Dr. John Talberth, Clifford Cobb,
and Noah Slattery

The Genuine Progress Indicator 2006

A Tool for Sustainable Development

REDEFINING progress
The Nature of Economics

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CONTENTS

On October 28, 2005 the following headlines appeared in leading newspapers throughout the United States:

> **GDP muscles through**
> *Economy brushes off storms and expands by 3.8 percent in 3Q, beating estimates.*
> The U.S. economy shook off headwinds from hurricanes Katrina and Rita to grow at a faster-than-expected 3.8 percent annual rate in the third quarter, a Commerce Department report showed Friday. (Reuters, 2005)

Perhaps no headline in recent history does a better job of illustrating why our nation's most trusted measure of economic performance is so woefully out of sync with people's everyday experiences. In one fell swoop, these headlines dismissed the inequitable and catastrophic toll associated with 1,836 preventable deaths, over 850,000 housing units damaged, destroyed, or left uninhabitable, disruption of 600,000 jobs, permanent inundation of 118 square miles of marshland, destruction of 1.3 million acres of forest, and contamination caused by millions of gallons of floodwaters tainted by sewage, oil, heavy metals, pesticides, and other toxins as irrelevant to the U.S. economy.[1]

Few would dispute the fact that gross domestic product (GDP) fails as a true measure of economic welfare. For decades, many economists have acknowledged that the GDP has fundamental shortcomings. "GDP is not a measure of welfare," wrote William Nordhaus and James Tobin, prominent economists at Yale in the early 1970s (Nordhaus and Tobin, 1972). The GDP is simply a gross tally of everything produced in the U.S.—products and services, good things and bad. In fact, in a 1934 report to Congress GDP's chief architect, Simon Kuznets, cautioned that "[t]he welfare of a nation can scarcely be inferred from a measurement of national income" (Kuznets, 1934).

Despite these cautions, GDP maintains its prominent role as a catchall for our collective well being. Perhaps this is because there has been little consensus on a suitable replacement. Perhaps, more fundamentally, it is that there is even less consensus on how well being should really be measured and if quantitative measurements can be made at all. Nevertheless, efforts to find replacements are critical since GDP forms the basis for important public policy decisions—i.e. those predicted to increase GDP growth fare better while those shown to restrict GDP growth are often killed by political shortsightedness. Recently, GDP growth was a prominent justification for highly controversial tax cuts on capital gains while efforts to secure long overdue increases in the federal living wage have been thwarted by persistent gloom and doom forecasts with respect to effects on jobs and economic growth (Foertsch, 2006; Roth, 2005).

In this report, we present an update to the Genuine Progress Indicator—one of the first alternatives to GDP vetted by the scientific community and used regularly by government and non-governmental organizations worldwide. The GPI is a variant of the Index of Sustainable Economic Welfare (ISEW) first proposed by Daly and Cobb (1989). Both the GPI and ISEW use the same personal consumption data as GDP but make deductions to account for income inequality and costs of crime, environmental degradation, and loss of leisure and additions to account for the services from consumer durables and public infrastructure as well as the benefits of volunteering and housework. By differentiating between economic activity that diminishes both natural and social capital and activity that enhances

1 For a useful compilation of Hurricane Katrina and Rita damage statistics see: http://en.wikipedia.org/wiki/Hurricane_Katrina. For wetland loss associated with the storms see USGS (2006).

such capital, the GPI and its variants are designed to measure sustainable economic welfare rather than economic activity alone. In particular, if GPI is stable or increasing in a given year the implication is that stocks of natural and social capital on which all goods and services flows depend will be at least as great for the next generation while if GPI is falling it implies that the economic system is eroding those stocks and limiting the next generation's prospects. The GPI's structure is grounded in principles set forth in Natural Step, Hannover, Coalition for Environmentally Responsible Economies (CERES) and other sustainable development frameworks that call for no net loss of natural capital, welfare based accounting, distributional equity, and throughput minimization.

The remainder of this report is organized as follows. In "Evolution of the Genuine Progress Indicator Framework" (below), we discuss the disconnection between GDP and true economic welfare and how the GPI responds to these defects. In "Theory, Principles, and Critiques" (page 3), we review the GPI's theoretical underpinnings, place the GPI in the context of several popular sustainable development frameworks, and review critiques. In "An Updated GPI Methodology" (page 8), we explain the new methodology and rationale for making particular additions or deductions from personal consumption expenditures. In "Results and Implications" (page 18) we present results of the 2006 update and key findings. In "Using the GPI as a Guide to Public Policy" (page 20), we demonstrate how the GPI can be used to inform public policy debates using globalization, tax cuts, and sprawl as examples. Concluding thoughts and directions for future research are set forth in "Concluding Thoughts and Future Refinements" (page 28).

Evolution of the Genuine Progress Indicator Framework

What's wrong with GDP as a measure of progress?

During World War II, gross domestic product (then gross national product) accounts were introduced to measure wartime production capacity (Cobb et al., 1995). Since then, GDP has become the world's most ubiquitous indicator of economic progress. It is widely used by policymakers, economists, international agencies and the media as the primary scorecard of a nation's economic health and well-being. Yet, as we know from its creator Simon Kuznets, the GDP was never intended for this role (Kuznets, 1934). It is merely a gross tally of products and services bought and sold, with no distinctions between transactions that enhance well being and those that diminish it. Instead of distinguishing costs from benefits, productive activities from destructive ones, or sustainable ones from unsustainable ones the GDP simply assumes that every monetary transaction adds to social well-being by definition. In this way, needless expenditures triggered by crime, accidents, toxic waste contamination, preventable natural disasters, prisons and corporate fraud count the same as socially productive investments in housing, education, healthcare, sanitation, or mass transportation. It is as if a business tried to assess its financial condition by simply adding up all "business activity," thereby lumping together income and expenses, assets and liabilities.

Moreover, the GDP ignores everything that happens outside the realm of monetized exchange, regardless of its importance to well-being. The crucial economic functions performed in the household and volunteer sectors go entirely unnoticed as do ecosystem services such as flood control, water filtration, carbon sequestration, soil formation and maintenance of genetic diversity. As such, GDP devalues welfare enhancing activities such as child and elder care, mentoring, or ecological restoration. In fact, GDP ignores the entire informal, or non-cash economy—a significant component of the overall exchange system worldwide and in the United States and made up of all bartered goods and services. In a 2002 analysis, the International Monetary Fund reported that worldwide, the value added by the informal economy had reached a "remarkably large amount"—up to 44% of GDP in developing nations, 30% in transition economies, and 16% in Organization for Economic Cooperation and Development (OECD) economies (Schneider and Enste, 2002). In the United States, the size of the informal economy is not systematically surveyed, but conservative estimates place its current size as 9% of official GDP and involving up to 25 million Americans (Barber, 2003).

Because GDP fails to properly distinguish between welfare enhancing and welfare degrading expenditures and ignores non-monetized costs and benefits including all informal sector exchanges, using GDP as a barometer of overall well-being leads to some perverse results. Consider these:
GDP increases with polluting activities and then again with clean-ups. Pollution is a double benefit to the economy since GDP grows when we manufacture toxic chemicals and again when we are forced to clean them up.

GDP is boosted by crime. Each year, Americans incur nearly $40 billion in crime related costs in the form of lost and damaged property and expenditures on locks, alarms, and security systems. GDP counts these needless expenditures as an economic gain, implying that crime is good for economic growth.

GDP is oblivious to gross inequality. If a billionaire spends $10,000 more of her income on aphrodisiacs made from endangered seals it counts the same as $10,000 spent by a New Orleans flood victim on bare essentials as far as GDP is concerned. As long as overall expenditures are increasing, GDP will grow even if the increase is entirely attributable to conspicuous consumption habits of the wealthy.

GDP plummets as communities become more self reliant. If a community decided to decrease its reliance on imported food, energy, and financial markets by expanding rooftop and community gardens, farmers' markets, local currencies, and solar energy and promote social cohesion by expanding the number of goods and services exchanged by friends and neighbors, GDP analysts would call for drastic measures to save the community from impending economic collapse. GDP grows when we deplete or degrade natural resources. Clearcutting and sprawl are good for economic growth since GDP assumes forests, farmland, and wetlands have relatively little economic value if left alone.

How the GPI attempts to correct these deficiencies

Beginning with the seminal work of Daly and Cobb (1989) there have been several attempts to develop alternative national income accounting systems that address these deficiencies. Collectively, these systems measure what is commonly referred to as "green" GDP. Major objectives of these green GDP accounting systems are to provide a more accurate measure of welfare and to gauge whether or not an economy is on a sustainable time path (Hanley, 2000). Two of the most popular green GDP systems are the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI). Examples of countries with ISEW data include Austria, Chile, Germany, Italy, the Netherlands, Scotland, Sweden, and the United Kingdom, while the United States and Australia offer examples of nations addressed by proponents of the GPI (Neumayer, 2000).

While methodologies are somewhat different, the ISEW, GPI, and other green GDP accounting systems all involve three basic steps (Stockhammer et al., 1997; Neumayer, 2000). Computation usually begins with estimates of personal consumption expenditures, which are weighted by an index of the inequality in the distribution of income to reflect the social costs of inequality and diminishing returns to income received by the wealthy. Additions are made to account for the non-market benefits associated with volunteer time, housework, parenting, and other socially productive time uses as well as services from both household capital and public infrastructure. Deductions are then made to account for purely defensive expenditures such as pollution related costs or the costs of automobile accidents as well as costs that reflect the undesirable side effects of economic progress. Deductions for costs associated with degradation and depletion of natural capital incurred by existing and future generations are also made at this stage. In this way, green GDP systems correct the deficiencies of GDP by incorporating aspects of the non-monetized or non-market economy, separating welfare enhancing benefits from welfare detracting costs, correcting for the unequal distribution of income, and distinguishing between sustainable and unsustainable forms of consumption. Applications of these new accounting systems provide compelling evidence of a widening gap between traditional and green GDP, indicating that over time, more and more economic activity may be self-canceling from a welfare perspective (Max-Neef, 1995).

For example, the per capita gross domestic product of Australia nearly tripled between 1950 and 2000, rising from $10,208 to $29,928 in 2004 dollars. For the period, the average growth rate was 3.86%. In contrast, per capita GPI as calculated by Hamilton and Denniss (2000) rose from $8,074 in 1950 to $14,013, an average growth rate of just 1.47%. Importantly, the gap between the GDP and GPI has grown precipitously—from just $2,134 in 1950 to $15,916 in 2000. What this implies is that a decreasing proportion of economic benefits registered by the GDP count towards improved welfare as time goes on because such benefits are increasingly offset by the costs associated with growing inequality and deteriorating social and environmental conditions.

Theory, Principles and Critiques

Theoretical underpinnings

To understand the theoretical foundations for the GPI it is important to clarify exactly what the GPI is actually measuring. Summarizing the literature, Asheim (2000) identifies three kinds of measurements green GDP accounts such as the GPI attempt to undertake: (1) welfare equivalent income; (2) sustainable income, and (3) net social profit. Welfare equivalent income refers to the welfare associated with consumption activities or "psychic" income as first tagged by Fisher (1906). Paraphrasing Fisher, Lawn (2003, pg. 111) explains, "[t]he national dividend consists not of the goods produced in a particular year, but of the services enjoyed by the ultimate consumers of all human-made goods." In recognition of the fact that the economic process involves many "irksome" activities so that welfare does not always improve with increasing levels of consumption the concept of psychic income should be thought of in a net sense—i.e. green accounts based on Fisher should measure not total but net psychic income, which deducts the harmful aspects of consumption from its welfare enhancing aspects (Lawn, 2003). To accomplish this, green accounts first isolate personal consumption expenditures by removing money spent purchasing, maintaining, or replacing durable goods and then make a series of additions or deductions to reflect both positive and negative externalities associated with that consumption.

Sustainable income refers to the basic Hicksian notion of income. In Value and Capital, Sir John Hicks (1948, pg. 179) maintains "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." As such, the very notion of income is sustainable by definition making the term "sustainable income" a redundancy. To arrive at an adequate measure of Hicksian income, green accounts deduct from GDP depreciation of both human built and natural capital stocks and certain expenditures (i.e. on security systems) made to defend ourselves from some of the undesirable side effects of economic growth (Daly and Cobb, 1994).

Net social profit is a measure of policy effectiveness. Net social profit analysis is simply an expanded form of cost-benefit analysis that uses welfare equivalent or sustainable income rather than GDP. Thus, using green accounts in net social profit analysis provides a measure of the welfare or sustainability implications of policy changes (Asheim, 2000). In particular, net social profit is the difference between green GDP with and without a particular policy change. Net social profits can be positive, indicating that the proposed policy is welfare enhancing, or negative, indicating that its social costs exceed benefits. Since not all components of the Fisher and Hicks income concepts are applicable in any particular policy setting, green accounts used to calculate net social profit are not necessarily the same as either welfare equivalent or sustainable income.

Although the Genuine Progress Indicator has individual columns that can be of use in calculating welfare equivalent income, sustainable income, or net social profit, in aggregate, it falls squarely under category 1—the Fisherian concept of welfare equivalent income—because it attempts to measure the net psychic income households derive from their consumption activities. However, it only counts the portion of Fisherian income that is sustainable, or derived from stable or increasing stocks of human built and natural capital. Thus, the GPI measures the "welfare a nation enjoys at a particular point in time given the impact of past and present activities" (Lawn, 2003, pg. 106). While certainly a more accurate measure of true welfare than GDP or green GDP accounts rooted in Hicksian notions of sustainable income, the methodological objectivity of Fisherian measures such as the GPI is necessarily much less clear because they necessitate value judgments over what does and does not constitute welfare enhancing forms of consumption, what costs and benefits are added or deducted from such consumption, and how these costs and benefits ought to be measured. It is necessary, then, to make explicit these more subjective aspects of the GPI. We do so by identifying core principles of sustainable development used to guide GPI accounting.

Principles of sustainable development

As noted by Hanley (2000), the term sustainable development has been widely and variously defined but a consensus as to its general implication is that sustainable development requires a non-declining level of well being for future generations. Since 1987, when this general concept was formalized by the World Commission on Environmental and Development, there have been countless numbers of processes initiated by non-governmental organizations, governments, business leaders, and academics to develop operational principles to guide lifestyle choices, public policy, and business practices. Such principles are typically grouped into three core domains: economic, environmental, and social (Harris, 2000). In fact, a key meta-principle is "that social, environmental and economic needs must be met in balance with each other for sustainable outcomes in the long term."[2]

This meta-principle is embodied in the GPI. Recognizing the interdependence of economic well being with the quality of the natural environment and the quality of our social relationships, the GPI sub-accounts track progress in each domain. As explained in detail in "An Updated GPI Methodology" (page 8), the GPI's economic domain is populated by personal consumption expenditures, consumer durable service flows, services from public infrastructure, net capital investment, and net foreign borrowing. The environmental domain assigns costs to air, noise, and water pollution, lost farmland, wetlands, and forests, depletion of oil reserves, as well as carbon dioxide and ozone damages. The social domain counts the benefits of volunteer work, higher education, and parenting as well as the costs of crime, inequity, commuting, and auto accidents. Thus, the GPI approximates welfare through a relatively well balanced set of sub accounts across each of the major sustainability domains.

2 Taken from the United Nations Conference on Environment and Development (UNCED) summary of the 1992 Earth Summit at Rio de Janeiro (http://www.un.org/jsummit/html/basic_info/unced.html).

Within each domain, the GPI operationalizes key principles common to a number of popular sustainability frameworks. Within the economics domain, Pezzey (1992) groups such principles into two major categories: (1) ends based definitions, such as non-declining per capita consumption or utility, and; (2) means based definitions, such as a non-declining stock of human and natural capital from which future generations can produce well being. By accounting for the costs of depleting both natural (i.e. farmland) and human built capital stocks (i.e. net capital investment) the GPI is closely aligned with frameworks based on the latter. British Columbia's Principles for Sustainability is an example. This framework contains normative guidance to promote long term economic development that increases the benefits from a given stock of resources by "living off the interest of natural resources" and not drawing down environmental asset stocks (Saunier, 1999).

This principle is closely related to a common principle from the environment domain—the principle of strong sustainability. Strong sustainability assumes a very limited degree of substitution between human and natural capital stocks (Pearce et al., 1990; Hanley, 2000). While some substitution is possible, many natural resource stocks are presumed to be irreplaceable and provide non-substitutable services to the economy. Examples include the natural processes that control the gaseous composition of the atmosphere, produce soils, or evolve complex ecological communities such as old growth forests. Strong sustainability, then, requires a non-declining stock of this irreplaceable natural capital. In contrast, the principle of weak sustainability simply requires that capital stocks in aggregate remain stable or increase on a per capita basis, and depletion of natural capital is sustainable to the extent that man-made substitutes can be found and used (Pearce and Atkinson, 1993). Because the GPI counts costs associated with lost farmland, wetland, and primary forest rather than assuming seamless substitutability it is more in line with the assumption of strong sustainability.

Another key sustainability principle from the environment domain is the principle of thermodynamic efficiency. In the mid to late seventies, and partially in response to the energy crisis of that period, ecological economists began to promote an entirely new framework for addressing the related issues of sustainability and economic growth-thermodynamics. The thermodynamic approach, in essence, calls for a comprehensive "bookkeeping" system to track the flows of energy, matter, and information through the economy, which is itself an open system embedded within the closed system of the earth's biosphere. From a normative standpoint, the approach calls for recognition of the limits imposed on the economic system by the first and second laws of thermodynamics. The first law of thermodynamics says that matter and energy can neither be created nor destroyed. They can only be converted from one form to another. The second law, also known as entropy law, states that all physical processes proceed in such a way that availability of energy involved decreases, i.e. the entropy of a closed system always increases. Entropy can be understood as a measure of disorder or energy not available for work.

Implications of the first law for economics are that all resources are finite, and that our use of those resources generates a flow of unusable or harmful residuals into the environment which, if left unassimilated, generate negative feedback in the form of pervasive externalities that impede production and consumption (Ayres 1978; Markandya and Richardson, 1992). Implications of the second law for economics are that since complete recycling is impossible, our current economic system will eventually break down as shortages of low entropy energy inputs are exhausted, as the residual high entropy energy and matter ceases to be capable of being recycled, and as natural resources of all types become increasingly scarce. Moreover, a greater throughput of energy and materials will hasten the day where shortages become acute and any incremental contribution to further growth is negated by an increase in overall disorder of the economic system. From the perspective of thermodynamic efficiency, a sustainable economic system is one that concentrates on development, not growth. Growth refers to the quantitative increase in the physical scale of the economy, its throughput of matter and energy, and the stock of human built artifacts while development refers to largely qualitative improvements in the structure, design, and composition of physical stocks and flows that result from greater knowledge, both of technique and of purpose (Folke et al., 1993; Daly and Cobb, 1989). In addition to being one of the core tenets of the ecological economist worldview, the notion of thermodynamic efficiency is embodied in several popular sustainable development frameworks including Natural Step (no net increase in substances produced by society), the World Congress of the International Union of Architects (eliminate the concept of waste), and the Hannover Principles (rely on natural energy flows).

In Figures 1 and 2 (page 6), the concept of materials, energy, and information flows is used to describe two different kinds of economic systems. Figure 1 describes a less sustainable economy based on maximizing production and consumption, greater reliance on exhaustible resources for inputs, and generation of a significant waste stream that produces a host of negative externalities (such as air

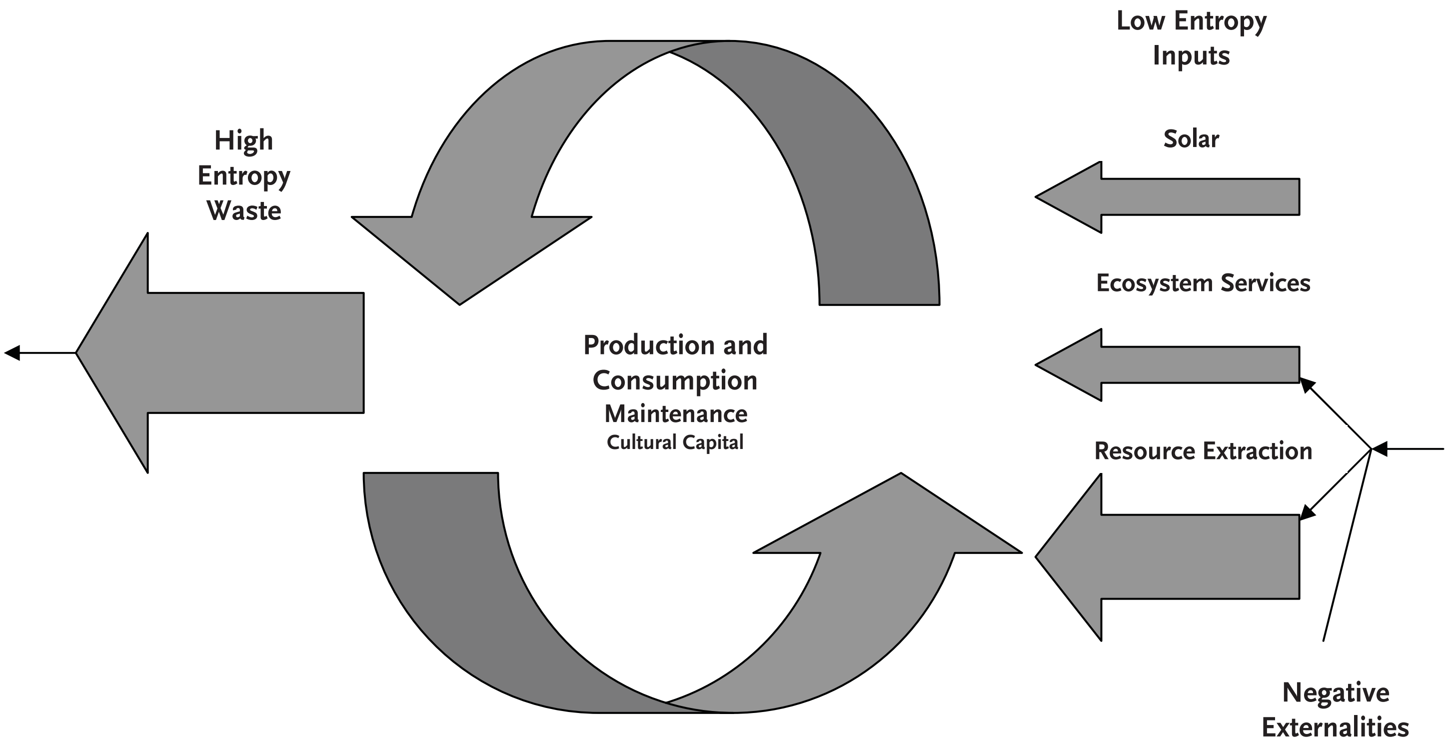


Figure 1:
Less Sustainable Economy Based on Maximizing Throughput

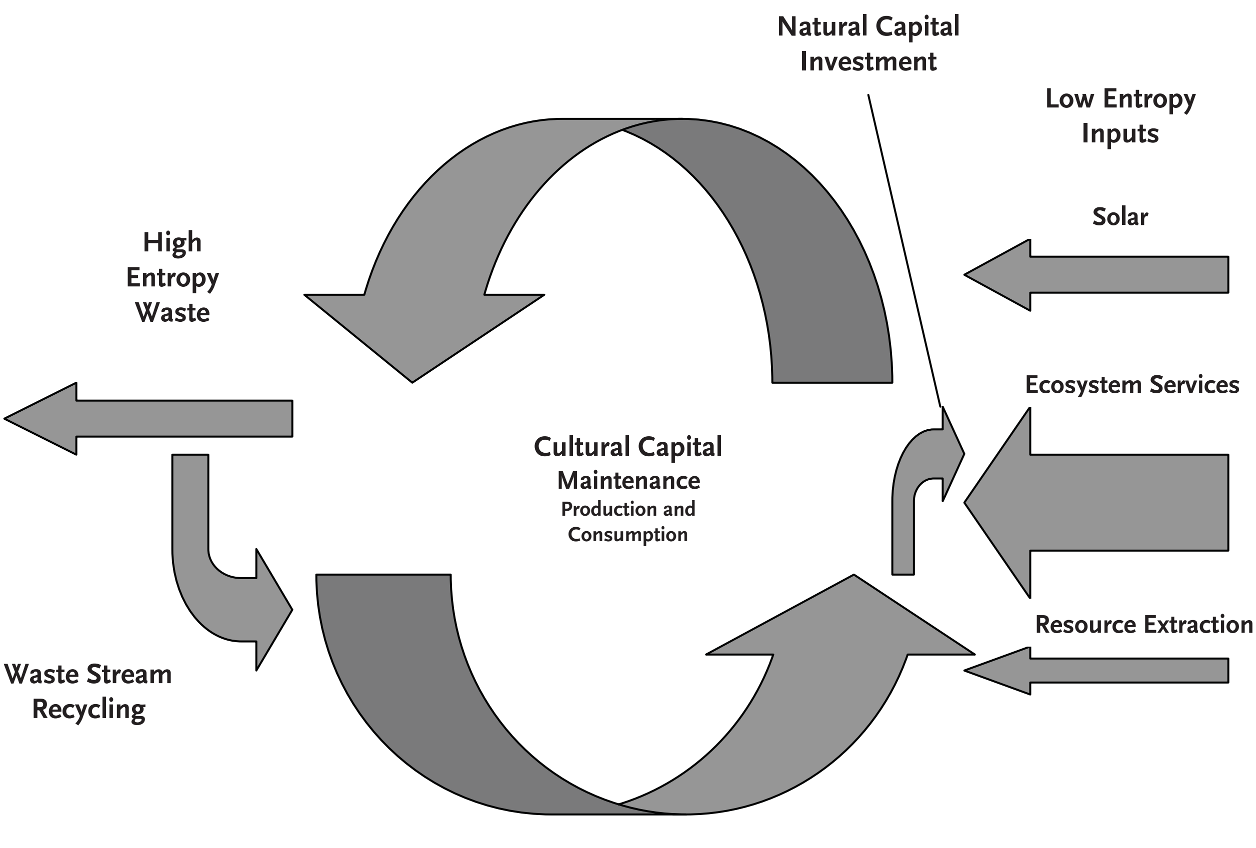


Figure 2:
More Sustainable Economy Based on Minimizing Throughput

and water pollution) that feed back into the natural world and impede ecosystem services. Figure 2, on the other hand, describes a more sustainable economy that depends more heavily on solar energy and the services provided by natural ecosystems, that invests more of its resources into development of cultural capital and knowledge rather than production and consumption, that recycles a significant portion of the waste stream, and which invests heavily in maintaining and restoring natural capital. In Figures 1 and 2, the relative size of arrows and text indicate what is emphasized or de-emphasized by each economic system. The GPI accounts provide a way to measure progress towards the type of economic system described in Figure 2 by providing at least some of the thermodynamic bookkeeping needed to fill in the market's inability to correctly signal scarcities of both low entropy inputs, the value of building up cultural capital, and the true costs of environmental externalities associated with air, water, and noise pollution.

In the realm of social sustainability, one example of the GPI's consistency with widely shared principles of sustainable development is the fact that the GPI makes an explicit adjustment to personal consumption expenditures for improvements or declines in distributional equity. This adjustment, of course, is based on the widely held belief that sustainable development must, by definition, be equitable. According to Hanley (2000, pg. 6), "[a] socially sustainable system must achieve distributional equity…". A major goal of the Habitat Agenda Principles is to create "a more balanced and equitable global system." The Natural Step is concerned that "resources should be used fairly and efficiently" (Saunier, 1999). Thus, the GPI's concern with distributional equity is well grounded within a number of sustainable development frameworks.

Critiques and limitations

Despite its roots in both economic theory and widely shared principles of sustainable development, the GPI is not without its detractors. Criticisms have been leveled at its theoretical foundations, components, and calculation methods. Many of the concerns were addressed during the formative years of the GPI. In their 1994 volume The Green National Product: A Proposed Index of Sustainable Economic Welfare, Cobb and Cobb published a series of critical essays and described how those criticisms were dealt with in the revised GPI accounts contained in that volume (Cobb and Cobb, 1994). It is not our intent to revisit those debates. Instead, we focus here on lingering criticisms.

Neumayer (1999), Dietz and Neumayer (2006) and Lawn (2003; 2005) have engaged in the most visible dialogue in the recent literature. Theoretically, Neumayer and others argue that it is "not possible to combine an indicator of current welfare with an indicator of sustainability" because costs associated with depletion of non-renewable resources and other forms of natural capital incurred by future generations make little difference to current welfare (Dietz and Neumayer, 2006, pg. 189). Deductions for natural capital depletion, then, are inconsistent with the Fisherian notion of income the GPI purports to measure. In response, Lawn (2003) maintains that because Fisher's concept of income and capital treat the production of replacement goods as the cost of keeping human made capital intact it is entirely appropriate to deduct natural capital depletion costs using the replacement cost method, as described in "An Updated GPI Methodology," below.

Critics have also noted the converse—that there are components of current welfare that have little apparent link to long term sustainability. Another theoretical flaw is the fact that while the GPI purports to be based on the principle of strong sustainability, it in fact measures weak sustainability. This is because the GPI measures the loss of both natural and human-built capital separately, so if natural capital is depleted, the costs of doing so can be masked by substitution of human-built capital of equal or greater value. According to Neumayer (1999, pg. 93), "[i]ronically, the ISEW does not measure strong sustainability, but weak sustainability at best since it assumes perfect substitutability among different forms of capital."

In terms of GPI components, the most important critique is that the GPI is arbitrary in what it includes or implicitly excludes as contributors to or detractors from welfare (Neumayer, 1999). For instance, the GPI corrects for income inequality but does not include corrections for the degree of political freedom or degree of equality between the sexes. The inclusion of almost every disservice item (i.e. commuting costs, loss of leisure, noise pollution) has been challenged because it is unclear whether or not these costs have already been factored into household and worker decisions (Lawn, 2005; Rymes, 1992). Because the GPI framework requires a subjective judgment of what does and does not count towards welfare and what does and does not properly count as a defensive expenditure, it cannot serve its desired role as an objective measure of sustainable economic welfare.

In terms of calculation methods, Dietz and Neumayer (2006) take issues with four components: (1) the valuation of the depletion of non-renewable resources; (2) the cumulative cost of long term environmental damage; (2) the adjustment of personal consumption expenditures for income inequality, and; (4) the deduction of defensive expenditures. The critiques here involve the precise calculation methods, not the basic components. For example, the GPI uses a replacement cost method to value depletion of non-renewable resources when Neumayer, Lawn and others believe a resource rent approach is more appropriate (Neumayer 1999; Dietz and Neumayer, 2006; Lawn, 2005). There have also been a number of criticisms made to the sources of data relied upon for calculating individual GPI sub-accounts. As described by Lawn, the lack of appropriate data for many GPI components and the need to "make heroic assumptions ensure the values of these items are likely to be, at best, distant approximations of their correct value" (Lawn, 2005, pg. 199).

Despite these lingering theoretical and methodological issues, the most outspoken recent critic of the GPI and ISEW has concluded:

> *…the ISEW's focus on comprehensive current welfare is laudable. Indeed, the emerging sustainable consumption discourse gives the ISEW renewed salience because, according to some, the task of making society's consumption more sustainable is in large part a question of separating out those things that we consume that make us "happier" and those that don't or even make us less happy.(Dietz and Neumayer, 2006, pg. 190).*

In the next section, we present a column by column explanation of the GPI 2006 update. While we have not changed the basic theoretical approach, we have made a number of significant changes to GPI components, calculation methodologies, and sources of date that seek to improve upon its overall accuracy.

An Updated GPI Methodology

The GPI is derived from 26 separate time series data columns spanning the 1950-2004 period. Due to delays in government reporting, there is a two year time lag in publishing GPI accounts. In this section we review the column by column calculations included in the GPI. We briefly describe the rationale for including each column, the data sources on which we rely, and the general calculation methodology. We encourage readers to contact the authors for a more detailed explanation and for the most up to date reference information for time series data sets. The methodology presented here represents a significant update to the methodology in use at Redefining Progress since the late 1990s as described by Cobb et al. (1998). Many of the changes are limited to changes in the sources of information, but several others include changes to the calculation approach. Unless otherwise noted, all figures are reported in year 2000 dollars.

Column B – Personal Consumption

Personal consumption expenditures on goods and services are the key driver of the GDP, and are the initial starting point for the GPI. As noted by Lawn (2005), personal consumption expenditures are a valid starting point for the GPI since we are ultimately interested in the welfare associated with this consumption rather than the monetary value of production. Accounting for nearly 67% of its total in 2004, consumer spending contributes far more to GDP than business investment expenditures (16%) and government (federal, state, and local) expenditures on products and services (17%). In 2004, U.S. personal consumption expenditures amounted to $7.6 trillion, compared with $1.2 trillion in 1950. On a per capita basis, personal consumption expenditures have risen steadily from $7,570 per capita in 1950 to $25,820 in 2004, an increase of 241 percent. Personal consumption expenditure data were taken from the National Income and Product Accounts (NIPA) tables published by the Bureau of Economic Analysis.

Column C – Income Distribution Index

There is strong empirical evidence that rising income inequality hinders growth in economic welfare (Hsing, 2005). A highly unequal distribution of income can be detrimental to economic welfare by increasing crime, reducing worker productivity, and reducing investment. Moreover, when growth is concentrated in the wealthiest income brackets it counts less towards improving overall economic welfare because the social benefits of increases in conspicuous consumption by the wealthy are less beneficial than increases in spending by those least well off (Lawn, 2005). The GPI accounts for income inequality by discounting personal consumption expenditures by the amount of inequality that persists in a given year using the Gini and income distribution indices (IDI).

The Gini index is the difference between actual distribution and equal distribution by income quintiles. The Gini index ranges from 0, when every household has the same income, to 1 when one household has all the income. Thus the higher the Gini index the greater the income inequality, or the greater the portion of aggregate income earned by the top household income bracket. It incorporates detailed aggregate income shares data into a single statistic, which summarizes the dispersion across the entire income distribution. It compares current income distribution with an ideal equal distribution of aggregate income, giving equal weight to all income levels by calculating the square root of the sum of the squared differences of each quintile from a 20 percent share. The Gini index is published regularly by the U.S. Census Bureau. The IDI simply measures the relative change in the Gini index. It is set at a value of 100 in 1968, the year the Gini index was at its lowest value.

As column C indicates, the income distribution index in the United States is at its most unequal level since 1950 and now stands at 120.10. According to the U.S. Census Bureau, the richest 20% of U.S. households now receive nearly 50% of all income, while the poorest 20% receive just 3.4%. The Gini index now stands at .464, up from .388 in 1968 (U.S. Census Bureau, 2003). As a result, on a dollar per dollar basis, personal income expenditures count less now than they ever have towards genuine progress at any time since 1950.

Column D – Weighted Personal Consumption

Weighted personal consumption is Column B (personal consumption expenditures) divided by Column C (income distribution index) multiplied by 100. The reason for dividing rather than multiplying is that larger numbers in Column B indicate greater inequality. Column C becomes the base number from which the remaining Columns in the GPI are either added or subtracted. For 2004, personal consumption adjusted for income inequality is $6.32 trillion.

Column E – Value of Household Work and Parenting

Work performed in households is more essential than much of the work done in offices, factories, and stores. Yet most of this goes unaccounted for in the national income accounts. While the housework and parenting of the stay-at-home mom or dad counts for nothing in the GDP, commercial childcare in the monetized "service sector" adds to the GDP. Other unpaid household labor, such as the physical maintenance of the housing stock (from cleaning to light repairs), also constitutes valuable economic activity.

The calculation of the value of household labor in the GPI is derived from the work of economist Robert Eisner, past president of the American Economics Association. Eisner first derived estimates of the annual hours spent performing relevant household tasks from time-use studies conducted by the Michigan Survey Research Center in 1965, 1975 and 1981. He then treated the value of an hour of housework as equivalent to the amount that a family would have to pay to hire someone to do equivalent work in their home. This then yields an estimate of the total annual value of household work (Eisner, 1985). Our GPI update incorporates three new data points: one from the final Michigan Survey Research Center study in 1985 and two from the Bureau of Labor Statistics (BLS) American Time Use Surveys (ATUS) of 2003 and 2004. For the years in between, we extrapolated using a regression on the years 1981, '85, '03 and '04. Each data point was incorporated slightly differently.

For the 1985 estimate we replicated Eisner's methodology as closely as possible. Starting with raw data from the Michigan survey we calculated the number of hours of household work performed by each of four groups: employed men, unemployed men, employed women, unemployed women. We then multiplied those numbers by each group's respective total U.S. population to calculate the total number of hours of household work performed: 235 billion. The work was valued at $7.14 per hour, based on houseworker salaries published by the Bureau of Economic Analysis. In the 2003 BLS time-use study the number of household hours for each of the four groups was multiplied by each group's respective total U.S. population to calculate the total number of hours of household work performed: 296 billion. The work was valued at $8.23 per hour, based on houseworker wage data from the BLS.

In the 2004 ATUS the data were not only broken down by sex and employment status, they were further subdivided by the ages of children in the household. To consolidate the numbers into the four subgroups we weighted them using household data from the U.S. Census Bureau's Current Population Survey. Otherwise, the methodology was the same as that used to calculate 2003. Total hours of household work performed were 304 billion, valued at $8.34 per hour. The GPI estimates the value of housework and parenting at $2.5 trillion in 2004. This represents the single most significant positive adjustment to personal consumption expenditures. The value of housework and parenting was roughly 33 percent of personal consumption expenditures in 2004; in 1950 it was 58 percent. In part, this reflects our increasing reliance on the market to provide services formerly contributed by households.

Column F – Value of Higher Education

There has been considerable debate over whether to include this column at all. Previous editions of the GPI have omitted the cost of higher education, considering it an investment. Other studies have considered higher education to be consumption, while still others have asserted that the primary value of higher education is as a signaling effect, or queuing mechanism, and it should be considered a defensive expenditure. While it is clear that the long-term earnings of college graduates are much higher than those without a college degree, we sidestepped the debate over how to address these individual benefits by focusing instead on the benefits to society.

Hill et al. (2005) provide an exhaustive list of such benefits, which are both monetary and non-monetary and in the form of increases in the stock of knowledge, productivity of workers and capital, civic participation, job market efficiency, savings rates, research and development activities, charitable giving, and health. Based partially on Moretti (2004) they estimate the total value of this social spillover effect to be $16,000 per year per college-educated worker. We multiplied this value by the number of people 25 years and older that had completed at least four years of college as reported in periodic U.S. Census Bureau Current Population Surveys. In 2004, we estimate the annual social benefits of higher education to be nearly $828 billion. This represents the GPI's second largest addition to personal consumption expenditures.

Column G – Value of Volunteer Work

Some of the most important work in America is not done for pay. Such work is not only performed at home, but also the broader realm of our neighborhoods and communities. Work done here is the nation's informal safety net, the invisible social matrix on which a healthy market economy depends. Whether each additional lawyer, broker, or advertising account executive represents a net gain for the nation is arguable. But there is little question that workers in the underserved community and volunteer sectors—the churches and synagogues, civic associations and informal neighborly efforts—are doing work that is desperately needed. Despite its crucial contribution, however, this work goes entirely unmeasured in the GDP. The GPI begins to correct this omission.

First we estimate the total number of hours volunteered each year. We relied primarily on three Current Population Surveys conducted by the Bureau of Labor Statistics in 1965, 1974, and 1989 and the American Time Use Surveys from 2003 and 2004. Intermediate years were interpolated. Since the questions asked in each survey were not exactly the same, there are some comparability problems. But the surveys are close enough to provide a workable estimate for the purposes of the GPI. Secondly, we applied the Independent Sector estimate of the value of an hour of volunteer time in 2000 (since all GPI figures are reported in year 2000 dollars). That value is $15.68 per hour (Independent Sector, 2006). The GPI indicates that the value of volunteer activities in the United States stood at $131 billion in 2004 or $447 per capita. This is significantly higher than the 1950 value of $202 per capita implying that over the past few decades, Americans have become more generous with their time and that this time is of much greater worth.

Column H – Services of Consumer Durables

The money spent on durable items, such as cars, refrigerators, and other appliances is not a good measure of the actual value consumers receive from them. It is important to take account, as well, of how long the item lasts. For example, when you buy a furnace or a dishwasher, you do not "consume" it in one year. The appliance (or "consumer durable") provides service for a number of years. Because of this, the GPI treats the services of household capital as a benefit and the initial purchase price as a cost. This column adds the annual services derived from consumer durables, which economic theory defines as the sum of the depreciation rate and the interest rate. If a product lasts eight years, it depreciates at 12.5 percent per year and thus provides that much of its service each year. At the same time, if the interest rate is 5 percent, the purchaser of the product could have received that much interest by putting the money into the bank instead. Economists therefore regard the interest rate as part of the monetary value of the product to the consumer.

Based on an assumed depreciation rate of 15 percent and an average interest rate of 7.5 percent, the value of services from household capital is estimated at 22.5 percent of the value of the net stock of cars, appliances, and furniture at the end of each year as estimated by the Bureau of Economic Analysis. To avoid double counting, we make an adjustment (column M) by subtracting out actual expenditures on consumer durables. Focusing on annual services that household appliances and equipment provide rather than on the purchase price corrects the way the GDP treats money spent on durables. The value of services from consumer durables is treated as a benefit and is thus an addition to the GPI account. In 2004, the benefits from household capital amounted to $743.72 billion, making it the GPI's third largest addition to personal consumption.

Column I – Services of Highways and Streets

The GPI does not include most government expenditures since they are largely defensive in nature; they protect against erosions in the quality of life, rather than enhancing it (Leipert 1986, 1989). This is particularly true of the government's largest budgetary item, military spending. On the other hand, some government activities, such as transit systems and sewer or water districts, provide services for a fee in a manner similar to private business. These fees show up in personal consumption figures in the national income accounts and thus are already included in column B. This leaves other government services that could be sold in theory, but are difficult to price with regard to individual users. Overwhelmingly, the largest item in that category is the use of streets and highways, which we include here as a separate GPI category.

The annual value of services from highways and streets is derived the Bureau of Economic Analysis figures of the net stock of federal, state, and local government streets and highways from 1950 to 2004. The annual value of services from streets and highways is estimated by taking 7.5 percent of the net stock value. This is based on the logic that around 10 percent of the net stock (2.5 percent for depreciation and 7.5 percent for average interest rates) is the estimated annual value of all services from streets and highways. However, since we assumed that 25 percent of all vehicle miles are for commuting (a defensive expenditure), this leaves 75 percent as net benefits. Thus the GPI assumes the net service value of streets and highways is 75 percent of 10 percent, or 7.5 percent of net stock. In 2004 we estimate the value of services from streets and highways at $111.55 billion, an addition to the GPI account.

Column J – Cost of Crime

Crime takes a large economic toll on society. Some of these costs are obvious, such as medical expenses and lost property. But others are more elusive, because they are psychological, such as the trauma of being violated, or are incurred in the form of lost opportunities, such as activities foregone because people fear the possibility of theft or violence. The GPI relies on the Bureau of Justice Statistics National Crime Survey year to year estimates of the cost of crime to victims in terms of their out-of-pocket expenditures or the value of stolen property. Undoubtedly the full cost of crime is underestimated given the absence of estimates of the more elusive costs.

We also include other defensive expenditures on locks, burglar alarms, security devices, and security services. Most of us would not otherwise purchase these personal, household, or business security items. In the GPI we subtract these expenditures on crime prevention because they represent personal consumption that does not add to the well-being of our households but merely prevents its deterioration or violation. Expenditures on locks were estimated by extrapolating data for locks from Laband and Sophocleus (1992) while expenditures on alarms were drawn from regular reports issued by Security Distributing and Marketing (SDM). Both data sets were extrapolated forward and backward in time based on security industry sales data and projections. In 2004, the GPI deducts $34.22 billion from personal consumption expenditures to reflect the cost of crime.

Column K – Loss of Leisure Time

The GDP creates the illusion that the nation is getting richer, when in fact people are working harder to produce and buy more and to pay interest on mounting personal indebtedness. According to Bluestone and Rose (1997) "since the 1980s people have been saying they work 'too hard'—that they are spending too much time on the job, with too little left for family, chores, or leisure." A more accurate measure of genuine progress and well-being would consider the loss of leisure that went along with increased output. Accounting for the nation's well-being ought to include the value of leisure time lost or gained.

In order to provide a reasonable estimate, the GPI includes only the value of leisure lost in relation to 1969, the year with the greatest leisure since 1950. The number of leisure hours per year is taken from a study by Leete-Guy and Schor (1992) who estimated the annual working hours (including housework) of labor force participants. Estimates from 1969 to 1992 were derived from their figures. For 1950 to 1969, we estimated that annual hours of work declined by 0.3 percent per year. For the period 1993 to 2004 we extrapolated the trend based on the work of Mishel et al. (1996) who estimate that annual hours of work have increased an average 5.2 hours per year between 1989 and 1994.

The number of work hours is then subtracted from 3,650 hours of discretionary time (10 hours per day) to arrive at an estimate of the total discretionary hours of leisure per person per year. The term "discretionary" simply means time away from work minus time spent sleeping and kindred maintenance activities. We use 70 hours per week as the threshold; thus discretionary time is the amount less than 70 hours per week that people work. The resulting figure for each year is subtracted from the amount in 1969 to derive an estimate of the hours of leisure per worker. The change since 1969 is the basis for estimating the loss of leisure time, which we value at $13.36 per hour in year 2000 constant dollars (which is approximately the average real wage rate for the period 1950 to 2004). The result is a GPI deduction of $401.92 billion in 2004.

Column L – Cost of Underemployment

The GPI does not deal with the effects of short-term and cyclical unemployment. Although such hardships are not without social consequences and costs, much of the financial hardship is mitigated by unemployment insurance benefits. Underemployment is a more inclusive concept than unemployment. It refers to persons who are either chronically unemployed, discouraged (gave up looking for work), involuntary part-time (would prefer full-time work but are unable to find it), or constrained by other factors, such as lack of child care or transportation. The costs of underemployment fall on the discouraged workers and their families. But the community and society also pays a price when limited work opportunities may lead to frustration, suicide, violence, crime, mental illness, or alcoholism and other substance abuse. The GPI treats each hour of underemployment (the number of unprovided hours for constrained workers) as a cost, just as leisure time is considered a benefit. An hour of leisure time is a desirable objective whereas an hour of underemployment is a burden.

The GPI uses the research of Leete-Guy and Schor (1992) who calculated the number of "unprovided hours" of work in 1969 and 1989 by constrained workers—people who want to work more. They found that the number of hours of underemployment in the entire labor force rose from 4.2 billion hours in 1969 to 14.6 billion hours in 1989. We extrapolate their figures from 1950 to 1968 and from 1990 to 2004. We assume the number of unprovided hours per constrained worker from 1990 to 2004 continues to increase at the rate of 0.59 percent per year (the rate of increase between 1969 and 1989). This approach bypasses changes in unemployment due to business cycles and focuses instead on the effects of long-term trends.

The estimates of unprovided hours per constrained worker are then multiplied by the millions of estimated constrained or underemployed workers using data from the Economic Policy Institute and Bureau of Labor Statistics and then by an average real wage of $13.36 per hour. As with leisure, this is the average real wage during the accounting period 1950 to 2004. These estimates suggest that the cost of underemployment peaked at $195.09 billion in 1989 and has since declined to $176.96 billion by 2004.

Column M – Cost of Consumer Durables

The actual expenditures on consumer durables are a negative adjustment in the GPI to avoid double counting the value of their services (column H). The value of private expenditures on consumer durables in constant 2000 dollars comes from the National Income and Products Accounts. The cost of consumer durables in 2004 is estimated at $1.09 trillion.

Column N – Cost of Commuting

Urban sprawl has put more cars on the road, exacerbated traffic congestion, and increased the time Americans must spend getting to and from work. According to the U.S. Department of Transportation, there has been a 66% increase in the number of vehicles per household and significant increases in commute times since 1960 (DOT, 2000). While commuting is for most people an unsatisfying and sometimes frustrating experience, the GDP treats it as a benefit to consumers. The more time and money spent commuting, the more these regrettable activities contribute to the GDP. Moreover, GDP does not account for the opportunity costs of time spent commuting; time that could be spent freely with family, at leisure, sleeping, or at work.

The GPI corrects for the shortcoming of the GDP account by subtracting the cost of commuting. There are two distinct types of costs incurred in commuting. The first is the money spent to pay for the vehicle, or for bus or train fare; the second is the time lost that might have been spent on other, more enjoyable or productive activities. In the GPI accounts, the direct (out-of-pocket) costs of commuting are a function of the portion of non-commercial vehicle miles used in commuting, the cost of user operated transport, the cost of depreciation of private cars, the portion of passenger miles on public transportation used for commuting, and the price of purchased local transportation. Data for these variables were taken from the Statistical Abstract of the United States and BEA's National Income and Product Accounts.

The indirect costs of commuting (i.e., the value of the time lost) are calculated as the total number of people employed each year times the estimated annual number of hours per worker spent commuting times a constant value for the time. Because some people regard commuting as part nuisance and part leisure, we assigned a cost of $8.72 per hour (rather than the $13.36 per hour for lost leisure). The number of hours per year was derived from survey data on time-use by households (Leete-Guy and Schor, 1992) coupled with data from the National Household Transportation Survey (NHTS) from 1983, 1990, 1995, and 2001. According to the National Center for Transit Research (NCTR) at the University of South Florida, NHTS data show that commuting times have increased by 29.1% since 1983 (NCTR, 2005). The estimated cost of commuting in 2004 was $522.61 billion or $1,778 per capita. Per capita costs have risen by 91% since 1950.

Column O – Cost of Household Pollution Abatement

One of the costs that pollution imposes on the households of the nation is the expenditures made for equipment such as air and water filters. These defensive expenditures do not improve the well-being of households, but merely compensate for the externalities—that is, pollution—imposed upon them as a result of economic activity. Such expenditures merely attempt to restore environmental quality to a baseline level.

For the period 1972 to 1994, we used data published by the Bureau of Economic Analysis (Vogan, 1996). For years prior to 1972, we assumed that personal expenditures on pollution abatement and control increased by 20 percent per year according to the trend after 1972. In 1996 the BEA data series was discontinued, therefore we extrapolated expenditures based on the average rate of increase from 1991 to 1994. We estimate the cost of household pollution abatement to be $21.26 billion in 2004.

Column P – Cost of Automobile Accidents

The damage and economic loss due to automobile accidents represents a real cost of industrialization and increasing traffic densities. The GPI uses fatality and injury statistics published in the Statistical Abstract and by the National Center for Statistical Analysis (NCSA, 2004). Economic losses are based on estimates by the National Safety Council (NSC, 2004). The figures cover motor vehicle accidents on and off the road and all injuries regardless of length of disability and address wage loss, legal, medical, hospital, and funeral expenses, and insurance administration costs. Property losses are not included because of significant data gaps. NSC estimates that on average each motor vehicle death represents $1,130,000 in economic losses and each injury $49,700 in 2004 dollars. Economic losses peaked in 1996 at $206.98 billion. In 2004, such losses amounted to $175.18 billion. NSC attributes this decline to advances in vehicle safety.

Column Q – Cost of Water Pollution

Water is the one of the most precious of all environmental assets, yet the national income accounts provide neither an inventory of the quantity or quality of water resources nor an account for the cost of damage to water quality. In the GPI framework, the costs of water pollution arise from (1) damage to water quality and (2) damage from siltation which reduces the life span of water impoundments or channels. Although this may involve some double counting (insofar as siltation also damages water quality), on the whole the estimates in this column understate damage because of the lack of data on nonpoint sources of pollution.

The cost of damage to water quality begins with a 1972 estimate of $12.0 billion, or $39.7 billion in 2000 dollars. This is based on the upper range of estimates in three studies of point source damage to recreation, aesthetics, ecology, property values, and household and industrial water supplies (Freeman, 1982). Between 1950 and 1972, damage from water pollution is assumed to grow 3 percent per year, from $20.3 billion to $39.7 billion. Between 1972 and 1992, damages are assumed to increase at a rate corresponding to the per capita increase in spending on water pollution abatement, which grew from $324 in 1972 to $570 in 1992 (Rutledge and Vogan, 1994). We assume per capita pollution abatement expenditures are roughly correlated with the magnitude of actual water quality damage. After 1992, water pollution abatement data is no longer available, and pollution damage is assumed to continue growing at 3% per year from $71.8 billion in 1992 to $102.3 billion in 2004.

Erosion imposes costs in the form of reduced river navigability, siltation of water impoundments, increased flooding, reduced recreational activities, and degraded fisheries. Uri and Lewis (1999) estimated the social cost of soil erosion to be $17.81 billion in 1997. In that year, we estimate total erosion from agriculture and forestry operations to be 2.02 billion tons. Adjusting for inflation yields a damage estimate of $8.81 per ton of erosion. As sources of siltation, we examined erosion from farming (960 million tons in 2004) and logging (925 million tons in 2004). Tons of cropland erosion comes from the National Resources Inventory, conducted by the Soil Conservation Service in conjunction with Iowa State University from 1982 to 2003. From 1950 to 1981, we estimate that erosion decreased by an average of 1 percent per year, based on the trend visible in the NRI data.

Tons of logging-related erosion comes from an estimate by Hagerman (1992) that forest operations contribute 231 tons of sediment per acre per year. We have assumed Hagerman's estimate applies to clear cuts, which are 38 percent of U.S. harvests (USDA, 2006). We further assumed that selective cutting contributes only half as much sediment as clear cuts, or 115.5 tons per acre. To estimate total acreage of forest operations, we relied on 1950-2002 statistics published by Adams et al. (2006). Combining damage to water quality and damage due to siltation we estimate the total cost of water pollution to be $119.72 billion in 2004.

Column R – Cost of Air Pollution

The annual economic cost of air pollution to households, infrastructure, the environment, and human health is a typical example of environmental costs that lie outside the boundary of the traditional national accounts. It represents a significant omission from conventional economic indicators like the GDP. The GPI relies on Myrick Freeman's (1982) analysis of the cost of air pollution. His figure of $30 billion in 1972 dollars is converted to $99.34 billion in year 2000 dollars. The damage estimate includes damage to agricultural vegetation, materials damage (paint, metals, rubber), costs of cleaning soiled goods, acid rain damage (aquatic and forest), urban disamenities (reduced property values and wage differentials), and aesthetics.

We estimate the annual cost of air pollution for years other than 1970 by extrapolating the $99.34 billion figure according to the relative change in air pollution levels. To do so, we measure the relative change in air quality using an index of ambient air pollution levels based on 1975-1996 data from EPA (EPA, 1998). For earlier years, ambient air conditions are assumed to have deteriorated by 1 percent per year in the 1950s and by 2.4 percent per year in the 1960s, and to have improved by 3.0 percent per year from 1971 to 2004 (as a result of the Clean Air Act of 1970). The 2004 figures for NOX, SO2, and particulates are projected based on the trend 1990–1996. Indices were created for ambient levels of particulates (PM), sulfur dioxide (SOX), and nitrogen dioxide (NOX). In each case, the year 1975 (the year the EPA began collecting the data) is set equal to 100. A single index number of ambient air pollution is created for each year by averaging these three indexes. A value greater than 100 implies an increase in air pollution, while a value less than 100 signifies a decline in air pollution. To calculate the cost of air pollution, we divide the ambient air pollution index of the given year by the index for 1970 and multiply the result by our estimate for the cost of air pollution in 1970 ($99.34 billion).

Since 1975, the decline in absolute emissions of sulfur dioxide and particulates (which outweigh the small increase in nitrogen dioxide emissions) suggests a decreasing economic cost of air pollution for these three emissions. The GPI account estimates the cost of air pollution to be $40.05 billion in 2004, significantly less than the all time high of $99.34 billion in 1970.

Column S – Cost of Noise Pollution

While the U.S. has noise pollution regulations, there are no official inventories of its extent or severity. The damage caused by noise pollution in the U.S. in 1972 was estimated at $4 billion by the World Health Organization (Congressional Quarterly, Inc. 1972). Starting with that estimate, we assumed that the quality of the auditory environment declined by 3 percent per year from 1950 to 1972, based on industrialization and increased noise emissions from motor vehicles and airplanes. From 1972 to 1994, noise abatement regulations are assumed to have reduced the rate of deterioration to 1 percent per year, but not to have improved it. With no new noise pollution data since the 1995 GPI estimates, we assume a constant rate of decline in the auditory environment at 1 percent per annum. The GPI account estimates the cost of noise pollution in 2004 at $18.21 billion.

Column T – Loss of Wetlands

Wetlands contain some of the most productive habitat in the world. Yet their value is not represented in economic accounts because the benefits—such as regulating and purifying water and providing habitat for fish and waterfowl—are generally "public goods," for which there is no overt price. When a farmer drains and fills a marsh, the GDP rises by the increased output of the farm. However, the loss of services from the wetland goes uncounted. The GPI rectifies this by estimating the value of the services that are given up when wetlands acreage is converted to other purposes. To do this, multiply wetland loss in each year by $914, the value of an acre of wetland as estimated by a meta-analysis of wetland valuation studies reviewed by Woodward and Wui (2000). We add this value to an assumed baseline of wetland loss prior to 1950, since we continue to incur the cost of not having these wetlands present to perform essential services such as water filtration.

The U.S. Fish and Wildlife Service (USFWS) estimates that 136 million acres of wetlands were filled in North America from the colonial period to 1950. Acreage declined from an original 395 million (including the contiguous lower 48 states and Alaska) in the 1780s to about 259 million acres in 1950—a loss amounting to 60 acres an hour for 200 years (USFWS, 1997). Our estimates of acres of wetland loss are based on USFWS data published in Status and Trends of Wetlands in the Conterminous United States (USFWS, 1997). Their most recent study estimated the loss of wetlands at 462,000 acres per year through 1975, 294,000 acres per year from 1976 to 1984, and 121,000 acres per year in subsequent years. Each of these figures includes 4,000 acres per year lost in Alaska while the remaining acres were lost in the lower 48 states. We extrapolate the loss figures since 1995 by using the rate of change from 1985 to 1995. The GPI estimates the value of ecological services lost due to the accumulated loss of wetlands in 2004 to be $53.26 billion.

Column U – Loss of Farmland

Loss of either natural or human-built capital generates costs to both present and future generations in the form of lost services from that capital. By destroying farmland, we are losing a vital ecosystem service - sustainable food supply. Farmland losses also generate costs in the form of lost scenic, aesthetic, and historic values, increased flooding, deterioration in water quality, and degradation of wildlife habitat. In the GPI accounts, we address farmland losses resulting from urbanization and lost productivity.

Obtaining accurate time series data on farmland loss is a surprisingly difficult task. Variations in time periods studied, how farmland is defined, and how acreage is counted are considerable. For this reason, we combined data from a number of sources including the American Farmland Trust, the National Agricultural Statistics Service, the USDA's National Agricultural Lands Study and the Farm Information Center. Using these data sets, we estimate the average annual conversion of prime farmland to urbanization to average nearly 400,000 acres per year since 1950.

To put a price tag on this loss, we added the average value ($5,459) from three contingent valuation studies summarized by Ready et al. (1997) that considered lost amenity values to the Costanza et al. (1997) figure of $41.34 per acre for lost ecosystem services. We then multiplied the resulting value ($5,501 in year 2000 dollars) by an index that deflates this value in years before 2000 and inflates it after to account for relative scarcity. By 2004, the GPI accounts assign a cost of $6,203 for every acre of farmland lost to urbanization. The cumulative loss figure is obtained by multiplying each year's value per acre by the acres lost in that year, then adding it to the previous year's loss. As with wetlands, the reason for tracking cumulative, and not marginal losses, is the fact that we are still incurring the costs of farmland lost in 1950, 1960, etc. because we are no longer receiving the stream of benefits these lands once conferred (and still could if they are restored). The GPI assumes that the initial pre-1950 loss was roughly $3.31 billion, a figure that has grown to $91.19 billion in 2004.

Urbanization removes the productive potential of farmland in a highly visible way. But it may not be as serious in the long run as the deterioration of soil due to poor management. The decline of soil quality over the past forty years has been masked by higher inputs of fertilizer, pesticides, and fuel. In addition, soil depletion is not necessarily linear. It may not show up gradually in yield reductions, but rather in a sudden and irreversible decline. Agricultural productivity losses from erosion have been estimated at $1.3 billion per year, or $2.5 billion in 2000 dollars (USDA, 1985). In 1985, erosion calculations from column Q show 2.9 million tons of cropland erosion in that year, which translates into roughly $.86 per ton. We assume the cumulative damage prior to 1950 was $16.3 billion, and add to that by multiplying the $.86 figure by the annual erosion estimated from column Q.

The damage to soil from compaction by heavy machinery in 1980 was estimated at $3.0 billion in 1980 dollars (Sampson, 1981), or $5.5 billion in 2000 dollars. We assumed a 3 percent increase per year in the losses due to compaction prior to and following 1980. The 2004 estimate of the cost of soil compaction is $11.27 billion. The total economic costs of the loss of farmland to urbanization, soil erosion, and soil compaction in the GPI is estimated at $263.86 billion in 2004 having risen steadily from an estimated $25.80 billion in 1950.

Column V – Loss of Primary Forests and Damage from Logging Roads

Whenever native, or primary forest land is cut for timber, converted into tree plantations, or cleared to build a road, that forest's ability to control floods, purify air and water, maintain biological and genetic diversity, provide habitat for sensitive species, produce non-timber forest products or provide scenic, recreational, and aesthetic values to nearby communities is impaired or lost forever. The GPI accounts measure this loss by assigning a price tag to year by year estimates of key primary forest losses and adding such losses to the cumulative damage from previous years. In particular, we assign costs to the loss of longleaf pine forests in the southeastern U.S., old growth forests in the Pacific Northwest, Sierras, and southeast Alaska, and inventoried roadless areas on national forests.

While certainly debatable, we assume relatively little overlap in the damage assigned to loss of roadless areas and old growth forest largely because roadless areas tend to be located in higher, less productive areas not typically included in inventories of low elevation, high productivity old growth stands. While there are other critical forest types lost in the United States each year, these primary forest types are particularly rich in biological diversity, have been extensively studied, and have reasonable estimates of both extent and value on which GPI accounts can be based. We also incorporate costs associated with national forest logging roads, which are continuing sources of sedimentation, landslides, fires, and habitat fragmentation.

For longleaf pine, data points for original extent, 1935, 1955, 1985, and 2003 as well as rate of loss in this period are drawn from Outcalt and Sheffied (1996) and the USFWS (2003). Out of an original extent of 60 million acres, only 2.9 million remain in 2004. In the Pacific Northwest, the Forest Service estimates that between 60 and 70% (65% as a mid point) or 19.57 million acres of forests within the range of northern spotted owl were in late successional/old growth condition during the pre-industrial era (USDA, 2005). In 1950, we assume that most old growth on private lands had been taken and that national forest boundaries provide a crude proxy for what remained. In 1994, the Forest Service found that only 7.87 million acres remained. Previous years assume a rate of loss of 180,000 acres per year back to 1950. Post 1994 figures are based on losses due to logging and fires reported by the USDA (2005).

In the Sierras, data points for 1945 and 1993 were estimated by Beardsley, et al. (1999). Remaining points were interpolated. In Alaska, we assume that nearly all timber harvests on the Tongass National Forest back to 1950 involved the clearing of old growth temperate rainforest. Harvest data were taken from spreadsheets provided by the Tongass National Forest. For inventoried roadless areas, we assume an original extent equivalent to the extent of national forest system lands in the western United States (167 million acres). In 1979, the Forest Service inventoried 62.02 million (USFS, 1980). In 2000, that figure fell to 58.51. For intervening years, we incorporated a variety of Forest Service data points on new road construction and multiplied these figures by the amount of roadless area loss per mile of new road construction (26.44 acres per mile). Taken together, GPI accounts show a cumulative primary forest loss of 74.56 million acres in 2004. To assign a cost, we take the Costanza et al. (1997) figure of $134 per acre for ecosystem services not including raw materials and climate regulation (since young forests also provide these functions) plus 3 times that amount for passive use values as estimated by numerous studies including Vincent, et al. (1995). An example of passive use values is the willingness to pay for preservation of old growth forest habitat critical to the northern and Mexican spotted owls, a value determined through contingent valuation surveys. In 2004, the GPI accounts estimate the magnitude of costs associated with primary forest loss to be $39.89 billion.

The calculation of losses due to national forest logging roads is based on the total stock of roads in any given year. A mile of forest road with a 60-foot right-of-way covers approximately 7 acres of land. If the impacts such as noise, edge effects, and runoff are included, a mile of road affects at least 500 acres of land. This provides a very rough estimate of the environmental costs because the damage caused by roads depends on many factors including age, location, slope, the quality of construction, and the frequency of maintenance. Nevertheless, even the best roads cause some continuing ecological disruption by breaking up the landscape, raising erosion levels, disturbing downstream fisheries, and generally increasing the level of human activity. Estimates of total miles of forest roads are taken from twelve separate Forest Service point estimates from 1955–2004. In the 1995 GPI, we assumed that the cost of damages to forests caused by roads from 1950 to 1959 was $10,000 per mile in 1982 dollars. That figure is here converted to 2000 dollars, or $15,939 per mile. From 1960 to 1979, the cost per mile is assumed to decline on a straight-line basis to $7,500 ($11,954 in year 2000 dollars) per mile due to improvements in road standards. We estimate the cost of ecological damage due to roads at $4.62 billion in 2004. Added together, the GPI accounts show that the loss of primary forest and damage from logging roads amounts to $50.64 billion in 2004.

Column W – Depletion of Nonrenewable Energy Resources

The depletion of nonrenewable resources is a cost shifted to future generations that should be borne in the present. Nonrenewable natural capital cannot be increased, it can only be diminished. As Herman Daly notes (1996) in Beyond Economic Growth, for nonrenewable capital the question is not how to invest, but how best to liquidate the inventory and what to do with the net financial wealth realized from that liquidation. Our current accounting system counts this liquidation of natural capital wealth as income "which is clearly wrong, because it is not a permanent or sustainable source of consumption" (Daly, 1996). A prudent approach to sustaining the income and well-being of America's households would require investment of a portion of the net rents derived from mining nonrenewable natural capital into sustainable renewable energy and productivity or energy efficiency gains. In this vein, the GPI uses estimates of renewable energy replacement costs as an approximation for the costs of depleting nonrenewable energy reserves.

To calculate replacement costs, we rely on the costs of biomass fuel production. While this approach is debatable, we believe it is both intuitive and reasonable, since biomass fuel was the largest share (47%) of the renewable energy market in 2004 according to the most recent annual data compiled by the Energy Information Administration. We assume a nominal replacement cost of $99.10 per barrel based on a USDA (1988) study that took into account the effects of subsidies and increasing marginal costs as biomass demand and production increase. To account for scarcity, we decrease that cost by 3% per year prior to 1988, and increase by the same rate in subsequent years. We convert annual nonrenewable energy consumption in quadrillion BTUs to equivalent barrels of oil, and then multiply by the adjusted annual replacement cost figure.

Using this methodology, the GPI accounts show the cost of replacing nonrenewable energy production to be $1.76 trillion in 2004. This represents the largest cost included in the GPI account. The fact that, after almost fifty years of nonrenewable energy liquidation, renewable energy makes up just 6.12% percent of total energy consumption in 2004 suggests insufficient investment of nonrenewable resource rents into sustainable energy substitutes for the well-being of future Americans. The longer we defer investment in renewable energy resources, the greater the economic impact on the well-being of current and future American households.

Column X – Carbon Dioxide Emissions Damage

Few scientists dispute the link between carbon dioxide emissions and global warming or the link between global warming and increasing incidence and severity of damaging storms, floods, and droughts. And as hurricane Katrina illustrated all too well, this erratic weather is exacting an enormous economic toll each year on our households, infrastructure, and natural capital. As the incidence of severe weather events escalate the costs in insurance payouts and replacing lost or damaged homes, buildings, livestock, and other household resources mount. Ironically, these natural disturbances result in a positive feedback loop whereby increasing frequency and intensity of storms and other severe weather leads to increasing use of natural capital resources as we rebuild shattered homes and infrastructure in the aftermath. Yet neither the cost of our impacts on the Earth's climate, nor the increasing costs of cleaning up after the storm, nor the increased depletion of nature's capital is accounted for by GDP. The GPI attempts to address this oversight by assigning costs to carbon emissions.

There are many ongoing studies that attempt to calculate economic damages per ton of carbon emitted into the atmosphere through our burning of fossil fuels. In one recent meta-analysis of 103 separate studies, Tol (2005) found a mean of $93 per metric tonne, or $89.57 in year 2000 dollars. Though hotly debated, we adopt this figure as a conservative starting point for incorporating carbon emissions damage into GPI accounts.

The GPI relies on carbon emissions data reported by the Oak Ridge National Laboratory. We assume that only excess emissions are contributing to global warming and deduct the portion of these emissions sequestered by the world's terrestrial and aquatic ecosystems. Globally, the Intergovernmental Panel on Climate Change estimates the Earth's carbon sequestration capacity to be 3 gigatonnes (Gt) carbon per year (IPCC, 2000). Worldwide, overshoot of this sequestration capacity began in 1964 (not counting natural sources of carbon dioxide), and has now risen to 58%, or roughly 4 Gt. In the GPI accounts, we assign costs to a percentage of U.S. emissions identical to the global overshoot percentage. We also assume that, due to positive feedback effects, marginal damage increases over time. To account for this, we taper the marginal damage costs down from $89.57 in 2004 to just over zero in 1964—the first year of carbon overshoot. Finally, we assume that marginal damage from carbon emissions are cumulative so that costs incurred in one year continue to be incurred the next year.

Using this approach, we estimate carbon emissions damage to be $1.18 trillion in 2004. This is the second largest cost included in the GPI, arguably, as it should be. After all, global warming is a phenomenon that threatens hundreds of millions of lives, entire cities, and the planetary economic system like no other threat in human history and the United States is by far the single greatest source of carbon emissions implicated in that warming.

Column Y – Cost of Ozone Depletion

While annual production of CFCs may have declined dramatically, the cumulative impacts on the depletion of the earth's ozone layer continues. According to NOAA's Climate Prediction Center, "[e]xtensive ozone depletion was again observed over Antarctica during the Southern Hemisphere winter-spring of 2005, with widespread total ozone anomalies of 45 percent or more below the 1979-1986 base period" (NOAA, 2006). In September 2005, the area covered by extremely low total ozone values of less than 220 Dobson Units, defined as the Antarctic "ozone hole" area reached maximum size of 25 million square kilometers, with an average size of more than 22 million square miles, among the largest sizes of recent years. There are no definitive studies showing the combined health and ecological consequences of ozone depletion over the next half century. However, scientists warn that the ozone loss could result in increased exposure to harmful solar radiation that can destroy plants and cause cataracts and skin cancer in humans. Given the potentially catastrophic effects on all forms of life, the GPI includes an estimate reflecting our expectation of the economic costs associated with this long-term environmental problem - $49,669 per tonne.

The calculation for the cost of ozone depletion involves multiplying the U.S. share of cumulative world production of CFCs 11, 12, 113,114 and 115 by $49,669 per metric tonne in year 2000 dollars. To calculate the U.S. share, we combined data sets from the Alternative Fluorocarbons Environmental Acceptability Study (www.afeas.org), the

EPA, the United Nations Environmental Programme, and the U.S. Congress. The GPI account estimates the cost of ozone depletion in 2004 at $478.92 billion. Since CFC production in the U.S. has all but halted, this cost figure has remained basically unchanged since 1995.

Column Z – Net Capital Investment

For an economy to prosper over time, the supply of capital (buildings, machinery, and other infrastructure) must be maintained and increased to meet the demands of increased population. If this does not occur, the society is consuming its capital as income. Thus, one element of economic sustainability is constant or increasing quantities of capital available for each worker. The GPI calculates changes in the stock of capital (or net capital growth) by adding the amount of new capital stock (increases in net stock of private nonresidential fixed reproducible capital) and subtracting the capital requirement, which is the amount necessary to maintain the same level of capital per worker. The aim of this column is to estimate increases in the stock of capital available per worker.

The capital requirement is estimated by multiplying the percent change in the labor force by the stock of capital from the previous year. Labor force statistics are provided by the Bureau of Labor Statistics while capital stock figures are taken from the Bureau of Economic Analysis. A five-year rolling average of changes in labor force and capital is used to smooth out year to year fluctuations. The GPI considers an increase in the capital stock available to workers or households as a positive adjustment in the GPI account. In 2004 growth in the net capital stock was $388.3 billion, down from its peak of $490.29 billion in 2001.

Column AA – Net Foreign Borrowing

The economic sustainability of a nation is also affected by the extent to which it relies on foreign funding to finance its current consumption. A nation that borrows from abroad to pay for a spending spree will feel rich for a short time. But the illusion of wealth will vanish when the debt comes due or when the value of the currency drops as foreign investors lose confidence in that nation's ability to repay its loans.

This column measures the amount that Americans invest overseas minus the amount foreigners invest in the United States, or the net change in our international investment position. The annual change indicates whether the U.S. is moving in the direction of net lending (if positive) or net borrowing (if negative). If the change is positive, the U.S. has in effect increased its capital assets. If it is negative, part of U.S. capital formation is in fact based on wealth borrowed from abroad that must eventually be repaid with interest. We have thus included annual changes in the net international position as a measure of the long-term viability of our economy.

The annual figures for the market value of the U.S. net international investment position (NIP) from the Bureau of Economic Analysis show a rapid deterioration through the 1980s through 2004. From a net lending position of $257 billion 1983, the U.S. has slipped to a net borrowing position of $2.54 trillion in 2004. The GPI accounts track the change in the five year rolling average of NIP and add or subtract this change depending on its sign. In 2004, the GPI deducts $254 billion.

Column AB – The Genuine Progress Indicator

The Genuine Progress Indicator (GPI) starts with personal consumption adjusted for income inequality (column D), adds five columns (E through I), subtracts sixteen columns (J through Y), and adds two columns (Z and AA). The result is a more honest account of the genuine economic progress of the U.S. economy and the state of its households than GDP because it takes into account the benefits of non-market activities, education, and services from capital and the costs associated with inequality, environmental degradation, and a weakening international position. While incomplete, the GPI demonstrates the value of services derived from real wealth and assets that one could argue are more meaningful in defining the well-being of the nation's households than those tallied by the GDP. The GPI accounting exercise demonstrates the complexity of accounting for real wealth. If as many economists and statisticians were devoted to this more complete accounting of the state of the economy as they are to GDP we might be empowered with better information to manage the collective well being of the nation more prudently.

Column AC – Per Capita GPI

Per capita GPI is calculated by dividing the GPI by the U.S. population. Annual population figures are taken from the Economic Report of the President.

Column AD – Per Capita GDP

The value of the GDP also comes from the Economic Report of the President. Per capita GDP is the GDP divided by the population.

Results and Implications

In "An Updated GPI Methodology," we discussed column by column results and some implications drawn from those results. Here, we present the GPI results in aggregate. Table 1 (page 21) provides a detailed year by year accounting of all GPI columns for the 1950 to 2004 period. In Figure 3 below, we show GPI and GDP side by side. As shown in Table 1 and Figure 3, real GPI has increased from $1.31 trillion in 1950 to $4.42 trillion in 2004. This corresponds to an average growth rate of 4% for the period. By comparison, GDP grew steadily from $1.78 trillion in 1950 to $10.76 trillion in 2004, an average annual growth rate of roughly 9%.

Of course, these figures mask the effects of increasing population. Thus, it is important to look at both GPI and GDP figures in per capita terms. As shown in Table 1 and Figure 4 (page 20), GPI per capita has barely moved since 1978, remaining near $15,000 since that time. Over the period 1950–2004, GPI grew at an extremely sluggish rate of just 1.33%. In contrast, GDP per capita rose precipitously from $11,672 in 1950 to $36,596 in 2004—an annual growth rate of 3.81%. It is also critical to look at annual growth rates for each year so that important trends within particular time periods are not overshadowed by the full time series. Figure 5 (page 23) compares annual GDP and GPI per capita growth rates using a rolling three year average to smooth out year to year fluctuations. Here, we find a rather striking trend: while GDP growth rates have more or less fluctuated within a positive range GPI growth rates fall into two distinct periods. In the first period, spanning 1950 to 1980, GPI per capita growth rates more or less match those of the GDP and are generally positive, ranging as high as 4%. Beginning in 1980, GPI growth rates are commonly negative, bottoming out at -1.64% in 1994. GPI per capita has more or less stagnated since 1978 when it surpassed $15,000 for the first time. Importantly, what this implies is that since 1980 or so the marginal benefits associated with growth in personal consumption expenditures, non-market time, and capital services have been offset by the marginal costs associated with income inequality, natural capital depletion, consumer durable expenditures, defensive expenditures, undesirable side effects of growth, and net foreign borrowing. This trend, found in many of the GPI and ISEW studies completed over the past fifteen years or so has been put forth as evidence of a "threshold" effect. According to Max-Neef (1995):

> *For every society there seems to be a period in which economic growth brings about an improvement in the quality of life, but only up to a point—the threshold point—beyond which, if there is more economic growth, quality of life may begin to deteriorate (Max-Neef, 1995, pg. 117).*

Dietz and Neumayer (2006) argue that the threshold effect found in most GPI and ISEW studies is less a true reflection of welfare growth and decline and probably no more than an artifact of methodological flaws. As a case in point, they argue that assumptions made about growth in nonrenewable resource depletion costs and long term environmental damage make the threshold effect all but certain. While their criticisms certainly have merit and warrant closer inspection of the relationship between the threshold effect and actual column by column assumptions, we believe this update has at least partially remedied some of those concerns. For instance, in the calculation of long term environmental damage, we have discarded any assumptions about growth in this damage and, instead, tied damage calculations to actual carbon emissions and the estimated marginal social costs of those emissions. In several other columns, assumed growth rates were replaced by actual data so it remains unclear the extent to which the "hard wired" threshold effect hypothesis Dietz and Neumayer (2006) suggest still applies.

Figures 6 and 7 (page 24) show the growth and relative importance of GPI contributions and GPI deductions over time. Following Lawn (2005) and for the sake of graphical clarity, we have condensed GPI columns into several groups. On the contributions side, we have left weighted personal consumption expenditures alone, and grouped columns E through I into two categories: non-market time (columns E, F, and G) and capital services (columns H and I). Figure 6 charts trends in these three categories of GPI contributions. While the absolute magnitude of each has grown steadily, the relative contribution of personal consumption expenditures and non-market time have changed. In 1950, personal consumption expenditures accounted for 51% of all positive contributions to the GPI. In 2004, that share had risen to 59%. The increasing relevance of personal consumption expenditures has been accompanied by a corresponding decrease in the relevance of non-market

FIGURE 3: Real GDP and GPI Per Capita 1950-2004 in $2000

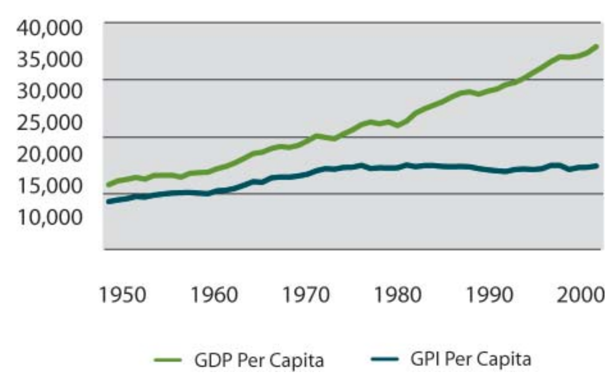
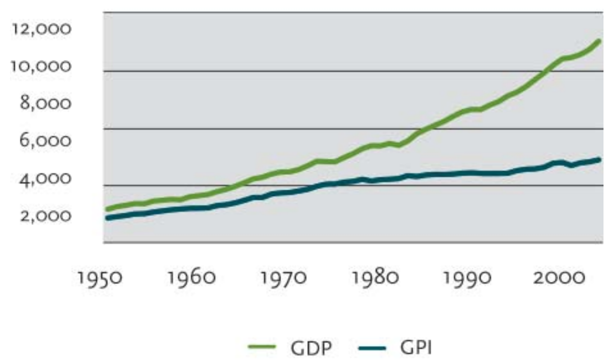


FIGURE 4: Real GDP and GPI 1950-2004 in 2000 Dollars (Billions)



time spent on volunteer activities, parenting, and higher education. This share has fallen from 41.21% in 1950 to 32.80% in 2004.

As briefly noted in the discussion of column E, this may reflect an increasing reliance on the market to provide services formerly contributed by households (such as home cooking) and a general decrease in our availability to volunteer, extend our formal or informal education, or participate in civic activities. Spending more money for more goods and services each year is seen as a sign of a healthy economy and a well-to-do society—at least so the GDP account tells us. The fact that the GDP has risen relentlessly and per capita personal consumption expenditures have more than tripled since 1950 would suggest that America is becoming more prosperous. There is little doubt that we have achieved unprecedented material gains and improved living standards. Yet the GPI account indicates that while per capita personal consumption of goods and services continues to rise, average real hourly wages have declined, personal indebtedness has risen, personal savings rates have fallen, and quality time with our families, participating constructively in civic affairs, or pursuing self betterment has steadily eroded. Yet according to the key yardstick of the economy, the GDP, all is well with the households of the nation. The declining share of non-market time in the GPI accounts is worrisome trend indicating that while our affluence may be on the rise, both our personal and collective sense of well being may be suffering.

As for GPI deductions, one significant trend that jumps out dramatically in Figure 7—GPI deductions—is the growing relevance of costs associated with depletion of and damage to natural capital. This share, which includes loss of wetlands, farmland, and primary forest, depletion of oil reserves, carbon dioxide and ozone damage rose from 35.45% of GPI deductions in 1950 to 59.32% in 2004. The largest component of this $3.8 trillion dollar cost is the $1.18 trillion cost associated with excess carbon dioxide emissions. One reason why this cost is so large is simply the fact that the damage is assumed to be cumulative. In other words, the GPI assumes that we are still incurring the cost of excess carbon emissions from 1950 and later. Dietz and Neumayer (2006) take issue with this and argue, instead, for counting only the marginal, not cumulative social cost of carbon emissions. In support of their argument, they point out that most marginal cost values incorporate the present value of future costs so tracking cumulative instead of marginal costs involves double counting.

However, global warming is replete with positive feedback loops. For example, warming induces greater carbon emissions by way of increasing forest fire extent and severity and thawing of the arctic tundra which leads to even more warming. Ice sheet melting diminishes the albedo effect which, in turn, leads to greater oceanic warming. Given the existence of these positive feedback effects it would clearly be inaccurate to assume constant marginal costs or somehow neglect the importance of atmospheric thresholds for carbon dioxide beyond which catastrophic effects are more likely. To their credit, Dietz and Neumayer (2006, pg. 200) suggest increasing the marginal damage figure over time in recognition of the fact that "the marginal social cost of each tonne of emissions is a positive function of the accumulated stock of carbon in the atmosphere." So something beyond constant marginal cost accounting is appropriate, but it is not clear what that is. Currently, the GPI treats the cost of carbon emissions as cumulative, and increasing over time, but reduces the magnitude of such costs by counting only excess emissions over and above the Earth's ability to sequester those emissions. Given the ongoing murkiness over exactly how to deal with carbon emissions, we suggest that the methodology presented in this 2006 GPI update be viewed as simply one approach among many potential approaches that should be properly vetted in the years ahead.

Using the GPI as a Guide to Public Policy

Given the subjective aspects of the GPI and lingering doubts as to its methodological rigor, some have argued its policy irrelevance (Neumayer, 1999). For example, Carson and Young (1994, pg. 112) have suggested:

> *…a single, dimension, aggregate measure of sustainable welfare will be of little direct use in guiding, shaping, or choosing among government policies because the factors determining welfare cannot be reduced and combined into a single measure that would command widespread agreement and acceptance.*

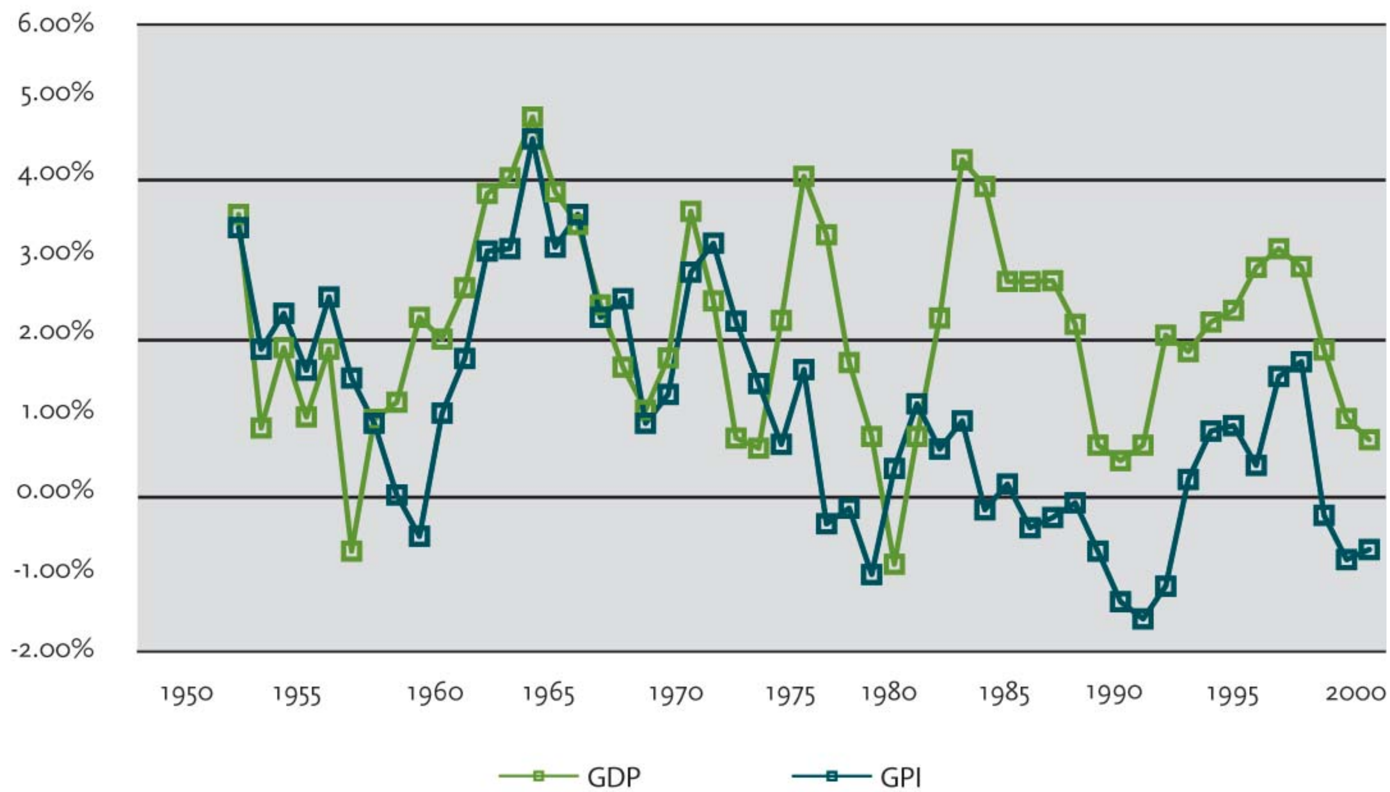
Table 1
Genuine Progress Indicator 2006 Update

Column A	Column B +	Column C +/-	Column D +	Column E +	Column F +	Column G +	Column H +	Column I +	Column J -	Column K -	Column L -	Column M -	Column N -	Column O -
Year	Personal consumption	Income distribution index	Weighted personal consumption	Value of housework and parenting	Value of higher education	Value of volunteer work	Services of consumer durables	Services of highways	Costs of crime	Loss of leisure time	Costs of under-employment	Cost of consumer durables	Cost of commuting	Cost of household pollution abatement
1950	1,152.80	107.97	1,067.73	749.48	84.35	30.72	133.85	32.01	8.82	12.07	15.88	77.08	141.84	0.02
1951	1,171.20	103.59	1,130.56	771.11	91.12	30.82	138.50	33.76	9.18	11.39	16.97	70.40	141.96	0.03
1952	1,208.20	105.04	1,150.21	793.36	97.89	30.93	144.39	34.85	9.49	10.76	18.14	68.34	141.08	0.05
1953	1,265.70	102.53	1,234.42	816.26	101.26	31.03	151.87	31.77	9.77	10.26	19.39	76.89	145.63	0.07
1954	1,291.40	106.08	1,217.39	839.82	104.63	31.14	154.24	32.55	10.09	9.70	20.72	76.69	142.09	0.10
1955	1,385.50	103.84	1,334.26	864.05	108.01	31.24	164.69	34.70	10.37	9.23	22.14	93.63	151.36	0.14
1956	1,425.40	102.43	1,391.59	888.99	111.38	31.35	174.37	37.72	10.68	8.76	23.66	89.75	152.23	0.20
1957	1,460.70	100.47	1,453.94	914.65	114.75	31.46	179.30	37.21	11.07	8.12	25.29	90.74	153.62	0.29
1958	1,472.30	101.33	1,452.96	941.05	119.25	31.57	179.18	39.15	11.47	7.52	27.02	83.26	148.60	0.41
1959	1,554.60	103.38	1,503.84	968.21	123.74	31.67	184.34	39.19	11.80	6.90	28.88	93.51	155.05	0.58
1960	1,597.40	104.24	1,532.40	996.15	121.87	31.78	186.35	40.40	12.20	6.31	30.86	95.28	158.31	0.83
1961	1,630.30	107.19	1,521.00	1,024.90	132.95	31.89	187.21	42.23	12.62	5.67	32.98	91.77	156.69	1.18
1962	1,711.10	103.85	1,647.60	1,054.48	144.03	32.00	191.17	44.87	13.03	4.97	35.25	102.50	161.89	1.69
1963	1,781.60	103.85	1,715.49	1,084.91	146.78	32.11	199.35	47.40	13.49	4.32	37.67	112.38	166.77	1.88
1964	1,888.40	103.57	1,823.34	1,116.22	149.52	32.22	206.76	48.68	13.94	3.66	40.26	122.88	171.55	2.09
1965	2,007.70	102.15	1,965.38	1,148.43	155.87	32.33	215.30	52.02	14.44	2.98	43.02	138.45	178.77	2.32
1966	2,121.80	100.18	2,117.92	1,181.58	163.39	37.20	229.75	55.53	14.96	2.27	45.98	150.05	182.99	2.59
1967	2,185.00	102.84	2,124.76	1,215.68	168.80	42.80	244.98	58.41	15.53	1.54	49.14	152.29	185.63	2.89
1968	2,310.50	100.00	2,310.50	1,250.76	178.74	49.25	262.07	60.10	16.09	0.78	52.51	169.22	193.74	3.22
1969	2,396.40	100.77	2,378.01	1,286.86	184.56	56.66	273.60	63.85	16.75	0.00	56.12	175.07	199.51	3.61
1970	2,451.90	101.55	2,414.56	1,324.00	192.99	65.20	280.82	68.89	17.44	0.00	59.73	169.50	198.85	4.05
1971	2,545.50	102.06	2,494.08	1,362.21	201.79	75.02	286.66	68.30	18.08	0.00	63.57	186.44	206.72	4.50
1972	2,701.30	103.35	2,613.73	1,401.53	213.82	86.32	300.26	68.97	18.69	0.00	67.65	210.16	217.71	4.73
1973	2,833.80	102.32	2,769.56	1,441.98	227.65	99.33	314.97	75.77	19.47	11.86	72.00	231.70	226.00	6.21
1974	2,812.30	101.80	2,762.46	1,483.59	244.80	114.29	328.85	91.40	20.26	12.04	76.63	215.79	219.17	7.02
1975	2,876.90	102.32	2,811.68	1,526.41	259.90	114.68	334.42	82.46	21.10	12.13	81.56	215.87	218.37	9.03
1976	3,035.50	102.58	2,959.23	1,570.46	279.94	115.07	347.09	76.44	21.88	12.29	86.80	243.42	233.50	10.03
1977	3,164.10	103.61	3,053.91	1,615.79	298.03	115.46	362.08	72.50	22.67	12.50	92.38	265.97	247.63	10.75
1978	3,303.10	103.61	3,188.07	1,662.42	309.31	115.85	381.92	71.99	23.57	12.75	98.32	279.99	260.71	11.21
1979	3,383.40	104.12	3,249.40	1,710.40	329.26	116.24	394.31	76.76	24.82	139.86	104.64	279.06	262.32	11.73
1980	3,374.10	103.87	3,248.51	1,759.76	355.09	116.64	393.25	83.46	26.18	146.34	111.36	257.21	255.24	12.78
1981	3,422.20	104.64	3,270.48	1,810.55	362.78	117.03	388.08	86.99	26.35	152.63	118.52	260.24	259.79	14.45
1982	3,470.30	106.19	3,268.15	1,837.46	384.80	117.43	383.21	85.06	26.87	158.78	126.14	260.07	262.76	13.96
1983	3,668.60	106.70	3,438.20	1,864.78	414.64	117.83	392.41	78.86	27.13	163.30	134.25	298.15	276.91	15.64
1984	3,863.30	106.96	3,611.95	1,892.50	429.79	118.23	410.07	74.92	27.84	168.06	142.88	341.71	298.28	17.04
1985	4,064.00	107.99	3,763.32	1,920.63	444.93	118.63	431.91	76.15	28.64	175.14	152.06	376.22	314.66	18.17
1986	4,228.90	109.54	3,860.74	1,949.18	455.82	119.04	466.81	80.76	29.08	183.08	161.83	412.55	334.02	18.50
1987	4,369.80	109.79	3,980.01	1,978.16	474.19	119.44	489.28	83.49	29.81	190.67	172.24	419.75	343.25	15.98
1988	4,546.90	110.05	4,131.61	2,007.56	492.59	119.85	511.38	82.91	30.48	198.07	183.31	445.05	358.47	16.93
1989	4,675.00	111.08	4,208.58	2,037.40	521.04	120.25	524.73	83.64	31.52	210.86	195.09	454.89	367.76	14.41
1990	4,770.30	110.31	4,324.48	2,067.69	532.66	118.56	530.85	84.47	32.21	220.28	189.23	453.52	372.45	11.59
1991	4,778.40	110.31	4,331.82	2,098.43	544.42	116.87	531.89	83.56	32.69	229.11	182.70	427.88	365.51	8.90
1992	4,934.80	111.86	4,411.76	2,129.62	549.39	116.07	535.89	83.45	33.07	240.23	177.58	453.00	376.51	9.20
1993	5,099.80	117.01	4,358.42	2,161.28	569.44	115.26	550.66	84.22	33.68	250.39	171.26	488.41	389.74	9.51
1994	5,290.70	117.53	4,501.74	2,193.41	584.70	117.83	569.59	87.56	35.97	271.52	167.14	529.38	406.98	10.88
1995	5,433.50	115.98	4,684.88	2,226.01	611.62	120.39	582.47	91.17	34.70	284.80	157.85	552.62	416.64	11.64
1996	5,619.40	117.27	4,791.93	2,259.10	634.69	120.66	593.68	93.44	33.73	297.98	154.71	595.94	429.03	12.44
1997	5,831.80	118.30	4,929.71	2,292.68	651.15	120.92	605.93	98.58	35.35	314.50	145.96	646.97	446.95	13.30
1998	6,125.80	117.53	5,212.30	2,326.77	671.57	121.19	628.95	100.69	34.00	329.61	134.00	720.29	467.88	14.23
1999	6,438.60	118.04	5,454.53	2,361.35	700.85	123.15	653.73	104.38	33.16	344.65	127.37	804.52	484.54	15.21
2000	6,739.40	119.07	5,659.93	2,396.46	717.52	125.10	678.35	107.80	31.04	363.30	124.48	863.30	495.19	16.26
2001	6,910.40	120.10	5,753.72	2,432.08	755.65	126.70	692.93	109.74	32.49	370.90	145.13	900.69	504.53	17.39
2002	7,099.30	119.07	5,962.18	2,468.23	779.14	128.20	711.23	111.50	34.64	376.93	171.83	964.75	512.03	18.60
2003	7,306.60	119.59	6,109.83	2,504.92	806.13	129.70	721.40	110.34	35.05	388.05	184.07	1,028.56	518.32	19.88
2004	7,588.60	120.10	6,318.41	2,542.16	827.98	131.30	743.72	111.55	34.22	401.92	176.96	1,089.91	522.61	21.26

Table 1 (Continued)

Column P -	Column Q -	Column R -	Column S -	Column T -	Column U -	Column V -	Column W -	Column X -	Column Y -	Column Z +/-	Column AA +/-	Column AB	Column AC	Column AD
Cost of auto accidents	Cost of water pollution	Cost of air pollution	Cost of noise pollution	Loss of wetlands	Loss of farmland	Loss of primary forests	Resource depletion	Carbon dioxide emissions damage	Cost of ozone depletion	Net capital investment	Net foreign borrowing	Genuine Progress Indicator	GPI per capita ($2000)	GDP per capita ($2000)
135.37	45.82	71.47	6.78	38.56	25.80	35.10	174.82		8.63	11.25	0.01	1,311.33	8,611.81	11,671.95
137.69	46.17	72.20	6.99	38.98	29.60	35.52	198.10		10.43	10.92	0.51	1,381.69	8,921.13	12,364.57
140.06	46.65	72.93	7.20	39.41	33.41	35.95	199.57		12.45	23.66	0.00	1,439.80	9,138.54	12,619.88
142.40	47.13	73.66	7.43	39.83	37.25	36.38	207.94		14.99	29.10	0.00	1,526.71	9,530.97	12,981.95
144.93	47.59	74.41	7.65	40.25	41.12	36.81	204.75		17.78	30.81	0.13	1,536.03	9,421.99	12,669.14
147.51	48.25	75.16	7.89	40.67	45.02	37.25	233.59		21.63	30.48	0.11	1,623.68	9,785.29	13,335.66
150.16	48.90	75.92	8.14	41.10	48.93	37.66	256.33		26.16	28.07	1.44	1,686.33	9,984.03	13,355.59
152.89	51.31	76.68	8.39	41.52	52.90	38.08	266.67		30.97	21.88	1.39	1,746.04	10,152.34	13,379.73
155.47	51.69	77.46	8.65	41.94	56.92	38.50	254.94		35.58	22.41	1.35	1,787.48	10,221.04	13,032.79
158.09	52.74	78.24	8.91	42.36	60.55	38.93	275.75		40.99	23.58	1.34	1,822.62	10,249.25	13,728.28
160.62	52.90	79.03	9.19	42.79	64.59	39.35	290.30		46.83	10.40	1.32	1,831.28	10,135.99	13,847.27
163.30	53.48	79.83	9.47	43.21	68.72	39.68	302.67		53.24	17.73	1.55	1,844.94	10,043.69	13,936.45
165.83	54.30	81.79	9.77	43.63	72.89	40.02	323.11		61.20	25.98	1.66	1,969.93	10,560.46	14,555.75
168.24	55.16	83.80	10.07	44.05	77.00	40.35	351.58		69.68	27.30	1.66	2,018.53	10,666.40	14,975.53
170.59	56.04	85.86	10.38	44.48	80.85	40.68	376.87	0.00	78.55	34.47	1.63	2,114.14	11,017.49	15,626.74
172.74	57.16	87.98	10.70	44.90	84.81	41.02	400.82	0.10	88.91	50.45	1.59	2,252.26	11,591.51	16,423.32
174.74	58.14	90.14	11.03	45.32	88.91	41.30	437.87	0.51	99.57	65.78	-3.71	2,401.05	12,215.34	17,292.94
176.66	58.89	92.36	11.37	45.75	93.93	41.57	474.72	1.34	111.01	67.59	-3.65	2,404.76	12,101.74	17,535.93
178.43	60.14	94.63	11.73	46.17	98.94	41.84	505.77	2.91	123.29	79.88	-3.60	2,588.27	12,895.85	18,199.26
180.18	61.12	96.95	12.09	46.59	103.80	42.12	540.48	5.55	137.29	84.34	-3.53	2,647.13	13,060.85	18,578.33
182.29	62.13	99.34	12.46	47.01	108.21	42.39	586.68	9.66	153.07	82.46	-3.45	2,672.68	13,034.16	18,394.85
184.61	63.07	96.36	12.85	47.44	112.64	42.72	594.94	14.96	169.42	76.67	2.75	2,749.16	13,238.71	18,773.87
186.60	64.36	93.47	13.25	47.86	116.92	43.06	624.54	21.87	187.83	76.56	2.56	2,845.05	13,554.58	19,557.30
188.39	65.46	90.66	13.38	48.28	121.03	43.40	639.85	30.85	208.10	90.16	2.49	3,005.25	14,181.81	20,487.57
190.12	66.22	87.94	13.51	48.70	124.98	43.75	642.37	40.48	228.44	124.52	2.30	3,114.78	14,565.00	20,198.83
189.20	66.62	80.31	13.65	49.13	134.94	44.09	651.09	50.55	244.94	76.14	2.12	3,125.25	14,470.55	19,961.75
191.89	68.47	82.48	13.78	49.55	139.43	44.43	673.61	63.39	260.98	68.14	2.53	3,222.96	14,781.85	20,826.47
195.60	69.96	78.95	13.92	49.82	144.23	44.77	706.27	78.14	275.16	64.00	-7.15	3,265.89	14,828.86	21,569.75
199.79	71.60	76.95	14.06	50.09	148.05	45.11	731.84	94.90	288.15	53.08	-0.52	3,375.03	15,162.87	22,530.72
201.93	73.29	69.61	14.20	50.36	151.81	45.45	789.32	114.47	299.71	35.40	5.58	3,284.80	14,595.54	22,987.27
213.42	74.17	68.65	14.34	50.62	155.68	45.85	826.66	134.22	311.57	99.48	2.57	3,354.46	14,730.24	22,666.27
196.00	75.26	64.26	14.49	50.89	160.04	46.25	849.33	153.58	324.40	99.89	7.12	3,376.43	14,682.31	23,010.79
192.41	76.97	57.96	14.63	51.16	164.93	46.63	862.11	172.81	335.03	85.15	80.32	3,418.34	14,722.31	22,349.56
192.95	78.94	57.30	14.78	51.43	169.12	47.01	845.20	193.15	347.37	97.31	77.45	3,568.86	15,231.57	23,148.26
195.85	80.61	59.23	14.92	51.70	173.67	47.40	943.67	216.36	361.81	98.05	32.21	3,526.68	14,921.55	24,597.63
197.09	81.92	56.28	15.07	51.97	178.26	47.78	960.58	241.79	375.21	98.27	23.54	3,606.54	15,123.92	25,386.01
190.62	84.06	55.88	15.22	52.24	183.15	48.05	979.70	269.44	390.66	98.41	16.48	3,639.17	15,122.17	26,027.73
192.32	85.58	55.96	15.38	52.29	187.61	48.32	1,025.99	300.17	405.72	110.31	-61.41	3,632.41	14,960.25	26,668.01
192.29	87.05	56.61	15.53	52.35	191.98	48.60	1,084.05	335.40	424.82	105.44	-76.17	3,654.19	14,913.77	27,518.87
184.72	88.40	55.94	15.69	52.41	196.24	48.88	1,109.68	373.22	440.73	98.43	-51.59	3,702.06	14,967.38	28,225.70
191.67	89.70	52.29	15.84	52.47	200.46	49.16	1,171.29	412.34	450.65	99.72	-68.10	3,725.17	14,892.80	28,434.99
187.13	91.22	52.15	16.00	52.52	204.59	49.45	1,199.31	453.66	459.20	89.75	-90.05	3,694.66	14,575.01	28,010.64
188.42	92.40	48.88	16.16	52.58	209.62	49.74	1,231.78	495.73	466.79	118.54	-118.50	3,684.52	14,342.57	28,558.86
189.38	93.85	47.99	16.32	52.64	214.61	50.03	1,230.66	541.52	473.13	138.55	-35.41	3,689.31	14,175.75	28,943.54
195.43	95.81	48.56	16.49	52.69	219.57	50.16	1,318.57	590.73	477.01	151.71	-18.01	3,701.64	14,051.40	29,743.47
205.88	97.92	44.36	16.65	52.75	224.57	50.22	1,355.38	643.22	478.74	178.32	-26.09	3,840.85	14,409.10	30,131.27
206.98	99.79	43.76	16.82	52.81	229.62	50.27	1,414.48	699.34	478.77	250.39	-14.95	3,912.45	14,508.46	30,885.87
200.63	101.87	42.60	16.99	52.87	234.73	50.33	1,456.64	761.08	478.81	301.02	-67.76	3,932.67	14,410.04	31,891.23
192.81	104.18	42.22	17.16	52.92	238.74	50.39	1,521.39	824.47	478.82	369.35	-189.34	4,018.36	14,553.23	32,837.40
195.09	106.60	42.06	17.33	52.98	245.91	50.44	1,539.69	889.51	478.84	446.63	-182.04	4,234.69	15,162.06	33,907.88
193.14	109.09	40.58	17.50	53.04	251.69	50.48	1,585.89	960.07	478.87	475.60	-249.80	4,277.03	15,145.93	34,764.23
186.14	111.21	40.40	17.68	53.09	255.26	50.52	1,669.58	1,033.53	478.89	490.29	-380.20	4,113.48	14,417.04	34,665.17
182.01	113.82	40.22	17.85	53.15	258.10	50.56	1,677.57	1,110.76	478.90	455.49	-298.81	4,255.44	14,765.33	34,866.85
180.15	116.57	40.05	18.03	53.21	260.97	50.60	1,701.30	1,146.79	478.91	372.14	-224.33	4,309.61	14,807.16	35,460.01
175.18	119.72	40.05	18.21	53.26	263.86	50.64	1,761.27	1,182.82	478.92	388.80	-254.02	4,419.08	15,035.65	36,595.59

FIGURE 5: GDP and GPI Per Capita Rates 1950-2004
Rolling three-year averages



Others, including Daly (1996) point out that using GDP growth as a policy target is a fundamentally flawed approach and that even the "poorest approximation" of welfare would do a better job of policy guidance. Anielski (2001, pg. 43) goes quite a bit further by asserting that GPI accounts "provide vital information for holistic and integrated policy decision making, covering virtually every area of government policy." Of course, what information policy makers choose to rely upon in making their decisions is often more a function of their political orientations, beliefs, and personal relationships and so regardless of concerns about the GPI's accuracy and rigor, leaders within government and non-governmental organizations (NGOs) have used the GPI and its variants as a basis for advocacy.

For example, in Alberta, the Pembina Institute has been publishing GPI accounts since 2001 as a way to persuade the provincial government to adopt a more comprehensive accounting framework that is "capable of assessing the full benefits and full costs of all forms of capital in Alberta —human, social, natural and built."[3] In Nova Scotia, the organization GPI Atlantic reported that the provincial government had created an Office of Health Promotion responsible for all matters relating to health promotion, wellness and addiction services in part based on GPI sub-accounts documenting the enormous toll ($3 billion) of largely preventable chronic diseases. As a result, they conclude "[t]he significance of this cannot be understated: GPI Atlantic is having an impact on public policy."[4] In the San Francisco Bay Area, the quasi-governmental Bay Area Alliance for Sustainable Communities adopted a local variant of the U.S. GPI as a means for tracking progress in achieving the policy objective of a "diversified, sustainable, and competitive economy" (BAA, 2004, pg. 12).

The policy relevance of green GDP indicators such as the GPI and ISEW has also been demonstrated by dozens of peer reviewed studies. As we previously noted in "Theories, Principles, and Critiques," Asheim (2000) found green GDP indicators useful as measures of welfare equivalent income, sustainable income, and net social profit. Hanley (2000) concludes that the ISEW can be used in tandem with more traditional economic indicators to generate useful insights for policy-makers seeking to implement broad sustainability goals such as those included in Agenda 21. More recently, Clarke and Islam (2004) estimated an ISEW for Thailand that further reinforced the threshold hypothesis and

3 See "Alberta could lead the way in sustainable progress indicators," posted May 16, 2006 at http://www.fiscallygreen.ca/gpi/news.php.

4 See GPI Atlantic Newsletter #14, April 2003, available online at: http://www.gpiatlantic.org/gpinews/gpinews14.pdf.

underscored the need for welfare enhancing interventions by governments of developing nations seeking to offset the deleterious impacts of pursuing economic growth.

Talberth and Bohara (2006) were among the first to use GPI and ISEW time series data to analyze the welfare impacts of policy change by focusing on the effects of greater trade openness. Using panel data from eight countries with GPI and ISEW accounts and an aggregate production function model, they found a strong negative correlation between openness and green GDP and a strong positive correlation between openness and the gap between traditional and green GDP. The effects, however, were non-linear, implying that up to a point, greater openness is beneficial. Below, we partially update their analysis using the new U.S. GPI accounts presented here and extend their analysis to policy variables of interest to the debates over tax cuts and urban sprawl.

Economic openness

The debate over the effects of economic openness or globalization has regularly captured headlines since the World Trade Organization began its attempts to significantly increase the pace of trade liberalization in the early 1990s. Empirical studies on the effects of openness fall into two distinct camps. A number of studies have reported on the beneficial aspects of more open trade regimes, noting, for instance, that export expansion raises the rate of economic growth by way of its impact on total factor productivity (Dar and Amirkhalkhali, 2003). Other studies link greater openness to deteriorating social and environmental conditions, such as increased income inequality or greater emissions of greenhouse gases (Baten and Fraunholz, 2004; Managi, 2004). Of course, what is actually being measured in these studies has a significant bearing on the outcome.

FIGURE 6: GPI Contributions in $2000 Billions 1950-2004

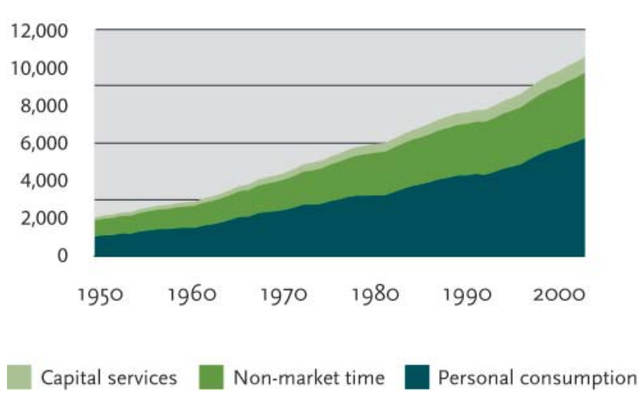
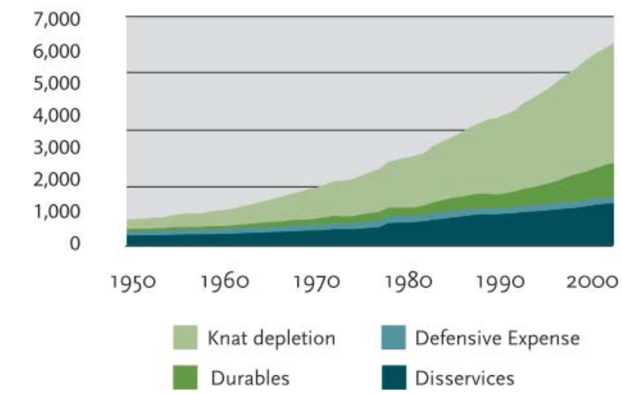


FIGURE 7: GPI Deductions in $2000 Billions 1950-2004



Studies relating openness to higher economic growth rates rely almost exclusively on GDP and related measures, while studies which document the immiserating effects of openness rely on measures outside the realm of traditional growth models. Thus, Talberth and Bohara (2006) suggest that conducting growth studies using green GDP can help bridge this divide because green GDP is a more accurate measure of welfare that explicitly addresses factors of paramount concern to GDP critics while maintaining components (i.e. personal consumption expenditures) that are more consistent with traditional notions of economic growth. Thus, they present a model of growth in green GDP using data sets spanning 30 – 50 years from eight countries: Australia, Austria, Brazil, Italy, the Netherlands, Sweden, the United Kingdom, and the United States. In their growth model, economic openness was considered along with measures of human and physical capital typically included in models of aggregate production functions.

In standard economic models, economic growth is assumed to be a function of changes in a nation's stock of both physical and human capital as well as other factors that may affect the productivity of these inputs such as economic openness (Solow, 1956; 1957). In their model, Talberth and Bohara (2006) used changes in the percent of GDP represented by gross fixed capital formation, the age dependency ratio, and economic openness. The use of gross fixed capital formation is standard variable measuring a nation's stock of physical capital. The age dependency ratio is a ratio of the non-working age to working age population, and is considered relevant to economic growth because the size of the dependent population may constrain productivity enhancing investments (Holtz-Eakin et al., 2004). Economic openness is the ratio of trade activity (imports and exports) to GDP.

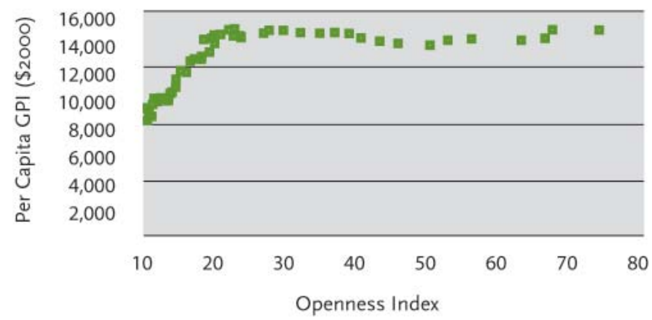
Here, we replicate and update the Talberth and Bohara (2006) analysis with respect to the United States. Time series data for gross fixed capital formation and the age dependency ratio were taken from the World Development Indicators data set. Time series data for economic openness were taken from the Penn World Tables. GPI data were taken from Table 1. Following Talberth and Bohara (2006) we tested:

[1] $GGPI_t = a_o + a_1 DGFCFpct_1 + a_2 DOPEN_t + a_3 DOPEN^2_t + a_4 DADR_t + u_t$

In equation 1, GGPI is the growth rate of the GPI in year t, DGFCFpct, DOPEN, and DADR are the year-to-year changes in the ratio of gross fixed capital formation to GDP, economic openness, and the age dependency ratio, and u is the error term. In recognition of the potential non-linear effects of openness, we have included the square of the openness term as well ($DOPEN^2$). In fact, non-linear effects are strongly suggested by Figure 8 (this page), which plots the relationship between the openness index and per capita GPI. In Figure 8, per capita GPI rises strongly when the openness index is below 25 or so, and then stabilizes when openness exceeds this level. The ⊠ terms are parameters estimated by the model. We are interested in the sign, magnitude, and significance of these terms. Table 2 (page 26) reports the results.

Validating Talberth and Bohara (2006), our modeling suggests a significant negative non-linear correlation between growth in the U.S. GPI and economic openness, a positive relationship with changes in gross fixed capital formation, and a negative relationship with the age dependency ratio. The results provide some empirical support for the burgeoning literature associating greater openness with environmental degradation, income inequality, and an increase in economic activity that may be self canceling from a welfare perspective. They also suggest a cautionary approach to trade liberalization policy that is cognizant of the fact that liberalization may be counterproductive past a particular threshold.

FIGURE 8: Openness Index and GPI Per Capita



Tax cuts

Tax cuts have been one of the most visible economic policy debates since the Bush Administration took office in 2001. The debate has been a bone of contention in both policy and academic circles. In the context of standard growth theory, tax cuts can stimulate long term economic growth through six main channels depending on the type and incidence of the particular tax involved: (1) they can encourage productivity-enhancing investments in the capital stock; (2) encourage growth in both the quality and quantity of the labor force; (3) stimulate research and development; (4) steer capital investment to sectors with higher productivity, and (5) steer workers towards sectors with higher social productivity (Engen and Skinner, 1996). Additionally, in the short run, tax cuts can lead to increases in consumer spending.

On the other hand, tax cuts can harm economic growth if not matched by a commensurate decrease in government spending; otherwise, they will raise deficits and interest rates. If tax cuts disproportionately benefit the wealthy, the resulting "windfall gains" on asset holders may undermine incentives for new investments (Gale and Orszag, 2005). Tax cuts may also reduce labor force participation if the incentive to work more hours at higher pay is more than offset by the incentive to work less and keep income constant (Gale and Orszag, 2005). Finally, if tax cuts are matched with decreases in government programs, the socio-economic benefits of those programs are sacrificed.

Empirical studies relating tax cuts to economic growth are also ambiguous. Hashemzadeh and Wayne (2004, pg. 112) assert that "[f]rom an historical perspective, there is scarce evidence of a consistent relationship between income taxes and economic growth." They also note that periods of high economic growth in output have correlated quite well with higher taxes. On the other hand, Engen and Skinner (1996) predict a .2 to .3% boost in economic growth rates associated with a 5% cut in marginal tax rates. Recently, Diamond (2005) predicted that extending the 2001 and 2003 income tax cuts would stimulate investment, employment, and output.

As with the debate over economic openness, both proponents and opponents of tax cuts have almost exclusively argued their points from a single perspective—economic growth as traditionally defined rather than from the standpoint of more comprehensive measures of welfare like the GPI. Given the empirical and theoretical ambiguity of the debate and given the paucity of studies relating taxation and welfare, a correlation between GPI and taxes may be a useful exercise. There are a number of ways GPI and tax cuts may be related. If tax cuts exacerbate income inequalities, the GPI will fall. If tax cuts cause reductions in beneficial government programs (i.e. for farmland conservation, renewable energy, or water quality improvements) the GPI may also fall. The GPI may also fall because tax cuts often induce an influx of foreign capital (Gale and Orszag, 2005). If this capital is used to finance current consumption (see discussion under "An Updated GPI Methodology," column AA) the GPI will fall. On the other hand, it tax cuts boost personal consumption or participation in volunteer work or educational activities, GPI could be expected to rise. GPI may also rise if tax cuts stimulate greater capital investment.

As a preliminary investigation, we modify equation [1] by adding a tax variable. In particular, we incorporate tax collection time series data from the National Income and Product Accounts tables published by the Bureau of Economic Analysis. Conceptually, adding a tax collection variable to the aggregate production function framework embodied by equation [1] is complicated by the fact that the causation may run in the opposite direction—growth may induce greater tax collections, and not vice versa. Of course, it is not clear if the causality concern is as relevant to GPI as it is to growth of GDP. In addition, we rely—as with openness - on growth rates as suggested by Engen and Skinner (1996) rather than absolute GPI and tax collection values. We also rely on per capita tax collection figures, not totals. Finally, we lag the tax collection variable so that we are testing the correlation between the change in tax collections between 1963 and 1964 on the growth in GPI between 1964 and 1965; a modification that makes intuitive sense if we are testing the proposition that reduced government spending affects welfare. By adding a lagged tax collection variable, our GPI growth model becomes:

[2] $GGPI_t = a_0 + a_1 DGFCFpct_t + a_2 DOPEN_t + a_3 DOPEN^2_t + a_4 DADR_t + a_5 DTAXCOL_{t-1} + u_t$

In equation 2, DTAXCOL is the change in per capita tax collections in year t-1. All other variables are as before. The results are displayed in Table 2, column B. As shown, we find a strong positive correlation between the change in per capita tax collections and growth of the GPI. This finding is consistent with the historical relationship between higher taxes and high economic growth (as measured by GDP) noted by Hashemzadeh and Wayne (2004). A full investigation of these findings to determine the exact channel by which changes in taxes influence GPI growth is beyond the scope of this report. Nonetheless, as with openness, we have demonstrated the potential use of GPI data to inform the debate over tax cuts and other adjustments to tax policy.

Growth in urbanization

In our discussion of openness and tax cuts, we relied on the aggregate production function framework to examine the impacts of policy variables on GPI growth. Another potentially useful approach is to explore the impacts of policy variables on the gap between GDP and GPI. By looking at the gap, we can simultaneously address economic changes in economic growth (GDP) and welfare (GPI). In particular, in years when the gap is widening, the costs of

TABLE 2: Models of U.S. GPI Growth (GGPI)

Independent Variables	Model 1 Openness	Model 2 Tax Cuts
DOPEN	-1.00***	-1.28***
	(-3.12)	(-4.31)
$DOPEN^2$	6.13*	7.55**
	(1.84)	(2.54)
DGFCFpct	1.14**	.21
	(2.33)	(0.696)
DDADR	-9.00***	-7.48***
	(-3.03)	(-2.80)
DTAX		0.65***
		(3.08)
Constant	0.03***	0.03***
	(6.73)	(6.74)
F-statistic	5.35***	7.38***
R-squared (adj)	.3383	.4841
Observations	35	35

Numbers in parentheses are t-statistics. *, **, and *** denote significance at the .10, .05, and .01 levels.

economic growth are more than offset by the deleterious social and environmental welfare costs of that growth. In years when the gap is closing, positive contributions to GPI overshadow these costs and economic growth is welfare enhancing. In their model, Talberth and Bohara (2006) modeled the effects of changes in economic openness, the growth rate of carbon dioxide emissions[5] and livestock production on the gap and found each to have a significant, positive influence on the rate of gap growth. Here, we adopt that model and substitute a variable of interest to the debate over urban growth for the livestock variable – degree of urbanization, measured in terms of urban land area per capita. Specifically, we test:

[3] $GGAP_t = a_1 + a_2 DURBAN_t + a_3 DCO2grw_t + a_4 DOPEN_t + a_5 DOPEN^2 + u_t$

In equation 3, GGAP is the growth rate of the gap between GDP and the GPI, DURBAN is the change in urban land area per capita as measured by Census Bureau data, DCO2grw is the change in the growth rate in per capita carbon dioxide emissions. The openness variables are as before. We are particularly interested in the urbanization variable, which is a good proxy for urban sprawl since it measures the amount of urban land per person. According to the General Accounting Office, urban sprawl is "sprawling, low density, fragmented, automobile-dependent development." (GAO, 1999).

There is little dispute that public policy has a direct influence on the extent of urban sprawl. According to the Environmental Protection Agency (EPA), a number of federal urban growth and development programs "intentionally or unintentionally accelerated the spread of low density development and businesses at greater distances from towns and cities."[6] The question is whether or not urban sprawl enhances or detracts from welfare. Despite the negative connotation associated with the term, there are at least two channels by which the GDP–GPI gap can improve with more sprawl, again, defined here as more urban land area per person.

First, it is important to note that urban sprawl is partially driven by the need to accommodate high volume, low cost retail "big box" stores such as Wal-Mart, Home Depot, and Costco, who bring an unprecedented volume and variety of low cost consumer goods to the public in a single location. Importantly, if more sprawl is associated with a greater abundance and easier access to these low cost consumer goods, the GPI will likely increase since it is based on personal consumption expenditures. But GDP also includes personal consumption expenditures, so this effect will have little impact on the GDP–GPI gap. However, to the extent that concentrated retail centers free up time otherwise spent shopping in multiple locations the GDP–GPI gap may improve if there is a corresponding increase in time spent volunteering, in educational activities, parenting, or housekeeping, the value of which is overlooked by GDP. Indeed, time savings have always been one of the most important benefits associated with concentrated retail centers:

> *Back in the city, the search for goods, whether pleasurable or not, consumes a great deal of time. Shopping competes with other activities and the geography of retailing has always been driven, in part, by the need to economize on time. Minimizing procurement time underlies the existence of retailers in the first place…Convenience, one of the most enduring themes of retailing, thus has driven the geographic arrangement of stores through cities and suburbs (Campbell, 1996).*

In addition, because the GPI counts the services yielded by pubic streets and highways, sprawl no doubt enhances this GPI contribution since by definition, more sprawl means more streets and highways per person. And since these services are not counted in GDP, sprawl may help close the GDP–GPI gap. On the other hand, the GPI deducts costs associated with longer commutes, auto-accidents, carbon emissions, and lost farmland. None of these costs are included in GDP, and so the gap will widen as these costs escalate. Thus, the net effects are ambiguous, and worth exploring in a more systematic fashion. Equation [3] does just that.

The results are displayed in Table 3 (page 28). First, we note that our results corroborate earlier findings of Talberth and Bohara (2006) by demonstrating a positive non-linear relationship between openness and growth of the GDP–GPI gap, and a positive relationship between changes in the growth rate of carbon dioxide emissions and the gap. Secondly, we note the positive relationship between growth in urban land area per capita and the gap. This suggests that on balance, the personal consumption, time savings, and public infrastructure benefits from sprawl are more than offset by the costs associated with traffic congestion, auto-accidents, carbon emissions, and lost farmland.

5 Because carbon dioxide emissions are indirectly included in the GPI calculations, care must be taken to avoid spurious regression results. To do this, Talberth and Bohara (2006) look at changes in the growth rate of emissions and not the level of emissions. Policy variables affecting this growth rate may be changes in CAFE standards, speed limits, regulations governing oil and gas development, or fossil fuel subsidies. Here, however, we are focusing attention on the effects of urbanization, and leave the debate over carbon policy for another time.

6 See "About Smart Growth," U.S. EPA, online at http://www.epa.gov/smartgrowth/about_sg.htm#fedrole.

Concluding Thoughts and Future Refinements

The Genuine Progress Indicator (GPI) and its variants such as the Index of Sustainable Economic Welfare (ISEW) were conceived as a way to measure changes in national economic welfare with a single, aggregate index. The GPI considers households as the basic building block of a nation's welfare, and thus begins its accounting exercise with personal consumption expenditures. To this the GPI adds benefits associated with welfare enhancing activities such as parenting, housework, volunteering and higher education as well as the services which flow from household capital and public infrastructure. The GPI then deducts costs associated with pollution, loss of leisure time, auto accidents, destruction or degradation of natural capital, international debt and resource depletion. The end result is an index that attempts to measure our collective welfare in terms of principles of sustainable development drawn from the economic, social, and environmental domains.

TABLE 3: Models of the GDP-GPI Gap(GGAP) and urbanization

Independent Variables	Urbanization Model
DOPEN	4.42***
	(4.68)
$DOPEN^2$	-35.12***
	(-3.94)
DGFCFgrw	0.60***
	(3.48)
DURBAN	88.41**
	(2.53)
Constant	-0.08**
	(-2.19)
F-statistic	9.87***
R-squared (adj)	.4249
Observations	49

Numbers in parentheses are t-statistics. *, **, and *** denote significance at the .10, .05, and .01 levels.

In this report, we presented an updated methodology for the U.S. GPI and a new set of accounts current through 2004. Our updates are the first significant changes to the GPI methodology since 1998, and incorporated a wealth of new studies and sources of information that have evolved since that time. The accounts suggest that while the U.S. economy has grown steadily since 1950, our collective welfare may have peaked in the late 1970s and stagnated ever since as the benefits of economic growth since that time have been more and more offset by costs associated with income inequality, loss of time spent on non-market activities, and environmental degradation. The costs of climate change are becoming an increasingly large share, as demonstrated all too well by the disasters in the Gulf of Mexico in the summer of 2005.

While some dispute the GPI's ability to measure sustainable welfare or take issue with its methodological soundness, it has, nonetheless, prompted government and non-governmental organizations throughout the world to use it as a tool for promoting sustainable policies and for demonstrating the fallacy of relying on gross domestic product (GDP) as a welfare measure. And because the GPI accounts yield historical data going back 54 years, it is readily adaptable for use by researchers seeking to test the influence of past policy changes on welfare growth. In this report, we demonstrated how GPI time series data can be incorporated into standard economic growth models to inform policy debates involving economic openness, tax cuts, and urban sprawl.

While future refinements to the GPI will attempt to address some of its outstanding theoretical challenges—such as relating future impacts to current welfare—the bulk of these new refinements will be focused on developing new sources of information and more precise calculation methodologies. The GPI accounts would be well served by a new set of valuation studies addressing time use, natural capital depletion, and costs associated with disservices such as air and water pollution, since many of the sources underlying these GPI columns are somewhat dated.

There are a number of changes to calculation methodologies that could be made in response to the latest round of vetting in the literature. For example, Lawn (2005) expresses wholehearted agreement with Neumayer's (2000) critique regarding the methods used to calculate resource depletion, and there is no reason why future GPI iterations could not adopt their recommendations. Taken together, these changes will make the GPI a more accurate, robust, and widely endorsed tool for promoting sustainable development in the decades ahead.

References

Adams, Darius, R. Haynes, and A. Daigneault. 2006. Estimated Timber Harvest by U.S. Region and Ownership, 1950-2002. Gen Tech. Rpt. PNW-GTR-659. Portland, Oregon: USDA Forest Service, PNW Research Station.

AFEAS (Alternative Fluorocarbons Environmental Acceptability Study). 1998. Production, Sales, and Atmospheric Release of Fluorocarbons through 1996. Washington, D.C.: AFEAS.

Anielski, Mark. 2001. Measuring the Sustainability of Nations: The Genuine Progress Indicator System of Sustainable Well Being Accounts. Edmonton, Canada: Pembina Institute for Appropriate Development.

Asheim, Geir B. 2000. "Green national accounting: why and how?" Environment and Development Economics 5(2000): 25048.

Ayres, R. U. 1978. Resources, Environment, and Economics: Applications of the Materials/ Energy Balance Principle. New York, New York: John Wiley and Sons.

Barber, D.A. 2003. "The 'new' economy," Tuscon Weekly, January 8th, 2003.

Baten, J. and Fraunholz, U., 2004. "Did partial globalization increase inequality? The case of the Latin American periphery, 1950-2000." CESifo Economic Studies 50(1), 45-84.

Bay Area Alliance for Sustainable Communities. 2004. State of the Bay Area: A Regional Report. Oakland, California: Bay Area Alliance for Sustainable Communities.

Beardsley, Debby, Charles Bolsinger, and Ralph Warbington. 1999. Old Growth Forests in the Sierra Nevada: By Type in 1945 and 1993 and Ownership in 1993. Research Paper PNW-RP-516. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

Bluestone, Barry, and Stephen Rose. 1997. "Overworked and underemployed: unraveling an economic enigma." American Prospect 31(March–April):58–69.

Campbell, John. 1996. Time to Shop: The Geography of Retailing. Boston: Federal Reserve Bank of Boston.

Carson, Carol S. and Allan H. Young. 1994. "The ISEW from a national accounting perspective," In Clifford W. Cobb and John B. Cobb (eds). The Green National Product: A Proposed Index of Sustainable Economic Welfare. Lanham: University Press of America.

Clarke, Matthew and Sardar M.N. Islam. 2004. "Diminishing and negative welfare returns of economic growth: an index of sustainable economic welfare (ISEW) for Thailand." Ecological Economics 54(1): 81-93.

Cobb, Clifford, Ted Halstead, and Jonathan Rowe. 1995. "If the GDP is up, why is America down," Atlantic Monthly: October, 1995.

Cobb, Clifford W. and John B. Cobb, Jr. 1994. The Green National Product: A Proposed Index of Sustainable Economic Welfare. Lanham, MD: University Press of America.

Dietz, Simon and Eric Neumayer. 2006. "Some constructive criticisms of the Index of Sustainable Economic Welfare." In Philip Lawn (ed.): Sustainable Development Indicators in Ecological Economics. Chetltenham: Edward Elgar Publishing.

Congressional Quarterly, Inc. 1972. Congressional Quarterly Almanac. Washington, D.C.: Congressional Quarterly, Inc.

Costanza, Robert, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert V. O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton, and Marjan van den Belt. 1997. "The value of the world's ecosystem services and natural capital." Nature 387(15 May):253–59, p. 256.

Daly, Herman and John B. Cobb. 1989. For the Common Good: Redirecting the Economy Toward Community, the Environment, and a Sustainable Future. Boston: Beacon Press.

Daly, Herman. 1996. Beyond Economic Growth: The Economics of Sustainable Development. Beacon Press, Boston.

Dar, A. and Amirkhalkhali, S., 2003. "On the impact of trade openness on growth: further evidence from OECD countries." Applied Economics 35(2003), 1761-1766.

Diamond, John W. 2005. "Dynamic effects of extending the 2001 and 2003 income tax cuts." International Tax and Public Finance 12(2): 165-192.

Engen, Eric and Jonathan Skinner. 1996. "Taxation and economic growth." National Tax Journal 49: 617-642.

Fisher, I. 1906. Nature of Capital and Income. New York: A.M. Kelly.

Foertsch, Tracy L. 2006. A Victory for Taxpayers and the Economy. Heritage Foundation WebMemo #1082. Washington: The Heritage Foundation. (www.heritage.org/Research/Taxes/wm1082.cfm).

Folke, Carl, Monica Hammer, Robert Costanza, and AnnMari Jansson. 1993. "Investing in natural capital—why, what, and how?" In AnnMari Jansson et al. (eds). 1993. Investing in Natural Capital: The Ecological Economics Approach to Sustainability. Washington, D.C. Island Press.

Freeman, Myrick. 1982. Air and Water Pollution Control: A Benefit-Cost Assessment. New York: John Wiley and Sons.

Gale, William G. and Peter R. Orszag. 2005. "Economic effects of making the 2001 and 2003 tax cuts permanent." International Tax and Public Finance 12(2): 193-232.

General Accounting Office. 1999. Community Development: Extent of Federal Influence on Urban Sprawl is Unclear. Washington, D.C.: General Accounting Office.

Hagerman, J.R. 1992. Upper Little Tennessee River Aerial Inventory of Land Uses and Nonpoint Pollution Sources. TVA/WR-92/10. Chattanooga, TN: Tennessee Valley Authority, Water Quality Department.

Hamilton, Clive and Richard Denniss. 2000. Tracking Well Being in Australia: The Genuine Progress Indicator. 2000. Canberra, Australia: Australia Institute.

Hanley, Nick. 2000. "Macroeconomic measures of sustainability." Journal of Economic Surveys 14 (1): 1– 30.

Harris, Jonathan. 2000. Basic Principles of Sustainable Development. Medford, MA: Global Development and Environment Institute, Tufts University.

Hashemzadeh, Nozar and Wayne Saubert. 2004. "The effects of Bush's tax cuts on income distribution and economic growth in the United States." Problems and Perspectives in Management 0(3): 111-120.

Heston, A., Summers, R. and Aten, Bettina, 2002. Penn World Table Version 6.1, Center for International Comparisons at the University of Pennsylvania (CICUP).

Hicks, John. 1947. Value and Capital, Second Edition. London: Clarendon.

Hill, Kent, Dennis Hoffman, and Tom R. Rex. 2005. The Value of Higher Education: Individual and Societal Benefits. Tempe, Arizona: Arizona State University, W.P. Carey School of Business.

Holtz-Eakin, D., Lovely, M. and Tosun, M., 2004. Generational conflict, fiscal policy, and economic growth. Journal of Macroeconomics 26, 1-24.

Hsing, Yu. 2005. "Economic growth and income inequality: the case of the U.S." International Journal of Social Economics 32(7): 639-47.

Independent Sector. 2006. Independent Sector's Giving and Volunteering in the United States, Annual Update. Washington D.C.: Independent Sector.

Intergovernmental Panel on Climate Change (IPCC). 2000. Land Use, Land-Use Change, and Forestry. Geneva: United Nations Environmental Program and the World Meteorological Organization.

Kuznets, Simon. 1934. National Income, 1929-1932. Senate document no. 124, 73d Congress, 2d session, 1934.

Laband, David N., and John P. Sophocleus. 1992. "An estimate of resource expenditures on transfer activity in the United States." Quarterly Journal of Economics (August):959–83.

Lawn, Philip A. 2003. "A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes." Ecological Economics 44(2003): 105-118.

Lawn, Philip. 2005. "An assessment of the valuation methods used to calculate the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and Sustainable Net Benefit Index (SNBI)." Environment, Development, and Sustainability 2005(7): 185-208.

Leete-Guy, Laura, and Juliet B. Schor. 1992. The Great American Time Squeeze: Trends in Work and Leisure, 1969–1989. Washington, D.C.: Economic Policy Institute.

Leipert, Christian. 1989. "National income and economic growth: the conceptual side of defensive expenditures." Journal of Economic Issues 23(3): 843-856.

Managi, S., 2004. "Trade liberalization and the environment: carbon dioxide for 1960-1999." Economics Bulletin 17(1), 1-5.

Max-Neef, M. 1995. Economic growth and quality of life: a threshold hypothesis. Ecological Economics 15: 115– 118.

Markandya, A. and J. Richardson. 1992. Environmental Economics: A Reader. New York, New York: St. Martin's Press.

Mishel, Lawrence, Jared Bernstein, and John Schmitt. 1996. The State of Working America 1995–96. Armonk, N.Y.: M.E. Sharpe.

Moretti, E. 2004. "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data." Journal of Econometrics, July/ August 2004: 175-212.

National Center for Statistics and Analysis (NCSA). 2003. Traffic Safety Facts, 2003 Data. Washington, D.C.: National Center for Statistics and Analysis.

National Center for Transit Research (NCTR). 2005. Public Transit in America: Results from the 2001 National Household Transit Survey. Tampa: National Center for Transit Research, Center for Urban Transportation Research, University of South Florida.

National Oceanic and Atmospheric Administration (NOAA). 2006. Southern Hemisphere Winter Summary 2005. Washington D.C.: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Climate Prediction Center (www.cpc.ncep.noaa.gov).

National Safety Council. 2004. Estimating the Costs of Unintentional Injuries, 2004. Itasca, IL: National Safety Council.

National Safety Council. 1998. Accident Facts. Itasca, IL: National Safety Council.

Neumayer, Eric. 2000. "On the methodology of ISEW, GPI and related measures: some constructive suggestions and some doubt on the 'threshold' hypothesis." Ecological Economics 34: 347–361.

Neumayer, Eric. 1999. "The ISEW—not an index of sustainable economic welfare." Social Indicators Research 48(1): 77-101.

Nordhaus, William and James Tobin. 1972. "Is growth obsolete," in Economic Growth, National Bureau of Economic Research Series No. 96E. New York: Columbia University Press.

Outcalt, Kenneth and Raymond M. Sheffield. 1996. The Longleaf Pine Forest: Trends and Current Conditions. Resource Bulletin SRS-9. Asheville, NC: Southern Research Station.

Pearce, D. and G. Atkinson. 1993. "Capital theory and the measurement of sustainable development: an indicator of weak sustainability." Ecological Economics 8(2): 103-108.

Pearce, D., A. Markandya, and E. Barbier. 1990. Sustainable Development: Policy and Analysis in the Third World. Cheltenham: Edward Elgar Publishing.

Pezzey, J.C.V. 1992. "Sustainability: an interdisciplinary guide." Environmental Values 1: 321-362.

Ready, Richard C., Mark C. Berger, and Glenn C. Blomquist. 1997. "Measuring amenity benefits from farmland: hedonic pricing vs. contingent valuation." Growth and Change 28(Fall):438-458.

Roth, Andrew. 2005. The Bridge to Nowhere and the Minimum Wage. Washington: The Club for Growth. (www.clubforgrowth.org/blog/archives/ o26323.php).

Rutledge, Gary L. and Christine R. Vogan. 1994. "Pollution abatement and control expenditures, 1972–92, estimates for 1992, revised estimates for 1972–91." Survey of Current Business, May 1994: 36.

Rymes, T. 1992. Some Theoretcial Problems in Accounting for Sustainable Consumption. Carleton Economic Papers, 92-02.

Sampson, R. Neil. 1981. Farmland or Wasteland. Emmaus, Penn.: Rodale Press.

Saunier, Richard E. 1999. Perceptions of Sustainability: A Framework for the 21st Century. Washington, D.C.: Executive Secretariat for Integral Development (SEDI), Organization of American States (OAS).

Schneider, Friedrich and Dominik Enste. 2002. "Hiding in the shadows: the growth of the underground economy," Economic Issues 30 (March 2002). Brussels: International Monetary Fund.

Solow, R. M., 1956. "A contribution to the theory of economic growth." Quarterly Journal of Economics 70(1956), 65-94.

Solow, R. M., 1957. "Technical change and the aggregate production function." Review of Economics and Statistics 39(1957), 312-320.

Stockhammer, E., H. Hochreiter, B. Obermayr and K. Steiner, K. 1997. "The index of sustainable economic welfare (ISEW) as an alternative to GDP in measuring economic welfare: the results of the Austrian (revised) ISEW calculation 1955–1992." Ecological Economics 21 (1997): 19– 34.

Talberth, John and Alok Bohara. 2006. "Economic openness and green GDP." Ecological Economics 58: 743-758.

The World Bank Group (TWBG), 2004. World Development Indicators 2004. Washington, D.C.

Tol, Richard S.J. 2005. "The marginal damage costs of carbon dioxide emissions: an assessment of the uncertainties." Energy Policy 33(2005): 2064-2074.

Uri, Noel D. and James A. Lewis. 1999. "Agriculture dynamics and soil erosion in the United States." Journal of Sustainable Agriculture 14(2/3): 63-75.

U.S. Census Bureau. 2003. Income, Poverty, and Health Insurance Coverage in the United States: 2003. Washington, D.C.: U.S. Census Bureau.

U.S. Department of Agriculture. 1988. Ethanol: Economic and Policy Tradeoffs. Washington, D.C.: U.S. Department of Agriculture.

U.S. Department of Agriculture. 2005. Status and Trend of Late Successional and Old Growth Forest. General Technical Report PNW-GTR-646. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

U.S. Department of Agriculture. 2006. U.S. Forest Facts and Historical Trends. Washington, D.C.: USDA Forest Service.

U.S. Department of Labor. Bureau of Labor Statistics. 1990. "Thirty-eight million persons do volunteer work." News 90–154(29 March). Washington, D.C.: U.S. Department of Labor.

U.S. Department of Transportation (DOT). 2000. Journey to Work Trends in the United States and its Major Metropolitan Areas 1960–2000, Publication No. FHWA -EP-03-058. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration.

U.S. Fish and Wildlife Service (USFWS). 2003. Recovery Plan for the Red-cockaded Woodpecker (Picoides borealis) Second Revision. Atlanta, GA: U.S. Fish and Wildlife Service, Southeast Region.

U.S. Fish and Wildlife Service (USFWS). 1997. Status and Trends of Wetlands in the Conterminous United Status and Trends of Wetland: Projected Trends 1985 to 1995. Washington, D.C.: U.S. Government Printing Office.

U.S. Forest Service. 1980. Final Environmental Impact Statement: Roadless Area Review and Evaluation (RARE II). Washington, D.C.: USDA Forest Service.

United States Geologcical Survey. 2006. USGS Reports Latest Land-Water Changes for Southeastern Louisiana. USDI/ USGS. (www.lacoast.gov).

Vincent, James W, Daniel A. Hagen, Patrick Welle, Kole Swanser. 1995. Passive Use Values of Public Forestlands: A Survey of the Literature. St. Paul, MN: University of St. Paul, Department of Economics.

Vogan, Christine R. 1996. "Pollution abatement and control expenditures, 1972–94." Survey of Current Business, September 1996: 48–67.

Woodward, Richard T., Yong-Suhk Wui. 2001. "The economic value of wetland services: a meta-analysis." Ecological Economics 37:257-270.

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