3. THEORETICAL FOUNDATIONS

Yet when we look at the composition of income more closely, it begins to seem as though welfare depends on two types of arguments some of which are included in income and some not.

(Dan Usher 1980)

3.1 Introduction

The view that the GNP measure should be revised or extended has gained prominence because of mounting concern with changes in the quality of the environment and the decline in working hours in developed countries. Thus, dissatisfaction with GNP as an overall measure of economic performance has given rise to several attempts to revise and extend the GNP computations.

The major premise of the present study is that GNP to a country is like salary to an individual, with increases in GNP seen as an improvement in the individual's income. Although details of the translation from national to family income are subject to criticism, Usher (1980) reasoned that while GNP is less than ideal as an income concept, it is still widely used because other measures require much more statistical guesswork and are based on less appropriate concepts.

The relevant economic theories dealing with consumer welfare, real income and leisure-time will be presented and discussed. These theories are introduced in an attempt to develop a theoretical framework for this study. The discussion of this chapter is structured such that the first half discusses the theory of the measurement of real income, and the second half explores the methods of revising measures of real income to include the environment and leisure. Specifically, Section 3.2 examines the relationship of the economy and the environment. In Section 3.3 the concept of real income is presented starting from a model of a representative household (consumer).

In Section 3.4 this is extended to a model of many households (consumers). Section 3.5 reviews the extension of the national accounts to include the environment. Further development in revising the GNP to include leisure-time in the national accounts, is introduced in Section 3.6. Section 3.7 details the concept of Real Business Cycle (RBC). Finally, Section 3.8 presents the summary.

3.2 The Economy and the Environment

The problem of environmental scarcity is one of trade-offs — controlling environmental degradation in the long-run versus increasing economic activity in the short-run (Barbier 1989). Thus a new or alternative theoretical approach is required in order to analyse the economy-environment relationship. The theoretical approach needs to incorporate the economic impact of ecological disturbances and to examine the trade-offs amongst all functions of the environment.

3.2.1 Economy-environment model

Most of the economics literature is concerned with the analysis of the activities of production and consumption. Macroeconomics concentrates on the overall levels of activities and flows. A typical macroeconomics concern is whether the economy contains mechanisms that maintain the level of productive capacity employing all the available labour services.

Figure 3.1 shows the relationship between the economy and the environment. The environment provides three types of services to the people. It is a source of inputs to production (**R**), it serves as a receptacle for production and consumption wastes (**S**), and it is a direct source of positive (eg. wildlife observation) and negative (sewage pollution of beaches) satisfaction (**A**). The diagram also indicates that these services are not independent, which means that more of one is likely to mean less of others.

The three important economic functions performed by the environment are described as follows (Common 1988).

(1) *The environment provides resources that become material and energy inputs into the economic process* (**R**). Conventionally defined, this function includes providing economically valuable non-market resource stocks (such as fossil fuels and mineral resources), renewable resources (such as commercial forests, fisheries and water supply systems), and semi-renewable resources (such as soils).

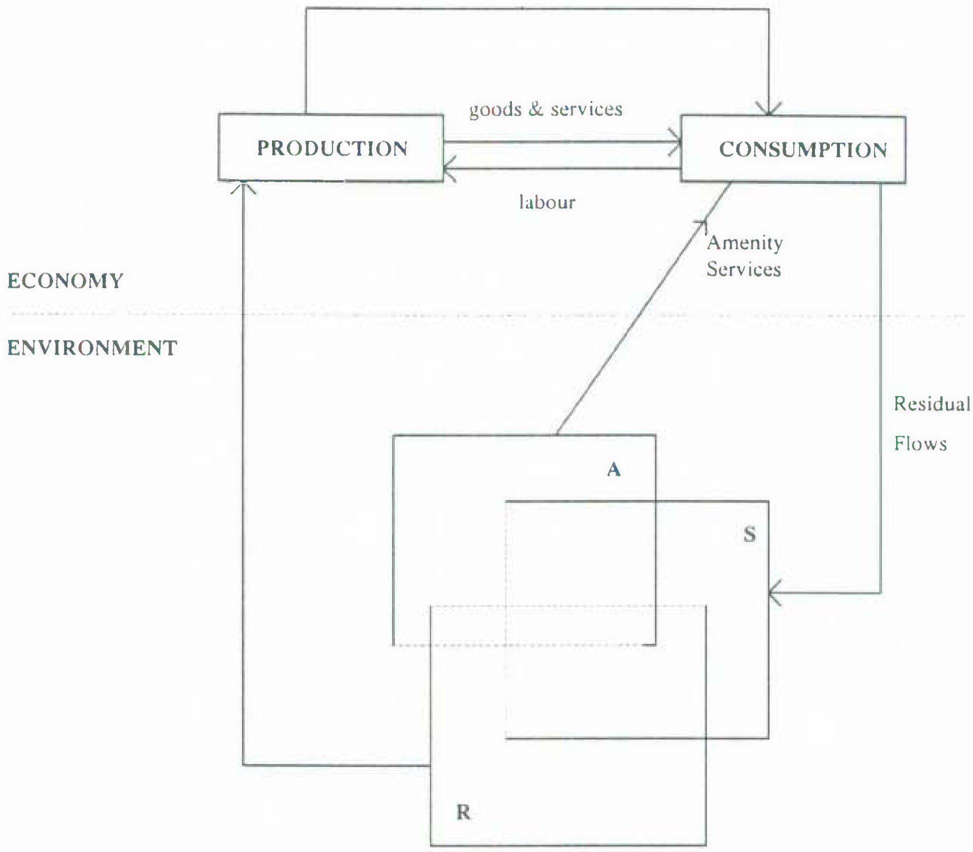
(2) *The environment assimilates the emitted wastes of the economic process* (**S**). Overtime, the processes of energy and material extraction and conversion, production and consumption associated with economic activity generate waste residuals. By-products, such as particulate matter, inorganic and organic waste, waste heat and junk, must be absorbed by the environment through its biological chains and material cycles.

(3) *The environment provides a flow of natural or environmental services to individuals and production systems* (**A**). These functions range from recreational, health, cultural, educational, scientific and aesthetic services, to the maintenance of essential climactic and ecological cycles and functions. These are mainly non-marketable services; that is, although they have important welfare implications these services are largely provided by common property resources directly to individuals or economic processes, and so lie outside the market mechanism.

Together, these three functions of the environment underline the physical dependency of economic and human welfare on ecological processes and on the sufficiency of potentially scarce environmental resources.

Figure 3.1

Economy-environment Linkages

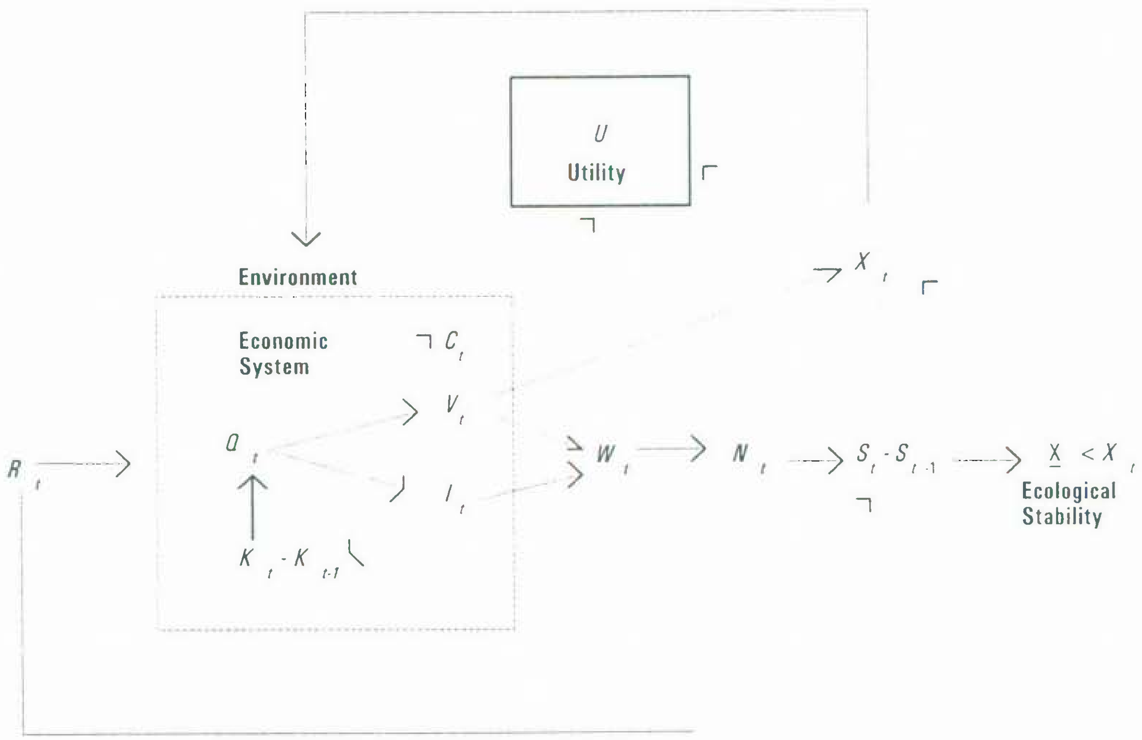


Adapted from Common (1988), p.13

As depicted in Figure 3.1, residual flows in a closed system reflect the operation of the first law of thermodynamics. This law states that neither matter nor energy can be created or destroyed. The diagram however, does not show the constraints on economic activity imposed by the second law of thermodynamics. This implies that some useful energy is always lost in conversions of energy and matter from one form to another. In the long run, when stocks of stored energy are gone, activity in the economic-environmental system will be constrained by the availability of environmental resources. In reality, even at the lowest level of aggregation, the combined economic-environmental systems will be very complex. On the economic side, this complexity is due to the number of human agents and goods and services, the diversity of technologies, and the ability of people to learn from experience. In the case of the environment, the complexity is a consequence of biological diversity and variations in the physical environment.

Figure 3.2

A Flow Diagram of Economic-Environmental Interaction



Adapted from Barbier (1989) p.102

An alternative economic view of natural-resource scarcity is described by Barbier (1989), in a model that illustrates the trade-off between environmental quality and resource depletion, and the waste generated by the economic process. Figure 3.2 summarises this model in a simple flow diagram depicting the interrelationships between the economic process, the natural environment and human welfare (utility). The model is concerned with the use of environmental resources which lead to increasing environmental degradation. However, Figure 3.2 only indicates the transformation of material and energy from terrestrial resources (ie. forests, coal deposits, mineral ores, *etc*.).

According to Figure 3.2, terrestrial resources (R_t), may be appropriated by the economic system at any time to produce output (Q_t). This output is then either allocated for consumption (C_t), environmental services (V_t), or investment (I_t). Consumption leads directly to increases in social welfare, which is represented by the utility box. Environmental improvement services generally enhance environmental quality (X_t), and also assist the recycling of some of the total waste emitted by the economic system, (W_t). The recycled waste effectively re-enters the economic system as a productive input. Investment can lead to capital accumulation from one period to the next ($K_t - K_{t-1}$), which in turn stimulates further expansion in output capacity. Through the processes of production, consumption and saving, the economic system gradually transforms environmental resources into various utility-yielding purposes.

But the extraction of the resources (R_t) and the generation of net waste (N_t) by the economic system must eventually lead to increased environmental degradation ($S_t - S_{t-1}$). In turn, increased environmental degradation can affect ecological stability and resilience (Barbier 1988). If overall environmental quality is above the minimum level $\underline{X}$, then overall ecological stability and resilience can be said to be maintained. Even before a complete ecological instability and collapse is experienced, any increase in environmental degradation is bound to lower environmental quality, and thus have a negative impact on social welfare.

Ecological growth may improve social welfare by increasing consumption and allowing for some improvement in environmental quality through the improvement of environmental services. At the same time, the cost of growth, in terms of increasing environmental degradation could have a negative impact on environmental quality and so on welfare. In the short-run at least, the problem is one of balancing the various costs and benefits of growth in order to maximise the generation of utility overtime. However, increases in environmental degradation could permanently disrupt ecological functions and thus the overall sustainability of the economic-environmental process (Barbier 1989).

3.2.2 Environment in the national accounts

Although the role of the environment in the production process has long been recognised, the national accounts concentrate only on the role of capital and labour in the production process. Natural resources have a passive role in the production process because they are regarded as gifts of nature with zero supply price (Ahmad *et al* 1989). This notion suggests that, as no dollar costs are incurred in their provision, nothing needs to be deducted from the current income as resource stocks are depleted. Also, the conceptual approach adapted in the national accounts does not consider the fact that the disposal of waste from the production process imposes costs on the environment.

3.2.3 Environment in macroeconomic studies

There are only a few studies on the national accounts that take into account the environment. Two of these recent studies are reviewed briefly in this section.

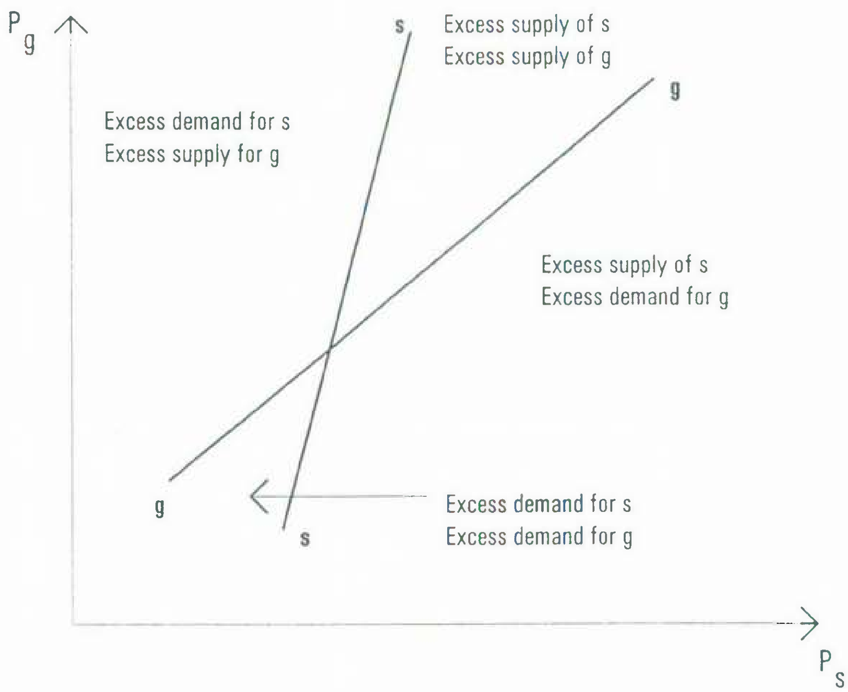
3.2.3.1 Messsaye Girma's Model

Girma (1992) constructed a model that shows how the environment can be incorporated as a sector of the macroeconomy. He then examined aggregate demand policy, and distributional issues within the context of his model.

The model he presented uses the concepts of demand and supply for environmental services. He tried to show how a policy maker can analyse the environmental consequences of macroeconomic adjustments within a 'holistic framework' that incorporates household and producer micro-decision making in capital, labour, goods and environmental markets. Graphically, his analysis is illustrated by Figure 3.3.

Figure 3.3

Walrasian Equilibrium in Markets for Goods and Environmental Services



Adapted from Girma (1992)

Figure 3.3 shows the relationship between goods and natural resource markets. The *'ss'* locus represents the points at which the market for natural resources is in equilibrium All points above the ss' locus represent points of excess demand for natural resources (s). All points below represent excess supply. The '*gg*' locus represents those combinations of the price of environmental services (P_s) and the price of goods (P_g) that maintain an equilibrium in the goods market.

A region of excess demand for any good implies that in that region such a good is undervalued (and over exploited). Conversely, a region of excess supply indicates an overvaluation (and under exploitation). The above diagram was then used to evaluate macropolicy effects on incentives and constraints (eg. agricultural subsidy, monetary contraction).

3.2.3.2 Dodo Thampapillai's Model

Thampapillai (1992) tried to illustrate how the salient concepts of environmental accounting can be included in the Keynesian macroeconomic framework of national income accounts. Central to the framework he constructed, are the concepts of the "assimilative capacity of the environment", and an "environmental cost function". Thampappilai then proceeded to show the probable relationships between environmental costs (e) and national income (Y). Examples of these relationships are shown in Figure 3.4

In Figure 3.4A, economic activity is assumed to commence in a pristine environment. Hence environmental restoration costs are absent, and e does not emerge until after a certain amount of national income, say Y_i, has been generated. That is, up to an income level Y_i any wastes that are generated due to economic activity are assimilated by the environment without diminishing the functions of the environment. Increasing national income beyond Y_i, results in an increase in e. However, the assimilative capacity of the environment cannot be recouped beyond Y_h, because e tends towards infinity at this point. Thus a feasible set of output targets is defined by the range $(0 < Y \leq Y_h)$.

Figure 3.4
Environmental Cost-National Income Relationships

Production Level $:0 < Y \leq Y_d$

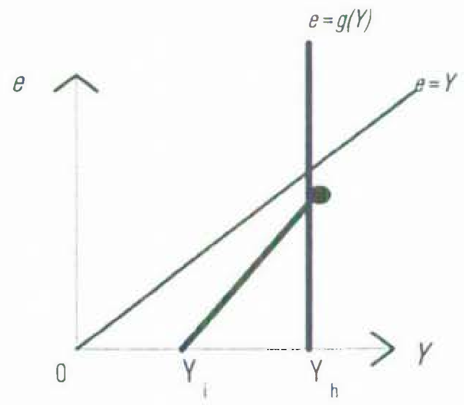


Figure 3.4A
Absence of Environmental Costs

Production Level: $Y_d < Y \leq Y_h$

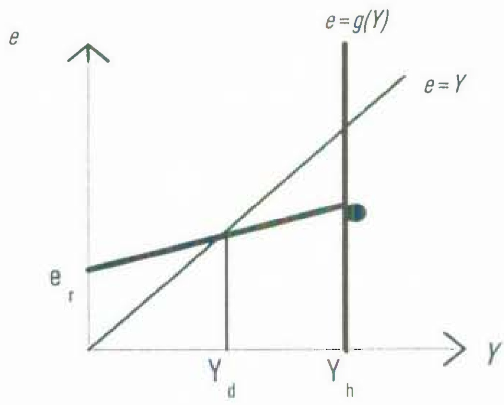


Figure 3.4B
Presence of Environmental Costs

Adapted from Thampapillai (1992)

On the other hand, Figure 3.4B deals with an environment that has already been degraded. Hence the value of e is positive at the start of the accounting period. For an economy displaying the features of Figure 3.4B, it would be irrational to set output targets over the range $(Y < Y_d)$, since $e > Y$ over this range. Hence, the feasible output targets in Figure 3.4B are defined by the range $(Y_d < Y \leq Y_h)$. The initial condition of $e > Y$ can occur if the environmental costs of previous periods have been neglected.

Thampapillai's innovative study concluded that the internalisation of the environment shows that investments in 'environmental saving technologies' can play an important role in meeting the goals of economic growth and employment.

3.3 The Welfare of the Representative Consumer

One obvious shortcoming of the GNP measure is that it is an index of production whereas the goal of economic activity is consumption (Nordhaus and Tobin 1972). Although this goal is the central premise of economics, the profession has been slow in developing, either conceptually or statistically, a measure of economic performance oriented to consumption, broadly defined and carefully calculated.

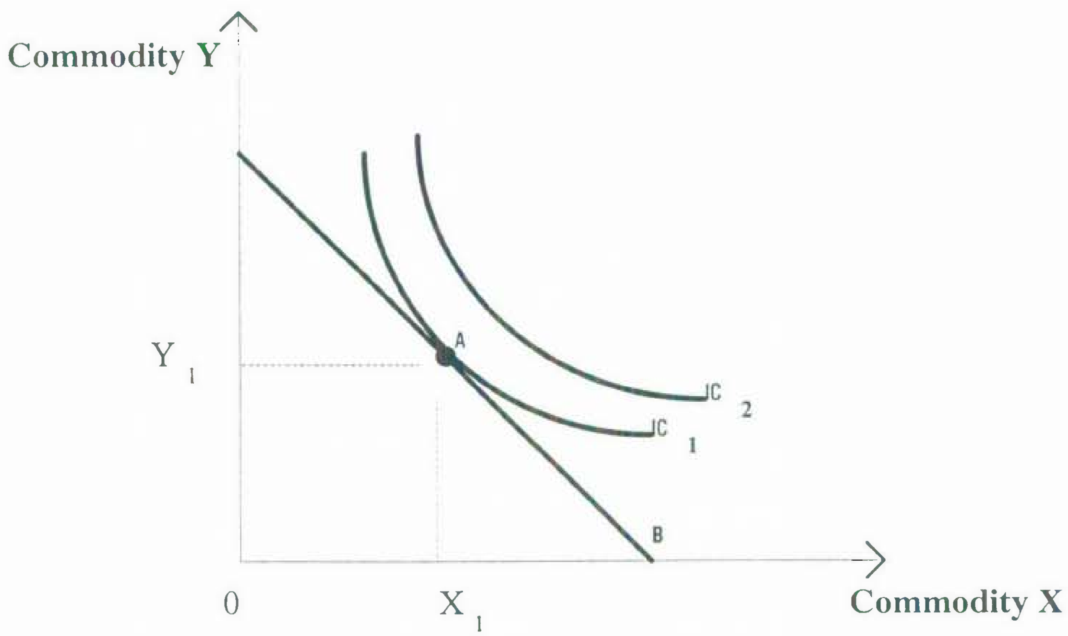
The present study takes the view that a society's welfare ultimately depends upon the welfare of its constituent households. Following Usher (1980), it is assumed that the economy consists of only one person, called the representative consumer, whose well being may be described by an ordinary utility function entirely dependent on the quantities consumed of a finite set of consumption goods, and who obtains different amounts of consumption goods each year. The term consumption goods is used in this study to mean both goods and services.

3.3.1 How does a representative household (consumer) make a choice?

The simplest economic model of household-decision making concerns a household that must decide how to spend an exogenous income on different goods. According to the basic theory of household choice, the household has a preference ordering overall the alternative bundles of commodities, and that the utility function satisfies certain assumed properties. An indifference curve (IC) represents all possible combinations of commodity X and commodity Y which a household (consumer) is indifferent. One IC corresponds to a particular level of satisfaction. Figure 3.5 shows that the further the IC from the origin, the greater the utility associated with it. In addition, the representative household (consumer) is confronted with a social state represented by a budget set (B), from which it (he/she) can choose a bundle of commodities. The budget set is determined by the set of prices and income facing the household.

Figure 3.5

A Model of Household Choice



Given a certain income and certain set of prices for commodity X and commodity Y, the household makes a choice, shown as point A, where it achieves the highest utility subject to the constraints of its budget. Thus, the measure of welfare is given by IC_1, for which (X_1, Y_1) are proxies.

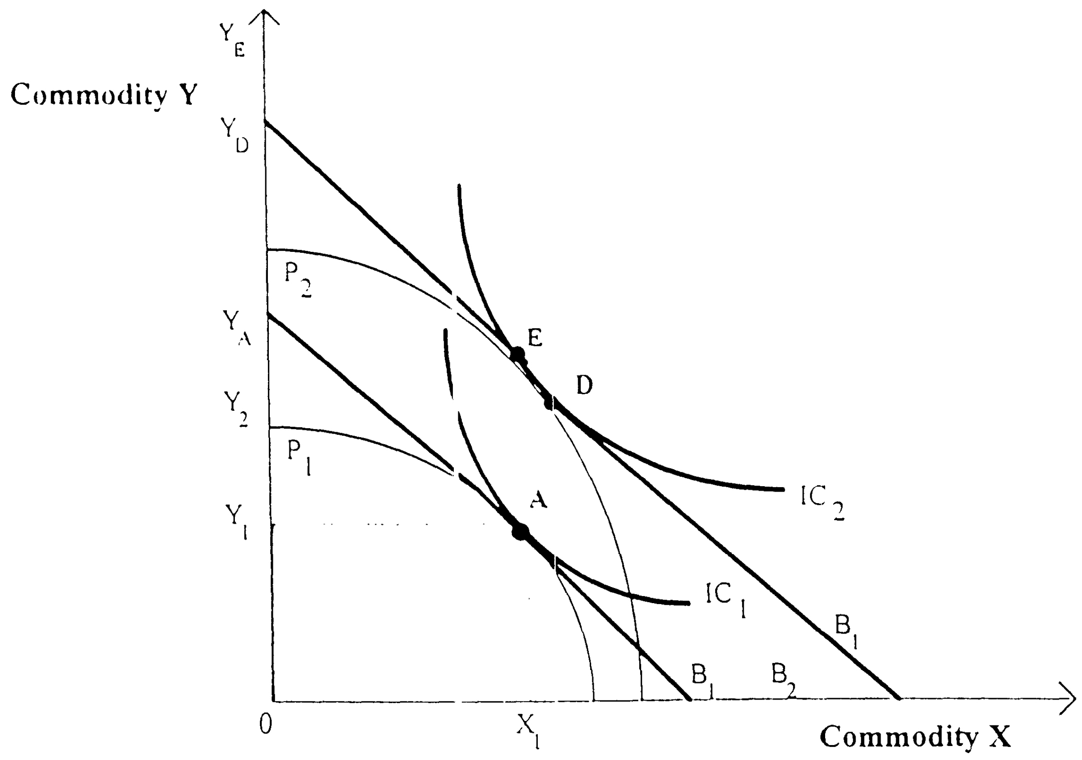
3.3.2 How does a representative household (consumer) maximise welfare?

Using the example of Usher (1980), Figure 3.6 depicts a representative household (consumer) whose tastes are invariant over time in the sense that it (he or she) evaluates bundles of goods consumed in different years with respect to a single, unchanging set of indifference curves. This also means that the bundles of goods consumed in different years can be evaluated with reference to the supposedly invariant utility function of the representative household (consumer), and that observed prices represent rates of substitution in use among goods in accordance with this utility function. To give a concrete example, assume that there are only two goods in the economy, commodity X and commodity Y, quantities of which are indicated on the vertical and horizontal axes of the figure. Two indifference curves are shown; these are labelled IC_1 and IC_2. For an increase in the economy's output to have taken place, the production possibility curve of the economy must have shifted outwards over time, otherwise, the quantities consumed would have remained the same, year after year. In this example, a production possibility curve represents the maximum combinations of X and Y that a country can produce given its limited resources.

The production possibility curves for years 1 and 2 are indicated by the curves labelled P_1 and P_2, respectively. The budget lines are represented by B_1 for year 1 and B_2 for year 2. Each year the representative consumer chooses the point on that year's production possibility curve which yields the greatest possible utility. The equilibrium condition is attained when the production possibility curve is tangent to an indifference curve. In Figure 3.5 the highest utility attainable in year 1 is indicated by the indifference curve IC_1. The optimum combinations are A and E for years 1 and 2 respectively. In this economy without excise taxes or other distortions in the price mechanism, the relative price of commodity X in each year is obtained at the

Figure 3.6

Maximisation of the Household's Welfare



common tangents of the utility curves at the equilibrium combinations A and E. Although the ratio of the prices is reflected by the slope of the budget line, money income is not reflected in the diagram. To reflect the money income concept in the diagram, money income is defined as

$$M = P_y Q_y + P_x Q_x \tag{3.1}$$

where

P_y = price of commodity y

Q_y = quantity of commodity y

P_x = price of commodity x

Q_x = quantity of commodity x

and income in units of Y is M/P_y, which is equal to $Q_y + Q_x(P_x / P_y)$ and which may be represented on the diagram as the projection of (Q_y, Q_x) onto the vertical axis by the line of the slope P_x / P_y. Following this rule, income can be represented in units of commodity Y for years 1 and 2 by the heights of Y_A and Y_E above the horizontal axis.

But it is the change in real income which is important. The real income level is determined by shifting the budget constraint for year 1 $(B_1 \rightarrow B_1^{'})$, without changing its slope, such that it is tangent to IC_2 at point D. The equilibrium point D lies on the IC_2 attained in year 1 and the slope of the indifference curve reflects the relative prices of the commodities. The intersection of this line with the vertical axis is labelled Y_D. The measure of real income in year 2 when year 1 is the base year, is the height of Y_D above the horizontal axis. The amount Y_D signifies the amount of money one would require to be as well off as a person in year 1 if the prices of commodity Y and commodity X were constant. Since year 1 is the base year, real income in year 1 and money income in year 1 are one and the same.

Real income is defined as a measure of the welfare of representative households (consumers), and this definition will apply to the rest of this thesis. Average consumption per household (head) will be treated as the representative household's (consumer's) consumption, and the observed prices as the rate of substitution in use.

3.4 The Welfare of the Community

Much of the literature on the theory of welfare economics and real income concerns the representative household (consumer). One conclusion drawn from this literature is that the sum of prices times quantities is a representative measure of utility. A representative household (consumer) is said to be better off in year t than he or she was in year 0 if total money income in year t is greater than total money income in year 0 at constant year t prices. That is:

$$\sum_{i=1}^{n} p_i(t)q_i^j(t) > \sum_{i=1}^{n} p_i(t)q_i^j(0) \qquad (3.2)$$

where

p_n = prices of the commodities in constant dollars, in constant prices

q_i = quantities of the commodities, i=1...n

The issue in most debates on welfare aggregation is whether the economy is 'better off' if the equation holds when all $q_i^j(t)$ and $q_i^j(0)$ are replaced by total quantities consumed.

3.4.1 How does the community maximise welfare?

Before proceeding, it is worth noting the important assumptions involved in analysing a single-person economy, and using it as a surrogate model for a multi-person economy. Treating a many-person economy as if it were a single-person economy implies that just as the individual demand functions reflect the preference orderings of an individual, the aggregate demand function represents an aggregate preference ordering, or set of community indifference curves. To answer the question whether the inequality $\sum p_i(t)q_i^j(t) > \sum p_i(t)q_i^j(0)$ holds true in a multi-person economy, consider Figure 3.7.

Furthermore, assume that there are only two persons in the economy, namely, person A and person B. These two individuals have their own utility functions and their choices are reflected by the Edgeworth box $O_AX_1O_BY_1$. The community indifference curve (CIC_1) is the locus of all combinations of X_1 and Y_1 which will leave persons A and B on their indifference curves U_1^a and U_1^b. The income level M_T^1 is the aggregate amount of income required at the relative price given by the slope O_b to allow the two individuals to reach utility levels U_1^a and U_1^b

Figure 3.7

Maximisation of the Community's Welfare

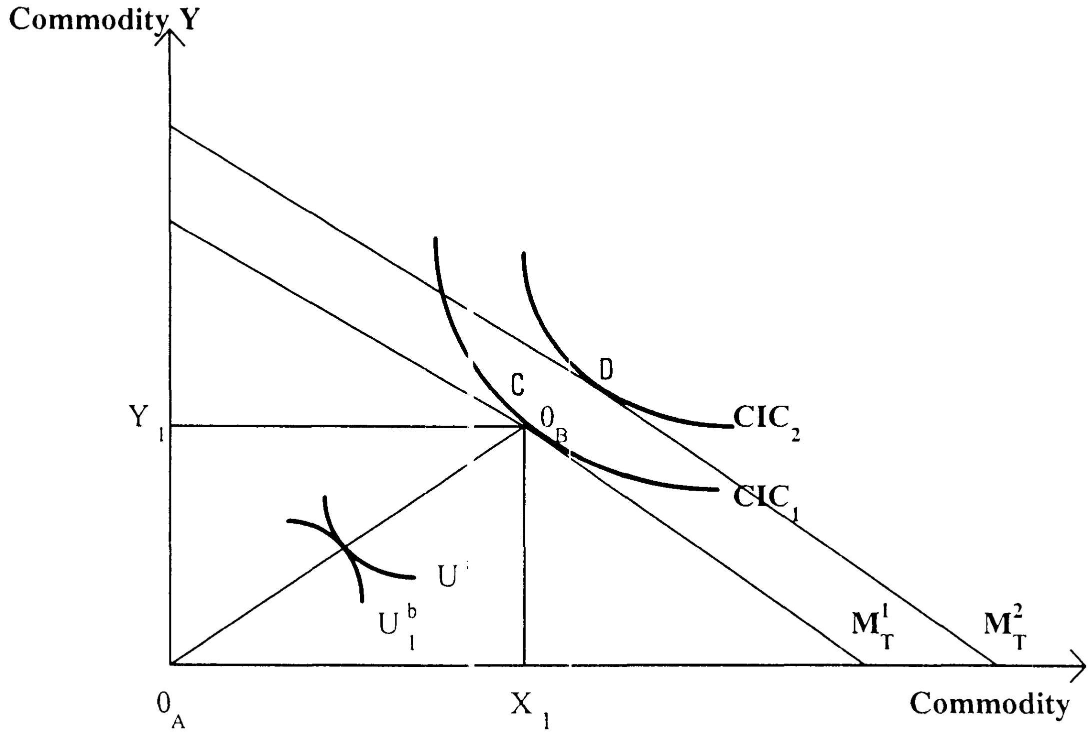


Figure 3.7 shows that in year 1, the community reaches a competitive general equilibrium at point C, and that the resulting allocation of goods is Pareto optimal. A Pareto optimal situation is reached when no one is made better-off without making someone else worse-off. An increase in the level of the community's income or a decrease in the prices of commodities X and Y in year 2 causes the M_T^1 (aggregate income) to shift to the right to M_T^2. The new M_T^2 will now be tangent to a higher CIC level represented by CIC_2. A new equilibrium level will now exist represented by point D. Thus, like the single-person economy case, the community reaches an equilibrium when the community's budget line (M_T) is tangent to a given community indifference curve. This result supports the inequality in equation 3.1.

3.4.2 Is aggregation possible?

The debate on aggregation was started by Hicks in 1940. Other contributors were Kuznetz (1948), Little (1949) and Samuelson (1950). Samuelson, summarising the debate, showed that one cannot infer from the inequality given by equation 3.1 that everyone is better off in year *t* than in year 0, or even that everyone could be made better off by a redistribution of goods and services. Additionally, Samuelson concluded that one cannot presume that everyone could be made better off by a combination of a shift in the composition of output in accordance with the given production possibility curve and a redistribution of the output of goods and services. However, Chapman and Moore (1976) illustrated that the inequality is sufficient to guarantee that everyone could be made better off in year t than in year 0 if, and only if, the households' utility functions are identical and homothetic.

The idea that the representative consumer might be given an equal chance of being anybody in the economy was put forward by Harsanyi (1955) and subsequently by Rawls (1971). In addition, empirical applications of the theory of demand can be interpreted as evidence for the existence of the representative consumer. Likewise, the existence of the representative consumer has its counterpart in the theory of aggregation where it is shown conclusively that, strictly speaking, community demand curves do not and cannot exist, except under conditions that correspond more or less to the existence of a utility function of the representative consumer (Usher 1980). Given that demand curves do exist in the sense that elasticities come out with the right sign, that prediction is sometimes possible, and that consumer surplus computations do not seem to be altogether meaningless, the interpretation of real national income as a measure of welfare of the representative consumer becomes meaningful, and aggregation possible.

However, there are two sets of conditions that need to be satisfied if an aggregation of prices and quantities is to represent levels of utility. The first condition is that all consumers have the same tastes and equal shares in the ownership of all factors of production. This means that the observed prices have to be consistent with the utility function of the representative consumer because each person, in effect, is the representative consumer. The second condition is that all consumers have income elasticities of demand which are equal to one. Together these two conditions imply that no transfer of income among consumers can affect relative prices because the consumers who receive the income are prepared to buy precisely the same set of goods that the consumers who loose the income have forgone.

3.4.3 What is the relationship between national income and household income?

As stated earlier, a premise of this study is that the national income to a country is like salary to a household. It is assumed that the details of the translation from national to family income are not merely numbers but have an impact on the lives of the people. Furthermore, without the possibility of such a translation, the measurement of national income has less relevance than economists and politicians argue.

To illustrate the relationship, consider the case of Australia. In assessing Australia's economic performance from 1962 to 1991 for example, the common practice is to compute for the GNP growth rate. If the GNP growth rate turns out to be 5 per cent, it is inferred that the total output in 1991 is five times higher than in 1962. Given the average income in 1991 was \$28 920, if national income translates into statistics of family income, then the income figure for 1962 should be \$27 543. That \$28 920 represents the exact value of the income of the average family in 1991 who are as well off as the average family of 1962, may not be entirely correct, however it has to be close to the true figure for the growth rate of 5 per cent to be correct. In this study it is taken as a premise that the identification of average income of \$27 543 in 1962 with a family income of \$28 920 in 1991 is correct, or can be made approximately right by appropriate changes in the GNP measure. Thus, it can be accepted that the principle of national income of a country can be translated into a $\sum_{i=1}^{n} p_i(t)q_i^j(t) > \sum_{i=1}^{n} p_i(t)q_i^j(0)$ among people or families at different periods of time.

3.5 Changes in the Environment

3.5.1 Theoretical Basis

In section 3.3, it was assumed that utility is a function of quantities $q_1,\ldots\ldots q_n$ designated collectively by the vector q,

$$U = U(q) \tag{3.2}$$

To include changes in the environment, consider a utility function with two sorts of arguments, commodities q and environmental conditions $E_1,\ldots\ldots,E_m$ designated collectively by the vector X:

$$U = U(X) \tag{3.3}$$

The distinction between commodities and environmental conditions is that commodities are purchased with money so that richer people may consume more than poor people, while environmental conditions are not purchasable and affect everyone alike in any given year. Environmental commodities may change from year to year so that people may enjoy more or less of each E_i , i=1,....m in year 2 than in year 1 (Usher 1980). A representative consumer is said to be as well off in year 1 as in year 2 if utility derived from consumption of commodities and environmental goods in year 2 is the same as that of year 1. Mathematically, it is written as

$$U(Y^{w2}, p^1, E^1) = U(Y^2, p^2, E^2) \tag{3.4}$$

where

Y^{w2} = real income in year 2

p^1 = prices in year 1

E^1 = environmental conditions in year 1

Y^2 = observed average income in year 2

p^2 = prices in year 2

E^2 = environmental conditions in year 2

Real income (Y^{W2}) in year 2 is defined as the amount of money that the representative consumer needs at year 1 prices and at year 1 environmental conditions. This definition is identical to the previous definition of real income except that it includes environmental goods. The significance of the inclusion of environmental goods is that the representative consumer is assumed to take account of the changes in the environment. Expanding equation (3.4) in a Taylor series becomes

$$\hat{Y}^{w2} = \sum_{i=1}^{n} p_i^1 q_i^2 + \sum_{j=1}^{m} s_j^1 (E_j^2 - E_j^1) \qquad (3.5)$$

where

$\hat{Y}^{w2}$ = approximation to Y^{w2} in equation (3.4)

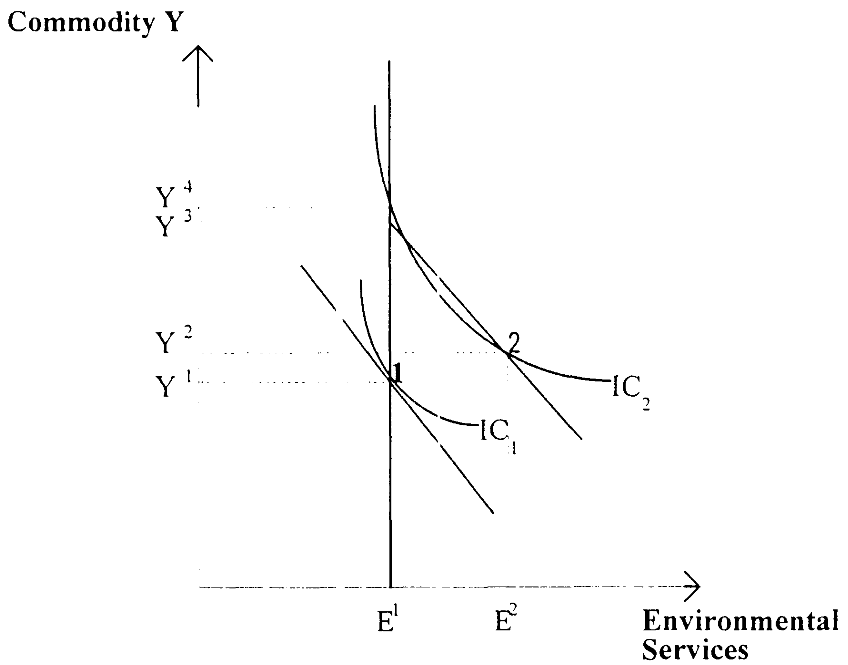
which implies that the real income in year 2, with respect to year 1 as the base year, is approximately equal to the value at year 1 prices of the total commodities consumed in year 2 plus the change in environmental conditions from year 1 to year 2 evaluated at the shadow price s_j^1 of the environment in year 1.

To illustrate equations (3.4) and (3.5) diagrammatically, consider Figure 3.7. Assume a representative consumer whose utility function consists of two arguments, an ordinary commodity called commodity Y and an environmental variable called environmental services (labelled as E).

Two indifference curves are shown in the Figure 3.8. Curve IC_1 represents the different combinations of commodity Y and environmental services in year 1 while IC_2 represents the combinations of commodity Y and environmental services in year 2. Since it is assumed that expenditure on commodity Y is part of income and environmental services is not, commodity Y will serve as numeraire. This means that income will be expressed in units of Y. The real income in year 2 is the sum of the quantity of Y consumed in year 1, plus the extra value of the environmental services

Figure 3.8

An imputation to real income for a change in the environment



Adapted from Usher (1980) p. 133

(*eg*. hours of sunshine) required in year 1 to compensate for the change in environmental services from year 1 to year 2. The real income as given by equation (3.4) is equal to Y^4. The income Y^4 corresponds to the height of the intersection of the indifference curve attained in year 2 with a vertical line at the value of the environmental services in year 1. In contrast, the real income represented by equation (3.5) is given by Y^3. The income Y^3 is obtained by multiplying the change in environmental services by the shadow price of environmental services in year 1. The figure also shows that the income in year 2 (Y^4) is greater than the income in year 1 (Y^1), which implies that the individual is better off in year 2 than in year 1. Thus, the imputation for changes in environmental conditions shows that unlike imputations of goods and services, society's welfare increases whenever environmental conditions improve.

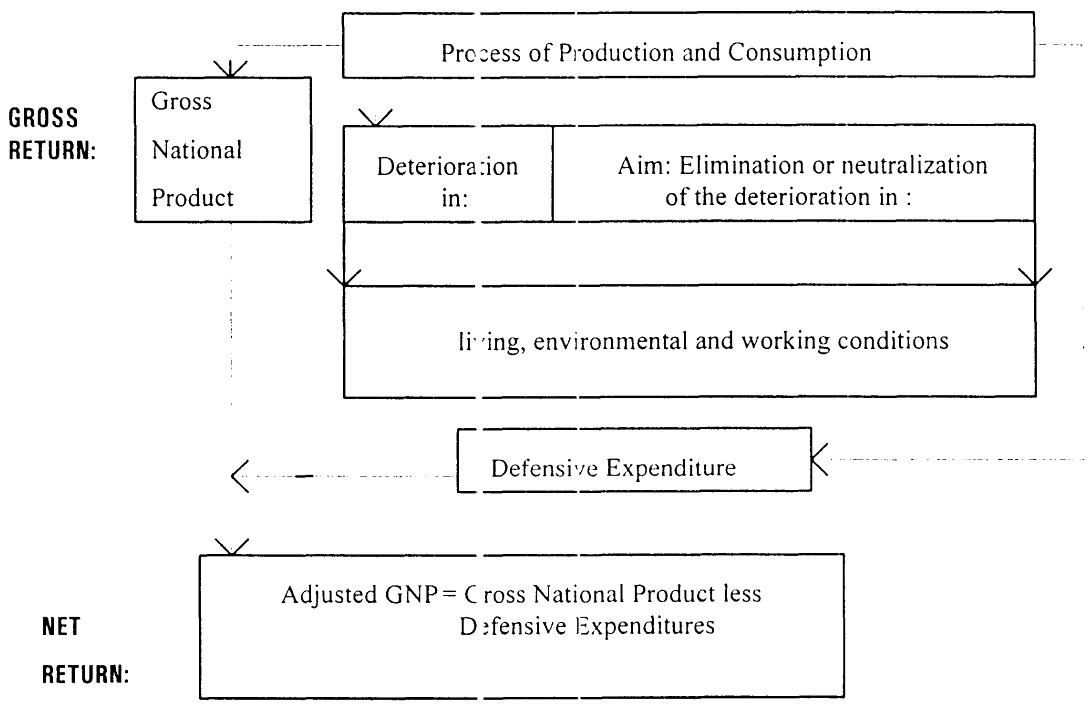
3.5.2 Why defensive expenditure?

The current methods of calculations of environmental protection in the national accounts distort the measurement of economic performance in two ways. Firstly, GNP obscures the real costs of production and consumption which include the costs of environmentally damaging activities. The point made by critics of GNP is that the costs of environmental damage, caused by production and consumption, are left completely unaccounted for in the calculations. Environmental damage implies the consumption of environmental assets, perhaps the irreversible loss of natural resources or a deterioration in the quality of human life and nature. Secondly, GNP records expenditure on protection of the environment (defensive expenditure) as positive entries which increase GNP, whereas in reality they are additional burdens placed upon private households, enterprises, and the state. The term "defensive expenditure" is understood to mean outlays by which society attempts to eliminate, mitigate, neutralise, anticipate and avoid damages that the economic process of industrial societies have caused to living, working and environmental conditions (Leipert 1989). Defensive expenditure serves only to restore or defend a status (say, a specific environmental quality) that has been lost or compromised by the negative impact of economic and social processes. Seen from a dynamic perspective, defensive expenditure are additional macroeconomic costs incurred by a specific growth and development pattern.

A welfare-oriented adjustment of the GNP to properly reflect the external costs of the economic process requires a concept and a classification of defensive expenditure. Two preliminary observations are helpful in understanding the defensive expenditure concept. The first is related to welfare theory and the longer term development of net income in the economy. For instance, it is still uncertain whether there is a parallel relationship between increases in net income and growth in consumption opportunities. The second is based on the observation that the production and consumption process has, over time, unequal positive and negative effects on the living, environmental, and working conditions of the people. Some of the present economic activities are aimed at eliminating, neutralising and reducing the negative side-effects of production and consumption. This expenditure is seen in the longer term as additional costs which, in contrast to the initial period on which the comparison is based, are essential for the production of the desired consumption and investment goods. Thus, part of the production performance indicated by GNP is not part of output but should be part of input and the relevant costs must still be deducted from the GNP.

Figure 3.9

The Transformation of Gross to Net Production Return



Adapted from Leipert (1989)

Figure 3.9 illustrates the concept of defensive expenditure. It is defined as the additional costs arising from the pursuance of income, production and consumption goals, related to the socio-economic conditions of the initial period. Defensive expenditure are not superfluous in the short-term but are necessary and useful under given socio-economic and ecological conditions. They also fulfil positive functions by allowing the cost of using nature in the year they are made to become clear. Examples include the deterioration of certain living and environmental conditions which are linked to industrial production, whose market performance is registered in the GNP. Thus, the provision of comparable, inter-temporal estimates of net production returns requires that defensive expenditure be subtracted from the GNP. This is because the expenditure that compensates for these environmental problems, or attempts to prevent them, is an additional expense made to achieve positive production returns.

In addition, the time-space related concept of defensive expenditure requires a consideration of the additional external costs and expenditures that must be accepted by society when a particular development and settlement pattern has become established. It is derived from the assumption that different development patterns lead to different scales of negative consequences of production and defensive expenditure. It shows particularly that the development of certain (environmentally detrimental) structures necessitates additional expenditure to achieve unaltered goals (that is, expenditure for pollution control and compensating environmental damage). A change in these types of expenditure-increasing variables can lead to a reduction in defensive expenditure without a reduction in the standard of living. Thus, there is a need to consider fully defensive expenditure in the derivation of real income.

3.5.3 Applying the theory

The causes of increases in defensive expenditure are related to developments in the evolution of an industrial society, namely: (a) the general process, accelerated in the post-war period, of economic growth, and (b) the simultaneous process of spatial centralisation and a concentration of production in an increasingly urban society.

Thus Leipert (1989) classified defensive expenditure according to whether a strong or weak causal relationship exists with the specific pattern of industrialised production. His categories of compensatory expenditure include five areas of increased costs and risk.

(1) Costs of the general growth process of production and consumption are increased by investment in, and running costs of, environmental protection in both the manufacturing industry and government, and by expenditure on environmental research and development.

(2) Costs of spatial concentration, centralisation of production and associated urbanisation are increased by rising costs of getting to work, increasing expenditure on rent, housing and land use, on public and private property.

(3) Increased risks generated by the maturation of the industrial system. Increased expenditure for protection against the increasing crime and growing insecurity in urban areas and for the provision of facilities and staff for emergencies, technical security, and risk minimisation.

(4) Costs of car transport are increased by the need to provide for the repair or replacement of vehicles, the treatment and rehabilitation of injured persons, and to cover costs of emission-reducing measures and equipment.

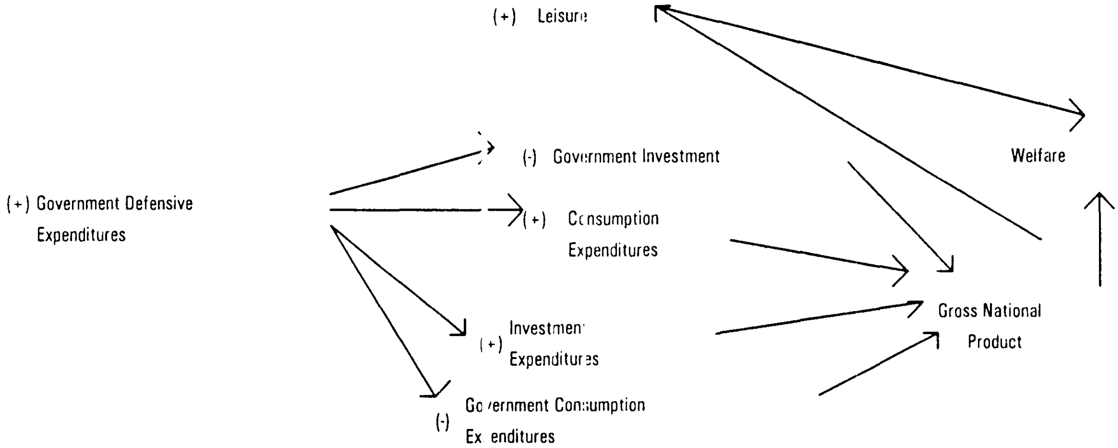
(5) Costs arising from the unhealthy consumption of goods and services, and behavioural patterns and from poor working and living conditions.

The above classification is important for those responsible for economic and environmental policies. The contemporary practice of measuring GNP as an indicator of personal well-being entirely conceals the fact that current business practices are not only ecologically and socially destructive, but actually increasingly counter-productive (Leipert 1989). Thus, the revision of the GNP computation to include defensive expenditure is an opportunity to improve its welfare measurement ability.

As discussed above, changes in environmental conditions are best expressed in terms of costs that the household, private firms and the government incur in correcting the environmental damage caused by production and consumption. However, only the expenditure of the government, classified as government defensive expenditure, is included in this study. Lack of data and the difficulties involved in imputing for the value of defensive expenditure by households and private firms are the reasons for dropping these costs in the analysis.

Figure 3.10

Long -run Relationships of Government Defensive Expenditure to Selected Macro Variables



Other than the study by Leipert (1989) of Germany, there appear to be no other studies on the inclusion of defensive expenditure in the national accounts. Thus, one of the purposes of this study is to determine the relationship of government defensive expenditure to the macroeconomic variables of private investment expenditure, consumption expenditure, government investment, government expenditure on goods and services and leisure. It is hoped that a better understanding, through a better model, is achieved, resulting in better policies.

The hypothesised relationships are given by Figure 3.10. Government defensive expenditure can be divided into those that directly improve environmental quality through, say, pollution clean-ups, resource management *etc*; and those that indirectly improve expected environmental quality by increased recycling and the abatement of waste residuals otherwise emitted into the environment. It is hypothesised that increases in government defensive expenditure will positively affect levels of consumption and investment in the long run An increase in government defensive expenditure to correct environmental damage which otherwise would have been paid by the household and the firm, will increase the amount of money available for consumption and investment. Likewise, an increase in government defensive expenditure may increase the productive capacity of the economy. As a result of an increase in output, the household will experience an increase in income which will enable it to purchase more leisure hours. However, negative relationships are predicted for government consumption expenditure and government investment. These relationships are the outcome of the substitutability between different types of expenditure by the government. Since the government has a fixed budget for a given year, any increase in one component of its expenditure will mean a decrease in one or more of the other components.

3.6 Changes in Leisure Hours

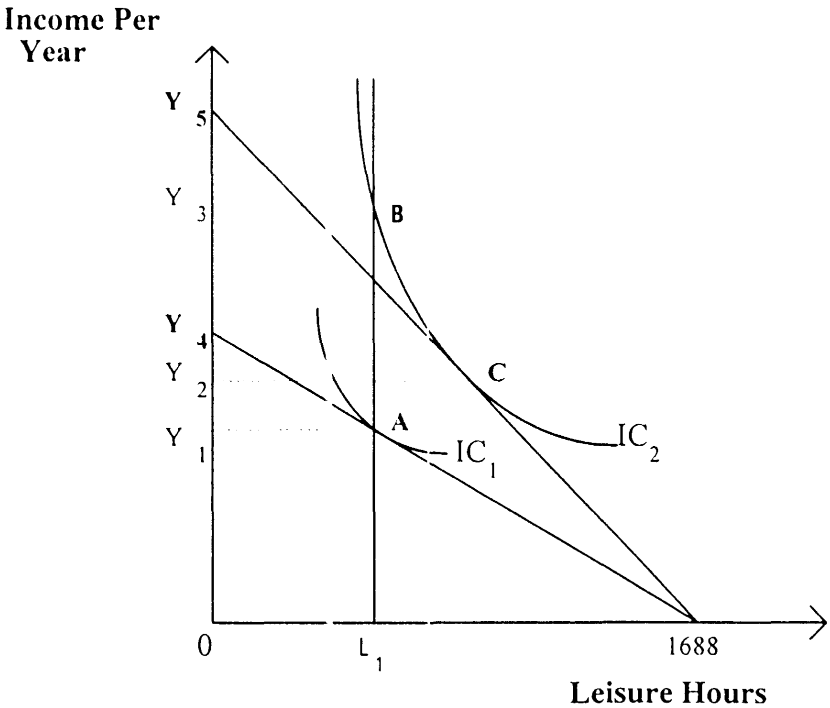
3.6.1 Theoretical Basis

As indicated in an earlier section, most measures of economic welfare are based on consumer expenditure on goods and services, but such measures omit an important item - leisure time. Observed changes in earnings may have come about because of changes in wage rates or changes in hours of work or combinations of the two. Yet for measures of welfare, the composition of changes in earnings is most important. For instance, observed changes in earnings include the choice of hours of work - decisions which themselves reflect adjustments to changes in wage rates - which imply that changes in time allocation should be incorporated in measures of welfare.

In order to calculate true measures of economic welfare, knowledge of the preferences of individual consumers or households are required. Two objectives relevant to the consumer are the maximisation of net income and the maximisation of leisure. The former is measured in terms of dollars earned per year, whereas the latter is measured by the number of hours of leisure per year. Figure 3.11 assumes that 17 hours a day or 1688 hours a year are allocated between work and leisure and that labour is the only source of income. Income per year is measured as the total number of hours worked times the wage rate. One method of imputing for the value of leisure is to leave income in the base year intact and add or subtract a sum of money to income in every other year sufficient to compensate the representative consumer for working the same number of hours as he or she worked in the base year. Assuming further that the productivity of leisure is the same in year 1 as in year 0, the real income in year 1, inclusive of the imputation for leisure, is indicated by the height of point B (Y_3). It is the amount of money that would make the representative consumer as well off as he or she was in year 1, with the same number of hours worked.

Figure 3.11

An imputation to real income for changes in leisure hours



Adapted from Usher (1990)

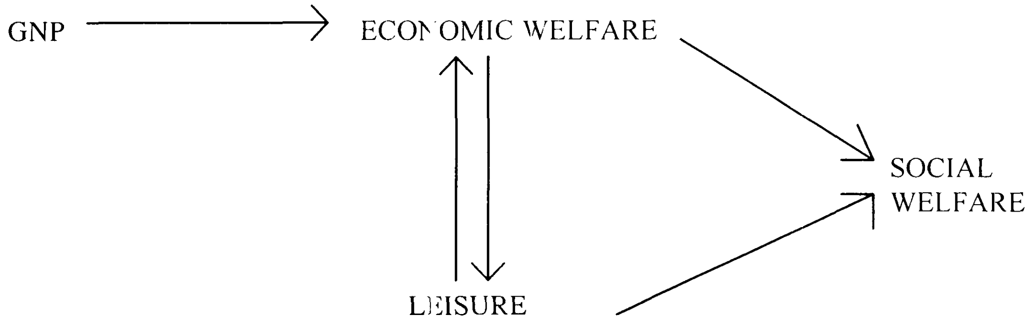
In contrast, if it is assumed that the productivity per hour of leisure increases from year 0 to year 1 in proportion to increases in real wages, the equilibrium positions will be given by points A and C for years 0 and 1 respectively. Thus, real income including the imputation for leisure is Y_4 for year 0 and Y_5 for year 1.

3.6.2 Why leisure?

As with the GNP measure, the associated statistical measures of economic welfare and cost of living are based on traded goods and services, and omit both the environment and leisure time. The omission of leisure is partly explained by the fact that leisure is purchased, not by spending and trading, but rather by not working. The proposed inclusion of leisure in the analysis is based on the fact that time, like any other resource, is limited. Time can be allocated to the market for the production of goods and services, to the household for the production of non-market goods and services, to leisure, and to personal care and biological maintenance. Also, Figure 3.11 shows that any increase in leisure time will lead to improvements in the individual's welfare. The most interesting feature of this relationship is that social welfare increases whenever leisure increases.

Figure 3.12

Leisure and Social Welfare



Adapted from Pigou (1924)

The basic concept that underlies much of the interest in social accounting systems is that measurement of real output, and the degree of improvement of social welfare, should not be influenced simply by variation in the share of economic activity conducted through markets. For example, one would expect to find relatively small market sectors in less developed countries, with much of the output produced within the household economy and most inputs being unpriced. However, such sectors may also enjoy a large quantity of leisure hours. In light of the diverse pattern of development among nations, accurate assessments of inter-country real output need to combine market transactions, non-market transactions and the value of leisure time. The theoretical foundations and analysis that will be used for leisure are similar to that of environmental services. As in environmental change, real income will be redefined and the value of leisure will be imputed. The above reasons are strong justifications for imputing for the value of leisure in the national accounts.

3.6.3 Applying the theory

Over the years, a number of attempts have been made to estimate the value of leisure on a national scale. But most of these studies were concerned with specific problems such as, the decision to work more or less hours (Bruce 1964), the effect of forgone earnings upon consumer choice (Becker 1965), and the valuation of travel time (Johnson 1966 and Oort 1969). Attempts to value leisure on a national scale will now be discussed. They are classified in Table 3.1 on the basis of the concepts of leisure hours and leisure price(estimates I to V).

In an early attempt to impute the value of leisure, Sametz (1968) argued that leisure should be converted into a commodity to enable trade-offs to be made against the standard constraints. He assumed that (a) the number of hours of leisure was the difference between the maximum feasible hours of work and the actual average number of hours worked, (b) the value of leisure increased over time in proportion to the real wage of labour, and (c) the relationships hold for a given individual over time as well as between individuals at a given time.

These assumptions led to the following formula, enabling one to adjust GNP

$$\hat{Y}^t = Y^t + 52(78 - h^t)w^t \tag{3.7}$$

where

$\hat{Y}^t$ = adjusted real income (or adjusted real GNP) per head in year t

Y^t = real income per head in year t as measured in conventional GNP

h^t = number of hours worked per week in year t

w^t = real wage per hour in year t

Table 3.1
Methods to value leisure to extend the national accounts

Concept of leisure hours	Concept of leisure value	
	Average Wage	**Marginal Wage**
Total Quantity of Leisure	*(I)* *Sametz, M (1968)* *Kendrick (1979)* *(II)* *Nordhaus and Tobin (1972)*	*(IV)* *Present Study*
Marginal Quantity of Leisure	*(III)* *Zolota (1981)* *Usher (1980)*	*(V)* *Present Study* *Usher (1980)**

*Lack of data prevented empirical estimation of this case.

In his calculations, Sametz used the average wage rate and total quantity of available leisure hours, and assumed that there are 78 hours available for work or leisure per week, and of course there are 52 weeks per year.

Nordhaus and Tobin (1972) followed similar assumptions to impute a value for leisure. Although they recognised that the amount of leisure time, and range of leisure activities are affected by technological progress, their procedures left the value of leisure unaffected by technological progress. They then assumed that increases in leisure time are due solely to changes in number of hours worked. Their imputation is similar to that of Sametz, in that they used the total quantity of leisure and the average wage. But they refined Sametz' assumptions as follows.

(a) Instead of assuming that leisure time is homogeneous, they employed evidence from a time-budget survey to allocate the 24 daily hours to work, sleep, transport time for work, personal care, leisure (entertainment, sports, reading, conversation), and non-market activity (housework and do-it - yourself activity).

(b) Personal care and sleep require seven hours a day, leaving 17 hours for all the other activities. They then treat leisure and non-market activities as any other commodity, as such they have market prices, confer utility and are traded in the market.

(c) Inputs to leisure and non-market activities consist solely of the hours of time devoted to these activities.

Their formula can be written as:

$$\hat{Y}^t = Y^t + n^t w^0 z_n^t + l^t w^0 z_l^t \qquad (3.8)$$

where the new symbols are

n^t = number of hours of non-market activity in year t

l^t = number of leisure hours in year t

w^0 = real wage which is constant at its value in year 0

z_n^t = productivity factor for non-market activity

z_l^t = productivity factor for leisure

Output of leisure was estimated by adjusting inputs to reflect labour productivity in the current year. Having no evidence on the growth rate of productivity the per hour non-market activity (z_n^t) and per hour of leisure (z_l^t), Nordhaus and Tobin resorted to three alternative assumptions:

(a) Productivity in both leisure and non-market activities remain unchanged over time.

$$z_l^t = z_n^t = 1 \quad \text{for all t}$$

(b) Productivity per hour of leisure remains constant, but the productivity per hour of non-market activity grows at the same rate at the real wage.

$$z_l^t = 1 \text{ for all t}; \quad z_n^t = w^t / w^0$$

(c) The productivity of hours of leisure and of non-market activity grows at the same rate at the real wage.

$$z_l^t = z_n^t = w^t / w^0$$

Nordhaus and Tobin's imputation for the value of leisure makes the assessment of economic growth analogous to the assessment of full income. One day consists of 17 hours, and a person's money income is a compensation for 17 hours of work. However, a person need not actually work a 17 hour day, for some part of the income may be used to buy hours of leisure from an employer at a price that varies according to assumptions (a), (b) and (c).

Furthermore, Nordhaus and Tobin (1972) assumed that the time spent on household work is a function of labour force status and sex. The number of hours of non-market household activity was then assumed to be constant for each work status/sex category for the entire period 1929 to 1965. Time in household production was valued at the pre-tax wage rates of household members. Also, Nordhaus and Tobin assumed that the number of leisure hours varied inversely with the number of hours in gainful employment. To impute a value for leisure, they multiplied the going average wage rate by the total number of available leisure hours, using each of their three assumptions in turn. Without any imputation for leisure, the index of welfare for the United States grew from 100 to 180.3 over the period 1929 to 1965. With imputation (a), it grew from 100 to 117.8. With imputation (b) it grew from 100 to 141.8, and with imputation (c), it grew from 100 to 223.6.

The effect of Nordhaus and Tobin's imputation depended, therefore, very much on which of their assumptions they used. The results show that imputation (a) reduced the rate of real economic growth. This rate is the average of the growth rate of the consumption of ordinary goods and the growth rate of leisure, in this case, the growth rate of leisure was smaller than that of consumption. Imputation (c) increased the overall rate of economic growth because the sum of the (growth rate of hours of leisure and growth rate of real wages) exceeds the growth rate of consumption of ordinary goods and services. Imputation (b) suggested that the overall rate of economic growth increased, but not as fast as suggested by imputation (c).

An important feature of all the valuations is their treatment of the leisure time of the unemployed. Nordhaus and Tobin (1972) valued the leisure time of the unemployed as if they were employed, and so applied the average wage rate to their leisure. This treatment produced some apparently curious results for periods of time like the Great Depression, when the estimated number of leisure hours, and hence the imputed value of leisure, grew rapidly and to relatively large proportions. There was also a rapid increase in involuntary unemployment during the Great Depression, and increases in the number of leisure hours were mostly due to more people being unable to find work, rather than more people opting for less work. Although more difficult, it would seem more appropriate to treat leisure time as being valuable only when it results from an interior solution to the utility maximisation problem, rather than from the corner solution due to involuntary unemployment. This, of course, presumes that consumers are rational and maximise utility from both work and leisure.

In a similar way, Kendrick (1976, 1979) used the average wage rate and total quantity of leisure hours to impute for the value of leisure. Data from a time budget survey were used to derive average weekly hours of leisure for various types of households, and these weekly hours were assumed to be constant over the entire period of the analysis (1966-1973, with updates to 1985). Kendrick's earlier work did not make an imputation for leisure hours, but his later work assumed leisure hours were fixed per capita over the whole time period, and valued at the pre-tax market wage rate. He also valued household production time a wage rates in household employment, that is, at the wage rate of cleaners, carpenters, plumbers, etc. The estimates by Kendrick (1979) differ from those of Nordhaus and Tobin (1972) in several ways. One distinction is that the latter authors used a much earlier (and more fragmentary) time-budget survey for the benchmark number. Kendrick used data from the 1960s and 70s — a somewhat later and perhaps better benchmark. Unlike Nordhaus and Tobin, Kendrick excluded the unemployed in his computations.

Another attempt to assess the importance of household work time was undertaken by Eisner (1982, 1988). His estimate for the United States of America was much more closely linked to available time budgets than the estimates by Nordhaus and Tobin, or Kendrick. Eisner used estimates from the time-budget surveys for 1965-1966, 1975-1976, and 1981-1982 to calculate hours per week devoted to household work by people classified by employment status and sex. He then interpolated annual estimates from these three benchmark time periods. Like Kendrick, Eisner used the wage rate of domestic workers to value household production time like child minding, cooking and cleaning the car. Unlike Nordhaus and Tobin and Kendrick, Eisner did not value leisure time in his accounting system.

The attempts discussed so far, produced different estimated growth rates for the economy. For example, Nordhaus and Tobin (estimate I) showed substantially higher real growth before World War II in their "welfare" measure than in conventional real Gross National Product. This difference was largely due to the inclusion of a leisure value, and the extent of the difference varies with assumptions about the appropriate deflator for the value of leisure time. The appropriate deflator depends on assumptions made with regards to the productivity of leisure. Kendrick's results (estimate I) showed lower real growth rates after World War II in comparison to reported growth rates in Gross National Product. His computations also revealed that a large proportion of post war GNP was spent on investment. Both estimates showed that the household sector contributed much more significantly than was recorded in the reported GNP accounts. This is due to leisure being included.

Another procedure to value leisure was developed separately by Zolotas (1981) and Usher (1980). They used the concepts of marginal quantity of leisure and average wage rate, which are classified as estimate III in Table 1. Zolotas focused on the current flow of goods and services and ignored capital accumulation and the issue of sustainability. He considered changes in aggregate national welfare rather than in per capita welfare, and defined leisure as all the time spent on activities without remuneration. However, he concluded from the time-budget survey that the rise in total hours of leisure during the period 1965 to 1975 (from 34.8 to 38.5 per week) for the United States was mainly attributable to a decrease in hours devoted to family care (from 25.4 to 20.5).

The imputation by Usher (1980) is given by equation (3.9). He assumed that productivity of leisure increases over time. Defining w^t as the rate of trade-off between goods and hours of labour, equation (3.9) is expressed as

$$\hat{Y}^t = Y^t + {w^t}/{z^t}\,(L^t z^t - L^0 z^0) \qquad (3.9)$$

where

L^0 = hours of leisure in base year 0, taking into account the productivity factor

L^t = hours of leisure in year t, taking into account the productivity factor

w^t = real average wage in year t

Further,

$$\text{value of leisure} = \frac{w^t}{z^t}\left(l^t z^t - l^0 z^0\right) \tag{3.10}$$

In equations (3.9) and (3.10)

z^0 = 1 by definition

w^t = rate of trade-off between goods and hours of labour

z^t = 1 for all t which implies that the productivity of leisure is constant overtime

Gross National Product (Y^t) is therefore an increasing function of the productivity of leisure (z^t). The definition of Y^t as an increasing function of z^t follows Usher's belief that progress of the economy rests on people's capacity to enjoy things.

To apply the imputation, Usher added the per capita value of leisure to per capita personal consumption expenditures in Canada for the period 1926 to 1974, with 1961 as the base year. The value of leisure was computed using equation (3.10). His imputation was based on the maximisation of utility, assuming that 17 hours a day is to be allocated between work and leisure, and that labour is the only source of income. The total wage per year was measured as the amount of money earned for each hour of work multiplied by the number of hours worked per year. Furthermore, he treated leisure like an environmental commodity for which there is no explicit payment. The overall effect of the imputation was to increase the rate of growth of per capita consumption over the whole forty-eight year period by almost a full per cent every year.

As explained by Usher (1980), a rue measure of economic growth would include increases or decreases in leisure since the base year. An improvement in the individual's welfare cannot be measured solely by the total quantity of leisure, but must also take into account the value of any change in leisure time. Conceptually, the marginal wage measures the wage per additional hour of discretionary work, and so is an appropriate value of leisure. An individual's decision to undertake extra work or not is influenced by the additional wage he gets by working an extra hour. For these reasons, estimates IV and V are theoretically relevant, and Usher (1980) attempted to implement estimate V. In this study, attempts will be made to implement and compare all of these estimates. No previous study has been undertaken using these valuations, probably because, as Usher says, it is difficult to measure the marginal wage. Two ways to measure this wage are attempted in this study, an actual arithmetic average and a smoothed regression-derived estimate.

3.7. Real Business Cycle Model

One of the most impressive developments in macroeconomics during the early 1980s was the influx of a substantial body of literature devoted to the "real business cycle" (RBC) approach to the analysis of macroeconomic fluctuations. Discussions on RBC was started by Keynes and Kalecki in the 1930's. Prominent papers on RBC were later contributed by Kydland and Prescott(1982), Long and Plosser (1983), King and Plosser (1984).

The earlier works of Lucas (1972, 1973, 1975) and Barro (1989) on RBC emphasise on analyses that rely on monetary shocks. In contrast, the recent work of McCallum (1989) emphasises on those that rely on real disturbances as sources of business fluctuations. The McCallum RBC model differ from the earlier works in two critical respects. Firstly, his model placed more emphasis than did the equilibrium-approach literature on mechanisms involving cycle propagation, that is, the spreading overtime of the affects of shocks. Secondly, he emphasised the extent to which shocks that initiate the cycles are 'real' as opposed to 'monetary' in origin. In short, the McCallum model stresses shocks on technology as the central driving force but allows an important role for the dynamic elements that influence the ways in which shocks propagate. The model is 'equilibrium' in style and feature cleared, competitive markets; optimising agents who are typically modelled as representative households with infinite horizons; and a neoclassical production function that is subject to stochastic disturbances. Although the model de-emphasise monetary shocks, the analysis of propagation mechanisms would apply to monetary as well as real models.

The McCallum (1989) RBC model generates results that are Pareto optimal. Hence the result demonstrate that observed fluctuations in aggregate business activity are insufficient reason for advocating government intervention in the form of stabilisation policy. However, the model can be extended to include government and external effects such as those implied by public goods and taxation (Barro 1989).

Overall, the RBC approach has generated many new insights and techniques that assist in modelling the economy (Barro 1989).

3.8. Concluding Remarks

This chapter shows that there are possible ways of improving the GNP measure to approximate real income. Suggested modifications in the definition of real income push for the inclusion of the value of the environment and leisure hours in computations of national income accounts. The core of this chapter is a sequence of almost self-explanatory diagrams: the first diagram illustrates household choice; this is followed by an illustration of the maximisation of the household's welfare; next, a representation of the welfare of the community; and finally a diagram showing how the GNP measure is affected by the various changes in the definition of real income. In addition, the concept of RBC is discussed. The McCallum (1989) RBC model is the basis of the models presented in Chapter 4.