9. Empirical Results 2: ADJUSTMENTS TO THE NATIONAL ACCOUNTS

Many government decisions affect the environment either directly or indirectly.
(AGPS, Environmental Resources Handbook 1995)

9.1 Introduction

The objective of this chapter is to show how adjustments to the national accounts for environment and leisure can be made. Section 9.2 presents the procedure used to compute for the unknown parameters of $\theta_1, \theta_2, \theta_{31}, \theta_{32}$ and α. A detailed discussion of the derivation of the environmental parameter is given in Section 9.3. Section 9.4 describes the effect of adding leisure to the Unadjusted GNE. The derived values of the $g(G_{31t}, G_{32t})$ function per period and Adjusted GNE(1) are discussed in Section 9.5. Section 9.6 summarises the results of adding leisure to Adjusted GNE(1). In addition an attempt to correct for double counting was made, the results are also presented in Section 9.6. Section 9.8 discusses the applicability of the models developed for this study. Finally, a summary is presented in Section 9.8.

9.2 Computed Value of the Unknown Parameters

As discussed in Chapter 6, the values of the unknown parameters have to be determined to derive the value of ε_t, the parameter that represents environmental, productivity disturbances, and $g(G_{31t}, G_{32t})$, the parameter that represents the success of government environmental programs.

9.2.1 The derived value of the thetas

The values of $\theta_1, \theta_2, \theta_{31}$ and θ_{32} were derived using non-linear equations. The results are detailed in **Appendix I** and summarised in Table 9.1. The theta values were determined after 737 iterations. Table 9.1 shows that the '*t-ratio*' of all of the thetas are significant. The 'rho' parameter has a 't-ratio' of 0.5716 which means that it is not significantly different from zero. This implies that the derived results are not autocorrelated.

Table 9.1

Relationship of Selected Macroeconomic Variables

Parameter	**Coefficient**	**T-Ratio**
θ_1 (measures the substitutability between C_t and G^w_{1t})	+0.8262	+9.17**
θ_2 (measures the substitutability between I_t and G^w_{2t})	+0.7015	+8.84**
θ_{31} (measures the substitutability between C_t and G^w_{31t})	-0.0662	-2.89**
θ_{32} (measures the substitutability between I_t and G^w_{32t})	-0.0467	-2.18**
RHO	+0.0018	+0.57

** Significant at 5%.

The results in Table 9.1 show that a substitute relationship exists between C_t and G_{1t}^{w}. This outcome suggests that government consumption expenditure (G_{1t}^{w}) partially substitute for private consumption (C_t). In addition, it reveals that as G_{1t}^{w} increases, effective consumption (C_t^{w}) also increases. An increase in government spending on goods and services may create additional demand for labour that results in an increase in income, and thus an increase in effective consumption. For example, an Organisation for Economic Cooperation and Development (OECD) study, taking Austria, Finland, France, the Netherlands, Norway and the United States as case studies, has concluded that employment could rise because of the stimulative impact of the increase in defensive expenditure. Moreover, an increase in expenditure on public goods directly consumed by households and firms, results in an increase in effective consumption.

Similarly, a substitute relationship is exhibited between I_t and G_{2t}^{w}. Again, this kind of relationship is expected since government investments (G_{2t}^{w}) in most cases are similar in nature to those investments pursued by private firms (G_{2t}^{w}). An increase in government investment expenditure will increase effective investment (I_t^{w}) because of the 'crowding-in' effect. Firms will look at the increase in government investment expenditure as a signal that the economy is doing well. In addition, investment expenditure on roads and other infrastructures will enable firms to access markets and thus increase their own investment expenditure.

The result concerning government defensive expenditure on goods and services (G_{31t}^{w}) is rather interesting at -0.0667. It shows that G_{31t}^{w} and private consumption expenditure (C_t) are complements. One of the themes of sustainability is the concern that gradual environmental degradation may lead to a reduction in well-being, even if the production of food and manufactured good is maintained (Quiggin 1991). In economic terms, this concern is related to those services of the environment that are employed directly, for example those yielded by unpolluted air, and those employed by production. Increases in government spending on the environment will make households spend more on consumption goods and less on defensive expenditure, knowing that environmental damages are being corrected.

Likewise, I_t and G^{w}_{32t} exhibit a positive relationship. An increase in government investment on correcting environmental problems (G^{w}_{32t}) will induce private firms to increase their investment expenditure (I_t) knowing that some environmental damages has been corrected.

9.2.2 The derived value of alpha

After the substitution coefficients had been determined, the next task was to determine the value of alpha. The values of (α) and ($1-\alpha$) were determined by regressing GNE with labour and capital, assuming constant returns to scale. Details are presented in Chapter 6. Results of the regression were

$$\begin{aligned} \ln GNE = 0.8915 &+ 0.6931 \ln n^{w}_{t} + 0.3069 \ln k^{w}_{t} \\ (41.14) & \quad (23.21) \qquad\quad (10.28) \\ R^2 &= 0.98 \end{aligned} \tag{9.1}$$

Both labour and capital are significant. The R^2 value of 0.98 means that 98 per cent of variations in GNE can be explained by labour and capital. Labour and capital values are expressed in money terms and not in units. The result reveals that α is equal to 0.6931 and that ($1-\alpha$) is equal to 0.3069. Specifically, the α of 0.6931 means that for every 1 percent increase in labour inputs, GNE will increase by 0.6931 percent.

9.3 Unadjusted GNE (1)

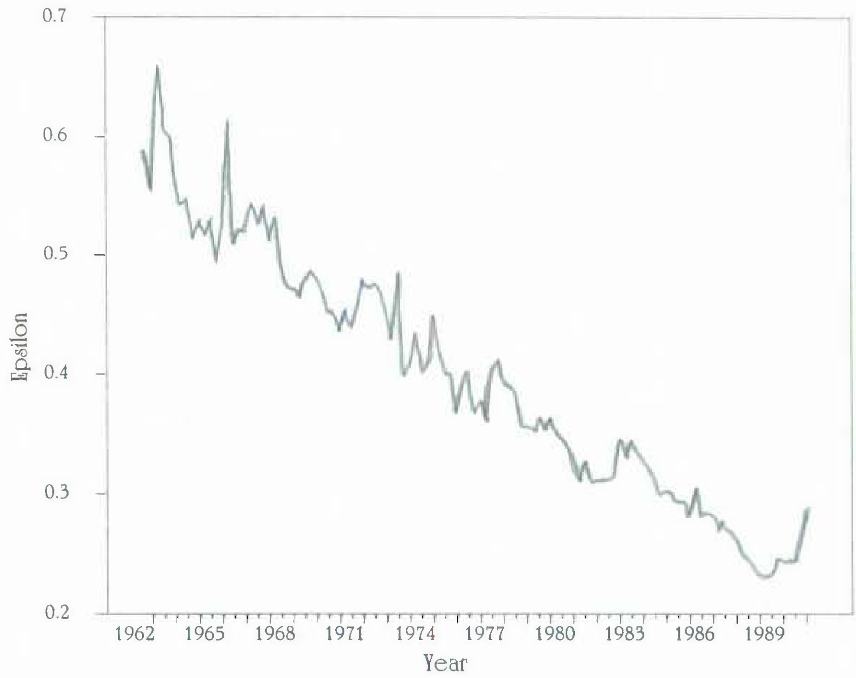
Using the assumptions and relationships presented in Chapter 4, an attempt was made to determine the value of ε_t, the parameter that represents environmental, productivity disturbances. The principal objective in computing for the value of ε_t, is to quantify the environmental degradation imposed on the economic system as a result of economic activities. Just as the rational consumer equates his or her marginal rate of substitution between any pair of goods he or she consumes up to the price ratio of the two goods, a profit maximising producer uses any pair of factors of production up to a point where the ratio of their marginal productivities is equal to their price ratio (Olson 1977). This means that if there is no charge or prohibition against external diseconomies, firms will produce these diseconomies until their marginal productivity becomes zero. The externalities tha these firms normally produce increase, resulting in greater losses of utility or higher defensive expenditure for the victims (Olson 1977).

Environmental degradation in this study is measured as $(1-\varepsilon_t)$. When ε_t is equal to one (1) it implies that the environmental degradation is equal to zero (0) and when ε_t is equal to 0 it suggests that environmental degradation is equal to 1.

Following the procedure detailed in Chapter 6, the results of the computation for the value of ε_t, are graphically illustrated in Figure 9.1. The result shows that the value of ε_t has been declining since 1962 up until 1989. After 1989, the computed ε_t value is increasing. The results indicate that the level of environmental degredation as measured by $(1-\varepsilon_t)$ is increasing until after 1989 when it starts to decrease. This decreasing trend was partly due to an increase in government defensive expenditure as a proportion of GNE.

In the early 1960s and 70s the value of ε_t, was between 0.5 and 0.6. The high $(1-\varepsilon_t,)$ values of 0.50 and 0.60 can partly be explained by the way firms perceive the nature of environmental resources. Firms treated environmental resources as if they were infinite, with zero economic cost. Because of this attitude, environmental damage was not corrected as soon as it occurred. The negative outcome on the environment of the production processes of the 60s and 70s were not felt until the early 1980s.

Figure 9.1
The ε_t value from 1962:4 to 1991:2



Through the years, the value of ε_t, decreased, with the lowest values recorded in 1989. In the 80s and 90s the ε_t, value ranged from 0.23 to 0.30 which implies that the value of (1- ε_t) has been increasing, around 0.20 higher than the previous decade. This implies that the environmental condition has been deteriorating more in these periods. However, in 1989 the value of ε_t, starts to increase. The increase in the value of ε_t means that the level of environmental deterioration (1-ε_t) is decreasing. One probable explanation for this is that in the late 1980s, the Australian government became more aware of the state of the environment and spent more on environmental protection. This is evident by looking at Appendix K, which shows that an increasing amount of the government's budget was spent on defensive expenditure.

Figure 9.2 reflects in monetary terms the Unadjusted GNE (Y_t^n) and the potential GNE (Y_t) . Since ε_t in all periods is less than one (1), the Unadjusted GNE is always less than Y_t . The output level Y_t represents the output level when the environment is in its pristine state.

The difference between Y_t and Y_t^n, is captured by ε_t, and (1- ε_t) represents the potential restoration or avoidance costs. These costs refer to the physical impact of economic production. This impact includes primarily discharges of (waste) residuals but may also include other environmental quality effects such as soil erosion from improper environmental, agricultural or construction practices.

Figure 9.2

Y_t and Y_t^n from 1962:4 to 1991:2

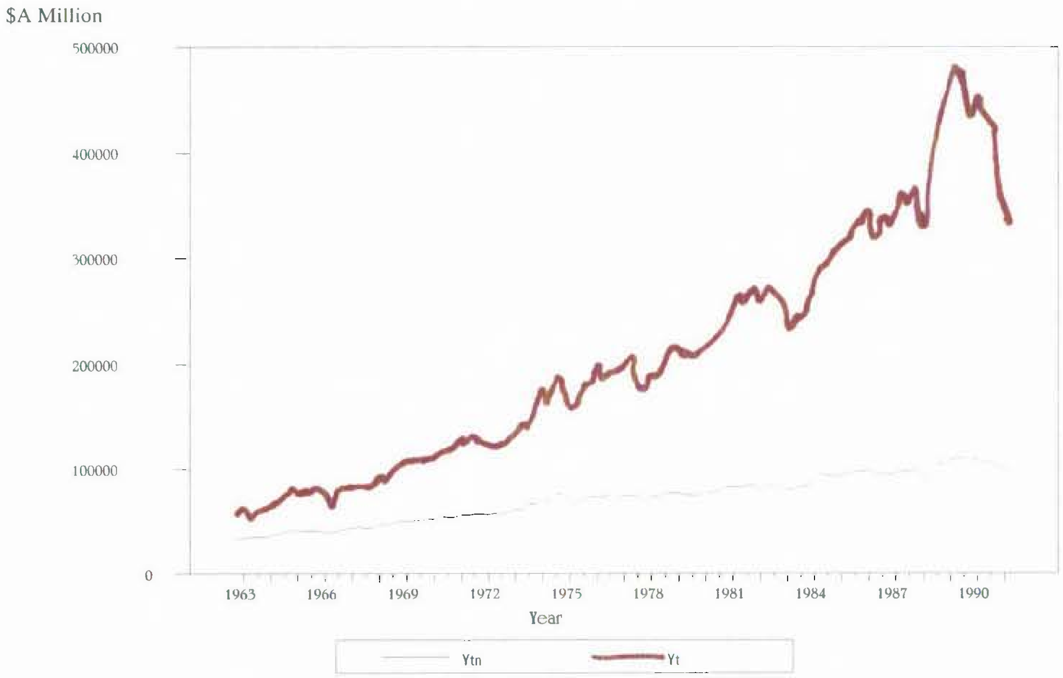


Figure 9.3 depicts the growth rate of the two measures of output. The graph illustrates the difference in growth rate between the two measures. The GNE growth rate in this study is defined as

$$GR_{q+1} = \left(\frac{GNE_{q+1} - GNE_q}{GNE_q} \right) \times 100 \qquad (9.1)$$

where

GR_{q+1} = growth rate in current quarter

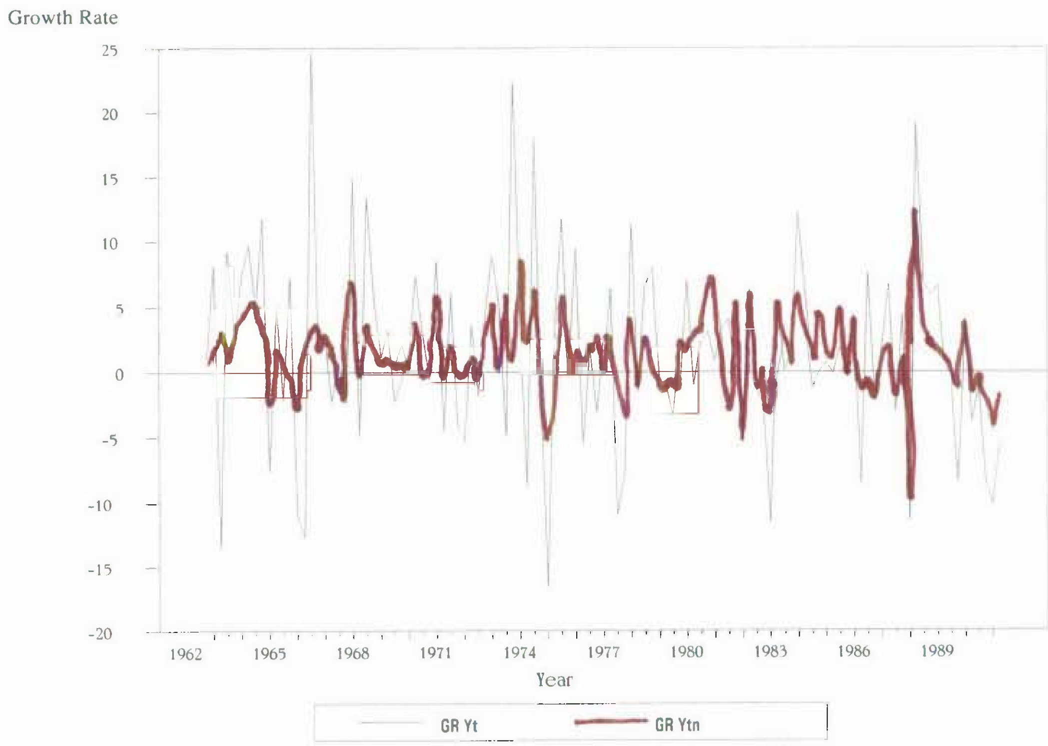
GNE_{q+1} = GNE of the current quarter

GNE_q = GNE of the previous quarter

The growth rate definition given by equation (9.1) is the measure of growth rate used throughout this chapter. In Figure 9.3. the result shows that changes in growth rates of Y_t are more conspicuous than those of the Unadjusted GNE (Y_t^n). The quarterly growth rate of the Unadjusted GNE(1) is within the range of the ABS computations. On the other hand, the Y_t growth rate in most cases, exceeds the average OECD growth rate .

Figure 9.3

Growth rate of Y_t and Y_t^n from 1962:4 to 1991:2



The quarterly observations were added to generate annual estimates. Unlike in Chapter 8, the values for each year are not 3-year averages. All the values presented in this chapter are the annual values of each variable. Table 9.1 compares the income level with and without the environmental disturbance associated with production.

Table 9.2
Adjustments to Gross National Expenditure for the environmental disturbance for 1963 to 1990

Year	Y_t	Y_t Index	ε_t	ε_t Index	Y_t''	Y_t'' Index
1963	230171	100	0.61	100	138834	100
1964	287360	125	0.54	89	155152	112
1965	314569	137	0.52	85	162485	117
1966	299999	130	0.54	89	162030	117
1967	328837	143	0.53	87	175019	126
1968	385491	167	0.50	82	192927	139
1969	430240	187	0.47	78	204274	147
1970	463077	201	0.46	76	213774	154
1971	507747	221	0.44	73	225662	163
1972	486964	212	0.47	78	230313	166
1973	583432	253	0.44	72	255511	184
1974	709488	308	0.41	68	292111	210
1975	678773	295	0.42	68	282126	203
1976	772080	335	0.38	62	293082	211
1977	758515	330	0.39	63	291655	210
1978	793058	345	0.38	62	300013	216
1979	631857	275	0.27	44	226177	163
1980	870662	378	0.35	58	307312	221
1981	1022935	444	0.32	53	330368	238
1982	1066760	463	0.31	51	331247	239
1983	1223300	531	0.42	68	407904	294
1984	1173655	510	0.32	52	369776	266
1985	1291838	561	0.30	49	383083	276
1986	1330908	578	0.29	47	382626	276
1987	1411823	613	0.28	45	388720	280
1988	1581443	687	0.25	41	393224	283
1989	1854463	806	0.23	38	433467	312
1990	1700469	739	0.25	41	420997	303

Column 2 of Table 9.1 presents the potential income level from factors of production when there is no environmental damage. The results show that the level of output has been increasing since 1963. The Y index grew by 8 times in 1989 and 7 times in 1990. The index formula used is given by

$$Index_{Y_t} = \left(\frac{Y_t - Y_{1963}}{Y_{1963}} \right) \times 100 \qquad (9.2)$$

The same index formula will be used throughout this chapter.

In column 4, the computed ε_t value is presented, and the result shows that it has been declining. The ε_t index had declined to 41 per cent by 1990. This however implies that $(1-\varepsilon_t)$ has been increasing and that environmental degredation has been increasing. Like Y_t, the Unadjusted GNE(1) level, represented by Y_t'', has been increasing. In contrast, the Y_t'' index, although increasing, is always less than the Y_t index. The highest Y_t'' recorded was in 1989 at 312 per cent.

9.4 Unadjusted GNE (2)

After the GNE has been adjusted for environmental damage, the next step is the adjustment to incorporate leisure into GNE. The method used to impute for the value of leisure is Estimate I. The procedure associated with Estimate I is discussed in detail in Chapter 8. The results of the computations are presented in Table 9.3. The findings are graphically presented in Figure 9.4. Unadjusted GNE with leisure is also referred to as Unadjusted GNE (2) in this study.

Figure 9.4 shows that the value of leisure has been increasing over time and is in all cases positive. Thus, Unadjusted GNE with leisure ($Y_t^{n l}$) is relatively bigger than the Unadjusted GNE (Y_t''). Likewise, the results show that the level of growth rate (see Figure 9.5) for the Unadjusted GNE (2) is greater than that of the Unadjusted GNE (1).

Figure 9.4

Y_t^n and Y_t^{nl} from 1962:4 to 1991:2

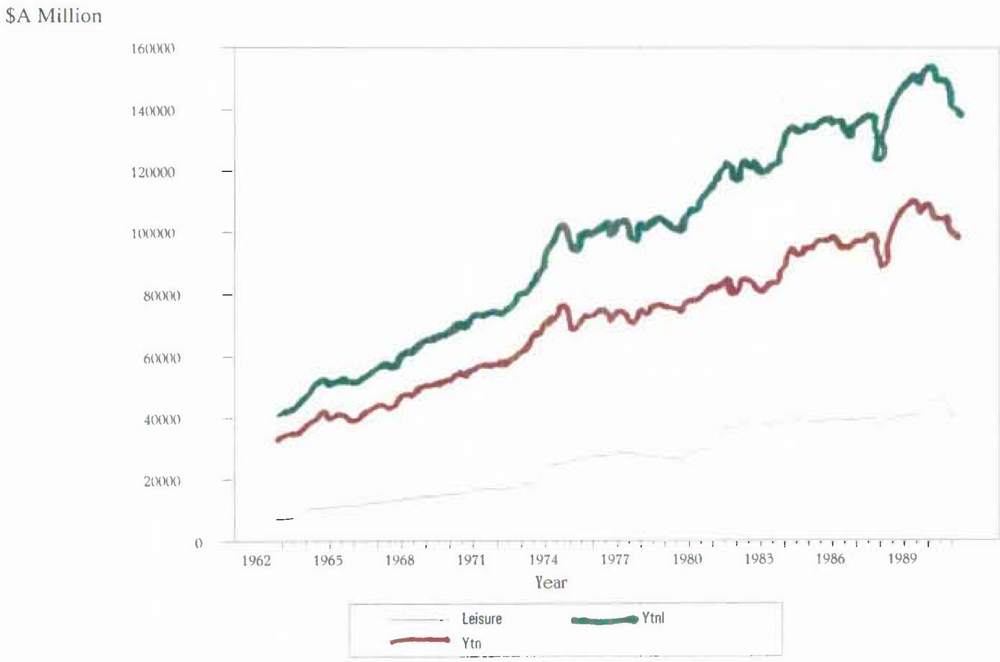
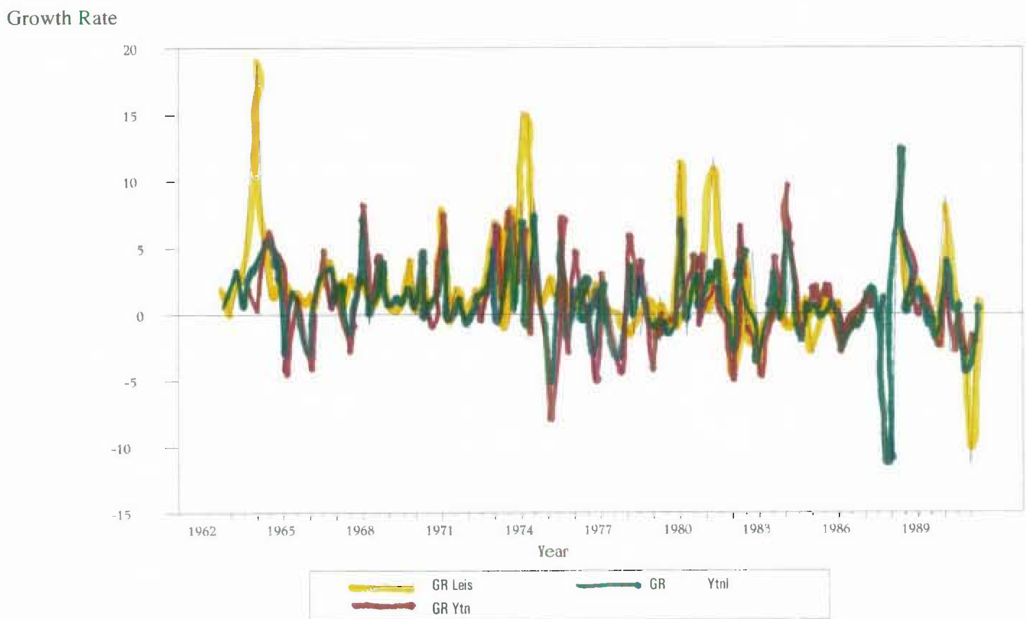


Figure 9.5

Growth rate of Y_t^n and Y_t^{nl} from 1962:4 to 1991:2



This result can be interpreted to mean that leisure is important and needs to be included in the national accounts to reflect the true level of income.

Since the early 1970s, criticism on the use of GDP as a measure of welfare has been heard from the ecological movement. The point being that environmental damage caused by production and consumption is left completely unaccounted for in calculations of national product. Continued increases in environmental damage imply that externalities associated with increased production and consumption are left completely unaccounted for in calculations of national income. Since the parameter ε_t is solved, true GNE, adjusted for environmental changes, is emulated by Y_t^n. To further adjust the income measure, the value of leisure is added to GNE(1).

Column 2 in Table 9.3 reveals that the Unadjusted GNE(1) output level has been increasing since 1963. In fact, Y_t^n has increased 3 times since 1963 (column 3). Column 4 reports the leisure value imputed using Estimate I. The results show that the value of leisure has been growing since 1963. Leisure value increased most in 1983 as indicated in column 5. Adding the values of columns 2 and 4 results in column 6, which presents the Unadjusted GNE(2) values. Like leisure and Unadjusted GNE(1), Unadjusted GNE(2) has been escalating since 1963. The computed value had increased by 3.56 times by 1990. Since leisure has been increasing, the Unadjusted GNE(2) value is always greater than the Unadjusted GNE(1). Comparing columns 3 and 6 discloses that Y_t^{nl} has been growing faster than Y_t^n.

Table 9.3

Adjustments to Gross National Expenditure for ε_t and the value of leisure for 1963 to 1990

Year	Y_t^n	Y_t^n Index	Leisure	Leisure Index	Y_t^{nl}	Y_t^{nl} Index
1963	138834	100	30684	100	169518	100
1964	155152	112	41626	136	196779	116
1965	162485	117	45017	147	207502	122
1966	162030	117	47772	156	209803	124
1967	175019	126	51248	167	226266	133
1968	192927	139	55231	180	248158	146
1969	204274	147	58152	190	262426	155
1970	213774	154	61111	199	274885	162
1971	225662	163	66896	218	292558	173
1972	230313	166	67647	220	297960	176
1973	255511	184	73414	239	328925	194
1974	292111	210	96041	313	388152	229
1975	282126	203	104940	342	387066	228
1976	293082	211	110137	359	403219	238
1977	291655	210	113956	371	405611	239
1978	300013	216	109996	358	410009	242
1979	226177	163	79542	259	305719	180
1980	307312	221	113652	370	420964	248
1981	330368	238	131060	427	461428	272
1982	331247	239	149456	487	480703	284
1983	407904	294	190864	622	598768	353
1984	369776	266	157229	512	527005	311
1985	383083	276	154880	505	537963	317
1986	382626	276	156687	511	539312	318
1987	388720	280	157645	514	546364	322
1988	393224	283	154191	503	547415	323
1989	433467	312	162713	530	596180	352
1990	420997	303	182333	594	603330	356

9.5 Adjusted GNE (1)

Adjusted GNE(1) represents the output value of government defensive expenditure. This income measure by definition, and as used in this study, is equal to the ABS measure of GNE. The $g(G_{31t}, G_{32t})$, which represents the success of government environmental programs, was computed using the procedure outlined in Chapter 6. The derived value for each quarter is illustrated in Figure 9.6.

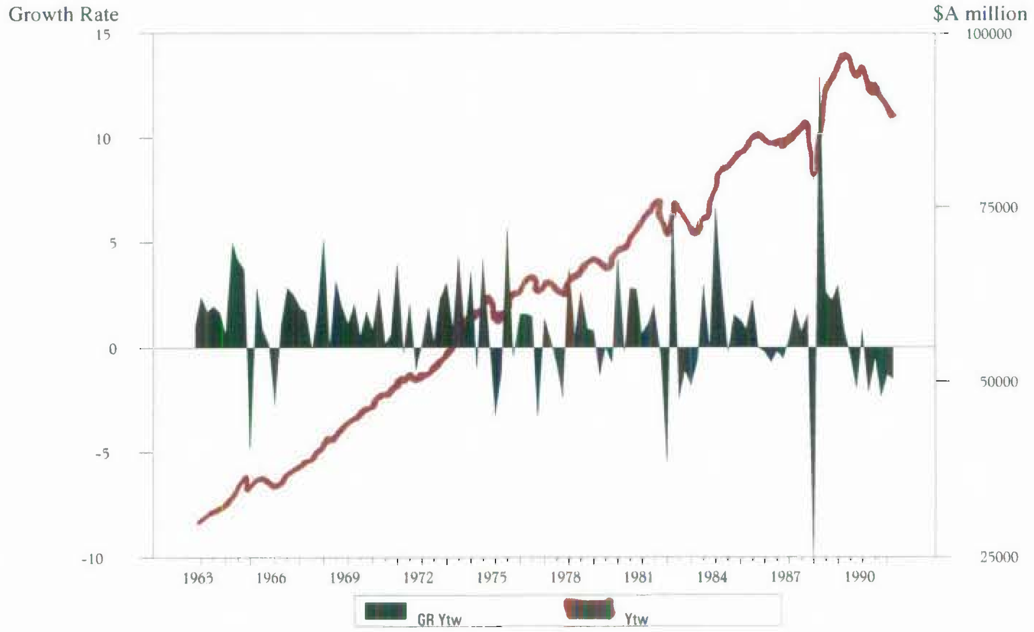
Figure 9.6
The $g(G_{31t}, G_{32t})$ value from 1962:4 to 1991:2

Figure 9.6 shows that the value of $g(G_{31t}, G_{32t})$ is always greater than one (1). This means that the government environmental program has been successful and has contributed positively to total output. The results also show that the $g(G_{31t}, G_{32t})$ value has been increasing since 1962 up to 1989. The fall in the $g(G_{31t}, G_{32t})$ value from 1989 can partly be explained by the presence of more environmental damage and the slight decline in the ratio of government defensive expenditure to GNE.

Australian government environmental programs include water treatment, household garbage, other sanitation, sewerage, urban stormwater drainage and other environmental protection. Total government defensive expenditure in 1990-1991, amounted to $2 193 million. This amount represents 1.5 per cent of the government's budget for all program areas, by all levels of government. Of the total government defensive expenditure in 1990, approximately 63 per cent ($1 384 million) was made by the State governments. The remaining outlays were made by local governments ($774 million).

Figure 9.7

Y_t^w and Growth rate of Y_t^w from 1962:4 to 1991:2



The highest levels of per capita defensive expenditure (based on 1991 Census population counts) occurred in the Northern Territory ($204.67 per person), followed by New South Wales ($167.65 per person). The lowest levels of per capita defensive expenditure were recorded in the Australian Capital Territory ($24.99 per person), Tasmania ($83.92 per person) and Queensland ($86.98 per person).

Table 9.4
Adjustments to Gross National Expenditure for $g(G_{31t}, G_{32t})$ for 1963 to 1990

Year	Y_t^n	Y_t^n Index	$g(G_{31t}, G_{32t})$	$g(G_{31t}, G_{32t})$ Index	Y_t^w	Y_t^w Index
1963	169518	100	1.84	100	125109	100
1964	196779	116	2.08	113	138160	110
1965	207502	122	2.20	120	142844	114
1966	209803	124	2.07	113	144656	116
1967	226266	133	2.12	115	155217	124
1968	248158	146	2.28	124	169232	135
1969	262426	155	2.39	130	180289	144
1970	274885	162	2.44	132	189896	152
1971	292558	173	2.53	137	200938	161
1972	297960	176	2.36	128	205950	165
1973	328925	194	2.60	141	224039	179
1974	388152	229	2.92	159	242512	194
1975	387066	228	2.78	151	243826	195
1976	403219	238	3.02	164	255622	204
1977	405611	239	2.99	162	253620	203
1978	410009	242	3.02	164	262574	210
1979	305719	180	2.36	128	200769	160
1980	420964	248	3.17	172	274409	219
1981	461428	272	3.47	188	294943	236
1982	480703	284	3.61	196	295646	236
1983	598768	353	4.22	229	362527	290
1984	527005	311	3.66	199	320404	256
1985	537963	317	3.84	209	335959	269
1986	539312	318	3.95	215	336866	269
1987	546364	322	4.11	224	343111	274
1988	547415	323	4.48	243	352195	282
1989	596180	352	4.84	263	383419	306
1990	603330	356	4.58	249	371256	297

The Adjusted GNE(1) values are depicted in Figure 9.7. The result shows that Australia's economy has been subjected to both internal and external shocks. The growth rates are computed using equation (9.1). Figure 9.6 shows that during periods of recession the economy registers a negative growth rate and during periods of boom a positive growth rate.

In Australia in the early 1960s, aggregate income, measured in real GNE, was growing at nearly 8 per cent a year. Around 1973/1974, GNE growth slowed down. By 1989, Australian real GDP was about a third below what it would have been if the 1960's growth rate had been maintained (McTaggart *et al* 1994).

A summary of the findings is presented in Table 9.3. As discussed in the previous section, Unadjusted GNE(2) has been increasing since 1963. With regard to the value of $g(G_{31t}, G_{32t})$, the results reveal that it has also been growing, which may mean that government environmental programs have been successful in preventing further environmental damage. The resulting Adjusted GNE(1) value is also increasing but slower than Unadjusted GNE(1). Comparing columns 3 and 6 reveals that the Y_t^u index is always greater than the Y_t^u index.

9.6 Adjusted GNE (2)

In order to account for leisure charges, leisure is added to Adjusted GNE (1). The results are presented in Figure 9.8. Total leisure for the quarter was computed by multiplying total leisure hours by the average wage rate. Over the period 1962 to 1991, the average number of work hours fell from 41 to 30 for men, and from 30 to 28 for women. This implies then that the hours of leisure have been increasing for men and women. Figure 9.8 shows that the value of leisure has indeed increased since 1962.

Since the value of leisure is positive, Adjusted GNE with leisure (Y_t^{wl}) is always greater than Adjusted GNE (Y_t^w). The difference between the two measures is the value of leisure.

Figure 9.9 depicts the growth rates of Y_t^{wl} and Y_t^w. The growth rate of Y_t^{wl} is often higher than Y_t^{wl}. The figure also shows that after 1986, the Adjusted GNE with leisure growth rate is lower than that of the Adjusted GNE without leisure. Probable

Figure 9.8

Y_t^{w} and Y_t^{wl} from 1962:4 to 1991:2

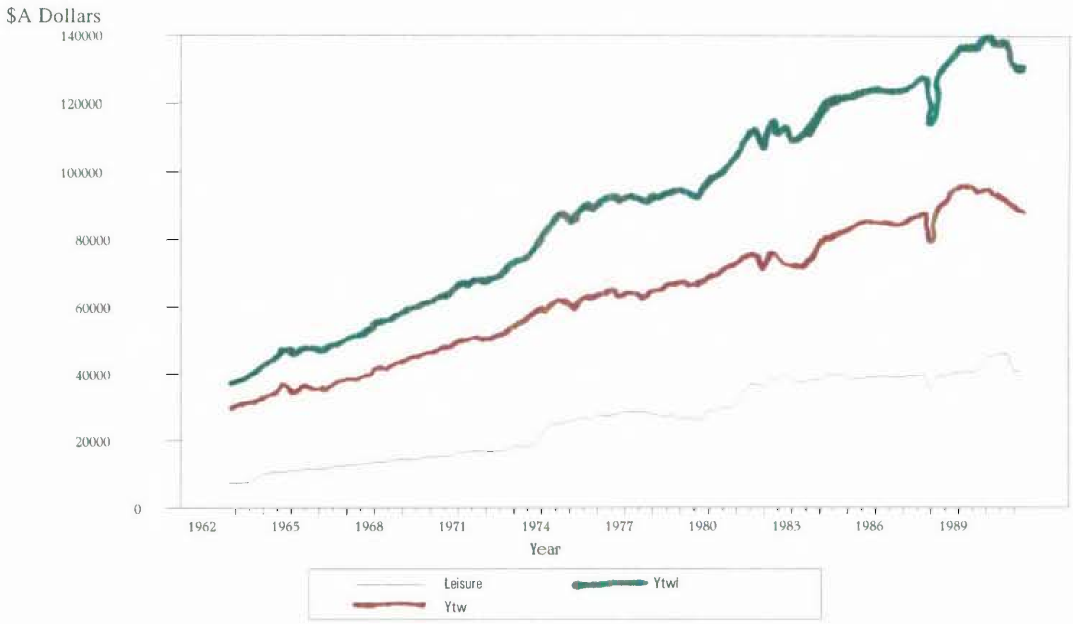
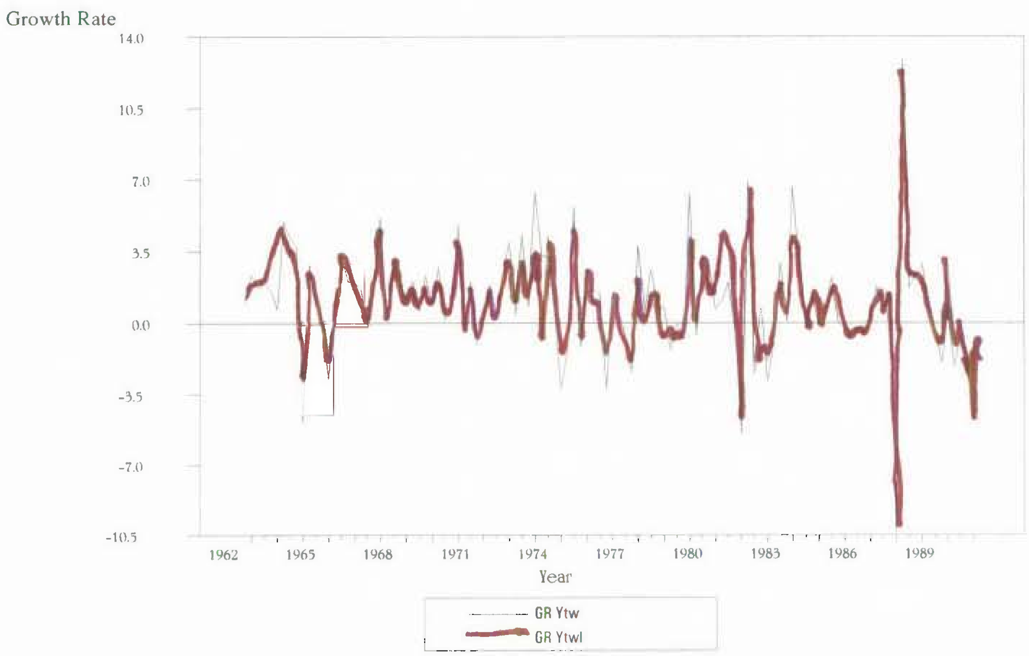


Figure 9.9

Growth rate of Y_t^{w} and Y_t^{wl} from 1962:4 to 1991:2



explanations include the economic recession of the 1980s and the slight increase in the number of working hours due to people working double jobs.

Another adjustment was also attempted. Government defensive expenditure was subtracted from the Adjusted GNE(1). Olson (1977) argues that since defensive expenditure counts as final output in the measured GNE, it must be subtracted out again, along with the psychic loss, to get true income or welfare. The outcome of this attempt is illustrated in Figure 9.10.

The result of adding the leisure value to Adjusted GNE(1) is presented in Table 9.4. As previously discussed the value of leisure has been increasing and resulted in an increasing Adjusted GNE(2) value. A decade or so ago it was 'common wisdom' in leisure studies that the long term decline of the average work week would continue (Mercer 1980). The arguments for less work included (i) increased expected life expectancy and (ii) changed nature of work. Life expectancy after age fifteen increased by over 10 years for men between 1969 and 1990 and by over 16 years for women (Mercer 1990). Those increases yield over twelve years outside the labour force for most men, and seventeen years for women employed to the age of sixty-five. Thus, a change in retirement age would alter the leisure projection. The other argument is based on the changing nature of work. As automated assembly is replacing many assembly line hands, drastic reductions in those segment of the work force have been predicted. In general, the long-term view combines the reduction in industrial hours with increases in life expectancy to project more free time in the future. However, this long-term view is contradicted by more recent trends.

The main argument against an increase in free time is based on the recent levelling off of the decline in work hours. The ABS reports that the average number of working hours is declining at a declining rate. That is, the rate of the decrease in average working hours per week has slowed almost to the point of stability. Table 9.4 shows that the value of leisure for Australia has continued to increase. It is interesting to note that the increase in the leisure index in the 1980s was slower than the previous decade, except in 1983. The stable increase in the leisure value can be attributed to an increase in the number of people employed and the average wage rate.

Table 9.5
Adjustments to Gross National Expenditure for $g(G_{31t}, G_{32t})$ and the value of leisure for 1963 to 1990

Year	Y_t^w	Y_t^w Index	Leisure	Leisure Index	Y_t^{wl}	Y_t^{wl} Index
1963	125109	100	30684	100	155793	100
1964	138160	110	41626	136	179787	115
1965	142844	114	45017	147	187861	121
1966	144656	116	47772	156	192429	124
1967	155217	124	51248	167	206465	133
1968	169232	135	55231	180	224464	144
1969	180289	144	58152	190	238441	153
1970	189896	152	61111	199	251006	161
1971	200938	161	66896	218	267834	172
1972	205950	165	67647	220	273597	176
1973	224039	179	73414	239	297452	191
1974	242512	194	96041	313	338552	217
1975	243826	195	104940	342	348766	224
1976	255622	204	110137	359	365759	235
1977	253620	203	113956	371	367576	236
1978	262574	210	109996	358	372570	239
1979	200769	160	79542	259	280311	180
1980	274409	219	113652	370	388062	249
1981	294943	236	131060	427	426003	273
1982	295646	236	149456	487	445103	286
1983	362527	290	190864	622	553391	355
1984	320404	256	157229	512	477633	307
1985	335959	269	154880	505	490839	315
1986	336866	269	156687	511	493553	317
1987	343111	274	157645	514	500756	321
1988	352195	282	154191	503	506386	325
1989	383419	306	162713	530	546132	351
1990	371256	297	182333	594	553589	355

Table 9.6

Adjustments to Gross National Expenditure for government defensive expenditure for 1963 to 1990

Year	Y_t^{wl}	Y_t^{wl} Inde	Government Defensive Expenditure(GDE)	Index of GDE	Y_t^{wld}	Y_t^{wld} Index
1963	155793	100	455	100	155337	100
1964	179787	115	684	150	179103	115
1965	187861	121	669	147	187192	121
1966	192429	124	672	148	191757	123
1967	206465	133	719	158	205746	132
1968	224464	144	766	168	223697	144
1969	238441	153	1094	241	237347	153
1970	251006	161	1448	318	249558	161
1971	267834	172	1645	362	266188	171
1972	273597	176	1827	402	271770	175
1973	297452	191	2029	446	295424	190
1974	338552	217	2212	486	336341	217
1975	348766	224	2429	534	346338	223
1976	365759	235	2416	531	363343	234
1977	367576	236	2171	477	365405	235
1978	372570	239	2083	458	370487	239
1979	280311	180	1551	341	278760	179
1980	388062	249	2175	478	385886	248
1981	426003	273	2254	495	423749	273
1982	445103	286	2664	586	442439	285
1983	553391	355	4787	1052	548604	353
1984	477633	307	3947	868	473686	305
1985	490839	315	3947	868	486891	313
1986	493553	317	3740	822	489813	315
1987	500756	321	2985	656	497771	320
1988	506386	325	2223	489	504163	325
1989	546132	351	2238	492	543894	350
1990	553589	355	2190	481	551399	355

As discussed in Chapter 3, defensive expenditure through purchases as intermediate good are treated as a final good in the national accounts. If the negative effects of production increase, the defensive expenditure associated with these effects will also increase. Some part of market output would be diverted to offsetting the adverse externalities resulting from economic growth. At present, the national accounts treat this expenditure as something new and desirable (Olson 1977). In the same study, Olson concluded that 'in any comprehensive system of national income statistics, defensive expenditure should be subtracted from the national income to avoid double counting since these expenditure represents intermediate goods'. Table 9.6 presents the result of subtracting government defensive expenditure from GNE.

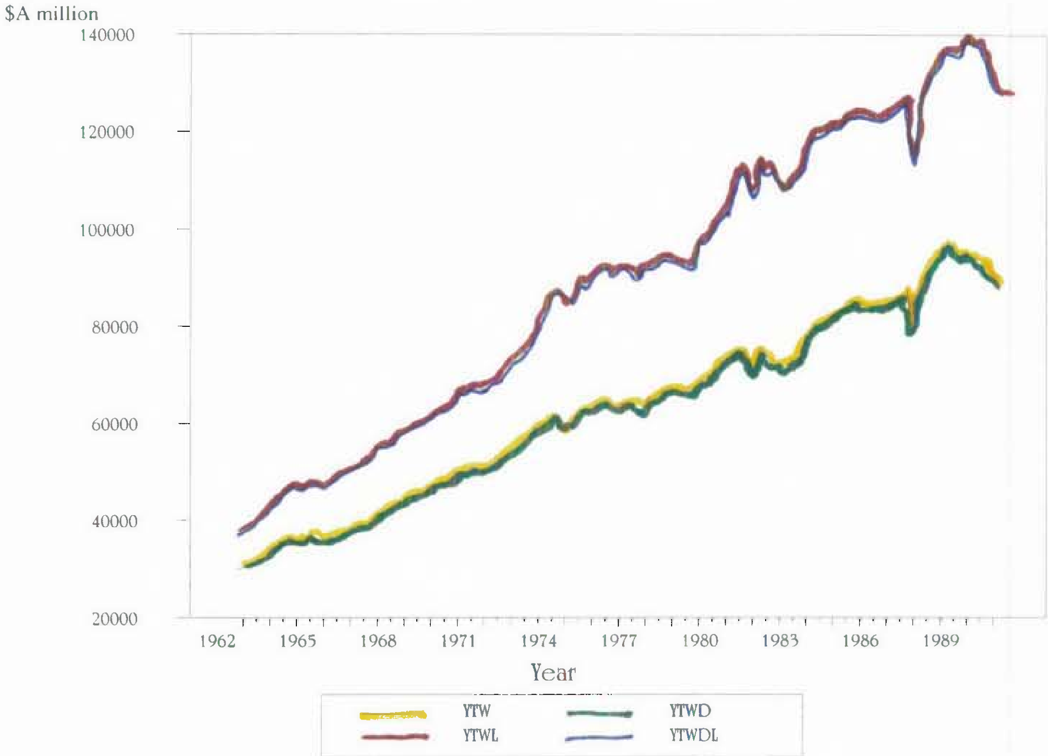
Table 9.6 shows that government defensive expenditure is much greater than in 1963. The highest defensive expenditure index was 10.52 (Column 5) times the 1963 value. This means that government defensive expenditure increased by 10.52 times more than the 1963 value. However, the real value of government defensive expenditure is so low relative to total GNE, that its impact on the level of aggregate income is very minimal. Comparing columns 3 and 6, it is clear that there is not much difference in their values. The Y_t^{wld} index is higher than the Y_t^{wl} index, except for some years where the latter is higher by 1 to 2 per cent.

Graphically, the different methods of adjustments are illustrated in Figure 9.10. Subtracting government defensive expenditure from either Y_t^{wl} or Y_t^{w} reduces the value of final income.

Although the ratio of government defensive expenditure to GNE is low, it has been increasing. The growing necessity to compensate for serious environmental damage that has occurred in the 1980s is one reason given for the increase in government defensive expenditure. The increase in environmental damage from the late 70s to the 90s has led to a wave of amendments that have strengthened anti-pollution laws. One can therefore expect that by the end of the 1990s, government defensive expenditure will have more importance in the national accounts.

Figure 9.10

Different Income Measures from 1962:4 to 1991:2



9.7 Evaluation of the Fitness of Models

Although the models used are straightforward and can easily be interpreted, some of the numerical results are doubtful. Take for instance the value of ε_t. The level of environmental degradation which is captured by $(1-\varepsilon_t)$ has a value of 0.75 for 1990. This implies that the environmental degradation level in Australia is very high. The value of the results can partly be explained by lack of quarterly data on government defensive expenditures and the failure to include private defensive expenditures. Furthermore, it is important to note that periods of high $(1-\varepsilon_t)$ values also corresponds to periods of recessions. The great disparity in the GNE values for those years may also be due to the low levels of economic activity in the country.

There are also essential shortcomings that needs to be mentioned. Further improment of the model should address these issues.

First of all, any model, is but a reflection of reality. The models derived for this study, however, do not deal with subtleties necessary to arrive at really sophisticated arguments. Indeed in this study, rigourous assumptions are made. Nevertheless, the models succeeded in showing relationships relevant to the problem identified in the study.

The second point has to do with costs. The models were not able to capture all the costs of environmental degradation nor the costs involved in correcting environmental degradation. As indicated earlier the value of ε_t can be enhanced by improving the data.

The third point is related to policy issues. The model developed does not provide ready answers for politicians in difficult debates. However, models such as the ones used in the study can provide one or two arguments in the array of arguments. The models developed can be used to pinpoint the possible areas where something can be done to correct environmental degradation.

9.8 A Summary

The value of ε_t was computed. The results show that the parameter ε_t, a measure of the environmental disturbance of production, has been declining up to 1989 and has been increasing since then. The outcome implies that the level of degradation as measured by $(1-\varepsilon_t)$ has been declining since the 1989. One probable explanation of the fall is the rise in government defensive expenditure as a component of the government's budget. The Unadjusted GNE was also determined. The results reveal that Unadjusted GNE is lower than Adjusted GNE (with government defensive expenditure).

The value of the parameter $g(G_{31t}, G_{32t})$ was also computed. The value of $g(G_{31t}, G_{32t})$ ranges from 2 to 5 with the later years registering the highest values. The rise in the $g(G_{31t}, G_{32t})$ values is due to increased awareness and better choice of environmental projects.

To account for leisure, the imputed value of leisure was added to both the Unadjusted and Adjusted GNE. Since the estimate used average wage and total leisure hours in the computations, the value of leisure was positive. An attempt was also made to

To account for leisure, the imputed value of leisure was added to both the Unadjusted and Adjusted GNE. Since the estimate used average wage and total leisure hours in the computations, the value of leisure was positive. An attempt was also made to further adjust the national accounts by subtracting government defensive expenditure from the national accounts.

10. ASSESSMENT OF THE STUDY

...societies inevitably face a trade-off between those goods that are measured in the national accounts and those that are not....

(*Mancur Olson 1977*)

10.1 Introduction

This chapter begins with a summary of the research: problem, the method, the findings, the applicability of the study and the limitations of the study. Then, Section 10.3 presents the policy implications of the study. Finally, the recommendations for further research are discussed in Section 10.4.

10.2 Review of the Study

10.2.1 The problem

The overall measurement of economic performance, as a guide to macroeconomic policy, makes use of the conventional national accounts. Development planners, economists and politicians make frequent use of the national income measure of Gross National Product (GNP) and its variants (Gross Domestic Product, Net National Product, *etc*) for a variety of purposes. GNP is defined as all goods and services produced by Australians for a given year. All groups in the economy assume that GNP measures something of importance and most assume that it is closely associated with human welfare. However, a major question raised by critics of economic growth is whether countries have been growing at all in the more meaningful sense of welfare. GNP statistics cannot give the answers, for GNP is not a complete measure of economic welfare (Nordhaus and Tobin 1972). The concept of welfare is much broader than this measure of monetary income, and covers many dimensions of subjective well-being other than those measured in the national accounts.

From the viewpoint of the critics of national accounts there are several problems with the national accounts as indicator of long-term sustainable economic growth and development. Firstly, costs incurred in protecting the environment are currently treated as an addition to national product, which may instead be considered as the social costs of the maintenance of environmental quality. Secondly, the depletion of non-renewable resources (fossil fuels and other minerals) is not charged against current income to reflect diminished potential production. Thirdly, the degradation of renewable resources (forests, fisheries, soil and water) is not charged against current income. Finally, leisure is not included in the national accounts.

In an attempt to improve the measurement of the national accounts to include the environment and leisure, this study illustrates how the environment and leisure can be analysed within the Neo-classical framework of income accounts.

10.2.2 Analytical approach

Among environmentalists and economists with environmental and resource concerns, there are several schools of thought on the analytical approach. Some advocate adjustment in physical terms and have little interest in establishing any linkage with the current system of national accounting. At the other end of the spectrum are those who feel that adjustments for the environment and leisure would be useless unless the accounts are monetised and integrated into the national accounts. The latter, purely economic approach is used.

Because no international consensus has been reached on how best to incorporate changes in the national accounts, it is appropriate to extend and clarify the existing system rather than to propose radical changes. Thus models developed for this study are still based on the Neo-classical framework of income accounts. The derived models are extended versions of the model developed by McCallum (1988). The first model known as the Unadjusted Gross National Expenditure (GNE) Model, extends the McCallum model by integrating the government sector and the environment in the real business cycle model (RBC). The second model proposed, known as the Adjusted GNE Model (1), incorporates government defensive expenditure in the specification of the production function. Government defensive expenditure is defined as the cost of compensating for past environmental damage or preventing its occurrence in the future. The third model, labelled the Adjusted GNE Model (2), expands the second model by adding the imputed value of leisure to GNE.

The study was conducted in three stages. The first stage was to determine the long-run macroeconomic relationship between government defensive expenditures and government expenditure on goods and services, government investment expenditures, effective consumption, effective investment, and leisure. To establish the nature of these variables, unit root tests were conducted and cointegration analysis was undertaken to determine the long-run relationship. Likewise, impulse response analysis was carried out to determine the responses of the selected variables to a change in government defensive expenditure.

The next step was to impute for the value of leisure. Five methods outlined in the literature were used to impute for the value of leisure. The most relevant method was selected for the adjustment of the national accounts. Finally, changes in the environment and leisure were integrated into one account. The last stage was only possible after the values of ε_t (the environmental productivity disturbance parameter) and $g(G_{31t}, G_{32t})$ – (the measure of success of government environmental programs) were established.

10.2.3 Findings

Using the Adjusted GNE Model (1), the cointegration tests find that there is one cointegrating vector in a six variable Error Correction Model (ECM). Cointegration exists among the ratios of government defensive expenditure to GNE (g^w_{3t}), of government expenditures on goods and services to GNE (g^w_{1t}), of government investment expenditures to GNE (g_{3t}^{w}), and effective consumption to GNE (i_t^{w}). A negative long-run relationship between g_{3t}^{w} and the ratio of effective investment expenditure to GNE (i_t^{w}) was established. If the negative side effects of the production of market output increase overtime, any defensive expenditure against these negative side effects will also tend to increase. As an associated increase in environmental damage will discourage firms from increasing their investment expenditures.

The exogeneity tests results show that the ratios of effective consumption to GNE (c_t^{w}) and leisure to labour (x_t^{w}) are weakly exogenous. These outcomes explain why c_t^{w} and x_t^{w} are not cointegrated with the rest of the variables. Using impulse response analysis, the results illustrate that only g_{2t}^{w} is adversely affected by an increase in g_{3t}^{w} while the rest of the variables are positively influenced initially. For all 6 variables, the adjustment process is slow. The stabilisation process only begins in the 28th quarter and it is not until the 32nd quarter that stability is once again achieved.

Imputing for the value of leisure using the five methods, reveals that the effect of adding leisure to the GNE index would greatly depend on the method of estimation selected. The conclusions derived from Estimate I, which uses average wage rate and total hours of leisure, the theoretical model that is standard in most leisure studies are as follows:

Between 1963 and 1991:

(a) The value of leisure increased by five times (100 to 518).

(b) The value of reported GNE increased almost three times (100 to 298).

(c) The percentage of leisure value to adjusted GNE increased by 30 percent, from 2 per cent to 32 per cent

(d) The average wage computations show a positive value for leisure unlike the marginal wage computations illustrated by estimates IV and V.

In Chapter 9, the parameter ε_t was discussed in more detail. The results show that the parameter ε_t which measures the environmental disturbance of production has been declining. It has been observed that present environmental conditions have deteriorated compared to the conditions of the 1960s and 1970s. In fact the ratio of government defensive expenditure to total government budget has been increasing. The Unadjusted GNE was then determined for each period using the values generated for ε_t. The outcome reveals that Unadjusted GNE (1) is lower than the Adjusted GNE (with government defensive expenditure).

The value of the parameter $g(G_{31t}, G_{32t})$, which represents the success of government environmental programs, was also solved, and was found to range from 2 to 5 with the later years registering the highest values. The rise in $g(G_{31t}, G_{32t})$ values is probably due to increased awareness and better choice of environmental projects by the government.

To account for leisure, the imputed value of leisure was added to both the Unadjusted GNE (1) and Adjusted GNE (1). Since Estimate 1 used average wage and total leisure hours in the computations, the value of leisure was always positive. In an attempt to correct the national accounts for double counting, government defensive expenditure was subtracted from the national accounts. Because the absolute value of government defensive expenditure is very small, the impact on GNE computations is also minimal.

10.2.4 Contributions

The theoretical framework presented and the method of analysis used in this study could be replicated in other countries. The analytical procedure presented are applicable to other similar studies that aim to establish relationships among selected variables. In addition, the theoretical framework formulated can further be extended to include defensive expenditure of households and private firms.

Although the literature on the interaction between the economy and the environment is vast and growing, there are significant gaps in the understanding, and it is these gaps which make it very difficult to formulate and to implement environmental policy. One of the gaps, which this research is trying to bridge, is the fact that at the macro level there is a need to extend the existing analytical framework so as to incorporate the effects of environmental expenditure on macroeconomic variables such as ε_t and $g(G_{31t}, G_{32t})$.

The study illustrates that it is possible to analyse the environment and leisure within the Neo-classical framework of income accounts. Since no study appears to have related environmental variables to other macroeconomic variables, a further contribution of this study is the identification of the long-run relationship between selected macroeconomic variables and government defensive expenditure.

With regard to leisure, this study compared all five methods of imputing for the value of leisure. This is another contribution since no previous formal study in Australia has employed all five methods. In addition, an attempt to measure the parameters ε_t, which represents the environmental productivity disturbance, and $g(G_{31t}, G_{32t})$ which represents the success of government environmental programs was also made in this study.

10.2.5 Limitations of the study

The data used for government defensive expenditure are annual data and needed to be distributed to quarters in order to apply the cointegration analysis. The value of government defensive expenditures used in the study does not include water supply and national parks and wildlife. These items were included in the ABS 1991 report on expenditures by the government on the environment. The addition of these items to the defensive expenditure total, and the availability of quarterly data would greatly improve the reliability of the conclusions generated from the study. Similarly, the measurement of parameters ε_t and $g(G_{31t}, G_{32t})$ could have been further enhanced if the unknown utility parameters were determined.

The results of this study are tentative. The purpose was to test the conceptual approach and to apply it in an actual country context. Given the general weaknesses of the available data, the estimates or range of estimates produced are more illustrative than precise. Clearly to improve this work, better data would be required.

10.3 Implications for Policy

10.3.1 Increased allocation on defensive expenditure

The study shows that there is cointegration among the ratios government defensive expenditure to GNE (g_{3t}^{w}), government expenditure on goods and services to GNE (g_{1t}^{w}), government investment expenditure to GNE (g_{21t}^{w}) and effective investment to GNE (i_t^{w}). Since g_{3t}^{w} has a positive long-run relationship with g_{1t}^{w} and g_{21t}^{w}, by implication an increase in g_{3t}^{w} will also increase g_{1t}^{w} and g_{21t}^{w}. Thus, any increase in government expenditure will be complementary to other government activities.

10.3.2 Policy of differentiated development

Under the present conditions of economic development, in which productive as well as destructive forces are at work, it can no longer be taken for granted that economic growth is equated with an increase in welfare. This study shows that the value of ε_t, which represents the environmental disturbances of production, is approximately between 0.3 to 0.5. This implies that the disutility associated with the production process is quite high. Disutility is used to mean the negative impact associated with increased production. What is needed then is a policy of differentiated development which would focus on addressing the structural causes of environmental damage and the costly patterns of production and consumption. To pursue such a policy implies that the growth rate of GNE will be of secondary importance.

10.3.3 Inclusion of leisure in the national accounts

The omission of leisure from measures of production conveys the impression that economists are blindly materialistic according to Olson (1977). Economic theory teaches that welfare could rise, even if GNE fell, as a result of voluntary choices to work for pay for fewer hours per week, fewer weeks per year, or fewer years per lifetime. The study presented five methods of imputing for leisure, and the conclusions depend on the method of estimate chosen. What is important though is the fact that the imputed value of leisure, shows that leisure is of a significant value.

10.3.4 Increased efforts in research and training

Statisticians and economic planners in government departments must be given training not only on the concepts proposed by the System of Integrated Environmental-Economic Accounting (SEEA) but also on the relevant aspects of the emerging discipline of environmental economics. The SEEA is advocated by the ABS for Australia. This study reveals that government defensive expenditure is increasing in importance in the government's budget. When defensive expenditure of the business sectors and the consumer sector is added to that of the government, it becomes clear that the magnitude of the expenditure at issue is rather large. Important as they are, the ratio of defensive expenditure and the way it must fit into the national accounts in a coherent system of social evaluation is not usually understood, probably because of the lack of adequate explanation in the specialised literature. The recent ABS publication entitled *Costs of Environmental Protection*, attempted to measure defensive expenditure for 1990/1991. However, there is still a need to improve on such efforts. Also, research is needed to establish priorities with regard to government environmental programs. The study shows that government defensive expenditures has been successful (based on the value of $g(G_{31t}, G_{32t})$) in correcting some environmental damage.

10.3.5 Closer link between revenues and uses

The results show that the environment parameter ε_t is significant but the level of government defensive expenditure is small. The government should reallocate its budget and spend more on correcting environmental damage since government defensive expenditure will increase both government consumption expenditure and investment. Also, policies that subsidise environmentally harmful activities should be stopped or should not be implemented. Crop subsidies that increase pesticide and fertiliser use should be eliminated, and forms of positive incentives should be used instead. The government should also offer incentives that increase awareness of, or contribute to, resource saving improvements.

10.3.6 Effect on macroeconomic performance

The impact of environmental policies on macroeconomic objectives depends on the environmental standards required and the resulting increase in defensive expenditure to control the deterioration of the environment. For example, an Organisation for Economic Cooperation and Development (OECD) study, taking Austria, Finland, France, the Netherlands, Norway and the United States as case studies, has concluded that: (a) the effects of the price level could be unfavourable (by an average of between 0.3 and 0.5 per cent per year) and (b) employment could rise because of the stimulative impact of the increase in government defensive expenditure.

The impulse response analysis conducted in this study shows that as the ratio of government defensive expenditure increases, the ratio of leisure to labour falls. This result implies that the number of hours worked increases or that the number of people employed increases. This supports the second finding of the OECD study. Thus, the government should increase its outlay on government defensive expenditure.

10.4 Implications for Future Research

10.4.1 Improvements to this study

The limitations identified for this study could be a starting point. An extension of the data to include firm and household defensive expenditure could be critical. This extension, however, is rather difficult conceptually and computationally. Although some of the data are available, there are difficulties associated with the identification of defensive expenditure. This extension will, however, improve the measure of ε_t, environmental disturbances of production, and will also correct the problem of double counting.

10.4.2 Extensions to this study

The theoretical framework developed for this study could be applied to other countries. Also, it could be modified to suit an individual country's needs. In addition, the theoretical framework could further be developed to include omitted variables (*eg*. household services, non-market goods and services).

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