

Accounting for the Environment or for Sustainable Development?

Robert D. Cairns
Department of Economics, McGill University
855 Sherbrooke St W
Montreal Canada H3A 2T7
Email robert.cairns@mcgill.ca

Abstract

Economic sustainability or intergenerational equity entails maintaining social well being by decisions about investments in different types of asset. Under certain conditions, consumption can be sustained by depleting resources, or various kinds of natural capital, while building up other kinds of capital. Theoretically, the choices involve the use of a set of accounting prices. The question becomes one of finding and implementing accounting prices that express the roles of the various capital goods in achieving the objective of the economy.

Hartwick's rule holds that an economy can be sustained if the value of the total, net investment in the economy, evaluated at those accounting prices, is zero. The rule applies to a special, abstract economic model which expresses a social objective different from the utilitarian objective on which national accounting is based. Different objectives give rise to different accounting prices. Because the prices may not be right, the zero-net-investment rule using available national-accounting prices cannot generate a condition for sustaining an economy.

Still, environmental accounting is a tool which, used prudently, can make an important contribution to social decision making. This paper expands upon these ideas by discussing the incorporation of natural resource and intangible environmental costs and benefits into green accounting at the firm as well as the economy level. Common techniques of mine valuation and standard corporate accounting are the bases for this extension to the valuation of and accounting for decisions concerning the environment.

Key words: Sustainability, Green Accounting, Accounting Prices, Investment

Economic Statistics and Decisions

What does it mean for a society to be sustainable or sustained? What should the society attempt to sustain? Can the 'degree' of sustainment be measured? In reading about such questions one is impressed, not by progress toward the goal of sustaining society, but by the vagueness of the concept. In a frequently cited statement, the Brundtland (1987) Report argues for a balance between the needs of the present and of the future. But needs are not specified and more importantly the balance to be implemented is not defined. In the intervening years, the notion of sustainment has come to encompass all that the proponent thinks would be ideal in a society, including such diverse goals as environmental protection, climatic stability, elimination of poverty, concern for the well being of future generations, good corporate and social governance, social inclusiveness, maintenance of small communities and ways of life, and so on.

An economist approaching the question of sustainability asks whether the concept can be defined precisely, and in particular whether there are statistics that can indicate how well society is doing at sustaining itself. Economic statistics are gathered by governmental statistical agencies that record consumers' expenditures, firms' transformations of inputs into outputs, and the activities of non-profit organizations. Each component is observed as a market transaction involving a quantity of some good, a price of the good, and the product of the two, a revenue. The revenues for different goods can be added together to form statistical aggregates. The most famous such aggregate is the gross national product, which is used by government for making policy to influence the levels of employment and inflation. There are, however, a large number of sub-aggregates.

Much that is important to modern society can be expressed using such statistics, but much cannot. For many environmental 'goods' there is a measurable quantity but no price. These goods cannot be incorporated into the market statistics, and so the statistics are incomplete in recording what 'matters' for policy.

Some environmentalists feel that the incompleteness is inescapable, that the (market) economy is only a *part of* the environment. In an obvious, physical sense, all activity occurs within the natural world. In an abstract sense, though, the economy is not limited to marketed goods. Economics is the study of how and why people make decisions. Society continually makes decisions about the environment: how much land to set aside as wildlife reserves, how much to invest in pollution control, and so on. In this way the environment becomes a part of the economy.

The decisions balance different, often conflicting, underlying values. To an economist this balance entails an implicit price. Without an *explicit* price, however, there is no way to compare the environment with the part of the economy that is mediated in markets and has prices. There is no consistent way to make or to evaluate decisions. How can a statistician make the implicit prices explicit?

This question raises a deeper question about the ultimate meaning of the statistics. The meaning needs to be clear if society is to use the statistics for making and evaluating policy. Much effort has been exerted in economics to understand the meaning of the statistics and to estimate prices for non-priced goods. Economics has an underlying criterion called *welfare* that gives meaning to a particular aggregate, the *net* national product (NNP). All that contributes to welfare, however, must be aggregated into NNP. That means finding prices for non-priced goods such as the environment.

Some economists have also attempted to use the same statistics to try to measure sustaining of the society. This paper argues that the focus of economic accounts should be welfare and that sustaining is not readily measured. Still, using the precepts of accounting, extensions can be made to

incorporate the environment in a way that expresses social values.

Green Accounting

In a real economy there are many types of *capital*. Capital is any good, even an abstract one such as knowledge or environmental quality, about which decisions are made over an interval of time in order to contribute to some underlying purpose or objective. A change (positive or negative) in any capital good is a net investment. The value of a net investment is obtained by multiplying the physical change by a price that summarizes the contribution of the capital good to the underlying purpose.

Economists usually represent the underlying purpose using a *utilitarian welfare function*. Utilitarian welfare is the present value of all future consumption. The method of compound interest is used to discount the level of future consumption at any future time back to the present by multiplying it by a discount factor that is lower for times further in the future. The discounted values for all future times are summed over the indefinite future to yield the level of welfare.

A utilitarian welfare function can be manipulated mathematically to show that current 'interest on social welfare' (the interest rate multiplied by the level of welfare) is equal to the sum of the value of consumption and of net investment, or NNP (Weitzman 1976). The most general form of income is interest: even one's wage can be considered 'interest on' one's lifetime capacity for work. In theory, NNP is equal to the income from the total value of social capital.

In practice, however, NNP excludes many non-priced goods that contribute to welfare, either as consumption goods (e.g. beautiful scenery and pollution, considered a 'bad' with a negative price) or capital goods (e.g. the capacity of the environment to absorb pollution). The aim of green accounting is to make NNP more comprehensive by including as many non-priced goods as possible.

NNP can be made closer to comprehensive income by estimating prices for non-priced goods through cost-benefit analysis. The estimation is difficult and subject to error and interpretation. More fundamentally, if an analyst's view of social welfare does not coincide with what is implicitly being pursued by the economy then the observed market prices used in comprehensive NNP are not the desired or 'right' accounting prices.

It is difficult to imagine using other than the observed, market prices in economic statistics. Otherwise, an unimaginably far-reaching analysis would have to be undertaken, itself subject to error and still subject to the analyst's own perception of how to express social welfare mathematically. People do base their decisions on market prices and do adjust to them. There is some justification for using market prices in general as measuring social value and adjusting those that are obviously wrong, provided that one is prepared to accept that the market, as constrained by government, does an acceptable job of promoting social welfare.

Sustainability

Sustaining means many things to many people. However, *any* definition of sustainability must encompass what is known as *intergenerational equity*. In analyzing the use of an exhaustible resource, oil, through time, Solow (1974) applied the following criterion: a society's success should be judged by the standard of living of the least fortunate generation looking forward from the present. His objective, called the *maximin* objective, was to maximize that minimum standard of living, an objective that contrasted starkly with the utilitarian one of maximizing present value. Discount factors, by which the consumption of future generations had steadily decreasing weight in utilitarian welfare, were not

considered equitable and were not applied. In Solow's model it was mathematically certain that, with an exhaustible supply of oil and a constant interest rate, society could not be sustained if it maximized present value. On the other hand, if manufactured capital (or any other productive stock over which society had control) was sufficiently substitutable for oil (natural capital), then there existed a constant level of consumption that could be enjoyed forever by building up manufactured capital as the natural capital was depleted asymptotically to zero.

A mathematical condition for intergenerational equity in a general maximin problem, with many types of capital goods, is *Hartwick's rule*, that the total value of the net investments in the economy be equal to zero at all times (Hartwick 1977). The appropriate prices, as well as the changes in the levels of stocks, are part of the mathematical solution to the maximin problem.

Sustainable Development

The interest of developing countries is in an extension of sustaining that encompasses increasing consumption until a 'developed' state is reached. Mink (1993) discusses links between poverty and environmental exigencies, and policies to break out of the trap of poverty with a degraded environment. Solow (1993) is clearly sympathetic.

In *Finance and Development*, 1993, the World Bank considers various perspectives on valuing the contribution of the environment. Serageldin (1993) puts the case persuasively that the concepts of green accounting and sustainable development are important to many developing countries which produce and export resources. These countries need to ensure that the use of their resources is consistent with their chosen criterion of social development, and hence that environmental deterioration and resource depletion are correctly recognized in their decisions. However, Serageldin argues that "conventional national accounts...do a poor job of measuring sustainable income or changes in a nation's productive capacity." (It is argued below that these two concepts are not necessarily the same, and that sustainable income cannot be measured with available statistics.) Steer and Lutz (1993) convincingly argue the case for green accounting and entitle their paper, "Measuring Environmentally Sustainable Development". The problem is pressing: Rees (1993), an ecologist, complains that "well defined and generally accepted measures of environmental and natural-resource management are in short supply."

Since the 1970s, natural resources and the environment have been the main motivators of extending the national accounts, especially to extend NNP to incorporate all measurable contributors to social well being. They have served a similar purpose in discussions of sustaining the economy or of sustainable development. Each has a mathematical representation of a social objective that gives rise to accounting prices. Many observers have the impression that the accounting prices are the same for both purposes. As a result, since the late 1980s, green accounting has been strongly associated with accounting for sustainability and for sustainable development. The 'zero-net-investment rule' has been applied to evaluate the degree of sustainment, and then extended to prescribing positive net investment for sustained development.

The national accounts provide valid expressions of national income and net investment only if the social welfare function is utilitarian. Many argue that a possible criterion of sustaining the economy is that the present value does not change through time. It is mathematically true that net investment is zero if the present value remains constant, and vice versa. This result looks a lot like Hartwick's rule for a maximin economy. Furthermore, if net investment is positive, the welfare function is increasing, and vice versa. This result looks like a neat prescription for sustainable growth or development. But the theoretical justification for Hartwick's rule applies to constant consumption in a maximin problem,

not increasing consumption in a utilitarian problem. In accounts that refer to a utilitarian objective, net investment can be shown to be zero or positive only for the current moment. Sustainable development would require that net investment be zero or positive forever, not just currently or even over the next several years.

This seemingly esoteric point has real implications. Environmentalists claim that growth in a market economy can continue for a period (even several decades) before the economy depletes its natural capital sufficiently to enter a long-term decline. The possibility of this decline is the reason for studying sustainability. Implementing zero comprehensive net investment using the accounting prices that pertain to a utilitarian welfare function is no guarantee that decline will not set in eventually. Solow's example, in which sustainment is mathematically possible but a utilitarian economy eventually declines, is theoretical evidence of that point.

The Economic Implications of Green Accounting

Computing the maximin prices rule for sustaining an economy would demand formidable knowledge on the part of statisticians. Sustainability accounts would not be an adjustment or an extension to, but a total break from, the national accounts. Also, there is no provision for growth (sustainable development) in a maximin program. In practice, sustainability accounting would have the following serious drawbacks:

1. Accounting prices of all resources would have to be determined from the solution to the infinite-horizon problem of finding the sustainable level of consumption.
2. In an uncertain world, the prices would have to be updated with each major realization of a stochastic environmental event through a new computation of the optimum.
3. The optimum would have to be computed without the aid of market prices.

Rent seeking is a term referring to the use of a government's powers for the advancement of special interests opposed to the general interest. The economics of rent seeking suggests that the authorities in any real economy would be subject to interest-group pressures in determining the prices to be used in implementing policy on sustainability. Among the special interests one must include environmentalists. Like everyone else's, their policy proposals usually demand sacrifices from people other than themselves. Hotelling (1931), for example, warned that, by advocating increases in price to reduce demand, conservationists might "play into the hands of" monopolists. The pressures would recur with the realization of any significant uncertain event. They could be strong, with especially detrimental consequences, in developing countries.

In practice, a society concerned about its future is thrown back on the use of economic statistics. Such statistics find their main justification in the model of an ideal, so-called perfectly competitive economy and are appropriate for the utilitarian measure of welfare. Economists have listed many discrepancies between the market outcomes that are summarized in the accounts and a particular, possibly even persuasive, version of welfare. The main interpretational difficulties are:

1. If there are important divergences from competition, market prices are not the right ones for utilitarian welfare.
2. The statistics imply discounting the well being of future generations. Discounting is an unappealing feature to many and is contrary to the value expressed in sustainability.
3. Hartwick's rule for sustaining an economy is not applicable when prices pertaining to utilitarian welfare are the basis for evaluating net investments. The national accounts are no guide for sustainment or sustainable development.

Even so, society does function in an economy and responds to market prices. Especially in a democracy, the market economy does at least as well as other types of economic organization in achieving the common good. Extending the national accounts to include the services and degradation of the environment does have positive features:

1. Although non-ideal prices are used, the method is based on a theoretical ideal that is well understood.
2. To the extent possible, the accounts use observable, market prices.
3. The market prices adjust to all available information about exogenous and random events. Therefore, computing stochastic accounting prices is not necessary.
4. If there is no market price or the market price is far from the appropriate accounting price, an accounting price can be determined using cost-benefit analysis.
5. The potential for abuse of cost-benefit techniques is well understood. Consequently, the effects of rent seeking are more transparent.
6. If development, defined as steadily increasing comprehensive NNP toward a 'developed' level, is successful, then there should be improvements, not just sustaining, of the environment and other features of the quality of life, as perceived by society in general if not environmentalists. The way to improve the environment may be to increase people's general income.

What of sustainable development? It is wise to accept that there is no statistic that can be devised to measure sustainment or especially sustainable development. In poor societies, growth is a good thing, and continuing increases in general productivity (positive net investment) will achieve that growth. The maximin model reminds the analyst that protecting the environment is not an absolute value, but that the environment contributes to human well being. Positive net investment is not always a good thing, however. Brundtland requires that present needs, too, be considered, Especially if it is anticipated that future generations will be much better off than the present one, intergenerational justice may be served by increasing current consumption and reducing investment.

A Practical Step

Firms too are expected to do environmental accounting. Green NNP may appear to be an abstract, overly aggregated measure that is not relevant to a firm's decisions. As a summary statistic for the entire economy, it does not express the great diversity of decisions made in an entire economy. But it would be a misapprehension to condemn it for being the summary that it is intended to be.

Extending the national accounts is practical in that it yields a firm-level method for accounting. Like the traditional national accounting of which it is an extension, green NNP is a linear aggregate (a sum of prices times quantities) of the values of the activities occurring in society. The traditional aggregate is obtained by observations of the decisions of a myriad of small, diverse decision-making units. The accounting identities -- the equality of income and product -- and the double-entry bookkeeping that maintains the equality apply to the decisions of the small units as well as to the whole economy. Since all the statistics are sums of revenues, the data gathered for the small units can be aggregated in any way that the user wishes. Many intermediate aggregates are quoted in the national accounts. The summary statistic, gross national product (GNP), is reported because of its usefulness for economic policy. Similarly, NNP is a useful expression of aggregate income.

As in the conventional national accounts, however, firms do not explicitly account for the use of the environment, because, having no price, this scarce, valuable resource is exploited as if it were free. Many observers have pointed out that a mining firm, say, does not record in its accounts the fact that the mineral, a social resource, is being depleted, and have claimed that the failure is significant.

Only in a very nuanced sense is the claim valid, and the nuances have not been taken into account adequately in most economic analysis to date. It is true that, while the mineral is being depleted, the *social* value added by the firm is less than is recorded in its income statement. An inconsistency arises, however, from the uncritical application of simple economic models.

In normal accounting, a part of cash flow is set aside for depreciation of the manufactured capital invested in the mine. Likewise a part should be set aside as depletion of the mineral. According to economic theory, the recorded depletion (depreciation of the value of the mineral) should be the value that is given up in the future because the resource is extracted for use now. If there are constant returns to scale in mining, Hotelling's rule from the economics of exhaustible resources suggests that what is given up is equal to the entire net income of the mining firm. Constant returns are a reasonable approximation, routinely used by engineers. This reasoning implies that the value added by a mine producing at constant returns to scale is nil: society would be as well off without the mining industry as with it! The implication is not plausible and Cairns (2004) has found that the reasoning behind it is not valid. The correct depletion is small compared to what is proposed by an analysis that does not recognize the investment of manufactured capital. It is a fraction of the net income that is reported in the corporate accounts.

The argument leading to this conclusion may be unfamiliar because it is a combination of reasoning from economics and accounting, and so it may require some contemplation before it reveals itself as straightforward. If the depreciation of the value of the mineral is to be recorded then it must be the depreciation of an investment. When a mineral deposit is developed by combining it with other capital to create a mine, someone (a private concern, a government, an aboriginal people, humanity in general) must, in a very general sense, own it. In effect, the owner invests the deposit in the enterprise. It is an accounting and an economic principle that over the life of an asset depreciation sums to exactly the value of the investment made. If green accounting is done correctly, the value of the investment is equal to the present value of the deposit. In turn this value is equal to the total (undiscounted) value of the depletion that will be reported as the mineral is extracted.

Some comparisons spring to mind.

1. If a large firm buys the rights to a property from a small firm, the cost is recorded as an investment in the large firm's accounts. The investment is expensed or depreciated.
2. If a firm develops a discovery on government land, the investment by government is, in theory, equal to the present value of the mineral.
3. In either situation, the owner may not be able to obtain the full present value because of, for example, a lack of information or bargaining power. In this case, the shortfall is a transfer from the owner to the firm. A government 'invests' the present value of its royalties and the firm 'invests' the shortfall.

Whatever may be the transaction, the total 'investment' is the net present value. In the aggregate account (for NNP), the utilitarian analysis (based on the present value of consumption) also holds that the present value is first invested and then depreciated.

If the owner's investment is correctly recorded, over the life of the mine the algebraic sum of the investment and the (undiscounted) depreciation is zero. In current practice it may be that none or only a part of the investment is recorded. In current practice, then, over the life of the mine, the algebraic sum is zero. Standard corporate accounting does not correctly record (all of) the investment and its depreciation. The method is imperfect. Still, the present value of net income recorded by the firm and the owner is the same in both the ideal green account and the corporate account. Also, the accounting method, including the accounts of the firm and the owner, 'corrects' itself in the sense that, at the end of the mine's life, the difference between investment and depreciation is zero.

Surprisingly, there is a conceptual and practical gain from the imperfection. Ideal green accounting requires an estimate of the investment made by the owner. This present value is the present value of the mine minus the investment of other capital. By recording only observed payments (purchase price, royalties, etc.), traditional accounting avoids the need (a) to estimate a present value of the mineral at the time of initial investment, and (b) to update that estimated present value throughout the mine's life as the ore is mined, adjusting not just for physical extraction but for price movements as well. The gain is very great: green-accounting estimates of the depletion of oil reserves over the past half-century, even when done in hindsight so that the true path of prices is known, have all had to deal with enormous annual revisions of mineral values because of price changes. The reported figures have looked silly and have been useless for policy analysis.

The upshot is that the traditional accounting for the *commercial* aspects of mining (and other) enterprises is adequate for use in the green accounts. It does not need adjustment, and any attempt to adjust leads to reports that are difficult to interpret. Mine valuation using standard accounting techniques is valid and is the correct basis for commercial decisions concerning investment in and production from mineral deposits.

Indeed, if one has a good economic intuition about the role of such an economic institution as accounting and about the role of the mining engineer, then one should expect to conclude that they have evolved to use methods and to report figures that are the best attainable estimates of the commercial value provided by mining enterprises. As further introspection suggests, if one applies economic reasoning correctly one should conclude that the mining and petroleum and forest and other resource industries provide substantial value to a modern society.

Traditional accounting, however, was devised for commercial transactions, not for the non-priced effects that are created by economic activities, including the resource industries'. There ought to be an adjustment, using the 'right' prices, for any harm done to the environment by, say, a mining enterprise. How can one estimate the right prices? One must refer to social norms, as expressed in regulations, laws, customs and accepted practice, and let the prices evolve as these underlying features of the society are changed. Cairns (2004) suggests a conceptual method, based on techniques of commercial mining valuation, to account for environmental costs by a mining firm. In general, non-market valuation is a difficult, contentious subject of economics, pioneered by environmental economists and still being researched.

Conclusion

The way forward seems clear: Accept the accounts as they are for commercial transactions. Adjust for non-priced costs and benefits to provide a statistic that can be used in making and evaluating social policy in the same way that commercial accounting is used in commercial enterprises. Correct accounting is good economics and good economics accounts correctly.

Society can benefit by using economic accounts prudently and not demanding from them what they cannot deliver. Anyone who is sceptical of the market as a social institution, including anyone who thinks that the market and economic growth will lead to ecological and social decline, will doubt the national accounts, even if they are adjusted to include cost-benefit estimates of the use or abuse of the environment. Green accounting does not provide a method of accounting for sustainability and cannot be massaged, manipulated or extended to do so. If one is prepared to accept the proposition that the market, as controlled and constrained and hindered by government, serves society tolerably well, then one can accept that green accounting provides a way of incorporating social values of non-

priced goods into economic thinking, so that some of the costs of and the potential to attain some of the vague social objectives listed in the first paragraph can be understood more fully.

Theory is easy compared to implementation. Transparency is an extremely desirable feature of policy, especially to developing countries. The national accounts are easily understood and easily calculable, using well understood procedures. They reduce the scope for rent seeking. Extending the accounts may be the practical step to recognizing the role of non-priced goods and services in economic decisions which is sought by Solow (1993).

References

Brundtland (World Commission 1987), *Our Common Future*, Oxford University Press, Oxford and New York

Cairns, Robert (2004), "Green Accounting for an Externality: Pollution at a Mine," *Environmental and Resource Economics* 27, 409-427.

Hartwick, John M. (1977), "Intergenerational Equity and the Investing of Rents from Exhaustible Resources," *American Economic Review* 67, 972-974.

Hotelling, Harold (1931), "The Economics of Exhaustible Resources," *Journal of Political Economy* 39, 137-175.

Mink, Stephen (1993), "Poverty and Environment," *Finance and Development*, December, 8-9.

Rees, Colin (1993), "The Ecologist's Approach to Sustainable Development," *Finance and Development*, December, 14-15.

Serageldin, Ismael (1993), "Making Development Sustainable," *Finance and Development*, December, 6-10.

Solow, Robert M. (1974), "Intergenerational Equity and Exhaustible Resources," *Review of Economic Studies*, Symposium Issue.

Solow, Robert M. (1993), *An Almost Practical Step Toward Sustainability*, Resources for the Future, Washington DC.

Steer, Andrew and Ernst Lutz (1993), "Measuring Environmentally Sustainable Development," *Finance and Development*, December, 20-23.

Weitzman, Martin L. (1976), "On the Welfare Significance of National Product in a Dynamic Economy," *Quarterly Journal of Economics* 90, 156-162.