Chapter 4

ECONOMICS-BASED APPROACHES[1]

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4.1 Introduction

Sustainability assessment has been employed by economists to assess the performance of an economy by adjusting standard economic indicators such as Gross National Product (GNP). It is also used to assess the consequences of policy at both national and international level and to examine the full costs and benefits of projects. This chapter examines economic approaches to assessing sustainability. First, we consider how economists define sustainability, as this heavily influences their approach to assessment. An important distinction is made between economic sustainability and how economists approach the broader concept of sustainability. We then discuss how economists estimate sustainability impacts in different situations, in particular the modelling of relationships between economic, environmental and social variables. Finally, we review the economic tools available to evaluate and compare economic, environmental and social impacts and to overcome the problem of different units of measurement.

4.2 Economic definitions of sustainability and economic sustainability

4.2.1 The term 'sustainability'

Sustainability and sustainable development are often used interchangeably by economists, or the former is considered to be a pre-requisite for the achievement of the latter. Common to both is an emphasis on the future and the maintenance of performance or improvements over time.

Economists use the term sustainability three main ways:

- First, to refer to the durability of purely economic performance variables without necessarily considering broader social and environmental impacts. Sometimes, in referring to economic variables such a growth, a distinction is made between "sustained" and a broader concept "sustainable" which addresses social and environmental dimensions as well. However, economists often use both terms interchangeably in the narrow sense.

- Second, economic sustainability is sometimes distinguished from social sustainability and environmental sustainability as one dimension of sustainable development which needs to be traded off against the other two dimensions. In some respects, this is little different from the interpretation in first bullet – the main difference is the explicit acknowledgement of the importance of the other dimensions and the inter-relationship between them.

- Third, to refer to the durability of human welfare levels – the extent to which this integrates environmental and social issues depends on how welfare is defined or is thought to be determined.

[1] Sections 4.1 – 4.5 were prepared by Maryanne Grieg-Gran and Annie Dufey, IIED.

Economic sustainability in a narrow sense

The term 'sustainability' is frequently used by economists or financial institutions in a narrow sense to imply viability or durability over time. Often, the question being addressed is whether economic growth and other economic performance indicators can be maintained or whether public expenditure can continue at current levels. The IMF carries out assessments of debt sustainability defined as the ability for a country to service its debt without an unrealistically large future correction in the balance of income and expenditure (IMF and IDA 2004) (see section 4.7). It also uses the term fiscal sustainability, defined by Yamauchi (2004) as a situation where the "present value of the budget constraint is satisfied without a major and abrupt correction having to be made in the balance of income and expenditure to avoid solvency and liquidity problems". The information used to assess such sustainability is primarily economic. In the case of debt sustainability, it is necessary to make projections of the flows of revenues and expenditures as well as exchange rate changes, i.e. economic variables. While these projections often incorporate judgements about what adjustment is feasible, politically or socially, the emphasis is on economic variables. For this reason, this type of approach to sustainability is not explored further in this chapter.

Economic sustainability as a dimension of sustainable development

Barbier (1987) provides an early articulation of the second type of approach, stating that "this process can be viewed as an interaction between three systems: the biological and resource system, the economic system, and the social system. The general objective is to maximise the goals across all these systems through a dynamic and adaptive process of tradeoffs". Barbier further argued that "making explicit the types of trade-offs involved is a vital function that economics can provide in applied sustainability research". This approach has since been widely adopted in a range of contexts including subsequent research projects such as "Towards a Sustainable Paper Cycle" (IIED, 1996), but with different definitions of system goals. Barbier (1987) considered that economic system goals would include: satisfying basic needs (reducing poverty); enhancing equity; and increasing useful goods and services. Others have since given more emphasis to the third of these goals and considered the first two to correspond to the social system. In the context of forestry, for example, the Forest Stewardship Council (FSC) defines responsible forestry[2] as economically viable, socially acceptable and environmentally appropriate, acknowledging the need to ensure that forest enterprises are not forced out of existence altogether by the requirement to address environmental and social concerns. Similarly, the triple bottom line concept used by some companies (see Chapter 8) emphasises the need for profitability and commercial viability alongside the achievement of environmental and social performance goals. Many people outside the economics profession have been less willing to entertain the concept of trade-off between the different dimensions of development and have given more emphasis to the win-win opportunities.

The operationalisation of this approach varies considerably. Most commonly, the impacts in each of the three systems have been addressed separately because of the difficulties involved in integration, and possibly due to the lack of credibility of attempts at such integration. This often reflects ways of working, as researchers from each discipline tend to work separately on their own part of the analysis. Where there has been attempt to examine the three dimensions of sustainability in an integrated manner, there has been some convergence with the third approach to sustainability (see next sub-section). Reed (1996) stresses these three dimensions, but also states that economic sustainability requires "internalising all costs, including the

[2] The FSC does not use the term sustainable forest management but its concept of responsible forestry equates to what other organisations call sustainable.

societal and environmental costs associated with the production and disposition of goods, thereby implementing the full cost principle".

Sustainability as non-declining human welfare

The third type of approach is the major focus of this chapter. Following Pezzey (1989), economists commonly conceive sustainable development and sustainability as the maintenance of a non-declining level of social welfare over time. This is consistent with the definition of sustainable development given by the Brundtland Commission: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED 1987).

Important in this approach is the treatment of social welfare and what it covers. A commonly cited definition of sustainable development is that of Solow (cited by Sen, 2004). This requires that the next generation must be left with whatever it takes to achieve a standard of living at least as good as that enjoyed by the present generation and, at the same time, the next generation must be similarly well looked after. In this defintion, much hinges on what is meant by living standards. In a recent article, Sen (2004) praises Solow's definition for addressing the time frame issue by making a link between each generation and the next, but questions whether the concept of living standards is sufficiently inclusive. He argues that the reasons for valuing particular opportunities need not always lie in their contribution to living standards, citing, as examples, the preservation of animal species for their intrinsic or existence values. Equally, it can be argued that society's willingness to preserve certain animal species reflects a belief that this contributes to quality of life.

4.2.1 Types of capital

The maintenance of living standards or quality of life requires the constant or increasing per capita production of goods and services, implying, in turn, the maintenance of the capital base (Pearce *et al*,. 1996) – capital is essentially a stock of assets that yields a flow of benefits. Traditionally, economics has focused on the produced capital base since this was considered the primary generator of growth. A central concern underlying the analysis of national accounts (Bartelmus 1997) is the relation between income and capital and the need to ensure that increases in consumption do not reduce the capital base. The innovation brought about by the focus on sustainability was to consider other types of capital - natural, human and social, amongst others - as important for the maintenance of human well-being.

Natural capital - weak and strong sustainability

Economists have given considerable emphasis to the implications of including natural capital in the requirement for maintenance of the capital base. Two lines of thinking can be distinguished: weak sustainability and strong sustainability (Pearce *et al.* 1996) (see also section 3.2.1). Both start from the view that the price system alone will be not be capable of ensuring that capital stocks are maintained, but emphasise different reasons for this.

Those who focus on weak sustainability (typically environmental economists) are optimistic about the ability of produced capital to substitute for natural capital. Some natural capital can be lost without affecting sustainability provided that produced capital is increased as a result and the overall capital base remains at the same level *(ibid*). Left to itself, the market will not ensure that this substitution takes place fully. This is because of information failures, divergences between private and social rates of time preference, and the fact that many components of natural capital are not marketed.

Those who focus on strong sustainability (typically ecological economists) also emphasise these failures in the market system. But their concerns are centred on the limits to substitution. They believe that there is less scope for substitution between natural capital and other types of capital and that there are limits to the extent to which natural capital can be used. Thus, if natural capital is allowed to fall below certain critical levels, it is believed there could be catastrophic consequences.

Proponents of strong sustainability highlight the irreversibility of natural assets (unlike produced capital, they cannot be destroyed and created again). They also focus on the uncertainty associated with ecological systems and the consequences of human interventions, and the likelihood of damage increasing more than in proportion to scale (unclear). They argue, therefore, that sustainability requires the conservation of critical elements of natural capital *(ibid)*. Monetary measures of natural capital are considered by the proponents of strong sustainability to be misleading. So attempts to operationalise this conservation criterion have focused on biophysical measures of carrying capacity and resilience. Wackernagel and Rees (1999), for example, argue that marginal prices for nature's services and resource commodities do not reflect biophysical scarcity, increasing marginal risk with scarcity, factor complementarity, or unaccounted service flows. Ultimately, value judgements are needed about which components of natural capital need to be preserved and to what levels.

Norton (2002) expresses the view that an adequate and appropriate definition of natural capital cannot be provided. In an attempt to define a constant natural capital rule for an area in Scotland, MacDonald *et al.*(1999) reach a similar conclusion: " it appears that the conceptual difficulties of determining critical elements are as much of an obstacle to operationalising a constant critical natural capital rule as are data inadequacies". One of the problems they identify is determining the degree of disaggregation of natural capital categories to be kept intact. They also point out that there may be conflicts between different elements of natural capital.

Other types of capital

Attention has also been given to including the maintenance of other types of capital in the criteria for sustainability, but similar issues of definition arise. For example, Harrison (1993) raises the issue of whether recreational education expenditure should be considered as capital or as consumption since it is unlikely to contribute to production. Social capital is particularly tricky since there is not consensus yet on proxy indicators for its measurement (Grootaert and van Bastelaer, 2002). Moreover, not all economists agree that social capital should be included as a type of capital. Dasgupta (2002) and Mäler (2003) both take the view that a society's institutions are not part of its wealth but are resource allocation mechanisms. It can also be argued that social and human capital, unlike natural capital, can both accumulate as a result of use (Grootaert and van Bastelaer, 2002). This means that the processes by which these types of capital are depleted are less clearly identifiable compared to natural capital.

4.3 Economic applications of sustainability assessment

The concept of sustainability is applied by economists at a number of stages in development decision-making - ex-post or ex-ante; and at different levels - macro, sub-national, sectoral and project level.

Ex-post assessment

- macro-level - to assess the sustainability performance of an economy, whether national or sub-national;
- sectoral level - to assess the contribution made by a particular sector to the economy;

- strategic level - to examine the impact of a particular policy or package of policies; and
- micro level - to examine the impact of a development project.

Ex-ante assessment

- to identify sustainable development policies/paths for the economy or for a region;
- to predict the impact of a policy or package of policy measures - structural adjustment policies have typically been the focus of such analyses. Trade policies and trade negotiations are also increasingly the target of sustainability analysis; and
- to predict the sustainability impact of a project.

Some people also include an additional stage of assessment during the implementation of a policy change for the purpose of designing monitoring systems or adaptive management. For example, in the context of sustainability impact assessment of trade, the Euroepan Commission's DG Trade refers to this as "real time assessment" (EC 2004).

Table 4.1 lists different methods that can be used to estimate impacts in different situations.

Table 4.1: Methods for integrating economic, environmental and social analysis

Level	Estimation	Evaluation and Comparison
Macroeconomic performance: *(ex post)* • National and sub-national, • Sectoral, •		• Natural resource accounting/Green GDP • UN System of Integrated Environmental and Economic Accounts (SEEA) • Genuine savings • Genuine Progress Indicator • Index of Sustainable Economic Welfare • Sustainable net benefit index
Policy *(ex-ante and ex-post)* • Structural adjustment, • Macroeconomic policy, • Sectoral policy • Trade and investment policy.	• Multiple regression and time series analysis • Field surveys • Partial equilibrium • Long-run economic growth models • Computable general equilibrium models • Product chain analysis • Scale, structure, technology and regulatory effects	• Qualitative comparisons • Conversion to monetary terms through valuation techniques
Project *(ex ante and ex-post)*	• Incorporation of feedback loops between economic and environmental variables in the estimation of costs and benefits over the life of the project.	• Qualitative comparisons • Social cost-benefit analysis based on valuation techniques • Cost effectiveness analysis

4.4 Approaches to integrating economic variables with social and environmental variables

In this chapter, the focus is mainly on applications of sustainability assessment that attempt to integrate economic analysis or variables with social and environmental analysis. Integration can take place at two main stages of the assessment:

- Estimation of the impacts in physical terms and the interactions between economic, environmental and social processes;
- Evaluation and comparison of economic, social and environmental impacts.

Some applications put more emphasis on understanding and modelling the relationships between economic factors, environmental and social factors in order to predict the various effects of a policy or a project, or to understand causal relations in the case of ex-post analysis. The resulting impacts may be left in different units and no attempt made to convert to a single unit. Comparison and assessment is made on a qualitative basis. This is the case for many of the assessments of the sustainability impact of trade agreements (see also Chapter 9). These mostly start by estimating the economic impacts using quantitative techniques and then identify the subsequent environmental and social effects. A set of economic, environmental and social indicators are then produced. For example, the EC's sustainability impact assessments use a set of nine core indicators.

In contrast, some applications put more emphasis on integration at the evaluation stage. Estimation of the impacts in physical terms may be carried out separately but, at the evaluation stage, effort is made to convert environmental, and more rarely social, impacts into monetary terms.

4.4.1 Approaches to integration in the estimation of impacts

Scope of Integration

There is considerable variation in the extent to which impacts are quantified and the extent to which relationships between economic, environmental and social variables are modelled. In general, there have been more attempts to integrate economic and environmental/ecological variables in modelled relationships. Whilst social variables have also been addressed in this way, the conceptual and modelling difficulties involved have forced a focus on readily quantifiable variables. For example, income distribution or numbers of people in different poverty categories have been used when examining the incidence of policy on different social groups. More qualitative dimensions of social sustainability such as participation and security (White 2003) are not so readily incorporated into modelling. It is also notable that many studies of social impact rarely mention sustainability as a concept, except in the sense of durability (see, for example, the World Bank's Users' Guide to Poverty and Social Impact Analysis, 2003). Furthermore, most of the methods developed to address sustainability grew out of attempts to integrate environmental analysis into economic analysis. This is illustrated by the case of sustainability impact assessments of trade which started with environmental assessments and later broadened their focus (see Chapter 9 and Box 9.1).

Methodological approaches and challenges

Estimation of impacts at project and policy levels involves the same basic challenge to understand the interactions between economic, environmental and social variables. How does a change in an economic variable affect an environmental variable, and how does this effect, in turn, translate into a change in another economic variable? The difference is that, for projects, the extent of these interactions is usually more limited and more localised than for a policy change. The latter usually involves a complex series of economic interactions that need to be modelled and understood. This means that impact estimation methods for projects are generally simpler than for policies. But much depends on the scale and nature of the project and of the policy and also on the level of data availability. For example, in the case of trade policy assessments, the methodology used depends heavily on the scale of economic activity concerned. For small trade negotiations such as the USA–Chile bilateral agreement, a simple examination of historical trends and tariff rates was used. For the USA–Jordan agreement, a partial equilibrium model was used. Thus, it was assumed that the impact of the policy change would affect one sector primarily and that it was not necessary to examine the knock-on effects on the other sectors. For large agreements, such as the Free Trade Agreement of the Americas (FTAA)[3], more sophisticated general equilibrium economic models have been used for environmental review.

Ex post analysis should normally be less complex than ex ante analysis as there is no need to make forecasts of future events. However, it faces a different challenge - to separate the impact of the policy from that of other changes occurring at the same time. Simple before and after analysis can be misleading unless an effort is made to understand other possible influences. Thus, modelling may be necessary for some ex post analyses in order to understand how the situation would have developed in the absence of the policy or project under assessment. For example, an evaluation of the impact of a fiscal incentive for biodiversity conservation in Brazil found that changes in municipal revenue were being attributed to the new incentive when in fact they were the result of other factors such as changing levels of economic activity. In order to isolate the impact of the incentive, a simulation was made of the distribution of revenue between municipalities in the absence of the incentive. This was then compared with the situation after the introduction of the incentive (Grieg-Gran 2000).

<u>Simple methods</u>

Where information is scanty, an alternative is the formulation of a conceptual model, identifying the factors that determine the response of producers and consumers to different policies, and using a mix of methods to make quantitative estimates or to establish the direction of change in qualitative terms. This approach was adopted in Cameroon, Mali, Tanzania and Zambia by Reed (1996) in reviewing structural adjustment policies in various developing countries. A similar approach underlies a number of sustainability impact assessments of trade policy in cases where there is insufficient data for detailed quantitative analysis and modelling, e.g. a study of trade liberalisation and the banana sector in Ecuador (Box 4.1).

Indeed, due to lack of data, high costs and time limitations, sustainability impact assessment of trade remains largely qualitative. Blanco (2003:9) suggests that, although the indicators are put forward as a quantitative assessment tool, recent experiences with sustainability impact assessments of trade policy (SIATP) have shown them to have a more qualitative nature and "*they have come to be used as a tool to structure, analyse and synthesise the most relevant issues, making them more into objectives than genuine indicators. This occurs as a result of the lack of data and information typical on the context of SIA of trade policy*".

Similar simple approaches are often advocated and used for estimating the social impacts of policy changes. The World Bank's "Users' Guide to Poverty and Social Impact Analysis" (2003) is intended to inform the preparation of Poverty Reduction Strategy Papers. It suggests that it is more practical to disaggregate expected overall impacts to individual reforms and examine them separately rather than to assess the combined effect of a series of policy

[3] The FTAA involves 34 countries of the Americas in the negotiation a single free trade agreement by year 2005.

Box 4.1: Integrated assessment of trade liberalisation – banana sector in Ecuador

This assessment involved an ex post, sectoral and qualitative analysis of the impact of trade policy on the banana industry in Ecuador. It involved first measuring selected indicators: economic (growth in banana production, banana yield per hectare and technology use); environmental (volume of imports of agrochemicals, use of agrochemical inputs and increases in the surface area planted); and social (minimum salaries, demography, housing, health and education conditions of banana districts). These were then related to policy reform indicators. The study was primarily qualitative owing to a lack of data, although quantitative trends in banana production and the structure of the sector were assessed. Some impacts were quantified in physical terms, e.g. land area, but the relationships between economic variables and environmental and social ones were considered only in qualitative terms and were not modelled. Similarly, the different types of indicators were compared without any attempt to convert them to a single unit of measurement.

Source: UNEP (2002)

changes in a single analytical framework. It acknowledges that the few tools that can accomplish this combined analysis tend to be complex and data-intensive. The Users' Guide identifies five main transmission channels for the impact of policy reforms on different stakeholders: employment; prices; access to goods and services; assets; and transfers and taxes. The methods recommended for estimation depend on the transmission channel that applies and the extent to which indirect impacts are likely to be important. Integration of economic and social information occurs to the extent that non-income dimensions of well-being as well as income ones are addressed. However, the guide notes that existing examples of the use of economic tools for poverty and social impact analysis focus mainly on the income/expenditure measures of welfare and that increased attention to assessing the impacts of policy on non-income measures of welfare is needed.

Some social tools focus more on the non-income dimensions of poverty and may give more scope for integration of economic and social information. The World Bank's social capital assessment tool aims to assist analysis of how social assets affect productive behaviour and how this, in turn, responds to policy reform. Alternatively, it can be used to examine whether certain policies strengthen or undermine social assets. There has been considerable effort to understand how levels of social capital can affect the success of development interventions (Box 4.2 provides an example). Less attention appears to have been given to quantifying the effect of development interventions on social capital.

Box 4.2: The importance of social capital for project success

A study by Isham and Kähkönen (2003) examines community-based water projects in the Central Java Province of Indonesia, and investigates why some have succeeded in terms of health outcomes and community satisfaction while others have failed. It analyses the effect of social capital on the content and enforcement of rules that govern service delivery and on the performance and impact of water services. A set of indicators for social capital are formulated, based on the existence of active civic associations and networks, patterns of social interaction, and norms of trust and reciprocity among households. Average levels of indicators for each village are estimated, drawing from household survey data. The results indicate that in villages with high levels of social capital, household participation in design is likely to be high and monitoring mechanisms are more likely to be in place. The conclusion is that the allocation of investment resources for water services may need to take into account differences in the level of social capital between villages.

Complex methods

Computable general equilibrium (CGE) models address supply and demand in a number of sectors, thus enabling the effects of a policy change in one sector on other sectors of the economy to be examined. Gallagher *et al*. (2001) identify three stages of effects:

- *primary* - which could be an increase in agricultural exports following trade liberalisation in a partner country;
- *secondary* - which would be the effects on other industries of the increase in agricultural exports, for example an increase in purchases of inputs; and
- *tertiary* - the impacts on consumer spending and employment throughout the economy as a result of changes in incomes and prices in the farm exports and farm inputs sectors.

By setting up relationships or making use of coefficients between sectoral output and environmental emissions or resource use, the models can predict the environmental impact of a policy change. This approach was used in a study of the impact of structural adjustment in Vietnam (Box 4.3). The validity of the results depend heavily on the coefficients used and the range of environmental effects included. The coefficients are not always up-to-date and so may not reflect recent technological change. Gallagher *et al*. (2001) note how a study to estimate the impacts of the North American Free Trade Agreement (NAFTA) on industrial pollution in Canada, USA and Mexico used the same coefficients for all three countries and based on pollution per employee in USA industry in 1987.

Box 4.3: Capturing feedback mechanisms between economy and environment computable general equilibrium modelling - Vietnam

The model captures the feedback impact of environmental changes on the economy, taking into account all indirect effects throughout the many sectors. The model is used to examine the direct and indirect effects of policy shocks (e.g. trade liberalisation, subsidising agriculture) on income, employment and environment.

Based on assumptions about deforestation, soil erosion and opportunity costs, it was concluded that putting one additional hectare of land under rice cultivation would lead to 1.4 ha of deforestation, leading, in turn, to 168 tons of upland soil erosion. 10% of this eroded soil would be caught by silt traps; the rest would destroy 0.03 ha of lowland rice causing a loss of US$6 per ha per year. This relationship was built into the general equilibrium model and the impact of a 10% subsidy to agriculture examined. The model indicated a reduction in real income of US$7.8 million.

Source: Panayotou and Naqvi, in Reed (1996)

Gallagher *et al*. (2001) also review the advantages and disadvantages of CGE modelling in the context of environmental reviews of trade policy. Their strength is that they incorporate interactions among all sectors of the economy and can express these in precise quantitative terms. Their disadvantages include high information costs, reliance on outdated data sets because of the expense of continual updating, and lack of transparency. They also make controversial assumptions regarding model relationships. In this regard, one of the key concerns is the reliance on perfect competition, implying numerous companies with little influence on price. But key sectors are often characterised by oligopoly, i.e. a few companies dominating the sector and with greater ability to set prices rather than accept market prices. CGE models also rely on assumptions about price elasticities related to supply and demand in various industries. In addition, such models may not be able to capture changes in investment flows related to trade agreements. It is also assumed that impacts on the environmental and social dimensions of sustainability only occur if an associated significant economic impact takes place.

Normally, only major economic effects are considered under the analysis, so such methodologies ignore those important environmental and social impacts that would be associated with less significant economic impacts, termed “marginal economic effects” by Gallagher *et al*. (2001).

A common criticism of CGE modelling is its static nature and inability to deal with long-term changes. This makes it less relevant to sustainability assessment with its emphasis on the future and the welfare of future generations. Alternative approaches give more attention to modelling long-term interactions between economic and environmental variables (Box 4.4).

Box 4.4: Long-term integration of economic and environmental variables – Pakistan

A study of the impact of structural adjustment in Pakistan used a long-run economic growth model projecting GDP, the national savings rate and population growth. The aim was to provide a long-run (50 years) picture of the relationships among economic growth, population growth and environmental degradation, with and without economic reforms. A 1% increase in the national savings rate was used as a proxy for the outcome of a range of structural adjustment reforms. The projected trends in economic output and population were related to environmental impacts through the application of relationships drawn from previous cross-country studies. These examined the relationship between per capita GDP and environmental quality (either ambient air or water quality or emissions of specific pollutants). In many cases, levels of environmental quality deteriorated as income rose, but then started to improve again after a certain income level was reached. It was recognised that the projections obtained in this way were no more than approximate because the model did not incorporate feedback effects from environmental quality to economic growth, and because the functional relationships drawn from other studies related mainly to developed countries and covered just a few years.

Source: Akhtar and Vincent in Reed (1996)

In some cases, as in the Pakistan example in Box 4.4, a combination of methods has been used to estimate the impacts of different policies and policy scenarios. Box 4.5 provides an example from Canada involving the use of a linear input-output model and more complex non-linear simulation models.

In developing countries, it is difficult to find suitable, appropriate CGE models. As Winpenny (in Reed, 1996) notes, “these models have a huge appetite for data, are often based on outmoded structural features and behavioural relationships, and are rarely calibrated in sufficient detail to display environmental factors”. For similar reasons, linking such models to social changes has proved difficult. Where such linkages have been addressed, it has been for a limited range of variables such as population growth, poverty levels and income distribution.

4.5 Evalution and comparison - integration of economic, environmental and social variables

A major challenge for sustainability assessment is to compare and evaluate impacts or trends expressed in different units. The approach of economists is generally to convert all impacts to a common unit, most usually money. Where impacts do not lend themselves to monetary

Box 4.5: Modelling of sustainable development indicators – Fraser River Basin, British Colombia, Canada

The study aimed to identify indicators and model them as a dynamic system to provide insights into policy trade-offs. The first step was to synthesise sustainable development goals into five broad categories

1) Maintain ecosystem integrity and diversity;
2) Meet basic human needs for social and economic development;
3) Maintain intergenerational distribution and options;
4) Improve intergenerational distribution and entitlements;
5) Improve local empowerment and decision-making.

Data was gathered for the period 1971-1991. On the basis of commensurability and data availability, 23 indicators were selected.

Three types of modelling approaches were adopted:

1) *Pair-wise and multivariate correlation analyses* – to analyse linkages between indicators, to structure the simulation models and to identify indicators which were highly correlated with others and hence could be eliminated.

2) *Linear input-output model with satellite accounts for environmental impacts*. The model is based on the 1990 economic accounts for British Columbia. It focuses on 16 economic sectors and final demand sectors (households, government and exports). Eight air pollutants were selected and emissions per sector estimated. The impact of changes in demand in specific sectors on emissions was then estimated using the model. It is assumed that the level of technology remains constant, that prices do not change and that there is no product substitution.

3) *Simulation models incorporating non-linear relationships and adaptive feedback loops*. The model used assumed relationships derived from the correlation and input-output models. The models were calibrated using past data and used to forecast indicator changes after 1991. While population growth is exogenous in the input-output model, it is endogeneous in the simulation model - being partly a function of net migration which, in turn, depends on economic conditions. The model forecasts changes in a GDP index, population index, water use, pollution and human health under different scenarios, for example doubling the area of land set aside for conservation.

Source: Gustavson *et al*. 1999

valuation, trade-offs can be examined or cost-effectiveness analysis can be used to address questions such as 'What is the cost of reducing one unit of pollution or of creating an additional job'?

More effort has been given to integrating environmental variables into economic analysis, drawing from economic valuation techniques. These methodologies address three types of environmental value following a typology introduced by Pearce *et al.* (1989).

- *direct use value* – the benefit of using environmental resources as an input to production or as a consumption good, e.g. the use of forests for recreation or for the harvesting of medicinal plants;
- *indirect use value* – the support and protection provided to economic activity and property by natural ecosystem functions, e.g. forests are thought to play a role in controlling sedimentation; and

- *non-use value* – intangible benefits derived from the mere existence of environmental resources or quality.

Methodologies for monetising environmental impacts, both tangible and intangible, have been applied since the 1970s (see Box 4.6) and have been steadily refined. But there is still considerable scepticism from outside the economics profession, and to a lesser extent within it, about the validity of the results. These techniques can also be expensive and data-intensive, with the result that recourse is often made to the more approximate cost-based

Box 4.6: Valuation techniques

Valuation using market prices

Many environmental goods and services are traded. So their market prices can be used to assess the value of environmental resources under different scenarios, including in situations where subsistence production predominates. It may be necessary to adjust market prices to account for market or policy failures.

Surrogate market approaches

Where environmental goods and services are not traded, it is sometimes possible to infer their values from the decisions made by consumers. The travel cost method estimates the amenity value of parks and other recreation sites from the travel costs (travel time, transport costs, entrance and parking fees) incurred by visitors to sites of different characteristics. The *hedonic pricing* method attempts to isolate the specific influence of an environmental amenity or risk on the market price of a good or service, for example, in the context of land or house prices.

Production function approaches

These start by determining the physical effects of changes in the environment on economic activity. i.e production or consumption - for example, the impact of pollution on human health and, in turn, on production and medical services. The second step consists of valuing the resulting changes in production or consumption, usually by means of market prices.

Stated preference approaches

Instead of relying on the use of market prices, consumers are asked to state their preferences directly for environmental goods or services in terms of hypothetical markets or payments. In *contingent valuation*, consumers are asked for their willingness to pay for an environmental benefit or their willingness to accept cash compensation for losing the benefit. Contingent ranking requires respondents to rank a series of alternative non-market goods. Choice experiments involve asking individual respondents to choose among alternative bundles of non-market goods which are described in terms of their attributes including a hypothetical price.

Cost-based approaches
These methods are used where there is limited time and resources for more rigorous valuation. They focus on the costs of providing, maintaining or restoring environmental goods and services eg preventive expenditures, costs of replacement of natural assets damaged by a project.. As the environmental benefit may not always justify the cost of prevention replacement, these approaches are only approximate and may over-estimate or under-estimate willingness to pay for environmental goods and services.

Source: Adapted from EEP (2003)

approaches, particularly in assessments of policy impact Less attention has been given to monetising social impacts. The main thrust of work has been on the valuation of changes in social capital. In a study of community-based water services in Sri Lanka and India, Isham and Kähkönen (2001) suggest that an economic value of social capital in the context of water projects can be given by the net present value of the marginal increase in health associated with active civic associations. As the measurement of social capital is itself somewhat contentious, assigning monetary values to changes in measured amounts has not been without criticism.

4.5.1 Assessment of projects

Environmental valuation methodologies are readily integrated into social cost-benefit analysis. Costs and benefits can thus be adjusted to include external environmental costs and benefits which would not normally be included in project appraisal. A project would be considered viable if the present value of the stream of benefits over the lifetime of the project, including external environmental benefits, exceeded the present value of the costs including that of any environmental damage. Such a project would satisfy the 'weak sustainability' criterion as it implies that the produced outputs from the project are sufficient to outweigh any loss in natural capital. A 'strong sustainability' criterion could be assessed also in the context of a set of projects, where one of the projects was designed specifically to restore natural capital and offset the losses implied by the other projects in the set (Barbier *et al.* 1990).

However, even at the project level, it is rarely feasible to make in-depth analyses of more than a selection of key impacts as the data requirements can be considerable. This applies particularly to impacts on indirect use values for which information is needed on biophysical linkages and relationships. Results are often very sensitive to the assumptions made about the time horizon of the project and to the discount rate used to convert costs and benefits at different points in the time to a present day value.

Incorporating social impacts into cost-benefit analysis is more challenging. Early methodologies for project appraisal proposed the use of *distributional weights* to weight consumption according to the income of the consumer, with higher weights for low-income groups (Squire and van der Tak, 1974) (ref needed). Projects benefiting certain low-income groups would therefore yield a higher return. The choice of the weights was subjective and required a political decision. Other approaches involve making separate calculations of the costs and benefits accruing to each social/stakeholder group, or focusing on the impacts on the poor.

4.5.2 Assessment of policy

The problems of monetary valuation at the project level are compounded at the policy level, as illustrated by the experience with sustainability impact assessment of trade policy.

To overcome the lack of a common unit of measurement, some methodologies suggest the use of "*significance criteria*" to prioritise environmental and social problems. Such criteria have been used by economists in a number of studies, for example, in the analysis of environmental impacts of trade liberalization in Chile's mining sector led by UNEP and CIPMA (Centro de Investigacion y Planificacion del Medio Ambiente – Centre for Environmental Planning and Research) (Blanco and Wautiez 1999). The proposed EU sustainability impact assessment (SIA) methodology also suggests the use of significance criteria "*to assess the significance of any change in an indicator*" (EC, 2004:18) (Box 9.1).

Nevertheless, some trade policy assessments have made use of environmental valuation techniques to convert economic and environmental impacts to the same unit of measurement. One approach, the *environmental domestic resource cost approach* compares the full domestic social costs of export production to the foreign exchange earned. An economic domestic resource cost (EDRC) ratio greater than one indicates that a country incurs greater costs in terms of domestic resource usage and environmental damage from production than it earns in foreign exchange from the product's export. Box 4.7 provides an example of the application of this approach in Chile.

Box 4.7: Application of the EDRC in three sectors in Chile

The study analyses the linkages between trade and environment using the Environmental Domestic Resource Cost (EDRC) approach and focuses on three Chile's leading export industries – copper mining, fish meal, and pulp and paper.

The EDRC approach adopts the framework of the conventional domestic resource cost (DRC) approach developed by Michael Bruno in the early 1960s (Bruno 1972). This compares the domestic social (opportunity) costs of export production to foreign exchange earned, but includes input and output prices that reflect the full environmental impacts of production, or at least those that can be quantified. Those costs are compared to the foreign exchange earnings. An EDRC ratio of less than one indicates that an export activity earns more in foreign exchange than the domestic resource costs (including environmental ones) required to produce the export. An EDRC ratio greater than one indicates that a country incurs greater costs in terms of domestic resource usage and environmental damage from production than it earns in foreign exchange from the product's export.

The EDRC method is conducted in two steps:

- The first step involves estimating the conventional DRC - starting with valuing the export product under study and the inputs used in its production process. The DRC measures the economic resource costs of production based on "social prices," i.e., prices of goods that reflect the true economic value without price distortions from taxes, subsidies, price controls, import tariffs, quotas or other government policies. To estimate social prices, tradeable goods are valued at their world price equivalent, i.e. the price at which they can be imported or exported, adjusted for transport costs and exchange rate distortions such as overvaluation. The study considered annual average f.o.b. prices subtracted from port charges and transport costs for, respectively, bleached long-fibre Kraft pulp manufactured from softwood, fish meal and refined copper. For the pulp and paper industry, subsidies for new plantations were also considered. Non-tradeable (primary) goods are valued according to their opportunity costs (i.e., the returns to their most socially profitable alternative use).

- The second step — the environmental DRC analysis (ERDC) — extends the analysis by estimating environmental impacts and including them in the domestic costs of production. In the case of pulp and paper, the benefits derived from carbon sequestration by forest plantations were included (US $0.40 per ton of cellulose produced) as well as the costs of water pollution (US $43.40 per ton of pulp produced) and those from odours (US $0.50 per ton of pulp produced). Environmental costs of the fish meal industry included effluents (US $56.16 per ton of fish meal), For the copper mining industry, air emissions (US $74.87 per ton of copper, respectively) and effluents (US $31.40 per ton of copper) were calculated. In all cases, environmental damages were valuated according to the abatement cost approach.

The study found that the EDRC ratios calculated were 0.30 for the pulp and paper industry; 0.57 for the fish meal industry; and 0.27 for the copper mining industry. This implies that even though the net negative environmental impact was significant when compared to total foreign exchange earning, the latter were still greater than the valuated production costs. However, the authors suggested that a more comprehensive study of environmental impacts would likely result in an even higher environmental DRC estimate.

Source: Borregaard and Bradley (2000).

More elaborate approaches involving modelling followed by valuation have also used. Examples are given by Boxes 4.8 and 4.9. These approaches have some drawbacks such as the exclusion of a number of environmental and social effects which do not lend themselves to monetary valuation and valuation approaches which lead to underestimation of environmental damage.

Box 4.8: Integrated assessment of the cotton sector in China

In integrated assessment (IA) was undertaken of the economic, social and environmental impacts of China's WTO accession for three crops – cotton, wheat and corn – but with a particular focus on the cotton sector. The study uses the equilibrium model Jiangsu Agricultural Policy Analysis (JAPA) to make a scenario analysis of the impact of large agricultural imports (TRQs). The JAPA model is a combination model, which includes a data bank, a series of econometric models, a partial equilibrium model and an interactive display system. The econometric model is established to estimate the human consumption level of various commodities and the price elasticity of major consumer goods, thus providing many coefficients for the partial equilibrium model to define human consumption behaviour. The objective function of the partial equilibrium model is maximizing producer and consumer surplus and includes the crop and animal sector for five regions in Jiangsu province. On the supply side, it considers all input items and output products. On the demand side, it takes into account human consumption, industrial demand, feed, storage, loss, regional transport, international import and export.

The JAPA model is used first to make a baseline projection on the situation in 2002, which will provide a comparative basis; and then a scenario analysis on the impact of agricultural imports increase. The model results show:

Economic Impacts:
- Increase in TRQs helps to resolve the shortage of two commodities;
- Sown area and output decrease (the sown area decreases by 4.91, 2.48 and 3.82% for wheat, corn and cotton, respectively. The total sown area decreases by 1.11 per cent (92,624 hectares);
- Price decreases of agricultural products (3.89, 0.57 and 2.84% for wheat, corn and cotton, respectively);
- Producer surplus decreases by 3.2% and farmer's income decrease by 921.75 million RMB.

Social Impacts:
- Promote industrial production structure adjustment;
- Utilization rate of cultivated land decrease, and about 92,624 ha of valuable land lies waste;
- Reduction in the self-sufficiency rates of agricultural commodities: from 144 to 137% for wheat, from 40 to 38% for corn, and from 91 to 87% for cotton;
- Agricultural employment decreases by 16.55 million working days;
- Poverty and social instability.

Environmental Impacts:
- Reduction in the use of chemical fertilizers and pesticides by 7.43 and 31.41%, respectively:
- Cultivated land may be lost: about 92,624 hectares of cultivated land will lie waste and would be used for non agricultural purposes.

The JAPA model provides results on economic, social and environmental impacts, but the results are estimated in different units of measure. Furthermore, some of the impacts such as poverty and social instability are deduced rather than estimated from the primary results. Thus, in order to apply the cost-benefit analysis (CBA) to assess the different impacts, a common indicator (a monetary value in this case) is required.

Economic Valuation of Social impacts: Agricultural unemployment is expressed in terms of agricultural working days. The current wage rate in the agricultural labour force per working day is considered as the opportunity cost. The cultivated land shadow price estimated by the partial equilibrium model is considered as the land rent (155RMB per ha). Other social impacts such as industrial production structure adjustment and social instability cannot be evaluated in economic terms.

Economic Valuation of Economic impacts: Pesticide pollution is valued using its shadow price, calculated using a formula to transform the pollution into a "converted pollution quantity" and multiplying it by the Chinese official pollution standard. The calculated shadow price is 5.88RMB per ha of cotton. The same methodology is applied for valuing the chemical fertilizer pollution, giving a shadow price of 18.17RMB per ha of cotton.

The total costs equal 3,730.51 million RMB and include: agricultural output value changes, decrease of producer agricultural prices, tariff loss, cultivated land lies waste and imports payment. The valuated benefits sum 2,427.20 million RMB and include: solving the shortage of two of the commodities, decrease in consumer agricultural prices, and reduction of pesticide and chemical fertilizer application. The calculated cost net is 1,303.31 million RMB.

Source: UNEP (2002c)

Box 4.9: Assessment of trade liberalisation effects on the fisheries sector, Argentina

The study analyses the social, economic and environmental impacts that trade liberalization has had on the fisheries sector in Argentina, particularly in the case of the Argentine hake.

Through a cost-benefit analysis (CBA), the study compares the net benefits of two scenarios:

- The *business as usual* scenario, which implies the identification and quantification of actual benefits and costs of recent policies and the evolution of the sector;
- The *'optimum-policies'* scenario which would identify and quantify the costs and benefits of a sustainable fisheries policy (simplified as catches equal to the Total Allowable Catch determined by the Federal Fisheries Council or other competent institution).

The comparison of the net benefits of both scenarios would show the costs of adopting the wrong policies for fisheries control and management. Discounting the flows of net benefits associated with each alternative over a period of thirty years provides an economic comparison of the two options. The profitability indicator is the net present value (NPV) of the net benefits flows. A social rate of discount of 4% is used.

The main positive economic impacts of the sectoral policies:

- Increase in fisheries catches (production);
- Increase in exports;
- Increase in employment;
- Improvement and growth of the fisheries fleet;
- Technological innovation in the sector;
- Increased research facilities and skills;
- Opening of new markets and trade relations;
- Increase in public income;
- Regional infrastructure investments (ports, other infrastructure, new firms, etc.).

From the point of view of CBA, the main benefits are supposed to be the net increases in value added for the economy, assuming that labour marginal productivity is nil (i.e. high unemployment rate). The average price of hake has been estimated at US$ 900/ton and the value added has been estimated at 89% of gross production value.

The main negative impacts (costs):

- Degradation of hake biomass (i.e. the value of the natural resource);
- Increased costs for fisheries regulation and control;
- Costs of subsidies;
- Corruption practices;

- Non-diversification of catches;
- Investment over-sizing (fleets, ports, etc.);

  Other: i.e. abrupt unemployment.

From the point of view of CBA, the main costs are those associated with the degradation of biomass.

The CBA shows that (assuming total degradation of hake biomass):
- The hake mass would have a total value of US$ 7,900 million;
- The business as usual scenario would have a net direct cost of US$ 500 million;
- An optimal set of fisheries management policies would have a net benefit of about US$ 5,100 million;
- The opportunity cost of the factual policies (comparison of the NPV for the best policy package with the worst factual situation) would amount to US$ 5,600 million;
- Under a more optimist scenario – where hake biomass would recuperate by 2004 – the opportunity cost of factual policies would amount to US$ 2,000 million.

Source: UNEP (2002b)

4.5.3 Economic performance

A number of criticisms have been made of traditional economic performance indicators, namely GDP and GNP. Reviewing these helps to understand the approaches for evaluating the sustainability of economic performance.

Natural resource accounting and related methodologies were developed to address the concern that traditional measures of the output of an economy and of growth are poor indicators of human well-being or of sustainability. NRA exercises have been undertaken since the 1970s (Harris and Fraser 2002), e.g. in Norway, France and the Netherlands. In the 1980s, the United Nations Statistics Division (UNSD) and the World Bank began to work together on modifying the System of National Accounts (SNA) to incorporate environment (*ibid).*

Various shortcomings of GDP as a measure of development have been widely observed (Lutz citing Harrison1993):
- The concept of capital maintenance is applied only to manufactured assets and not to natural assets;
- Limited attention is given to the contribution of the environment to economic activity;
- Limited attention is given to the impact of economic activity on the environment;
- GDP excludes human and institutional capital;
- The contribution of household services is ignored;
- GDP measures activities on the basis of market price rather than their value to suppliers and consumers.

Other shortcomings relating to social issues have also been cited (Lawn and Sanders 1999):

- GDP fails to separate benefits and costs. It treats some costs as benefits, for example, medical and dental expenditures, cost of vehicle repairs, crime prevention measures and efforts to rehabilitate and protect the environment. It also fails to include some benefits, e.g. household work and the annual services of owner-used assets (e.g. consumer durables), and publicly provided assets such as art galleries, museums, roads and highways and natural capital services;

- The calculation of GDP assumes that an extra dollar of income to the rich adds as much to a nation's welfare as an extra dollar of income to the poor. This runs counter to the idea of diminishing marginal utility;
- GDP does not include the social cost of unemployment;
- GDP does not include the potential unsustainability of growing foreign debt[4].

Most of the early efforts were directed towards addressing environment pollution and natural capital use through natural resource accounting. Adjustments were made to official GDP figures to allow for the depletion of renewable and non-renewable resources and other types of environmental impact. Different methods have been developed, giving different results. This applies to resource depletion as much as to the more intangible types of environmental impact. Common and Sanyal (1998 - cited in Harris and Fraser 2002) used the Net Price method and the Serafy method (Serafy 1989) to estimate asset depreciation for non-renewable mineral resources in Australia, and obtained very different results. Several reviews of the literature on natural resource accounting have concluded that there is little consensus on how to make adjustments (e.g. Hanley *et al.* 1999; Harris and Fraser 2002)

The UN System of Integrated Environmental and Economic Accounts (SEEA) – a set of satellite accounts for the official SNA – has developed two adjusted forms of GDP figures: EDP1 which includes the consumption of natural capital; and EDP2 which, in addition, includes pollution costs. The latter applies estimation of environmental externalities based on hypothetical maintenance or prevention costs (Bartelmus 1999). It defines environmental externality as the loss of environmental services of waste absorption resulting from the over use of natural capital. It makes no attempt to estimate the costs of environmental damage, Rather, it is assumed that abatement costs equal the damage.

The differences in approach were highlighted in the Philippines where, according to Hecht (2000), there were two separate natural resource accounting initiatives. One project was based within the agency responsible for the national income accounts and followed the UN's SEEA. This agency calculated EDP1 and EDP2 but did not feel that the meaning of these indicators was clear enough to warrant publishing them as government statistics. The other project was the initiative of the Department of Environment and followed an approach based on economic principles, which was not compatible with the SNA. Hecht (2000) discusses how the existence of these two separate projects in the Philippines, using different methods, estimating different resource depletion figures and calculating different values for green GDP, caused confusion.

A broad distinction can be made between methods concentrating on flows as in the case of green GNP, and those examining changes in stocks. The genuine savings methods (Pearce and Atkinson, 1993) compares the savings rate with the sum of depreciation on natural and man-made capital expressed as a fraction of national income. This is a 'weak sustainability' measure as it allows for natural capital to decline so long as manufactured capital is built up. In a publication on World Development Indicators, the World Bank (1999) employed the genuine rate of saving for 100 countries.

Hanley *et al.* (1999) summarise the common criticisms of *Genuine Savings* as an indicator:

- The difficulty of measuring depreciation of natural capital given the lack of a common unit of measurement;

[4] The argument presented by Lawn and Sanders (1999) for including this aspect in the list of defects of GDP is not convincing. They question whether an increase in GDP represents an increase in economic welfare if a nation is forced to liquidate much of its natural capital in order to service the debt. But as loss of natural capital is already being adjusted for, then to adjust GDP for foreign debt as well would be double-counting.

- The implausibility of the substitutability assumption – " it is not clear how investments in man-made capital could substitute, for example, for that part of natural capital Kn which is involved in photosynthesis and the regulation of atmospheric composition";
- It reflects a narrow conception of sustainability since, for example, it pays no attention to income distribution.

Subsequent modifications added human capital to the analysis. The World Bank used this approach to compare 13 regions of the world in 1994 and found that human resources were the dominant component of wealth, comprising between 40% and 80% in all regions (Dixon and Hamilton 1996. Natural capital is more important in developing regions but is more equitably distributed between countries than other forms of capital (Dixon and Hamilton 1996).

A further modification was to add environmental degradation to the analysis, and to consider education expenditure as investment in human capital instead of a form of consumption, as in traditional economic accounting. These modifications were associated with a change in the name of the indicator to *Extended Genuine Savings*. The World Bank used this approach to examine the sustainability of 103 countries (World Bank 1997)). Extended genuine savings was defined as "gross domestic investment minus net foreign borrowing plus net official transfers plus education expenditures minus depreciation of man-made capital minus resource rents from the depletion of natural resources minus damage caused by CO2 emissions as a proxy for other pollutants". The World Bank later changed the name to *Adjusted Net Savings*.

> "*From the adjusted net savings standpoint, for example, a nation which reinvested all of its profits from the exploitation of non-renewable natural resources in the formation of human capital through its educational system would have imposed no net opportunity cost on the country's future citizens.*" (Bolt *el al*. 2002)

The World Bank has produced a manual for calculating adjusted net savings (Bolt *et al.* 2002) and continues to make periodic calculations of this indicator. Results for 2001 show that Sub-Saharan Africa has negative adjusted net savings rates, Latin America and the Caribbean rates continue to show a positive trend apart from Venezuela and Ecuador, while East Asia and the Pacific region have rates exceeding 20% of Gross National Income (www.worldbank.org/ESSD).

Neumayer (2000a) shows how applying a different method for estimating the cost of natural resource depletion than that used by the World Bank changes the conclusions regarding sustainability for a high proportion of the countries studied. He also highlights the incomplete treatment of natural resources in the World Bank estimates as these include only forests and minerals, and exclude water, soil, fish and biodiversity. Similarly, the World Bank's treatment of pollution is incomplete as only one pollutant is used (CO_2) and a standard value of US$20/per tonne is used. Neumayer highlights the pitfalls of using sustainability analysis in this way for policy implications, e.g. making aid conditional on countries following a sustainable path.

Other approaches have gone much further in addressing social variables but come in for considerable criticism for the ad hoc way in which these variables are chosen and estimated (eg Harris and Fraser 2002; Bartelmus 1999; Hanley *et al.* 1999; Neumayer 2000b). The most well-known of these is the *Index of Sustainable Economic Welfare* (ISEW) developed by Daly et al. (1989) covering the years 1950 to 1987. Later Cobb *et al.* (1999) renamed the ISEW as the *Genuine Progress Indicator* (Box 4.10).

Box 4.10: The Genuine Progress Indicator

The Genuine Progress Indicator (GPI) begins with the nation's personal consumption expenditure. Unlike GDP, it does not add the nation's spending on investment and government as most of these are considered defensive, ie they are making up for degraded conditions. Personal consumption is then weighted by the Gini Coefficient to adjust for income distribution. The GPI then adds the following categories of spending considered to enhance the nation's well-being:

1) The value of time spent on household work, parenting and volunteer work;
2) The value of services of consumer durables;
3) The services of highways and streets.

The GPI subtracts the following categories of expenditure considered to detract from the nation's well-being:

1) Defensive expenditures – money spent to maintain the household's well-being in the face of declines in the quality of life due to crime, automobile accidents or pollution, eg the personal water filters, security systems, hospital bills from auto accidents, cost of repainting houses damaged by air pollution;
2) Social costs such the cost of divorce, costs of crime and loss of leisure time;
3) Depreciation of environmental assets and natural resources, including loss of farmland, wetlands and old-growth forests, reduction of stocks of natural resources and damaging effects of wastes and pollution.

Source: Cobb *et al*. (1999).

The basic approach has been described as adding "desirables" and deducting "regrettables" from per capita national income or consumption (Bartelmus 1999). The original ISEW included adjustments for such things as income distribution, environmental damage, the value of housework and resource depletion. It has since been applied, usually with some modifications, in Austria, Canada, Chile, Germany, the Netherlands, Sweden and the UK. A variant called the *Sustainable Net Benefit Index* has been applied by Lawn and Sanders (1999) to Australia. Castaneda's (1999) applied ISEW to Chile (Box 4.11) and found that while GDP increased by 2.95% annually from 1965 to 1995, the ISEW declined at an annual rate of –0.16%. Most of this difference was attributable to the depletion of non-renewable resources. Stockhammer *et al.* (1997) found a similar disparity between GDP and their revised ISEW index, but mainly reflecting future welfare reductions, increasing income inequality and a stagnation in the value of unpaid household labour. Although they claim to have based their ISEW on a more consistent framework than Daly and Cobb, their estimation involves some assumptions. For example, they exclude the value added of the whole mining sector and their estimates for housework are based on data for three years only (Box 4.12).

Box 4.11: The ISEW applied in Chile

An analysis by Castañeda (1999) is based on personal consumption and excludes government expenditures and trade. He first makes adjustments for income inequality, then deducts defensive expenditures associated with air and water pollution, over population and congestion, and a proportion (half) of healthcare and education private expenditures. The next step is to add in non-marketed services such as household labour, and a proportion (half) of government expenditures for healthcare and education considered to increase welfare. There is then an adjustmwnt for depletion of natural capital (including pollution) and manufactured capital formation. Unlike the original version of the ISEW, Castaneda's approach includes depletion of renewable resources and criminal cost. But, owing to the lack of data, it excludes categories included in other applications: loss of wetlands, costs of ozone depletion and international position.

The results show that while GDP increased from 1965 to 1995 at an annual average rate of 2.95%, the ISEW declined at an annual rate of –0.16%. Depletion of natural capital accounts for a large part of the adjustments made and most of this is depletion of non-renewable resources – estimates for forestry were included, but under-estimated because of exclusion of erosion, loss of biodiversity, etc. Environmental pollution has little impact on the overall results.

Source: Castañeda 1999

Box 4.12: The revised applied ISEW in Austria

Stockhammer *et al*. (1997) applied a revised ISEW to Austria for the years 1955 to 1992. They found that GDP rose throughout this period, but the ISEW stagnated from the mid 1980s. The main causes for this divergence were future welfare reductions, increasing income inequality and a stagnation in the value of unpaid household labour.

Steps involved:

1) The volume of market and non-market consumption expenditure was calculated. Public consumption was taken directly from the SNA. Private consumption by households was modified to convert expenditure on consumer durables to flows). The value of unpaid household labour was included as consumption and estimated using hours worked multiplied by the average wage of a janitor. Data for hours worked were available for three years only (1969, 1977 and 1981). Investment expenditure was also included but converted to a consumption flow by multiplying the change in net capital stock by the productivity of capital.

2) Items to be subtracted were estimated:

   - Environmental and social defensive expenditure on activities that do not "genuinely" contribute to economic welfare but are required to maintain the standard of welfare or to repair damages caused by economic activity. Estimates were made for unsustainable cultivation of soil, loss of natural areas, air ,water and noise pollution. Social defensive costs included, for example, the increase in commuting costs over the base year since commuting is the "logical consequence of a society that concentrates its production locations", and 50% of spending on advertising - on the grounds that only part of this is useful for conveying information. Half of all health expenditure is considered to be defensive and was therefore subtracted.

   - Future reductions that will be caused by today's production or consumption:
     - greenhouse effect (the authors took 50% of Hohmeyers (1992) (need ref) estimate of cost per ton of CO_2 and converted his cumulative damage estimates to yearly damage estimates); and
     - resource depletion (the value added of the mining sector).

The result of subtracting 2) from 1) was weighted by an index for the inequality in the distribution of income and labour. Due to lack of data, instead of using the Gini Coefficient, income inequality was measured by taking the income differences between workers and employers, men and women, and employed and unemployed, and dividing each by the average income and then weighting the result by the share of the group concerned.

In a review of studies of alternatives to GNP, Neumayer (2000) points out that a widening gap tends to occur between the alternative indicator and GNP which reflects the assumptions made in computing resource depletion, and long-term environmental damage. When these indices are recalculated with different assumptions, the gap disappears. The sensitivity of these indicators to the assumptions made is highlighted also by Hanley *et al.* (1999) who examined sustainability in Scotland over the period 1980 to 1993. They used various approaches: AENP (give in full), genuine savings, ISEW, GPI and some environmental indicators and obtained quite different results for each. According to ISEW and GPI (give in full), development in Scotland is unsustainable and getting worse, but according to AENP it is becoming increasingly sustainable. The Genuine Savings indicator suggests that the country's development path [is unsustainable but becoming less so.

4.6 Regional sustainable development assessment

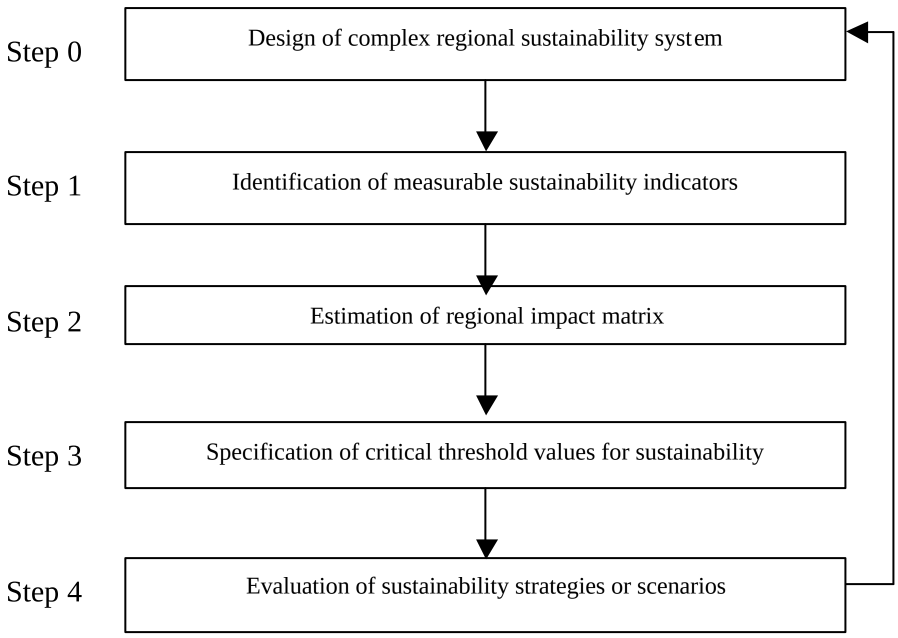
Over the last decade, there has been a growing interest in research that focuses less on global sustainability analysis and more on empirical policy-relevant research at the regional and urban level (Giaoutzi and Nijkamp 1994, Capello et al. 1999). A wide range of studies address explicitly the regional aspects of sustainability issue, although there is some bias towards agricultural and land use issues, e.g. a sustainability analyses of communal rangelands (Abel 1997) and agricultural pesticide policies (Douven 1996); economic analysis of deforestation in Mexico (Barbier and Burgess 1996); natural resource degradation effects of poverty and population growth (Heath and Binswanger 1996). Internal and external sustainability is also distinguished – where assessment of external sustainability considers the spill-over effects to and from other areas, eg the idea of ecological footprints (Wackernagel and Rees 1996).

Njikamp and Vreeker (1998), researchers at the Tinbergen Institute in The Netherlands, note that there is little commonality amongst theoretical frameworks and methodological foundations. Thus, in an attempt to offer a general methodological approach, they have suggested a framework for assessing sustainable development policies at the regional level, based on the use of critical threshold values (CTV).

According to Van Pelt *et al.* (1992, 1995), a constraint to sustainability has at least four attributes: it is expressed in one or more measurable parameters; these parameters are linked to sustainability targets; the parameters have a proper geographical scale; and they also have a relevant time dimension. Ideally, such constraints should be 'mapped' quantitatively, but, often, the available information is qualitative, fuzzy and incomplete. For policy analysis, various useful tools are available to identify such constraints such as safe minimum standards, quality standards, carrying capacity, ecocapacity, maximum sustainable yield, critical loads, vulnerability (or fragility), environmental utilisation space, etc. In their decision-support model, Nijkamp and Vreeker (1998) use the term CTV as a catchall heading for such approaches

A CTV for sustainable development is defined as "the numerical normative value of a sustainability indicator that (at the margin) ensures a compliance with the carrying capacity of the regional environmental system concerned". Exceeding a CTV means unacceptably high social costs to the environment or socio-economic system concerned. Nijkamp and Vreeker cast the CTV approach in the framework of a decision-making support approach which is presented in several steps in which various feedback mechanisms and/or iterative steps may also be envisaged and included (Figure 4.1).

Figure 4.1; Steps in regional sustainability assessment procedure
(Source: Nijkamp and Vreeker, 1998)



> "Once the data base and set of VTCs have been collected, one may use policy experiments (scenarios, visioning methods, forecasting techniques, Delphi-types of communicative procedures) to generate a series of 'alternative futures' which then may be judged on the basis of a multi-dimensional set of relevant policy criteria, while taking into account the importance and exietence of CTVs in identifying policy-decisions" (Nijkamp and Vreeker, 1998).

The concept of CTV is based on existing knowledge which may be specific for a given area, for local socio-economic and natural conditions, and for particular local/regional policy ramifications. Scientific information and expert opinion are critical in assessing a CTV, and there is also a policy dimension.

Based on a multidimensional indicator system, a systematic multi-criteria model is used, employing a user-friendly Flag model - to indicate (flag) the level of concern about particular trends and help evaluate policy options. This is able to take into consideration various interesting classes of (non)-compliance with CTVs.

The model was tested in an empirical case study for the Songkhla/Hat Yai area in southern Thailand. Three policy scenarios (decentralisation, sectoral promotion and environmental protection) were systematically evaluated using a blend of the CTV and Flag approach. One conclusion to emerge was that lack of quantitative and reliable in formation may force the use of adjusted qualitative methods.

4.7 Debt sustainability assessment (DSA)

In June 2002, the Executive Board of the IMF endorsed a framework for assessing the sustainability of countries' public and external debt. The framework aimed to "bring a greater degree of consistency and discipline to sustainability analyses, including by laying bare the basis on which projections are made and subjecting them systematically to sensitivity tests" (IMF 2003). The framework consists of three elements (see example from Benin in Table 4.2):

- *Baseline scenario* – the set of macroeconomic projections – normally for a five-year horizon - that form the basis for understandings on an IMF-supported programme, or the articulation of the authorities' intended policies as discussed with the staff in a surveillance context – with the main assumptions and parameters clearly laid out;

- A series of *model-independent sensitivity tests*, applied to the baseline scenario, providing a probabilistic upper boundary for the debt dynamics under various assumptions regarding policy variables, macroeconomic developments, and costs of financing. The sensitivity tests are applied to key parameters – including the interest rate, the growth rate of the economy, the GDP deflator, the exchange rate, and the primary (or non-interest current account) balance, and contrast the baseline projection to the country's historical performance.

- Recognising that debt sustainability assessments (DSA) inevitably involve judgement, the output of the *framework is interpreted in terms of the vulnerability of the country to a crisis*.

IMF staff have been exploring ways in which DSA can be linked more closely to assessments of financial sector vulnerability, in particular, the possible contingent liabilities arising from financial sector restructuring. DSAs have become routine for countries with significant market access, but are not yet well integrated with the rest of the IMF staff's analysis of economic developments or with the policy dialogue with national authorities.

Recently, a new World Bank-IMF operational framework for debt sustainability in low-income countries was proposed (IMF/World Bank 2004) and has discussed by their respective boards. It purports to offer a forward-looking approach that will involve conducting a more systemic analysis of borrowing countries ability to repay debt before loans are approved. The proposed new framework is based on two broad pillars:

- Indicative country-specific external debt-burden thresholds that depend on the quality of the country's policies and institutions;
- An analysis and careful interpretation of actual and projected debt-burden indicators under a baseline scenario and in the face of plausible shocks.

> *"The proposed debt thresholds are based on empirical analysis undertaken both at the Bank and the IMF which demonstrate that there is significant dispersion in the debt ratios that countries can sustain: countries with weaker institutions and policies are likely to experience debt distress at significantly lower debt ratios. Projections of debt burden indicators are essential for a forward-looking analysis, and need to incorporate, among other things, judgements on the evolution of domestic public debt and private external debt over the projection period as well as the impact of normal volatility on a country's repayment capacity".*

Table 4.2 Example debt sustainability analysis: Benin

(Source: www.imf.org/external/np/hipc/pdf/benin.pdf)

	1996	1997	1998	1999	2000	2005	2010	2015	Average 1997-2005	Average 2006-2015
Baseline scenario										
Debt and debt service indicators 1/										
Debt service ratio 2/	12.8	10.3	9.2	9.4	9.6	6.8	5.4	6.1	8.6	5.8
Multilateral debt-service ratio 3/	5.2	5.8	6.6	6.6	6.9	4.5	1.7	1.4	6.0	2.0
Debt service as a percentage of										
Government revenue (excluding grants)	20.9	17.1	16.0	16.1	16.4	11.4	8.5	9.0	14.6	9.0
Government expenditure	16.0	12.5	12.0	12.4	12.8	9.1	7.2	8.1	11.3	7.7
NPV debt-export ratio 4/	162.7	148.9	136.1	123.6	113.1	94.0	80.9	68.9	113.3	81.1
NPV debt to government revenue	245.9	231.0	211.6	193.4	180.5	146.5	118.9	94.6	178.5	118.9
Debt-to-GDP ratio	70.4	55.1	49.4	45.3	42.5	35.6	32.7	28.8	42.4	32.1
Key assumptions/Projections 1/										
Real GDP growth	5.5	5.8	6.2	6.2	5.0	5.0	5.0	5.0	5.4	5.0
Export volume growth	21.6	13.6	18.4	7.6	8.0	6.6	5.8	6.4	8.8	6.2
Import volume growth	-3.2	5.2	11.2	6.0	5.6	5.1	5.1	5.1	6.2	5.1
Terms of trade (percent change)	-6.6	-8.3	3.8	1.1	0.7	-0.1	0.1	0.2	0.0	0.1
Current account (percent of GDP)	-4.9	-4.6	-4.2	-4.2	-4.1	-3.8	-3.4	-3.0	-4.1	-3.4
Excluding official transfers	-7.1	-6.5	-5.2	-4.8	-4.3	-4.0	-3.6	-3.1	-4.6	-3.5
Net official transfers (percent change in dollar terms)	10.9	19.6	-14.7	1.2	1.5	1.6	1.6	1.6	1.3	1.6
Financing gap (percent of GDP)	0.0	0.7	0.2	-0.1	0.0	-0.1	-0.5	-0.5	0.1	-0.4
Sensitivity analysis										
Debt and debt-service indicators 1/										
Debt-service ratio 2/	12.8	10.3	9.5	9.9	10.4	8.4	7.6	9.3	9.5	8.2
Multilateral debt-service ratio 3/	5.2	6.1	6.0	6.4	6.8	5.0	2.1	1.8	6.2	2.4
Debt service as a percentage of										
Government revenue (excluding grants)	20.9	17.1	16.5	17.0	17.7	13.6	11.5	14.2	15.9	12.5
Government expenditure	16.0	12.5	12.0	12.5	13.1	10.1	9.2	11.4	11.9	9.9
NPV debt-export ratio 4/	162.7	148.9	138.5	129.4	122.9	118.6	112.1	101.2	126.1	112.0
NPV debt to government revenue	245.9	231.0	218.3	206.3	197.7	183.4	162.3	145.8	199.1	164.0
Debt-to-GDP ratio	70.4	55.1	51.5	49.5	48.3	47.1	46.7	44.7	48.9	46.3
Key assumptions/Projections 1/										
Real GDP growth	5.5	5.8	3.0	3.0	3.0	3.0	3.0	3.0	3.3	3.0
Export volume growth	21.6	13.6	11.0	5.0	5.8	2.4	1.9	2.0	5.2	2.0
Import volume growth	-3.2	5.2	5.2	3.2	2.9	3.2	3.2	3.2	3.6	3.2
Terms of trade (percent change)	-6.6	-8.3	3.8	1.1	0.8	0.0	0.1	0.2	0.0	0.1
Current account (percent of GDP)	-4.9	-4.6	-3.9	-3.8	-3.6	-3.5	-3.7	-3.7	-3.7	-3.7
Excluding official transfers	-7.1	-6.5	-4.9	-4.5	-3.9	-3.7	-3.9	-3.9	-4.2	-3.9
Net official transfers (percent change in dollar terms)	10.9	19.6	-14.7	-1.1	-0.3	2.6	2.7	2.7	1.4	2.7
Financing gap (percent of GDP)	0.0	1.4	0.6	0.6	0.6	2.1	1.0	0.8	1.2	1.2

1/ After debt relief from Paris Club creditors and assumed debt relief from non-Paris Club creditors.
2/ In percent of current-year exports of goods and nonfactor services.
3/ Including IMF.
4/ NPV of debt as a ratio of three-year average of exports of goods and nonfactor services.

The proposal argues that these two pillars, in combination with other relevant country-specific considerations, can help in the design of an appropriate external borrowing strategy under which the amount and terms of new financing would facilitate progress toward achieving the MDGs and generate a sustainable debt and debt-service outlook. The proposed framework has had a mixed reception. NGOs have generally applauded the proposal to abandon the previous standard debt-to-exports threshold and take the potential impacts of shocks more seriously. Box 4.13 illutstrates how the proposed approach would operate.

Many countries are now conducting DSA, whether it be for HIPC eligibility testing[5] or for determining whether a country is facing an unsustainable debt situation. The UK Crown Agents now offers expertise to undertake DSA. Their website (www.crownagents.com/debt/default.asp?pid=691&step=4) lists the three key determinants of sustainability as: the existing stock of debt, the development of fiscal and external repayment capacity which is linked closely to economic growth, and the availability and concessionality of new external financing. Conducting a DSA provides important data not only for improving specific debt management operations but also in formulating accurate and prudent macroeconomic policies (focusing on fiscal policies, economic growth and assuring access to adequate concessional flows from the international community).

[5] The conventional measurement of whether a country is eligible for debt relief under Highly Indebted Poor Countries (HIPC) terms = Net Present Value (NPV) of debt to exports ratio of 150%.

Box 4.13: Debt sustainability analysis – illustration of approach of the proposed new IMF-World Bank framework

"In general the sustainability of both external and public sector debt should be assessed separately, unless domestic debt of the public sector (external debt of the private sector) is negligible, in which case a single analysis of external (public) debt would be deemed sufficient. Moreover, in those low-income countries that have access to private international capital markets and hold relatively small amounts of concessional debt, the IMF's existing template for countries with "significant market access" may be a more suitable analytical tool to assess debt sustainability.

The results of the external debt sustainability analysis are summarised in the left-hand panels of Figure 4.2 for hypopthetical country A. Based on an assessment of Country A's policies and institutions, debt-burden thresholds of 40% of GDP and 180% of exports are deemed appropriate upper benchmarks for the net present value (NPV) of its exports. A comparison of the projected debt-burden ratios with these thresholds suggests that Country A's debt situation, while projected to improve in the long run, is tight over the medium term, with little room for borrowing beyond what is projected in the baseline.

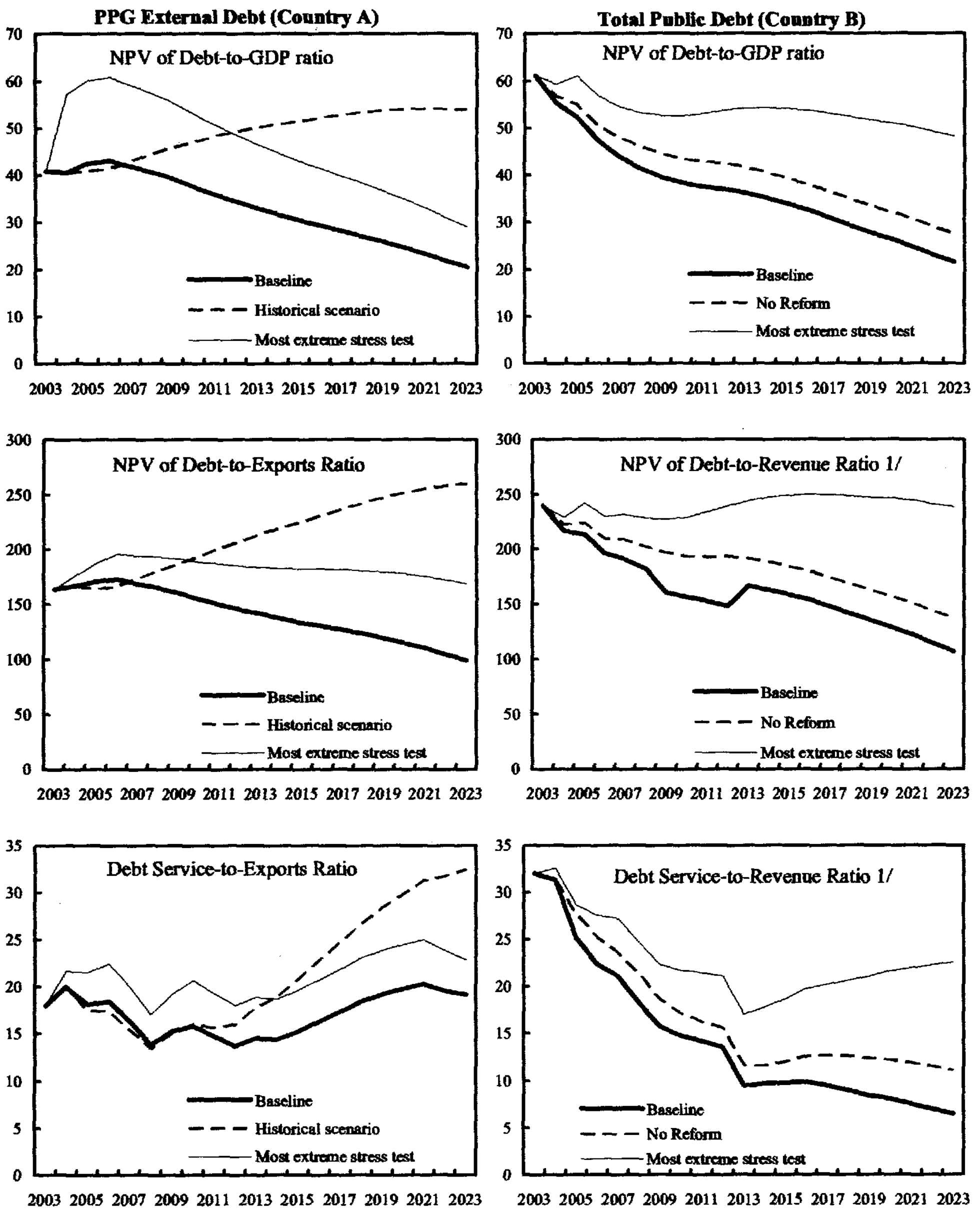
Stress tests confirm this preliminary conclusion. The analysed stress tests include a "historical scenario" where key variables are assumed to be at their historical averages, an "adverse financial scenario", simulated as a consistently higher interest rate on new borrowing, and so-called "bound tests" that model the implication of temporary adverse deviations in key parameters from the baseline projections – with the size of the deviations informed by Country A's historical experience, measured by averages and volatility. The interpretation of the bound tests is linked to projections 10 years ahead, at which point they correspond roughly to an average probability of 25%. Country A's historical scenario produces a considerable deterioration in the debt-burden indicators over time. The reason for the deviation from the baseline is the gap between current outlook for foreign direct investment (FDI) inflows, which is projected to shrink over time. Thus, a convincing case for the favourable outlook of FDI flows and the current account would have to be made, in this specific case, to justify the baseline projections. Moreover, four of the six bound tests result in NPV of debt-to-GDP ratios that exceed the indicative threshold by 4-7 percentage points after 10 years. The analysis therefore suggests that Country A should try to seek higher concessionality in its new financing or keep its borrowing levels below those envisaged under the baseline to create more room for manoeuvre in the event of adverse shocks. A revision of borrowing plans would seem warranted, in particular, if FDI inflows over the coming years fall short of expectations.

The analysis of public debt sustainability in Country B is summarised in the right hand panels of Figure 4.2. Country B's government has considerable domestic obligations of 20% of GDP, which are included in the NPV simulations at their face value. However, due to HIPC (Highly Indebted Poor Country) assistance, the external component of Country B's public sector debt is below its assumed indicative thresholds pf 45% of GDP and 200% of revenues, including grants, in present value terms. Both overall and external debt are projected to improve considerably over time, on account of strong GDP growth (relative to Country B's history) and front-loaded fiscal adjustment. Total debt service, which absorbs more than 30% of revenues in the near term, is projected to fall rapidly, as expensive domestic debt is being reduced.

The stress tests, which are applied to total public debt, suggest that Country B's debt dynamics are particularly vulnerable to a weaker growth outlook. While the "historical scenario", as well as a "no-reform scenario" (akin to an unchanged primary balance) would imply a favourable debt outlook – though less optimistic than under the baselines – slower long-term growth would keep debt ratios high. Vulnerability to weaker growth is also confirmed by the "bound tests". Reflecting Country B's poor and volatile historical growth record, the standard two-period shock to growth would be sufficient to keep NPV of overall public debt high after 10 years, at about 55% of GDP and 245% of revenues. With projected domestic debt of less than 7% of GDP and 30% of revenues, the implied ratios for PPG external debt would be slightly above their respective thresholds. Although total debt service would remain below 20% of revenues, Country B's borrowing strategy would have to be revisited, if the optimistic growth assumptions fail to materialise in the coming years. More generally, an adjustment strategy focused on raising revenues rather than relying on spending cuts, would appear more viable to protect priority expenditure in the event of adverse macro-economic developments".

Source: IMF/World Bank (2004)

Figure 4.2: Simulations of debt-burden indicators under alternative scenarios, 2003-2023 (in percent) (Source: IMF/World Bank 2004)



Source: Staff simulations.
1/ Revenues are defined inclusive of grants.

4.8 Advanced sustainability analysis (ASA)

ASA is a mathematical information system for analysing macro-economic data from different sustainability points of view. The empirical analyses can be conducted at any spatial level with adequate statistical macro-economic and environmental data available from the global level to regional and country levels.

> "The method decomposes environmental, workforce or welfare data into different effect components. The explanatory variables used in the decomposition analysis are the economic growth, population growth, and material intensities. The decomposition gives rise to the ASA-concept system of sustainability including dematerialisation of production, rebound effect of growth, sustainable technology development, sustainable growth, sustainable structural shift of the economy, , welfare productivity of GDP, immaterialisation of consumption, and forward or landing place sustainable scenarios" (Malaska 2003).

The ASA approach differs from concepts such as the 'ecological footprint' or 'ecological rucksack' since it "does not reveal 'state or level' information but information of a direction of change of the levels".

4.9 Conclusions

The main strength of economic approaches to sustainability assessment is in the extent of integration that they achieve between the different dimensions, particularly environmental and economic variables. They are also useful in illuminating the complex relationships between economic, environmental and social variables, improving the predictive and explanatory power of ex ante and ex post sustainability assessment. Where economic assessments are transparent about the assumptions made, they can provide useful information for stakeholders on the tradeoffs between different types of variables and the effects on different groups. This can provide a starting point for negotiation on policy.

Considerable progress has been made in developing methods for valuing environmental goods and services. People may disagree about the estimates made and the precise techniques but there is increasing acceptance of the idea that the costs and benefits of environmental goods and services can be considered in monetary terms. Policy makers are increasingly drawing on economic valuation to inform their decisions. The main weakness of economic approaches is the complexity of the various valuation methodologies and the modelling techniques. The financial resources and time needed for a rigorous application of economic modelling and valuation techniques are seldom available. This means that simple approaches often need to be adopted and assumptions made, thus reducing credibility. Complexity can also have the effect of reducing the transparency of economic approaches, with adverse implications for their ability to influence policy and to inform stakeholder discussions.

There has been less progress in integrating social issues into economic approaches to sustainability. This reflects a lack of clarity about the concept of social sustainability and what it covers. Where attempts have been made to integrate economic and social issues, as in the case of indicators of sustainable economic welfare, the results are not very credible because of the arbitrary assumptions involved. In the past, monetary valuation of environmental goods and services has paid insufficient attention to their value for different groups in society, although there are signs of change in this respect. There is still limited understanding of how policy and project interventions can affect social capital and the economic importance of this. More attention is needed by economists to the social dimension of sustainable development.