One way to do this is to compare the gross fixed investment in human-made capital with the depreciation of the existing stock. The difference between the two is commonly referred to as net capital investment (i.e., NCI = INV – DEP). It follows that a level of investment in excess of depreciation (i.e., NCI > 0) implies a physical expansion of the stock of human-made capital. Moreover, it constitutes the growth of a nation's macro-economy.

Consider the following macro-investment strategies:

- INV ≥ 2DEP (NCI/DEP ≥ 1.0)
- 2DEP > INV ≥ 1.5DEP (1.0 > NCI/DEP ≥ 0.5)
- 1.5DEP > INV > DEP (0.5 > NCI/DEP > 0)
- INV = DEP (NCI = 0)

The first can be regarded as a 'rapid-growth' strategy since the current addition of human-made capital provides for more than two years' worth of current-year depreciation. In this instance, the ratio of net capital investment to depreciation is ≥1.0. The second can be regarded as a 'high-growth' strategy since the stock of human-made capital continues to expand but at a lower rate than the first strategy. With a high-growth investment policy in place, the ratio of net capital investment to depreciation lies somewhere between 0.5 and 1.0. The third is a 'low-growth' strategy whereby the current addition of human-made capital is sufficient to marginally exceed one year's worth of current-year depreciation. On this occasion, the ratio of net capital investment to depreciation lies somewhere between 0 and 0.5. The final strategy is a 'steady-state' strategy where, quite obviously, the current addition of human-made capital is sufficient only to keep the stock of human-made capital intact.

The distinction I have drawn here between a high-growth and low-growth investment strategy is, of course, a purely arbitrary one. Even the assumption regarding a rapid-growth strategy involves a subjective judgement about net capital investment and its growth implications. However, as we shall see, the distinction becomes quite useful when comparing a nation's Fisherian income with changes in its macro-investment policy.

2.3 Adopting the appropriate macro-investment strategy

What macro-investment strategy should a nation adopt at a particular point in its development process? In the introductory paper of this issue [3], some attention was given to the notions of *maximum sustainable scale* and *optimal macro-economic scale*. The former was defined as the largest macro-economic scale that a nation can physically sustain while ensuring the necessary throughput of matter-energy remained ecologically sustainable. The latter – sometimes referred to as the 'sufficient' macro-economic scale – was defined as the macro-economic scale that maximises a nation's sustainable economic welfare or Fisherian income. It was shown that unrestrained growth not only leads to a macro-economy larger than the optimum but, should growth continue further, a macro-economy in excess of the maximum sustainable scale. It was consequently argued that growth only increases sustainable economic welfare in the early and adolescent stages of a country's development.

With this in mind, a rapid-growth strategy is likely to be desirable should a nation's macro-economy be well short of the optimal scale. Rapid growth is desirable because the marginal benefits of growth are presumably large while the marginal costs are small. As such, a rapid rate of growth will increase Fisherian national income. Countries in this position are likely to be poor and in desperate need of a good dose of rapid growth. It is unlikely, however, that a rapid-growth strategy would be desirable for wealthy nations, particularly those that had recently completed a long phase of industrialisation. Not only would a rich country adopting such a strategy quickly surpass its optimal scale – in which case Fisherian national income would fall – it would risk exceeding its maximum sustainable scale.

The transition from a rapid-growth to a high-growth strategy is desirable for a developing country once the expansion of its macro-economy begins to impinge more heavily on the supporting ecosphere. This is because the marginal costs of a rapid-growth policy, should such a policy continue, will eventually exceed the marginal benefits it generates. As such, the Fisherian national income will at some stage begin to decline.

Assuming that a developing country's macro-economy is now growing as per the high-growth strategy, it will eventually enter the category of a newly industrialised country. Once it does, it is the continuation of a high-growth strategy that lowers its Fisherian national income. It will now be desirable to shift to a low-growth investment strategy. At this stage of the development process, continued growth – albeit at a much lower rate – will eventually lead to a metamorphic change from a newly industrialised country into one with a well-established industrial base. Because the macro-economy ought now to be nearing the optimal scale, a transition to a steady-state strategy will need to be initiated. This can be achieved by gradually restricting the throughput of matter-energy until the rate is consistent with the ecosphere's regenerative and waste assimilative capacities. In a steady-state milieu, Fisherian national income can be increased by qualitatively advancing the stock of human-made capital, improving the manner in which production activities are organised and conducted, and encouraging people to substitute towards pursuits that increasingly satisfy their high-order needs.

3 The empirical evidence

3.1 Calculating Australia's Hicksian and Fisherian national income

To assist in the calculation of Australia's Hicksian and Fisherian national income for the period 1967–1997, Table 1 is provided below. Constructed on the basis of equations (3) to (6), Table 1 reveals the annual value of each of the principal indicators and the items used in their calculation. All monetary values are based on 1989–1990 prices. The most important columns are columns *x*, *y*, *aa*, *bb*, and *cc* which disclose the ratio of net capital investment to depreciation (NCI/DEP), Australia's investment strategy, per capita Hicksian income, per capita Fisherian income, and per capita real GDP, respectively.

Most of the data used to compile Table 1 were directly sourced from various publications produced by the Australian Bureau of Statistics [13–15]. There are, however, a few exceptions. First, the data used to list the annual value of the stock of consumer durables (column *d*) were sourced from the Commonwealth Treasury of Australia [16]. Second, the ecosystem health index (column *q*) was calculated from the data generated by two landcover disturbance surveys [11,17]. Finally, a GPI study by the Australia Institute was used to calculate the cost of lost natural capital services (column *p*) [18]. The value of column *q* is the sum of the following environmental costs:

- cost of land degradation
- cost of depleted energy resources
- cost of lost native forests
- cost of irrigation water use
- cost of air pollution
- cost of urban water pollution
- cost of climate change
- cost of ozone depletion.

Table 1 Per capita Hicksian income (Y_H), Fisherian income (Y_F), and real GDP for Australia, 1967–1997

	CON ($) *a*	*CON$_H$* ($) *b*	*ECS* ($) *c*	*Consumer durables* ($) *d*	*SCS* ($) *e*	*Unadjusted CON$_F$* ($) *f*	*Adj. CON$_F$* ($) *g*	*Distribution index* *h*	*Weigted CON$_F$* ($) *j*	*INV* ($) *k*	*DEP* ($) *m*	*NX* ($) *n*	*LNCS* ($) *p*	*Ecosystem health index* *q*	*LNCS (weighted)* ($) *r*
Year		($a \times 0.9$)			($d \times 0.1$)	($a - c + e$)	($f \times 0.8$)	1967 = 100.0	(g/h) × 100					1967 = 100.0	(p/q) × 100
1967	117.33	105.59	8.90	43.90	4.39	112.82	90.25	100.00	90.25	42.32	20.99	-3.47	43.35	100.00	43.35
1968	124.88	112.39	9.44	45.60	4.56	120.00	96.00	100.00	96.00	44.68	22.43	-4.72	48.75	99.50	48.99
1969	130.27	117.24	9.86	47.60	4.76	125.17	100.14	100.00	100.14	48.58	24.10	-4.34	52.71	98.90	53.30
1970	137.54	123.78	10.38	49.70	4.97	132.13	105.70	98.80	106.99	51.10	25.75	-2.97	56.30	98.40	57.22
1971	143.19	128.87	10.75	51.10	5.11	137.55	110.04	97.60	112.75	54.01	27.54	-0.52	59.59	97.80	60.93
1972	149.01	134.11	11.40	53.00	5.30	142.91	114.33	96.40	118.60	55.76	29.01	2.22	62.80	97.30	64.54
1973	156.70	141.03	12.31	55.20	5.52	149.91	119.93	95.20	125.98	56.54	30.46	2.49	66.52	96.70	68.79
1974	165.78	149.20	14.13	58.30	5.83	157.48	125.98	93.90	134.16	58.27	31.55	-7.19	70.62	96.20	73.41
1975	173.00	155.70	15.24	62.10	6.21	163.97	131.17	98.80	132.77	55.38	33.89	-5.40	72.88	95.70	76.15
1976	180.20	162.18	16.10	64.90	6.49	170.59	136.48	103.60	131.73	58.15	35.09	-2.28	77.48	95.10	81.47
1977	184.95	166.45	16.10	67.50	6.75	175.60	140.48	108.50	129.47	59.34	36.30	-3.62	77.93	94.60	82.38
1978	188.95	170.05	15.33	68.40	6.84	180.46	144.37	113.30	127.42	58.63	37.64	-1.23	80.19	94.00	85.31
1979	195.73	176.16	14.99	67.00	6.70	187.44	149.95	118.20	126.86	62.67	39.21	-1.45	81.42	93.50	87.08
1980	200.66	180.59	14.96	67.80	6.78	192.48	153.98	119.10	129.29	62.96	40.96	1.01	83.39	93.00	89.67
1981	209.11	188.20	15.84	68.90	6.89	200.16	160.13	120.30	133.11	69.36	42.50	-4.26	83.90	92.40	90.80
1982	216.21	194.59	16.41	71.20	7.12	206.92	165.54	121.20	136.58	73.86	44.18	-7.91	86.89	91.90	94.55
1983	219.55	197.60	16.22	71.90	7.19	210.52	168.42	122.10	137.93	65.48	45.95	-4.06	85.14	91.70	92.85
1984	225.96	203.37	16.90	72.00	7.20	216.26	173.01	122.70	141.00	67.68	47.37	-3.45	87.88	91.60	95.94
1985	235.00	211.50	17.37	73.90	7.39	225.02	180.02	123.60	145.65	73.90	48.93	-4.07	90.65	91.50	99.07
1986	244.32	219.88	17.99	79.10	7.91	234.24	187.39	124.20	150.88	77.51	50.25	-2.60	92.49	91.30	101.30
1987	247.81	223.03	18.06	82.00	8.20	237.95	190.36	125.80	151.32	76.72	51.30	5.44	94.30	91.20	103.40
1988	257.33	231.60	18.78	81.90	8.19	246.74	197.39	127.30	155.06	81.46	52.78	5.16	98.75	91.00	108.52
1989	267.43	240.69	19.20	82.60	8.26	256.49	205.19	128.80	159.31	89.86	54.14	-6.40	101.74	90.90	111.93
1990	278.42	250.58	19.68	83.90	8.39	267.13	213.70	130.30	164.01	89.48	55.91	-6.57	104.83	90.70	115.58
1991	282.21	253.98	18.99	84.50	8.45	271.67	217.33	131.50	165.27	80.38	57.77	3.79	102.53	90.60	113.17
1992	290.27	261.24	19.45	85.30	8.53	279.35	223.48	132.70	168.41	76.84	59.70	7.63	103.66	90.40	114.67
1993	297.84	268.06	19.94	87.20	8.72	286.62	229.30	133.90	171.24	79.44	60.93	7.03	106.25	90.30	117.66
1994	304.97	274.47	20.47	90.50	9.05	293.55	234.84	135.20	173.70	83.38	62.16	9.35	107.71	90.10	119.54
1995	319.50	287.55	21.18	93.80	9.38	307.70	246.16	136.40	180.47	92.69	64.90	-1.18	111.04	90.00	123.38
1996	333.17	299.85	21.47	95.50	9.55	321.25	257.00	134.50	191.08	94.62	66.89	4.29	114.33	89.90	127.17
1997	340.98	306.88	21.78	95.60	9.56	328.76	263.01	136.70	192.40	102.12	68.38	5.26	115.96	89.80	129.13

Note: All values are in billions of 1989–1990 dollars except columns aa, bb, cc, and dd, and where indicated.

Table 1 Per capita Hicksian income (Y_H), Fisherian income (Y_F), and real GDP for Australia, 1967–1997 (continued)

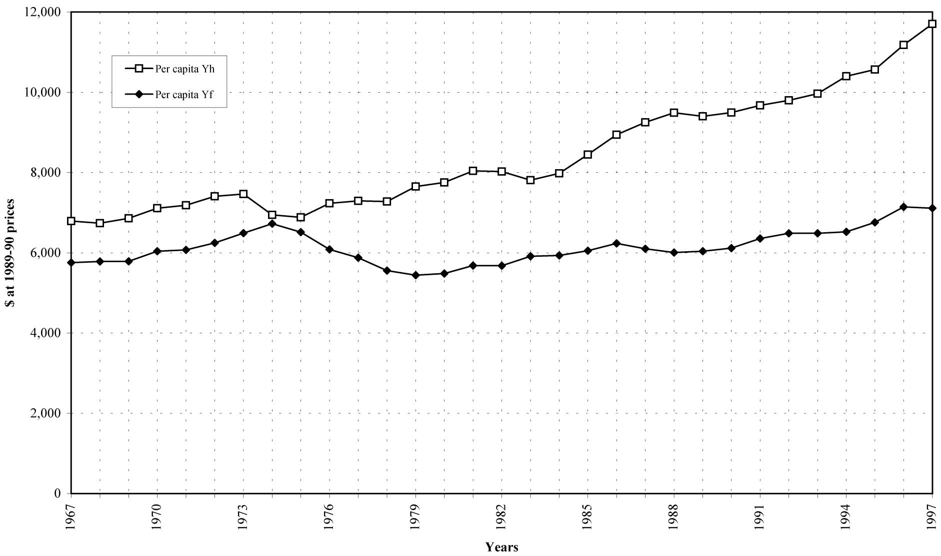
Year	Y_H ($) *s* (*b* + *k* - *m* + *n* - *r*)	Y_F ($) *t* (*j* + *m* - *r*)	*Real GDP* ($) *u*	*Real NDP* ($) *v* (*u* - *m*)	*NCI* ($) *w* (*k* - *m*)	*NCI/DEP* (ratio) *x* (*w/m*)	*Growth strategy* *y*	*Aust. Pop.* (thousands) *z*	*Per capita* Y_H ($) *aa* (*s/z*)	*Per capita* Y_F ($) *bb* (*t/z*)	*Per capita real GDP* ($) *cc* (*u/z*)	*Per capita real NDP* ($) *dd* (*v/z*)
1967	80.10	67.89	158.75	137.76	21.33	1.02	rapid/high	11,799	6,789	5,754	13,455	11,676
1968	80.93	69.44	164.67	142.24	22.25	0.99	rapid/high	12,009	6,739	5,782	13,713	11,845
1969	84.09	70.94	179.16	155.06	24.48	1.02	rapid/high	12,263	6,857	5,785	14,610	12,645
1970	88.95	75.52	189.21	163.46	25.35	0.98	rapid/high	12,507	7,112	6,038	15,128	13,069
1971	93.89	79.36	198.28	170.74	26.47	0.96	high	13,067	7,185	6,073	15,174	13,066
1972	98.54	83.07	207.87	178.86	26.75	0.92	high	13,304	7,407	6,244	15,625	13,444
1973	100.81	87.65	215.87	185.41	26.08	0.86	high	13,505	7,465	6,490	15,984	13,729
1974	95.32	92.31	225.89	194.34	26.72	0.85	high	13,723	6,946	6,726	16,461	14,162
1975	95.63	90.50	230.16	196.27	21.49	0.63	high	13,893	6,884	6,514	16,567	14,127
1976	101.49	85.35	236.93	201.84	23.06	0.66	high	14,033	7,232	6,082	16,884	14,383
1977	103.49	83.39	243.79	207.49	23.04	0.63	high	14,192	7,292	5,876	17,178	14,620
1978	104.51	79.75	246.30	208.66	20.99	0.56	high	14,359	7,278	5,554	17,153	14,532
1979	111.08	78.99	260.02	220.81	23.46	0.60	high	14,516	7,653	5,442	17,913	15,212
1980	113.94	80.58	265.43	224.47	22.00	0.54	high/low	14,695	7,753	5,484	18,062	15,275
1981	120.00	84.80	274.78	232.28	26.86	0.63	high	14,923	8,041	5,683	18,413	15,565
1982	121.81	86.21	281.04	236.86	29.68	0.67	high	15,184	8,022	5,678	18,509	15,599
1983	120.22	91.04	276.24	230.29	19.53	0.43	low	15,394	7,809	5,914	17,944	14,959
1984	124.29	92.43	293.00	245.63	20.31	0.43	low	15,579	7,978	5,933	18,808	15,767
1985	133.33	95.50	307.84	258.91	24.97	0.51	high/low	15,788	8,445	6,049	19,499	16,399
1986	143.24	99.82	319.92	269.67	27.26	0.54	high/low	16,018	8,943	6,232	19,973	16,836
1987	150.49	99.22	328.21	276.91	25.42	0.50	high/low	16,264	9,253	6,100	20,180	17,026
1988	156.92	99.32	345.28	292.50	28.68	0.54	high/low	16,532	9,492	6,008	20,885	17,693
1989	158.08	101.53	360.04	305.90	35.72	0.66	high	16,814	9,402	6,038	21,413	18,193
1990	162.00	104.34	371.05	315.14	33.57	0.60	high	17,065	9,493	6,114	21,743	18,467
1991	167.22	109.87	366.67	308.90	22.61	0.39	low	17,284	9,675	6,357	21,214	17,872
1992	171.34	113.44	357.80	298.10	17.14	0.29	low	17,489	9,797	6,486	20,459	17,045
1993	175.93	114.51	379.35	318.42	18.51	0.30	low	17,656	9,964	6,486	21,486	18,035
1994	185.50	116.31	396.58	334.42	21.22	0.34	low	17,838	10,399	6,520	22,232	18,748
1995	190.78	121.99	414.77	349.87	27.79	0.43	low	18,054	10,567	6,757	22,974	19,379
1996	204.70	130.79	432.40	365.51	27.73	0.41	low	18,311	11,179	7,143	23,614	19,961
1997	216.75	131.65	448.62	380.24	33.74	0.49	low/high	18,518	11,705	7,109	24,226	20,534

Note: All values are in billions of 1989–1990 dollars except columns aa, bb, cc, and dd, and where indicated.

3.2 A descriptive analysis of the empirical evidence

In Figure 1 Australia's per capita Hicksian income and per capita Fisherian income (taken from columns *aa* and *bb* from Table 1) are compared for each year over the study period. There are a few things worthy of interest. First, over the entire study period, per capita Hicksian income remained higher than that of Fisherian income. Second, per capita Hicksian income increased in almost every year during the study period. Small decreases were confined to the recessionary years of the mid-1970s and early 1980s (when per capita real GDP decreased). Third, while per capita Fisherian income rose continuously between 1967 and 1974, it declined in every year to 1979. It rose only marginally in 1980 and 1981, but declined both in 1982 and in the period of 1986 to 1988. Per capita Fisherian income increased in every year after 1988 with modest gains obtained in 1991 and 1995. Fourth, in the years that per capita Fisherian income rose, the increases were considerably more moderate than those associated with per capita Hicksian income. Since Hicksian national income is akin to an index of sustainable cost, it is clear that the rise in sustainable cost did not effectively translate into a rise in sustainable economic welfare. In other words, the sustainable cost incurred during most of the study period went largely to waste since it did little to increase Australia's sustainable economic welfare. The lack of effective translation from cost to welfare is also reflected by the lengthy periods that per capita Hicksian income and per capita Fisherian income ran contrary to each other (1973–1980 and 1986–1990). Fifth, per capita Fisherian income was only slightly higher in 1997 than it was in 1967 (US$ 7,197 compared to US$ 5,754). Furthermore, the 1997 figure was not much higher than the 1974 inter-period peak of US$ 6,726. Overall, per capita Fisherian income increased by 25.1% while per capita Hicksian income rose by a much larger 71.1%. This, again, reflects the lack of effective translation of sustainable cost to sustainable economic welfare – presumably the result of excessive growth and an insufficient focus on qualitative improvement.

Figure 1 Per capita Hicksian income (Yh) and per capita Fisherian income (Yf) for Australia, 1967–1997. Derived from the result revealed in Table 1



What about the change in Australia's macro-investment strategy over the study period? To consider this, refer back to columns *x* and *y* in Table 1. From 1967 to 1970, Australia was initially engaged in a rapid/high-growth strategy (average NCI/DEP = 1.01). Why might Australia have been carrying out a rapid/high-growth investment policy at this time? Despite Australia's considerable wealth in the 1960s, it had historically relied on the export of commodities until the 1950s. The rapid/high-growth strategy being conducted in the late 1960s doubtless reflects Australia's commitment to establish an industrial base upon which its development could proceed in the 1970s and beyond. Although Australia maintained a high-growth strategy between 1971 and 1982 (average NCI/DEP = 0.71), its rate of growth clearly decelerated during this period. By 1983, Australia had moved to what appears to have been a low-growth strategy (NCI/DEP = 0.43). This strategy did not, however, endure for any length of time. Indeed, Australia's rate of growth increased between 1985 and 1990 and occasionally edged back into high-growth territory (average NCI/DEP = 0.56). But at no stage did Australia's growth rate return to the levels experienced early on in the study period. One can probably conclude that the lower-growth rate of 1983 and 1984 had more to do with the early 1980s' recession than a deliberate policy to lower the overall rate of growth. Having said this, Australia appears to have made the transition to a low-growth strategy in the period of 1991 to 1996 (average NCI/DEP = 0.36). In 1997, the final year of the study period, Australia's growth rate rose to something just short of the high-growth mark (NCI/DEP of 0.46 in 1997). Interestingly, if one goes beyond 1997, Australia's growth rate had returned to the high-growth mode by the year 2000 (NCI/DEP of 0.50, 0.52, and 0.53 in 1998, 1999, and 2000).

3.3 Assessing Australia's macro-investment policy for the period 1967–1997

An assessment of Australia's macro-investment policy can be made by juxtaposing per capita Fisherian income with the growth trend of the Australian macro-economy (Table 1 and Figure 1). It can be seen that the rapid-growth and high-growth policies of the late 1960s and early 1970s had a positive effect on per capita Fisherian income. However, the continuation of a high-growth policy beyond the mid-1970s led to its eventual decline. Given the degree to which per capita Fisherian income peaks in 1974, there is good reason to believe that the Australian macro-economy reached its optimal or sufficient physical scale at this point in time. Whether by luck, circumstance, or design, the transition to a low-growth rate by 1984 had a positive impact on Australia's per capita Fisherian income. Nevertheless, the return to a high-growth policy in the mid- to late-1980s caused per capita Fisherian income to again fall. The upturn in Australia's per capita Fisherian income after 1991 was again precipitated by a return to a low-growth policy, although the higher rate of growth experienced in the last year of the study period severely dampened the trend rise in per capita Fisherian income.

What can we conclude from this? First, apart from the period 1967 to 1974, high rates of growth were unambiguously associated with a decline in Australia's per capita Fisherian income. Conversely, per capita Fisherian income recovered on both occasions that Australia made the transition to a lower-growth rate (1979–1984 and 1991–1996). If nothing else, the rise in per capita Fisherian income during times of decelerating growth was sufficient evidence to suggest that a high-growth rate is not a sustainable development prerequisite.

Second, the close correlation between a high-growth policy and rising per capita Fisherian income – that occurred only from 1967 to 1974 – is further evidence that Australia reached its optimal macro-economic scale in the mid-1970s. Although per capita Fisherian income was higher in 1997 than it was in 1974, this does not indicate that the larger macro-economy of 1997 was naturally preferable to the much smaller macro-economy of the mid-1970s. It is quite conceivable that Australia's per capita Fisherian income was higher in 1997 vis-a-vis 1974 because of a beneficial shift in Australia's uncancelled benefit (UB) and uncancelled cost (UC) curves in keeping with advances made in efficiency-increasing technological progress (see Figures 5 and 6 in [3]). If so, Australia's per capita Fisherian income might well have been considerably higher in 1997 had the macro-economy been of a similar physical scale to that possessed in the mid-1970s.

Finally, if Australia has, as earlier suggested, reverted back to a high-growth strategy (1998 onwards), one can surmise that the failure to make the transition towards a steady-state economy will lead to further declines in per capita Fisherian income. Moreover, if continued for too long, a high-growth strategy could also result in the Australian macro-economy exceeding its maximum sustainable scale, in which case the economic welfare of the average Australian will not only diminish but also cease to be ecologically sustainable.

4 Concluding remarks

This paper has demonstrated how a measure of Fisherian national income can guide a nation's macro-investment policy. When applied to Australia for the period 1967–1997, empirical evidence suggests that Australia probably surpassed its optimal or sufficient macro-economic scale during the mid-1970s. From this time on, Australia's rate of growth began to decelerate. This transition to a lower-growth rate appears to have arrested the decline in Australia's per capita Fisherian income. However, Australia had reverted back to a high-growth policy by the year 2000. By electing not to move towards a steady-state economy, Australia has chartered itself on a future course that could well see it having to endure a decline in sustainable economic welfare or, worse still, a macroeconomy in excess of its maximum sustainable scale. Only time will tell if Australia has regrettably opted for the wrong macro-investment strategy in its quest to achieve sustainable development.

Acknowledgments

Funding for this paper was made available from an ARC-Linkage Grant (ARC Project # LP0348013).

References and Notes

1 Lawn, P. (2004) 'Response to 'Income, investment, and sustainability' William J. Mates', *Ecological Economics*, Vol. 48, No. 1, pp.5–7.

2 For a background on ecological economics see Lawn, P. (2002) 'Grounding the ecological economics paradigm with ten core principles', *International Journal of Agricultural Resources, Governance, and Ecology*, Vol. 2, No. 1, pp.1–21.

3 Lawn, P. (2004) 'The policy-guiding value of sustainable development indicators: an introductory essay', *International Journal of Environment and Sustainable Development*, Special Issue on Sustainable Development Indicators.

4 Hicks, J. (1946) *Value and Capital*, 2nd ed., Clarendon, London.

5 Fisher, I. (1906) *Nature of Capital and Income*, A.M. Kelly, New York.

6 Basic equations for Hicksian and Fisherian income appear in Mates, W. (2004) 'Income, investment, and sustainability', *Ecological Economics*, Vol. 48, No. 1, pp.1–3.

7 It is reasonable to suggest that should the distribution of a nation's income be so unequal as to leave a measurable proportion of the population physically and mentally degraded, the productive capacity of such a country would be significantly impaired. I would subscribe totally to such a view; however, it is the impact of a *change* in the distribution of a nation's income over a given study period that must matter if we are to also make an adjustment to Hicksian national income. The overall impact and the change in impact are two entirely different things. If the magnitude of the overall impact is considerable in country A but not in country B, one would expect, all things being equal, for the disparity to be reflected by the reduced level of production over the entire study period in country A relative to country B.

8 Lawn, P. (in press) 'An assessment of the valuation methods used to calculate the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and Sustainable Net Benefit Index (SNBI)', *Environment, Development, and Sustainability*.

9 Easterlin, R. (1974) 'Does economic growth improve the human lot?' in David, P. and Weber, R. (Eds.): *Nations and Households in Economic Growth*, Academic Press, New York.

10 Abramowitz, M. (1979) 'Economic growth and its discontents', in Boskin, M. (Ed.): *Economics and Human Welfare*, Academic Press, New York.

11 Biodiversity Unit (1995) *Native Vegetation Clearance, Habitat Loss, and Biodiversity Decline: An Overview of Recent Native Vegetation Clearance in Australia and its Implications for Biodiversity*, Department of Environment, Sports, and Territories, Biodiversity Series Paper No. 6, AGPS, Canberra.

12 The value of many of these items is used in the calculation of the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI).

13 Australian Bureau of Statistics (various), *Australian National Accounts*, Catalouge No. 5241.0, AGPS, Canberra. Used for columns *a*, *c*, *k*, *m*, *n*, and *u*.

14 Australian Bureau of Statistics (various) *Income Distribution in Australia*, Catalouge No. 6523.0, AGPS, Canberra. Used for column *h*.

15 Australian Bureau of Statistics (various), *Australian Year Book*, Catalogue No. 1301.0, AGPS, Canberra. Used for column *z*.

16 Commonwealth Treasury of Australia (various) *Economic Roundup*, AGPS, Canberra. Used for column *d*.

17 Graetz, R., Wilson, M. and Campbell, S. (1995) *Landcover Disturbance Over the Australian Continent: A Contemporary Assessment*, Department of Environment, Sports, and Territories, Biodiversity Series Paper No. 7.

18 Hamilton, C. and Denniss, R. (2000) *Tracking Well-being in Australia: The Genuine Progress Indicator 2000*, Australia Institute Discussion Paper Number 35, December. Used for column *p*. Where a discount rate was required to calculate the cost of a particular lost natural capital service, a 5% rate was applied. This, in effect, means that the cost of lost natural capital services is more in keeping with the weak sustainability paradigm discussed in [3].