ECONOMICS OF NATURAL RESOURCES AND THE ENVIRONMENT

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1.1 INTRODUCTION

Environmental stresses and strains are now ubiquitous phenomena appearing in all economic systems, regardless of political ideology, from the very poorest to the very rich. Despite the impression given in some of the environmental literature, environmental degradation is not the unique attribute of advanced Western industrial capitalism. Eastern bloc economies face acute water and air pollution threats, notable examples being river-water pollution in many industrial areas of Poland and declining urban air quality levels in industrial Czechoslovakia. The Soviet environment has suffered from a catalogue of pollution abuses over a long period of heavy industrialisation. Pollution there now threatens even the most precious of biospherical assets such as Lake Baikal. Among the developing economies, air pollution in cities such as Caracas, Mexico City and Sao Paulo is extremely severe and poses a significant health hazard. For the group of thirty-six (the poorest countries on earth) their very poverty is a major cause and effect of environmental problems. Poverty, which denies poor people the means to act in their own long-term interest, creates environmental stress (such as overgrazing of rangeland, soil erosion and eventual desertification) leading to resource degradation and growing population pressures.

Uncertainty still surrounds the exact nature and extent of the global interdependencies between economic growth and the supporting environmental systems. We still cannot fully quantify the risks to future human well-being posed by acid rain, ozone depletion and the greenhouse effect. Even so, half of the net natural output produced by environmental systems is now utilised by humans.

Future necessary global economic growth will further diminish that sector of nature in which self-regulating natural systems can regenerate free of human intervention. The margin for error in economic planning that has the capacity to inflict irreversible change on the natural resource base is, in the view of many, narrowing.

Environmental issues, on the boundaries of economic and natural systems, are undoubtedly complex and in many cases contain inherently uncertain outcomes. The sub-discipline of environmental economics which seeks to analyse such issues consequently sits on the boundaries of a range of social science and natural science disciplines. The current position in the economics profession is one in which mainstream analyses are firmly anchored to earlier neoclassical foundations (neoclassicism is explained on p. 10). Since any economics needs value judgements, and in the absence of agreed meta-ethical criteria for choosing between value judgements, it cannot be argued that neoclassical economics and its Paretian value judgements are 'worse' or 'better' than any other economic doctrine.

Particularly in its formative years (1960s), environmental economics encompassed a diversity of economic doctrines. A pluralistic view (i.e. one that recognises more than a single tradition in the development of economic thought) of the contribution that economics can make would guard against narrowness in economics, as well as fostering more interdisciplinary analytical linkages. We devote most of the chapters in this book to an analysis which expands the horizons of modern conventional economic thought. 'Alternative' economic paradigms are surveyed in this first chapter.

1.2 EARLY ECONOMIC PARADIGMS AND THE ENVIRONMENT

In order to appreciate the modern arguments (roughly over the period 1960 into the 1980s) both between economists themselves and between economists and other environmental analysts, the historical roots of environmental economics must be explored.

Figure 1.1 summarises some of the more important concepts and ideas that have influenced environmental economists and traces their origins back to past doctrines. Economic theories ought to be appraised within the context of their wider framework ('paradigm'). There is a complex interaction taking place as both scientific

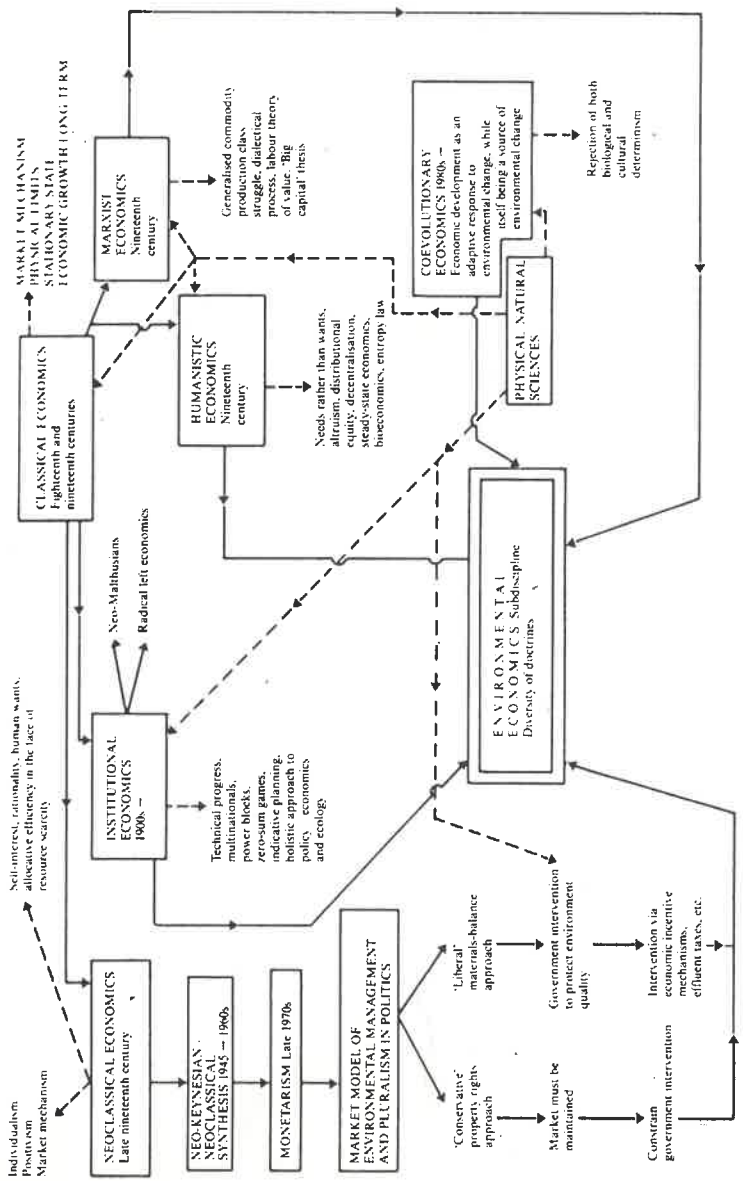


Figure 1.1 Economic paradigms and the environment. Some caveats are in order. The figure is meant to be descriptive rather than analytical. It is probably not correct to view changing economic doctrines over time in terms of Kuhnian 'scientific revolutions'. Rather it is more fruitful to think of clusters of interconnected theories or 'scientific research programmes' which compete against each other.

(natural, physical and social) theory and social order evolve. The ways in which scientific research asks its questions of the human and natural worlds it seeks to explain will at times be influenced by social, cultural and political factors. Thus attitudes toward nature and preservation/conservation will change as humanity and nature evolve.

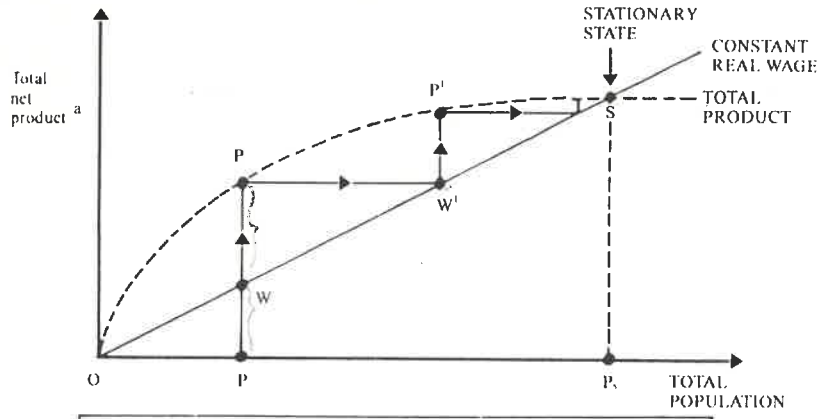
The classical economic paradigm

The classical economists left a legacy of ideas many of which are relevant to, and have been re-introduced into, contemporary environmental debates. Classical political economy stressed the power of the market to stimulate both growth and innovation, but remained essentially pessimistic about long-run growth prospects. The growth economy was thought to be merely a temporary phase between two stable equilibrium positions, with the final position representing a barren subsistence level existence – the *stationary state*.

Adam Smith (1723–1790), through what became known as the doctrine of the *invisible hand*, argued that there were circumstances in which self-interested rational behaviour by individuals could satisfy individual wants but also serve the interests of society as a whole. Governments were important only in the sense of providing 'nightwatchman' services (law and order, national defence, education). What was vital to economic and social progress was that economic transactions should be allowed to operate on the basis of freely competitive markets.

Thomas Malthus (1766–1834) and David Ricardo (1772–1823) were, like Smith, pessimistic about the prospects of long-term economic growth. They expressed their 'environmental limits thinking' in terms of the limits on the supply of good quality agricultural land and therefore diminishing returns in agricultural production. For Malthus, the fixed amount of land available (absolute scarcity limit) meant that as population grew, diminishing returns would reduce the per capita food supply. Standards of living would be forced down to subsistence level and the population would cease to grow.

In Ricardo's more complex economic model, economic growth again peters out in the long run because of a scarcity of natural resources. Diminishing returns set in not so much because of



Model assumes the entire economy operates like a giant farm producing a crop by applying homogeneous doses of capital and labour to a fixed supply of land of varying quality. With population at level OP, the wage bill = PW and farmer profits = WP, which induces investment and consequent rise in market wage rate. Population growth serves to force down wages back towards subsistence. Over time profits are squeezed W'P' etc., until all investment and growth ceases at the stationary state point, S.

[a]Total product subject to the axiom of diminishing returns minus rent accruing to non-productive landlord class; workers are paid wages, farmers gain profits and undertake productive investment. No technical progress assumed.

Figure 1.2 Ricardo's simple commodity production model. (*Source*: M. Blaug, 1978.) Simple commodity production, i.e. production for sale by independent producers in which labour power is a commodity (a measure and a source of value); but capitalist institutions and activities treated as external to the model.

absolute scarcity but because the available land varies in quality and society is forced to move on to successively less productive land. Figure 1.2 summarises the main Ricardian analytics. Note that the lack of technical progress in the model means that the total product curve (subject to diminishing returns) remains fixed. Technical innovation (e.g. artificial fertilisers, irrigation and deep drainage, etc.) would shift the total product curve upwards, increasing output per unit of input and offsetting, but not eliminating, the tendency towards diminishing returns.

John Stuart Mill (1806–1873) conceived of economic progress in terms of a race between technical change and diminishing returns in agriculture. But unlike the other classical economists he viewed the distant prospect of the stationary state with some optimism. By then, he reasoned, technical progress would have provided for much of

mankind's individualistic material wants and society would be free to pursue educational, aesthetic and other social goals.

During the nineteenth century fundamental changes in these traditional classical patterns of thought were established with Marxism, neoclassicism and humanism.

The Marxist paradigm

Karl Marx (1818–1883), adopted the *labour theory of value* from the classical economists (workers were the sole source of net economic product) and was equally pessimistic about the future standard of living for the majority of people (working class) in capitalist society. According to Marx, the classical economists had failed to place capitalist economic organisation in its historical context. He sought to formulate a generalised commodity production model which characterised commodity production as a social relationship. History was to be interpreted as a dialectical phenomenon, a process of conflicting material or economic forces out of which a synthesis, a resolution of the conflict, would emerge. Capitalist society would inevitably be beset by a class struggle (workers versus capitalist entrepreneurs) for social power. Power would be gained via control of economic resources. Marx predicted that the capitalist economic system would be faced with a falling rate of profit over time, increasing destitution for the majority working class and increased monopoly. Ultimately, the majority would overthrow the small capitalist class (existing via the exploitation of surplus value produced by workers) and seize power to create a socialist society.

Marx believed that progress was a process of natural development, inherent in human history. Progress itself was to be defined in terms of material and technological advance made possible by the exploitation ('humanising') of nature. He saw the political state as apart from nature, created as an alternative to 'natural' environment. Nature was there to be humanised via science so that inherent value could be turned into use value. But some modern Marxian writers have pointed out that Marx does emphasise the *process* of production and the fact that a viable basis for any society can only be provided if the system of production is capable of reproducing itself. There is a strong hint in this analysis that natural systems could be a limit to reproduction, as well as the economic and political make-up of society. In this sense, it can be argued that Marx took what we call

today a 'materials balance' approach to the process of production over time (see Chapter 2). In terms of modern environmental issues this reproductive economic system analysis raises questions about the sources and nature of technological change. Does such change alleviate or aggravate the environmental constraints on an economy's capacity to reproduce itself? Further, is the process of reproduction consistent with reasonably stable social systems?

According to Marxian analysis, modern capitalist economic systems fail the reproduction test, i.e. capitalist systems are not sustainable, and *one* source of non-sustainability is environmental destruction. Questions of economic power, exploitation and the dialectical process encompassing the two classes in society are at the root of an inevitable environmental despoliation process, which in turn contributes to the failure of capitalism.

More formally, a Marxian economic model would have competitive capitalists seeking 'labour-saving' innovations to increase short-run labour productivity and total surplus value. This pushes up the rate of profit and capital accumulation. However, over the long run the new technologies impose a heavy cost burden on the environment as both the toxicity and durability of waste discharges increase. Pollution generates damage costs which include human morbidity and mortality. These damage costs become 'class costs' because of their uneven social incidence. Workers both at home and at work are exposed to more than their fair share of pollution. There is then an increased requirement for worker medical care in order to maintain labour productivity. If unions demand and get better compensatory health care or shorter working hours to escape occupational health hazards, their real wages will have increased at the expense of profits and capital accumulation. A familiar Marxist confrontational situation is now inevitable in the market-based economy. Just how well centrally-planned socialist economies have dealt with environmental problems is discussed in Chapter 12.

In the international economy the exploitation process manifests itself in terms of the operations of the transnational corporations. There are structural linkages between economic development in the Northern economies and the South, and these linkages radically affect the environment in the South. Changes in the environments of the South need, according to Marxians, to be understood in terms of the international redivision of labour.

Neoclassical and humanistic paradigms

Starting around 1870, neoclassical economic thought began to be developed by analysts within the mainstream of the economics profession. The labour theory of value was abandoned and a commodity's price was seen not as a measure of its labour cost but of its scarcity. The concentration on scarcity value allowed both sides of the market to be analysed simultaneously. Analysts compared the amount of a commodity that was available (supply) with the amount required (demand). The interaction of supply and demand then determined the equilibrium market price for the commodity. The economic activity that was observed in the real world was seen as the result of the interaction between productive activity (determined by technological progress) and the preferences of individual buyers constrained by the feasible range of choice and income.

The neoclassical economists also introduced a new methodology, *marginal analysis*, i.e. the study of the relationships between small or incremental changes. This type of approach was well suited to the investigation of price determination and market structures. Consequently, the classical concern with long-term growth patterns was sidelined almost completely over the period 1870–1950.

The neoclassical theory of the market was supposed to be neutral and value-free. The basic aim had been to define a set of economic laws which governs economic activity (in much the same way as physicists had done following Newton's discoveries). Rational individuals were seen in terms of seeking to satisfy substitutable wants (or preferences) and this pursuit of individual self-interest was also believed to be improving societal welfare; thus, within the 'hard core' of the neoclassical system was a particular model of human nature – the 'rational and egotistic person'. In its modern version the model has economic person holding the preference structure of indifference and operating on the basis of constrained satisfaction (utility) maximisation. The economic (instrumental) value of marketable commodities, unpriced environmental goods and services, or sympathy for future generations, is determined according to the amount of personal utility yielded. Economic person makes trade-offs at the margin to identify positions of equal personal satisfaction. The preferences of individuals are revealed by the choices they make, and efficiency and consistency of choice reflect rational behaviour.

The criterion of social desirability is usually expressed in terms of the so-called *Pareto criterion*. A Pareto optimum situation is one in which it is impossible to make any individual better off without making someone else worse off, where 'better off' means 'more preferred' and 'worse off' means 'less preferred'. Every competitive market equilibrium is a Pareto optimum and every Pareto optimum is a competitive equilibrium, as long as a set of restrictive assumptions (e.g. perfect information, absence of externalities, etc.) hold true. The 'basic theorem of welfare economics' seeks to legitimise rational behaviour as being socially desirable and also to justify some government intervention to improve the conditions under which individuals make choices. Intervention would be especially justified whenever so-called *market failures* exist, i.e. when it is clear that markets are not maximising collective welfare. The basic neoclassical view sees government as an essentially ethical agent only intervening in the market in the public interest to ease the inevitable tension between individual rationality and collective ethics. Ethical or moral obligations are not recognised at the level of the individual.

Supporters of the minority-*humanistic paradigm* reject the 'rational economic person' model and instead adopt a behavioural psychology approach which emphasises a hierarchy of *needs* in place of a flat plane of substitutable wants. Humanistic analysts emphasise that preferences (tastes) are not static, independent, and determined by genetics (some of this critique is misplaced in that neoclassics does not say wants are genetically determined; it does not ask the question at all). Instead they are interdependent and can and do change over time because they are at least partially learned via the culture.

In the absence of a theory of how tastes are determined, how they differ between individuals and how they change over time, neoclassical theory treats tastes as 'exogenous'. Wants and needs are therefore not separable in the conventional analysis. Quite recently supporters of the 'human capital theory' movement have argued that all economic agents do hold exactly the same set of 'stable preferences'. It is then possible to interpret these particular preferences as beliefs about how to meet basic human needs. Needs cannot be traded off against each other or against market commodities without threatening survival. As we shall see later in this chapter, environmentalists would argue that 'high' levels of environmental quality are human needs.

Humanists, among others, have also been critical of the neoclassical theory of self-interested rationality. They argue that individuals are capable of truly altruistic acts and that an extended notion of rationality is required. *Extended rationality* could be analysed in terms of multiple preference rankings within a single individual – one self-interested and the other altruistic (group-interested). Moral consideration will then determine a 'meta-ranking' of alternative motivations, e.g. altruistic motives might be judged morally superior to ones based on self-interest. Individuals possess a sense of community which is reflected in a willingness to view assets as a common pool. This extended rationality also generates a strong obligation to abide by particular laws which are seen by the individual as promoting his/her meta-preferences, despite a potential tension between the law and narrow self-interest. The law is seen as personally beneficial not just because of its restrictive effects on others, but also because of its direct effects on the individual concerned. Given these sorts of assumptions the humanistic economy, especially in its transition phase, would be subject to central planning and direction. The government's role would not be restricted merely to correcting market failures.

The humanistic economics viewpoint would not seek to abolish the market mechanism but would seek to restrain and supplement it to a significant degree. In order to facilitate greater social system stability over the long term, increased government intervention would be required in order both to decentralise economic activity and to promote a more deliberately egalitarian distribution of income.

1.3 POST-WAR ECONOMICS AND THE RISE OF ENVIRONMENTALISM

Neoclassical economics contained the basic assumption that the economy had an in-built tendency to operate at an overall level of activity fixed by the full employment of labour. Full employment would be the norm because of the further assumption of flexible wage rates: wages would simply vary up or down until full employment is achieved. The experiences of the inter-war years (1920s and 1930s), when mass unemployment became the norm, led to the formulation of Keynesian economics with its emphasis on government intervention and deficit spending. Thus during the 1950s economic

growth got back onto both the economic and political agendas. Economic growth driven by technical innovation appeared to offer limitless progress.

During the 1960s environmental pollution intensified and became more widespread. Environmental awareness was consequently heightened in some sections of industrialised societies, spawning new environmental ideologies. A number of these ideologies were basically anti-economic growth.

These events caused economists to look afresh at a central economic idea: resource scarcity in relation to possible uses. Between 1870 and 1970, mainstream economists (with some notable exceptions) appeared to believe that economic growth was sustainable indefinitely. After 1970 a majority of economists continued to argue that economic growth remained both feasible (a growing economy need not run out of natural resources) and desirable (economic growth need not reduce the overall quality of life). What was required, however, was an efficiently functioning price system. Such a system was capable of accommodating higher levels of economic activity while still preserving an acceptable level of ambient environmental quality. The 'depletion effect' of resource exhaustion would be countered by technical change (including recycling) and substitutions which would augment the quality of labour and capital, and allow for, among other things, the continued extraction of lower quality non-renewable resources.

Since 1970 a number of 'world views' has crystallised within environmentalism, providing the background to the emerging environmental economics sub-discipline. Four basic world views can be distinguished, ranging from support for a market and technology-driven growth process which is environmentally damaging, through a position favouring managed resource conservation and growth, to 'eco-preservationist' positions which explicity reject economic growth. Figure 1.3 outlines some of the main features of these different positions and a further discussion is presented in Chapter 15.

It was against this backdrop of emerging environmental ideologies that environmental economics became established as a sub-discipline. Its development within the economics profession was in one sense a reaction to the prevailing conventional paradigm. A minority of revisionists wished to alter the 'hard core' of the conventional economic research programme, in order to speed up the

evolution of economics towards a paradigm that was 'relevant' to the coming zero-growth society. Others merely saw an opportunity to accommodate better the environmental systems implications of the growth economy and society within a modified, but not radically different, set of economic models. The majority mainstream view

TECHNOCENTRIC		ECOCENTRIC	
Extreme 'Cornucopian'	'Accommodating'	'Communalist'	'Deep Ecology'
Resource exploitative, growth-orientated position	Resource conservationist and 'managerial' position	Resource preservationist position	Extreme preservationist position
Economic growth ethic in material value terms Maximise Gross National Product	Infinite subsitution is not thought realistic but sustainable growth is a practicable option as long as certain resource management rules (e.g. for renewable resource sustainable yield management) are followed	Pre-emptive macro-environmental constraints on economic growth are required, because of physical and social limits	Minimum 'resource-take' socio-economic system (e.g. based on organic agriculture and de-industrialisation)
It is taken as axiomatic that unfettered market mechanisms or central planning (depending on the ruling political ideology) in conjunction with technological innovation will ensure infinite substitution possibilities capable of mitigating long-run physical resource scarcity		Decentralised socio-economic system is necessary for sustainability	Acceptance of bioethics (i.e. non-conventional ethical thinking which confers moral rights or interests on non-human species)
Instrumental value (i.e. of recognised value to humans) in nature	Instrumental value in nature	Instrumental and intrinsic value in nature (i.e. valuable in its own right regardless of human experience)	Intrinsic value in nature

Figure 1.3 Environmental ideologies. (*Source*: adapted from O'Riordan and Turner, 1983.)

remained optimistic about future growth prospects, with 'Ricardian scarcity' being offset by technology and compensatory market processes (see Chapter 19).

From outside economics, *ecocentrists* tried to bring to the forefront of public debate profound questions relating to the 'acceptability' of conventional growth objectives, strategies and policies. The influential Meadows Report (Meadows *et al.*, 1972) adopted a distinctive Malthusian position which implied that environmental protection policies and the promotion of economic growth objectives were incompatible (i.e. that long-run economic growth objectives were not feasible). This line of thinking led eventually to calls for steady-state (zero growth) economies, and even more radical bio-economic communities based on organic agriculture which in some people's minds ought to be guided by the ethical principles of 'deep ecology' (see Figure 1.3).

The anti-growth argument was buttressed by economic analyses which sought to highlight the social costs, especially the environmental costs, of living in a 'growth society' (i.e. desirability of economic growth and social system stability). Easterlin's 'paradox' (i.e. survey data indicating that material affluence and human happiness were not closely correlated), Hirsch's 'positional goods' concept (i.e. that the enjoyment of a range of commodities is necessarily restricted to a small group of high income earners, despite the illusion given that all sections of society might one day participate in such consumption), and Scitovsky's 'joyless economy' analysis (again emphasising human need for more than mere material affluence) are representative of 'social limits' thinking (Boskin, 1979; Hirsch, 1977; Scitovsky, 1976).

1.4 INSTITUTIONAL ECONOMICS PARADIGM

This minority economic doctrine began to emerge around the beginning of the twentieth century, although it has remained a somewhat diverse collection of views. Institutionalists have adopted what they call a 'processual paradigm' which encompasses the concept of the economy as a dynamic process. Their explanation of socio-economic change is one based on *cultural determinism*. Culture is an on-going complex of ideas, attitudes and beliefs that is absorbed by individuals ('cultural person' not 'rational economic

person') in a habitual manner through institutional arrangements. Special significance is attached to scientific and technological change as factors that provide for dynamic change in the structure and functioning of the economic system.

Individual preferences are *learned* preferences which change over time and any one individual will hold both private and public preferences. The latter are thought to be important and justify an active public sector in the economy, and some analysts go as far as advocating indicative planning. Environmental problems are judged to be an inevitable result of economic growth in advanced industrial economies. Institutionalists have long accepted an approach which encompasses the notion of social costs of pollution and stresses the importance of the ecological foundations of any economic system. State intervention is required to control, as far as possible, the activities of transnational corporations and also to mediate between the interest groups (power blocks) that have emerged in modern economies. Institutionalists remain divided over the extent of intervention required in order to reach a social consensus. Some 'neo-Malthusians' believe that only an authoritarian system would be capable of bringing about the necessary changes to protect the environment, while others put their faith in decentralised socialist systems.

1.5 THE MARKET MODEL OF ENVIRONMENTAL MANAGEMENT: PROPERTY RIGHTS PARADIGM VERSUS MATERIALS BALANCE ANALYSIS

The conventional approach has generated two variants of an environmental resource management model, one more revisionist than the other in terms of the required modifications to the neoclassical blueprint. These approaches are the property rights approach and the materials balance approach.

The property rights approach

Some analysts at first maintained that pollution cost problems were non-pervasive and could be adequately mitigated via a process of re-defining the existing structure of property rights. A particular interpretation of the 'Coase theorem' (Coase, 1960) was used as the

theoretical basis for this non-interventionist pollution control policy (see Chapter 5). According to Coase, given certain assumptions the most efficient solution to pollution damage situations is a bargaining process between polluter and sufferer. Each could compensate the other according to who possesses property rights: if the polluter has the right, the sufferer can 'compensate' him *not* to pollute; if the sufferer has the right, the polluter can compensate him to tolerate damage.

The non-revisionist 'property rights paradigm' approach to environmental economics has become more sophisticated. Key neoclassical assumptions about human behaviour in the marketplace (i.e. self-interested utility maximisation) have been extended to cover the activities of bureaucrats in the public sector (drawing on public choice economics literature) and notions of extended rationality (i.e. the possession of motivation other than self-interest alone) have been resisted.

Sociobiological explanations for 'rational economic man' have also been advanced. Self-interested behaviour, it is argued, is genetically programmed into humans and is therefore inevitable. At the level of the individual, economic person is still seen as making trade-offs at the margin to identify positions of equal satisfaction. The idea of 'rational ignorance' has, however, been added to the model, i.e. it is rational for individuals to obtain less than complete information before making a decision, because information is scarce and something must be given up – time, effort or money – to obtain more of it. Exactly how much information is rationally required is not specified.

It is argued that in an economy with well-defined and transferable property rights, individuals and firms have every incentive to use natural resources as efficiently as possible. Markets and prices emerge from collective economic behaviour provided exclusion is possible – i.e. any individual consuming a good can exclude other individuals from consuming the same good – and property rights exist. Environmental pollution is a form of market failure, usually because of the over-exploitation of resources held as common property or not owned at all. The market fails therefore when property rights are inadequately specified or are not controlled by those who can benefit personally by putting the resources to their most highly valued use.

According to the property rights approach, increased government

intervention should be resisted because public ownership of many natural resources lies at the root of resource control conflicts: there is 'government failure'. It is assumed that the theory of the public sector should be based on the same motivational assumptions (self-interest) employed in the analysis of private individual behaviour. Thus the decision-maker will seek to maximise his own utility, not that of some institution or state, in whatever situation he finds himself. The public sector, it is argued, provides no incentives for politicians or bureaucrats to resist pressures from special interest groups. Gains to such groups often come only at a net cost to society.

The misallocation of environmental resources is not, therefore, just a question of market failure. A range of government intervention policies have themselves been the cause of environmental disruption (government failures). For example, non-integrative government policy and inefficient government intervention have resulted in 'created' land-use conflicts in wetland ecosystems and consequent sub-optimal wetland protection levels in industrialised and developing countries.

The fundamental organising concepts employed in economics and biology are strikingly similar. Some have, therefore, been tempted to claim that there is empirical proof (sociobiological evidence) of the existence of selfish economic person and of the 'optimality' of the competitive market system in a world of scarce resources. The sociobiologists interpret the findings of molecular biology as saying that human nature is fixed by our genes and the characteristics of individuals are a consequence of their biology. The Darwinian evolutionary process encourages the view that human society as well as the rest of nature progresses by the survival of the fittest in a competitive struggle. So genetically-based general forms of social organisation have been established by natural selection during the course of evolution. It is arguable then that 'selfish gene'-dominated humans (economic person) and their social organisation (the market) are a consequence of natural selection for traits that maximise reproductive fitness. For some, the competitive market process therefore represents a Darwinian process of survival. It produces exactly the same results that would ensue if all firms maximised their profits, and all consumers maximised their utility. Competitive rivalry guarantees that we will only observe survivors who actually maximise profits, and all that matters for the theory is whether it correctly predicts this outcome. It would seem that the genetically-determined competitive market is a product of natural selection and therefore must be in some sense optimal or adaptive.

The merits of this biological determinist belief will be critically examined further when sustainable development is discussed (p. 23). But there is an apparent circularity in the sociobiology/economic synthesis argument. The sociobiologists have incorporated some economic concepts such as cost-benefit analysis and game theory into their world view. It is this world view which is then cited by some economists as a justification for the continued existence of a certain social organisation.

Overall, property rights paradigm supporters would probably concede that markets are imperfect but equally they would emphasise that their failings do not automatically imply that collective action is superior. The market mechanism is then judged to be superior to any other practical alternative. Any further relinquishing of private rights and the rule of willing consent in favour of collective action will create rather than resolve environmental problems.

The materials balance approach

Revisionists have sought to incorporate materials balance models and to a more limited extent entropy limits into economic analysis (these issues are explored in detail in Chapter 2). While pollution is seen as a symptom of market failure, it is also recognised that it is a pervasive and inevitable phenomenon (because of the laws of thermodynamics) requiring government intervention via a package of regulatory and incentive instruments.

In principle, an economic optimum (efficient) level of pollution can be defined, given certain simplifying assumptions. It is that level of pollution at which the marginal net private benefits of the polluting firm are just equal to the marginal external damage costs (see Chapter 4). Because of data deficiencies and the limitations of this static approach, the optimum situation is not a practicable policy objective. Instead society sets 'acceptable' levels of ambient environmental quality, and policy instruments are directed at these standards. The analytical task is to seek out the least-cost policy package sufficient to meet acceptable ambient quality standards. Many economists favour the use of effluent taxes (per unit of pollution) but actual pollution control policy has been based on a

regulatory approach often involving uniform reductions in pollution emissions across classes of industry (see Chapter 6). Because of the uncertainties involved, pollution control policy should be seen as an iterative search process based on a 'satisfising' (extended rationality) rather than an optimising principle. Pollution control instruments and policy are examined in Chapters 5, 6, 7, 8, 11 and 12.

1.6 POLICY ANALYSIS: FIXED STANDARD VERSUS COST-BENEFIT FRAMEWORK

In the face of the complexity of ecological interdependence and uncertainties surrounding resource management, two alternative approaches have been suggested. Some analysts have argued for the adoption of a *cost–benefit framework*, utilising monetary valuations but also incorporating explicit recognition of uncertainty and irreversibilities. Others urge the adoption of a *fixed standard approach*, either in selected cases or as a way of implementing a general 'macroenvironmental policy'. Macroenvironmental standards could encompass land-use zoning policy, ambient environmental quality standards for air and water, etc. In this form, such standards would operate as binding constraints and, although perhaps flexible over time (as knowledge increases), would limit the scope of cost–benefit analysis to cost effectiveness analysis.

In the policy-making context, the acceptance of the axiom of infinite substitutability, positive rates of discount and a belief in long-term ecosystem resilience capacities, would mitigate against any radical restructuring of economic growth or resource pricing policies. Revisionists, on the other hand, would caution against such optimism. The principle of infinite substitution would be rejected and a conservationist position advocated. It is now clear that in a number of developing economies severe ecosystem losses have accumulated in a matter of decades. Global pollution issues – climate warming, ozone depletion, ocean contamination – threaten more widescale problems for the future, while acid rain has generated regionally localised damage to ecosystems. Neglect of sustainability constraints could also result in irreversibility over a wide front for future generations in both developed and developing economies. The presence of irreversibility (e.g. permanent loss of unique wilderness areas and other valuable environmental resources, wetlands,

productive soils, etc.) almost always favours postponement of the development options and support for resource conservation/preservation options (see Chapters 20 and 21). A safety-margin approach (for example, based on the concept of the 'safe maximum standard') to policy has been recommended in this context (see Chapter 20).

Another related idea, the 'shadow project' approach, has also been suggested in cases where locally irreversible environmental losses are likely because of economic development. The costs of the development scheme responsible for these losses (such as the destruction of a particularly valuable wetland) should be increased by an amount sufficient to fund a 'shadow' project designed to substitute for the lost environmental asset. It may be possible, for example, to restore a partly degraded wetland somewhere else in the region under consideration. We expand on these ideas in Chapter 14.

Radical re-interpretations of the cost–benefit analysis (CBA) method and technique are also thought necessary. Supporters of extended CBA have adopted a 'value sensitivity' approach and have sought to incorporate non-efficiency decision criteria into their analysis. It is argued that actual decision-makers require rational advice on both their objectives (or more strictly the implications of different objectives) and on the means to achieve these objectives. In any case, the 'positivist' attack against extended CBA is based on the curious argument that the standard value judgements that underlie the concept of a Pareto optimum (and standard CBA) command wide assent and this consensus renders them 'objective'. More convincingly, multi-criteria analysis does undoubtedly involve a trade-off of greater comprehensiveness against loss of precision. The appraisal of environmental policies that involve substantial risks and costs for future generations has also led some analysts to consider the implications of alternative systems of ethics. We survey the environmental ethics debate in Chapter 15.

1.7 ECONOMIC AND ENVIRONMENTAL VALUES

There are various interpretations of the term 'value', but economists have concentrated on monetary value as expressed via individual consumer preferences. On this basis, value only occurs because of the interaction between a subject and an object and, in terms of this

explanation, is not an intrinsic quality of anything. A given object can then have a number of assigned values because of differences in the perception of held values of human valuators and different valuation contexts. Economic assigned values are expressed in terms of individual willingness to pay (WTP) and willingness to accept compensation (WTA) (see p. 125).

The environmental literature has identified three basic value relationships which seem to underlie the policy and ethics adopted in society: values expressed via individual preferences; public preference value which finds expression via social norms; and functional physical ecosystem value. Some writers argue that economic value measures are context-specific, assigned values and may therefore be inappropriate as the *sole* value measures for public resource allocation. Ecocentric ideologies seek to base policy on social norms that individuals accept as members of a community (public preferences) and that are operationalised via 'social' legislation. Deep ecology advocates place primary emphasis on a distinction between instrumental value (expressed via human-held values) and intrinsic, non-preference-related value. They lay particular stress on the argument that functions and potentials of ecosystems themselves are a rich source of intrinsic value. This value would, it is argued, exist even if humans and their experiences were extinct. Some of these issues will be examined in Chapter 15, but for now we merely raise the possibility that the intrinsic value and object–subject value distinction is not clear-cut. Humans may capture part of the intrinsic value in their preferences, e.g. valuing 'on behalf of' other species. Economists use the term 'existence value' to encompass these notions.

Economic research into the monetary valuation of environmental commodities is still in a state of flux, although considerable progress has been made. In the absence of a demand curve and market price for many environmental commodities, a number of non-market methods for estimating value has been devised. For value data collection techniques – travel cost method, participation/unit day value method, hedonic pricing and contingent valuation – have been extensively tested. A growing literature has suggested that non-use values (bequest and existence values) and option value should be counted as part of the total economic value of the natural resource. We analyse the concept of total economic value and valuation methods in Chapters 9 and 10.

1.8 SUSTAINABLE ECONOMIC GROWTH AND DEVELOPMENT

The re-birth of environmentalism in the 1960s was confined to the industrialised countries of the North. In the developing countries of the South, environmental policies, over and above a concern for basic necessities, were regarded as unaffordable luxuries. It was not until 1972, with the Stockholm Conference on the Human Environment, that a milestone was reached in the development of international environmental policy. It resulted in the establishment of the United Nations Environment Programme and the creation of national environmental protection agencies in the economies of the North. In the years that followed, developing countries, while pressing for the establishment of a new 'International Economic Order', also came to realise that the health of the environment should concern them as much as it did the industrialised countries.

In 1980, the US *Global 200 Report* (Barney, 1980) appeared to confirm environmental prophesies about the consequences of the neglect of the global 'common interest' and the over-exploitation of open-access resources. But in a re-run of the original *Limits to Growth* debate based around the Meadows report, *Global 2000* stimulated a 'cornucopian technocentrist' backlash and the publication of *The Resourceful Earth* report in 1984 (Simon and Kahn, 1984).

The rejection of the physical limits to growth thesis, the appropriate role of market forces in the development process, the role of poverty in natural resource degradation and the need to recognise and build on common interests, are all themes that reappear in highlighted form in reports such as *Our Common Future* (WCED, 1987) and *The Global Possible* (Repetto, 1985). In these documents it is accepted, in principle, that the world's resources are sufficient to meet long-term human needs. The critical issues under debate, therefore, concern the uneven spatial distribution of population relative to natural carrying capacities, together with the extent and degree of inefficient and irrational uses of natural resources.

The 1980s have also seen a re-orientation of some environmental thinking. The term *sustainability* has appeared in a range of contexts and probably most prominently in the *World Conservation Strategy* (IUCN, 1980). Underlying some sustainability thinking is an

increased recognition that knowledge accumulated in the natural sciences ought to be applied to economic processes. For instance, the scale and rate of throughput (matter and energy) passing through the economic system is subject to an entropy constraint. Intervention is required because the market by itself is unable to reflect accurately this constraint. Modern economics lacks what we call an *existence theorem*: a guarantee that any economic optimum is associated with a stable ecological equilibrium (see Chapter 2). The Pareto optimality of allocation, for example, is independent of whether or not the scale of physical throughput is ecologically sustainable. There is a risk that some 'ecologically relevant' externality situations may involve damage to the ecosystem itself. Such externalities can cause false signals to regulatory authorities in such a way that sustainability conditions are not fulfilled.

A working definition of sustainable development might be as follows: it involves maximising the net benefits of economic development, subject to maintaining the services and quality of natural resources over time. Economic development is broadly construed to include not just increases in real per capita incomes but also other elements in social welfare. Development will necessarily involve structural change within the economy and in society. Maintaining the services and quality of the stock of resources over time implies, as far as is practicable, acceptance of the following rules:

(a) Utilise renewable resources at rates less than or equal to the natural rate at which they can regenerate.
(b) Optimise the efficiency with which non-renewable resources are used, subject to substitutability between resources and technological progress.

Economic development and natural resource maintenance are related in the following two broad ways:

1. Up to some level of resource base utilisation there is likely to be a trade-off between development and the services of the resource base (complementary relationship).
2. Beyond this level, economic development is likely to involve reductions in one or more of the functions of natural environments – as inputs to economic production, a waste assimilation service and recreation/amenity provision. In this trade-off context, the multifunctionality of natural resources is a critical concept. We analyse sustainability more formally in Chapter 3.

1.9 ECOLOGICAL AND CO-EVOLUTIONARY ECONOMIC PARADIGM

Thinkers within this paradigm (Norgaard, 1984) have seriously questioned the validity of either biological determinism or cultural determinism as explanations of development and change. Reality is more complex and dynamic. There is a constant and active interaction of the organism with its environment. Organisms (especially humans) do not merely receive a given environment but actively seek alternatives or change what they find. Organisms are not simply the results but are also the causes of their own environments.

Economic development can therefore be viewed as a process of adaptation to a changing environment, while itself being a source of environmental change. From this perspective there are three distinct sources of change – the breakdown of ecological equilibrium (i.e. any combination of a method and a rate of resource use which the environment can sustain for long periods), the demands of technical consistency, and the development of new forms of need as the real costs of living are changed – none of these alone explain all change. Development is then a process of moving through a succession of ecological niches. Niche occupancy is variable, and a niche may be destroyed by means external to a society's own development process.

Over time the development process results in an increasing level of environmental exploitation. The available stock of low entropy is diminished by resource extraction and waste generation. Economic production systems become more roundabout and complex as development proceeds. Work done by natural scientists on dissipative structures is relevant to the management of complex systems. Again it appears that the evolution of such systems is neither entirely deterministic nor entirely stochastic, but a subtle mixture of both.

The *co-evolutionary perspective* has been designed to provide a link between ecological and economic analysis. Co-evolution refers to any on-going feedback process between two evolving systems.

During co-evolution, energy surpluses are generated within systems, and these are then available for stimulating new interactions between systems. If the interactions prove favourable to society the development process continues. But co-evolutionary development feedback systems frequently shift from the ecosystem to the sociosystem, i.e. production systems become more roundabout and complex and environmental exploitation increases. Since learning, knowledge and evolution are interrelated, additional co-evolutionary development potential remains untapped. However, the magnitude and extent of this development potential, which will determine how tolerable survival will be, remain uncertain.

The physical limits to growth are manifestations of the increasing complexity of the productive system. Individual subsistence requirements depend on the technology and culture of contemporary society. As complexity in the social system increases so do subsistence requirements. Preferences change because the context in which individuals learn their preferences is changed by development. This explains the 'Easterlin paradox' (i.e. survey data indicating no close correlation between material affluence and human happiness), along with explanations couched in terms of the interdependency of preferences (relative income hypothesis) and 'positional goods'. Steady-state models can be seen to be advocating the deliberate selection of a new niche of a particular kind, one which is thought would offer the prospect of prolonged occupancy (sustainability).

Some advocates of the need for more sustainable economic development strategies call for more government intervention in order to impose, for example, increasingly stringent environmental quality protection regulations. They also argue, as we have seen, that the Pareto optimality is independent of whether or not the scale of physical throughput in the economy is ecologically sustainable. But this intervention view also requires the acceptance of some global moral operative about survival, because there is the possibility that otherwise we may well be trading off survival at a lower 'quality' of life against a shorter time horizon with a higher 'quality' of life.

1.10 CONCLUSIONS

A brief overview of alternative ways of thinking about natural environments can do no more than touch on salient issues. Three in particular stand out.

First, while economists typically acknowledge the fact that there are several varied objectives possessed by individuals and by societies generally, they tend to work with only one – economic efficiency. One possibly powerful reason for this is that it may well dominate in many of the contexts that economists have typically analysed – markets in goods and services, for example. Translating that objective to the supply and demand for non-marketed goods, which is the typical context for environmental assets, permits the application of the economist's tools of the trade – optimising, marginal analysis and so on. But it may well be that finding the economically 'optimal' provision of environmental assets is not the dominant concern of individuals or societies. Issues such as fairness of access to those assets, both within a time period and over time, could be of equal and possibly greater significance. Similarly, uncertainty about the role which natural environments play in providing for the quality of our lives, and even for its very existence, might make us wary of engaging in a standard comparison of costs and benefits. Making allowance for the different objectives that people have with respect to environments could therefore alter the perspective that neoclassical economics places on those environments.

Second, some alternative views raise the issue of whether preference-based systems are relevant *at all* to the analysis of environmental issues. If habitats and their non-human occupants have some form of 'intrinsic' value, unrelated to the *act* of preferring or dispreferring by humans, then we face the problem of how to account for those values. That is, we may have values that are *of* people *for* a given environmental asset, and values that somehow reside *in* that environment and that are not *of* people. The extent to which this distinction poses a real problem depends on several factors. One is the extent to which people actually do capture some of this intrinsic value by expressing preference *on behalf* of species and habitats – we raise this issue again on p. 134 when we discuss existence value. If this is a feature of human preference expression, then the distinction between intrinsic and subject–object values may well remain valid but not be of great importance for real-world decisions. Another problem is the extent to which any prescription for social action can be based on 'rights' not possessed by humans. An animal rights campaigner would have no difficulty in affirming that human action should be guided in part by the rights of non-human beings. Others

would query whether it makes sense to speak of 'rights' outside of the province of human attributes.

Third, much of the literature that questions the role of economic analysis and the environment does so, we believe, because it is not convinced that economics has come to terms with ecological conditions for sustainability. Put another way, economics does not appear to have an 'existence theorem' which enables us to be sure that whatever economy we devise will be sustainable ecologically. The only way to be sure of this sustainability is to ensure that economic models have sustainability conditions built into them. Beliefs about what would happen if we did this have clearly varied markedly over time. The 'limits to growth' school of thought would argue that such an extended economic–ecological model would show that economic growth, as traditionally understood, would not be sustainable. Others would argue that growth may be perfectly feasible but that the configuration of growth, the way in which it is achieved, would differ from the patterns we observe today. As an example, it might be growth based more on the sustainable use of renewable natural resources and less on exploitative use of exhaustible resources. But it might also be a 'hi-tech' economy in which growth is based on very low resource inputs and high technical progress: the *presumption* in much of the literature that an ecologically constrained economy is a low growth, austerity economy need not be true at all.

Our belief is that only by improving substantially our understanding of economy–environment interactions will we get a better grasp of these wider issues.

2 · THE CIRCULAR ECONOMY

2.1 NARROW AND HOLISTIC VIEWS OF ECONOMIES AND ENVIRONMENTS

Undergraduate economics textbooks now pay some attention to issues of environmental economics. But, typically, this attention is confined to supplying an 'add on' chapter illustrating how the theory in the rest of the book can be applied to environmental issues. The danger in this approach is that it obscures the fundamental ways in which the consideration of environmental matters affects our economic thinking.

Figure 2.1 shows a stylised picture of economy and environment interactions. At this stage, the diagram is deliberately vague – we make it more meaningful on p. 35. The upper square, or 'matrix', shows the economy. We consider shortly what might enter into this matrix, but the point for the moment is that economics textbooks are primarily concerned with that matrix only. For example, economics will be concerned with the way in which the various component parts of the economy interact – how consumer demand affects steel output, how the production of automobiles affects the demand for steel, how the overall size of the economy can be expanded, and so on. The lower square shows the environment. This consists of all *in situ* resources – energy sources, fisheries, land, the capacity of the environment to assimilate waste products, and so on. Clearly, there are interactions *within* this matrix as well. Water supply affects fisheries, forests affect water supply and soil quality, the supply of prey affects the number of predators, and so on. Just as within the economy matrix the relationships studied are between economic entities, so within the environment matrix the entities studied appear