

a direct substitution of capital for labor. Working at home has already become possible for larger numbers of people as computer communication provides a substitute for transportation. Such changes will boost productivity while reducing pollution and our dependence on raw materials and energy. Intelligence will eventually replace oil as the prime mover of the system. Education is, therefore, growing in importance, not only as the means of providing that skilled labor, but as the wellspring of ideas that fuel the new growth.

Other effects of the information economy will directly affect environmental policy. The lower cost of gathering, storing, and structuring information as well as the lower cost of providing more universal access to it will enable a host of new disclosure strategies. These can serve to promote both efficient policy and environmental justice. New possibilities for quick and effective information sharing streamline cooperation among governments and nongovernmental organizations as they jointly seek sustainable outcomes. Better information technology also enhances monitoring and enforcement of environmental policies, historically one of the weak links. The new analytical techniques that are part and parcel of the information economy (such as geographic information systems) will be able to provide a better foundation for policy.

Better information technology is, however, a two-edged sword. Following the events of 9/11, it has become clear that better information technology has also made coordination easier for those seeking to destroy, rather than to build. In response to that threat, governments have allowed measures that significantly change the privacy border, a different, but nonetheless troubling threat. Information technology, it seems, is a mixed bag.

The Growth-Development Relationship

Has economic growth historically served as a vehicle for development? Has growth really made the average person better off? Would the lowest-income members of the United States and the world fare better with economic growth or without it?

These turn out to be difficult questions to answer in a way that satisfies everyone, but we must start somewhere. One appropriate point of departure is clarifying what we mean by growth. Some of the disenchantment with growth can be traced to the way that growth is measured. It is not so much that all growth is bad, but that increases in conventional indicators of growth are not always good. Some of the enthusiasm for zero economic growth stems from the fact that economic growth, as currently measured, can be shown to have several undesirable characteristics.

Conventional Measures

A true measure of development would increase whenever we, as a nation or as a world, were better off and decrease whenever we were worse off. Such a measure is called a *welfare measure* and no conventional existing measure is designed to be a welfare measure.

What we currently have are *output measures*, which attempt to indicate how many goods and services have been produced, not how well off we are. Measuring output

sounds fairly simple, but it is not. The measure of economic growth with which most are familiar is based upon the GDP, or gross domestic product. This number represents the sum of the outputs of goods and services produced by the economy in any year. Prices are used to weight the importance of these goods and services in GDP. Conceptually, this is accomplished by adding up the value added by each sector of the production process until the product is sold.

Why weight by prices? Some means of comparing the value of extremely dissimilar commodities is needed. Prices provide a readily available system of weights that takes into account the value of those commodities to consumers. From early chapters we know that prices should reflect both the marginal benefit to the consumer and the marginal cost to the producer.

GDP is not a measure of welfare and was never meant to be one. One limitation of this indicator as a measure of welfare is that it includes the value of new machines that are replacing worn-out ones rather than increasing the size of the capital stock. To compensate for the fact that some investment merely replaces old machines and does not add to the size of capital stock, a new concept known as net domestic product (NDP) was introduced. NDP is defined as the gross domestic product minus depreciation.

NDP and GDP share the deficiency that they are both influenced by inflation. If the flow of all goods and services were to remain the same while prices doubled, both NDP and GDP would also double. Since neither welfare nor output would have increased, an accurate indicator should reflect that fact.

To resolve this problem, national income accountants present data on *constant-dollar* GDP and *constant-dollar* NDP. These numbers are derived by "cleansing" the actual GDP and NDP data to take out the effects of price rises. Conceptually, this is accomplished by defining a market basket of goods that stays the same over time. Each year this same basket is repriced. If the cost of the goods in the basket went up 10 percent, then because the quantities are held constant, we know that prices went up by 10 percent. This information is used to remove the effects of prices on the indicators; remaining increases should be due to an increased production of goods and services.

This correction does not solve all problems. For one thing, not all components of GDP contribute equally to welfare. Probably the closest component we could use in the existing system of accounts would be consumption, the amount of goods and services consumed by households. It leaves out government expenditures, investments, exports, and imports.

The final correction that could easily be made to the existing accounts would involve dividing real consumption by the population to get *real consumption per capita*. This correction allows us to differentiate between rises in output needed to maintain the standard of living for an increasing population and rises indicating more goods and services consumed by the average member of that population.

Real consumption per capita is about as close as we can get to a welfare-oriented output measure using readily available data. Yet it is a far cry from being an ideal welfare indicator.

In particular, changes in real consumption per capita fail to distinguish between economic growth resulting from a true increase in income, and economic growth

resulting from a depreciation in what economists have come to call "natural capital," the stock of environmentally provided assets such as the soil, the atmosphere, the forests, wildlife, and water.

The traditional definition of income was articulated by Sir John Hicks (1947):

The purpose of income calculations in practical affairs is to give people an indication of the amount they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning. [p. 172]

While human-created capital (such as buildings, bridges, and so forth) is treated in a manner consistent with this definition, natural capital is not. As human-created capital wears out, the accounts set aside an amount called depreciation to compensate for the decline in value as the equipment wears out. No increase in economic activity is recorded as an increase in income until depreciation has been subtracted from gross returns. That portion of the gains that merely serves to replace worn-out capital is not appropriately considered income.

No such adjustment is made for natural capital in the standard national income accounting system. Depreciation of the stock of natural capital is incorrectly counted as income. Development strategies that "cash in" the endowment of natural resources are in these accounts indistinguishable from development strategies that do not depreciate the natural capital stock; the returns from both are treated as income.

Consider an analogy. Many high-quality private educational institutions in the United States have large financial endowments. When considering their budgets for the year, these institutions take the revenue from tuition and other fees and add in some proportion of the interest and capital gains earned from the endowment. Except in extraordinary circumstances, standard financial practice, however, does not allow the institution to attack the principal. Drawing down the endowment and treating this increase in financial resources as income is not allowed.

Yet that is precisely what the traditional national accounts allow us to do in terms of natural resources. We can deplete our soils, cut down our forests, and douse ocean coasts with oil, and the resulting economic activity is treated as income, not as a decline in the endowment of natural capital.

Because the Hicksian definition is violated for natural capital, policy-makers are misled. By relying upon misleading information, policy-makers are more likely to undertake unsustainable development strategies.

Adjusting the national income accounts to apply the Hicksian definition uniformly to human-made and natural capital could, in resource-dependent countries, make quite a difference. For example, Robert Repetto (1989) and colleagues of the World Resources Institute studied the growth rates of gross national product in Indonesia using both conventional unadjusted figures and figures adjusted to account for the depreciation of natural capital. Their study found that while the unadjusted gross national product increased at an average annual rate of 7.1 percent from 1971 to 1984, the adjusted estimates rose by only 4.0 percent per year.

Motivated by a recognition of these serious flaws in the current system of accounts, a number of other industrial countries have now proposed (or in a few

cases have already set up) systems of adjusted accounts including Norway, France, Canada, Japan, the Netherlands, and Germany. Significant differences of opinion on such issues as whether the changes should be incorporated into a complementary system of accounts or into a complete revision of the standard accounts remain to be resolved.

In the United States, the Bureau of Economic Analysis (1994) published some initial estimates of the value of the U.S. stock of minerals—oil, gas, coal, and non-fuel minerals—and how the value of that stock (in constant dollars) has changed over time. The objective was to determine whether current use patterns are consistent with the constant-value version of the sustainability criterion. Declining values would indicate a violation of the criterion while constant or increasing values would be compatible with it. In general they found that the value of additions just about offset the value of the depletion; for the period 1958–1991, their estimates suggest that the criterion was not violated. It is not possible to examine what has happened over time since these estimates fell victim to budget cutting and were discontinued.

Alternative Measures

Are we fulfilling the sustainability criterion or not? Although that turns out to be a difficult question to answer, a number of indicators have now been designed to allow us to make some headway. These indicators differ in both their construction and the insights that can be derived from them.

Adjusted Net Savings. We begin with an indicator that attempts to provide an empirical method for judging whether or not we are fulfilling the weak sustainability criterion. Recall from Chapter 5 that a decline in total capital indicates unsustainability according to the weak sustainability criterion. This implies that net savings, which is the addition to the value of total capital, must be positive. Negative net savings implies that the total capital stock has gone down, a violation of the criterion.

Adjusted net savings (formerly called “genuine savings”) is the sustainability indicator that examines a net savings concept that explicitly considers natural capital. Constructed by the Environmental Economics group of the World Bank, adjusted net savings estimates are derived by making four types of adjustments to standard national accounting measures of gross national savings. First, estimates of capital consumption of produced assets are deducted to obtain net national savings. Second, current expenditures on education are added to net domestic savings as an appropriate value of investments in human capital (in standard national accounting, these expenditures are treated as consumption). Third, estimates of the depletion of a variety of natural resources are subtracted to reflect the decline in asset values associated with their extraction and harvest. Estimates of resource depletion are based on the calculation of resource rents. Rents are derived by taking the difference between world prices and the average unit extraction or harvest costs (including a “normal” return on capital). Finally, pollution damages are deducted. Because many pollution damages are local in their effects, and therefore difficult to estimate without location-specific data, the World Bank estimates include only global climate change damages from carbon dioxide emissions.

What do these estimates show? Generally, adjusted savings indicate that the countries violating the weak sustainability criterion are some of the former Soviet Republics and countries in Sub-Saharan Africa and the Middle East.² Higher-income countries are generally estimated to be weakly sustainable because their savings and expenditures on education are large enough to offset declines in the value of natural capital.

Wealth Estimates. The World Bank has also begun collecting wealth estimates for a large group of countries. The wealth estimates include produced capital, natural capital, and intangible capital. This latter category includes human capital, institutions, and governance. For all countries, intangible capital makes up the largest component of wealth, but for the poorest developing countries, natural capital is also a significant component and is larger than produced capital.³ Traditional measures of wealth may underestimate the significance of this fact, if sale of natural resources shows up as income.

Genuine Progress Indicator. The Genuine Progress Indicator (GPI), developed and maintained by an organization called Redefining Progress in San Francisco, differs from adjusted savings in two main ways: (1) it focuses on an adjusted measure of consumption, rather than savings, and (2) it includes many more categories of adjustments.⁴

The GPI adjusts national personal consumption expenditures in several ways. The most unique (and the most controversial) adjusts personal consumption expenditures for income distribution; more equal income distributions increase the GPI, while less equal income distributions reduce it.⁵ Using personal-consumption expenditures adjusted for income inequality as its base, the GPI then adds or subtracts categories of spending based on whether they enhance or detract from national well-being. Examples of additions include the value of time spent on household work, parenting, and volunteer work; and the value of both services of consumer durables (such as cars and refrigerators) and services of highways and streets. Examples of subtractions include defensive expenditures, defined as money spent to maintain the household's level of comfort, security, or satisfaction such as personal water filters, locks or security systems, hospital bills from auto accidents, or the cost of repainting houses damaged by air pollution; social costs such as the cost of divorce, crime, or loss of leisure time; and the depreciation of environmental assets and natural resources (due to the loss of farmland, wetlands, and old-growth forests; the reduction of stocks of energy and other natural resources; and damaging effects of

²Up-to-date data can be found on the World Bank's Environmental Economics and Indicators Web site: <http://lnweb18.worldbank.org/ESSD/envext.nsf/44ByDocName/GreenAccountingAdjustedNetSavings/>.

³Details on this measure can be found at <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTTEEL/0,,contentMDK:20487828~menuPK:1187788~pagePK:148956~piPK:216618~theSitePK:408050,00.html>.

⁴Details about this indicator, including the data and its calculation, can be found on the Redefining Progress Web site at <http://www.redefiningprogress.org/>.

⁵This step relies on the measure of inequality known as the Gini coefficient, which is defined in the Glossary to this text.

wastes and pollution). In 2004 for example, \$1.8 trillion is subtracted for cumulative carbon dioxide emissions. Per capita GDP in the United States was \$36,595 while the per capita GPI was estimated to be \$15,036 (2000\$).

According to this indicator, not only do traditional accounting measures such as the Gross Domestic Product considerably overstate the health of the economy, but in several years since the 1970s, per capita well-being has actually declined. In those years, declines in income inequality and leisure time, coupled with increases in the costs of crime, pollution, and other social ills, have more than offset the increases due to larger levels of economic activity and increases in socially productive activities such as volunteerism.

Ecological Footprint. Another example of an indicator, the Ecological Footprint, differs considerably from the other two in that it is based upon a physical measure rather than an economic measure. The Ecological Footprint indicator attempts to measure the amount of renewable and nonrenewable ecologically productive land area that is required to support the resource demands and absorb the wastes of a given population or specific activities.⁶ The footprint is expressed in "global acres." Each unit corresponds to one acre of biologically productive space with "world average productivity." Every year has its own set of equivalence factors since land-use productivities change over time. By comparing this "footprint" to the amount of ecologically available land, deficits or surpluses can be uncovered.

This indicator, like the others, departs from a calculation of national consumption, which is calculated by adding imports to, and subtracting exports from, domestic production. This balance is computed for 72 categories such as cereals, timber, fishmeal, coal, and cotton. The footprint (in terms of acres) for each category of resource uses is calculated by dividing the total amount consumed in each category by its ecological productivity (or yield per unit area). In the case of carbon dioxide (CO₂) emissions, the footprint is calculated by dividing the emissions by the average assimilative capacity of forests to find the number of acres necessary to absorb the pollutants.

According to this indicator, the industrialized nations have the most unsustainable consumption levels (meaning that their consumption requires more ecologically productive land than is domestically available). This analysis also suggests that current global consumption levels cannot be sustained indefinitely by the current amount of ecologically productive land—we are in a deficit situation.

The Human Development Index. One reason for dissatisfaction with all of these measures of well-being is the focus on an average citizen. To the extent that the most serious problems of deprivation are not experienced by the average member of society, this focus may leave a highly misleading impression about well-being. To rectify this problem, in 1990 the United Nations Development Program (UNDP) constructed an alternative measure, the Human Development Index (HDI). This index has three major components: longevity, knowledge, and income.

⁶The details about this indicator can also be found on the Redefining Progress Web site at <http://www.redefiningprogress.org/footprint/>. Anyone can have his/her own ecological footprint calculated by answering a few questions at <http://www.myfootprint.org/>.

Though highly controversial because both the measures to be included in this index and the weights assigned to each component are rather arbitrary, the UNDP (2004) has drawn some interesting conclusions from the results of comparing HDIs among countries:

- The link between per capita national income and human development is not automatic; it depends on how the income is spent. Some relatively high-income countries (such as South Africa and the Persian Gulf states) do not fare as well as expected in human development terms, while some low-income countries (such as Sri Lanka and Cuba) were able to achieve a higher level of human development than would be expected given their income levels.
- Nonetheless, income is a major determinant of the capacity to improve human development. It is not a coincidence that the top five countries in terms of the human development index (Norway, Sweden, Australia, Canada, and the Netherlands) are all very-high-income countries.

A Summary of Alternative Measures. All of the alternative measures described above acknowledge and attempt to address flaws in the traditional measures of wealth. Each offers a potential contribution. However, some of the characteristics of the alternative measures rely on prices to weight their importance, but in many nonmarket circumstances those prices are difficult, but not impossible, to measure (see Chapter 3).

The estimation difficulties become most problematic in developing countries where nonmarket valuation methods have been utilized the least. Whittington (2002) offers some reasons why the contingent valuation studies that have been implemented in developing countries are unreliable. Suggesting that surveys are poorly administered and poorly crafted for the target audience, he goes on to recommend more research since the questions being addressed tend to be extremely important for policy and the cost of policy mistakes can be tragic in poor countries.

The above measures all suggest that intrinsic values are important. The ability to measure these values with some confidence is vital, but difficult.

Growth and Poverty: The Industrialized Nations

Conceiving of the growth-development relationship only in terms of the effects on the average citizen obscures a great deal of what may be happening in a society. Two societies may have the same per capita growth in average well-being, but if the fruits of this growth are shared uniformly in one and unequally in the second, it seems overly simplistic to argue that the increase in welfare levels would be the same in the two countries.

While the evidence suggests that economic growth has improved the lot of the average citizen in the developed world, it tells us little about how the poorest members of society have fared. To determine whether the poorest citizens also benefit from growth, we must dig deeper into the nature of the growth process.

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