

**PRELIMINARY DRAFT**

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**MEASURING SUSTAINABLE ECONOMIC WELFARE :**

**LOOKING BEYOND GDP**

**Hans Messinger, Statistics Canada**

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**The empirical results presented in this paper are part of experimental work at Statistics Canada into the feasibility of developing composite progress indicators. Replications of the “Measure of Economic Welfare” and the “Genuine Progress Indicator” using Canadian data are for illustration purposes only, and should in no way be regarded as products endorsed by Statistics Canada. All opinions expressed in this paper are those of the author and do not necessarily reflect those of Statistics Canada. Any errors or omissions rest solely with the author.**

**ABSTRACT**

*Simon Kuznets and other pioneers in the field of National Accounting never conceived that Gross National Products could or should serve as a measure of economic or social welfare. Yet real per capita GDP is commonly used as a measure of comparative living standards. There is some notion that an increase in GDP is like a rising tide that lifts all boats. The benefits of a larger market economy trickles down to benefit all. In a democratic society government policies and programs ensure equitable sharing of the total economic pie among today's society as well as future generations. Post-war prosperity in highly industrialized western societies raised doubts in the late 1960's and early 1970's about economic growth as the major goal of societal progress. The appropriateness of GDP as a measure of economic welfare became the subject of much discussion and debate. A noted attempt at testing whether GDP adequately serves as an aggregate indicator of societal well being, was the Measure of Economic Welfare (MEW) developed by two Yale economists, Nordhaus and Tobin. This research in the early 1970's concluded that there was sufficient correlation between MEW and GDP such that the latter can be reasonably construed as an indicator of economic welfare trends. “If the Economy is Up, Why Is America Down?” (Atlantic Monthly, October 1995) re-kindled the debate about the validity of using GDP as a proxy measure of economic welfare. The Genuine Progress Indicator (GPI) developed by the Center for Redefining Progress, San Francisco, showed a widening gap between GDP and sustainable economic welfare.*

## **1. Introduction**

This paper focuses on the limitations of GDP as a measure of sustainable economic welfare, and how recent economic, social and demographic trends may have resulted in deviations between macro-economic growth and sustainable economic welfare. The paper begins with a discussion of limitations Gross Domestic Product as a measure of economic progress and sustainable growth. Two composite indicators of sustainable economic welfare developed in the United States, the Genuine Progress Indicator (GPI ) and the Measure of Economic Welfare (MEW), are reviewed. These measures were replicated for Canada covering a period from 1971 to 1994 and compared to the findings in the U.S. The GPI and MEW are assessed in terms of their strengths and weaknesses as composite measures of sustainable economic welfare. In conclusion, the implications of developing and constructing composite indicators of sustainable economic welfare are summarized in the context alternative and extended frameworks of the System of National Accounts.

Gross Domestic Product measures the total market value of production, but tells little about how the economic returns to factors of production are distributed among society. GDP does not include the value of production that occurs outside the formal marketplace, such as unpaid housework, childcare and volunteer work. GDP does not account for changes in leisure, the opportunity cost of work. Natural and “man-made” disasters, crime and accidents all contribute to GDP in a positive way since these activities generate production, but do not add to the well being of society. GDP is not adjusted to account for the harms resulting from industrial, household and motor vehicle emissions, and waste disposal. Finally, GDP takes no account of investment required to produce goods and services for the economic well being of future generations, even though Net National Product (NNP) does to a limited extent. Concerns about sustainable economic development have more recently centered on the concept of “green accounting”, by extending Gross Domestic Product to include environmental and resource accounts.

Development of social indicators aimed at measuring “quality of life” spread rapidly among all industrialized nations and international organization such as UN and OECD in the late 1960’s and 1970’s. These indicators were usually presented as collections of social and economic statistics classified by major subject areas such as health, education, labour market, culture, recreation etc. With few exceptions, there were no bottom lines, and with good reason. Firstly, it would be virtually impossible to draw a consensus on all the information that should be included in a single measure. A second problem would be aggregating components to a single measure. Finding a common denominator (such as market values in GDP) would be difficult without considerable subjective weighting.

## **2. Limitations of GDP as a Measure of Sustainable Economic Welfare**

GDP represents the market value of all goods and services produced in Canada within a given year. Estimates are developed within an internationally accepted economic accounting framework – the most comprehensive of which are the input-output accounts (a detailed supply and demand structure of the economy). Although Kuznets and other pioneers in the development of national accounts never conceived of GDP as a welfare measure, it has nevertheless been openly criticized for its inadequacies in monitoring economic progress from a sustainable welfare perspective. Major shortcomings include the following:

### ***GDP does not include the value of non-market production and leisure***

- *Unpaid housework*
- *Child Care*
- *Volunteer Work*
- *Leisure*

All these activities are based on production and consumption that occur outside the market economy. Unpaid housework, childcare and most volunteer services can, with few exceptions, be purchased in the market economy. Leisure to a certain extent represents an individual choice in offering one's labour services in the market economy

### ***GDP contains intermediate and regrettable expenditures that do not contribute to economic welfare***

- *Most elements of Government spending (defense etc.)*
- *Elements of personal spending such as; costs of commuting to work, and costs related to crime, accidents, environmental protection etc.*

### ***Changes in GDP are insensitive to the distribution of personal income and distribution of consumption***

- *Inequality in the distribution of family income (Lorenz Curve, GINI etc.*
- *Poverty*

- *Distribution of Personal Consumption*

***GDP Expenditures on health, education, social services and environmental protection do not necessarily reflect outcomes in these areas***

- *Quality of physical and mental health of the population*
- *Levels of educational achievement*
- *Labour market skills (human capital)*
- *Quality of the environment (clean water, air etc.)*

***GDP does not account for resources required for sustainable economic development (an issue of intergenerational equity)***

- *Produced Assets (plant and equipment, infrastructure, financial assets)*
- *Natural capital (environmental resources)*
- *Human resources*
- *Research and Development (Technology)*

***GDP does not directly measure investment in social capital***

- *Social Capital (investment in communities, social institutions etc.)*

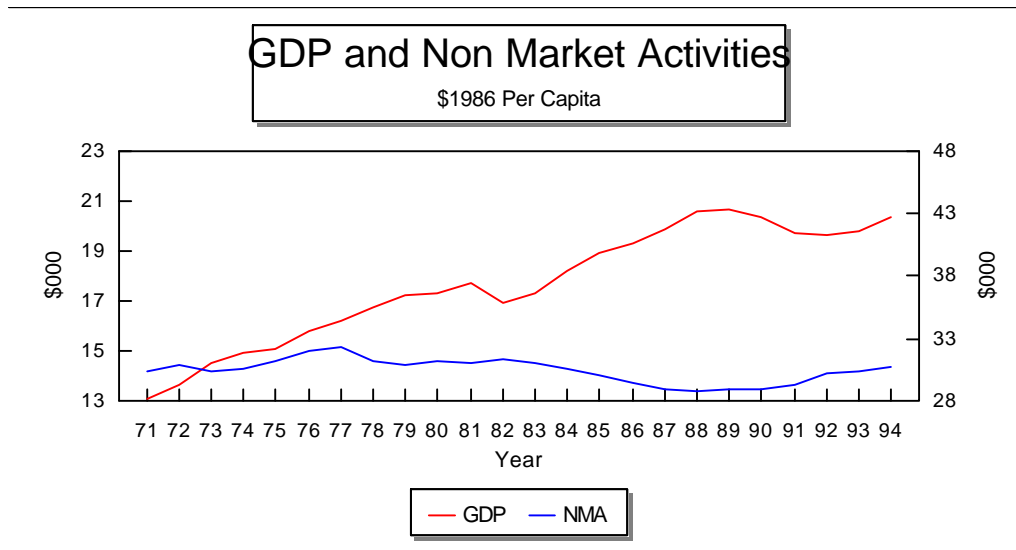
***Possible Sources of Divergence between recent trends in GDP and Economic Welfare***

***Socio-Demographic Trends***

- *Labour Market participation*
- *Family formation*
- *Aging*

The rapid increase in labour market participation rates of the female population is one of the major factors underlying the divergence of GDP and economic welfare as measured in two composite indicators reviewed in this paper. The higher growth in GDP resulting from a shift from work at home to work in marketplace is not offset to account for lower production of unpaid housework and childcare and lost leisure.

**CHART 1 - per capita GDP and Non-Market Production + Leisure**

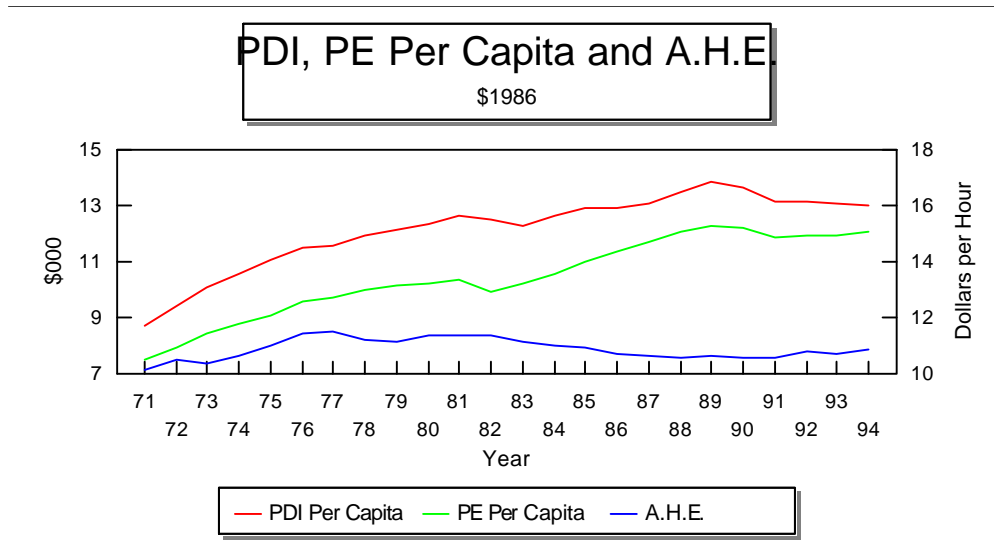


### ***Technological and Structural Changes***

- *Downsizing*
- *Re-engineering*
- *Good jobs - Bad jobs (Employment growth in service economy)*

Following each economic downturn since the early 1980's, unemployment remained stubbornly high, and failed to return to pre-recession levels. In addition, the incidence of involuntary part-time work increased dramatically from under 2 percent in the late 1970's to 5 percent in the 1990's. Higher unemployment, declining employment in manufacturing and growth in lower paying service jobs have kept the average hourly earnings flat. Real Personal Disposable Income over the past two decades has improved largely through increased labour supply and transfer income. The rise in per capita personal spending also resulted from lower personal savings rate and increased consumer debt

**CHART 2 - Per Capita Real Disposable Income, Per Capita Personal Consumption (\$K) and A.H.E.**



### ***Public Policy Constraints***

- *Pressures to eliminate deficits and reduce public debt*

Public debt (all levels of government) has risen from about one-quarter of GDP to the actual level of GDP over the past two decades. Recent efforts to reduce deficits have mitigated government's ability to provide social services and benefits.

### ***External Factors***

- *Trade globalization*
- *International competitiveness*
- *Environmental Issues*

A continued lowering of trade barriers and growth of the information economy has prompted rapid expansion in international trade. With increased global competitiveness social and environmental concerns are seriously challenged.

### **3. Composite Measures of Economic Welfare**

#### **3.1 Measure of Economic Welfare (MEW)**

The Measure of Economic Welfare (MEW) was developed by two Yale University economists, Nordhaus and Tobin, in the early 1970's. The empirical results cover a period from 1929-1965 for the United States. The authors started with a premise that GDP is not a satisfactory measure of economic welfare. The correlation of MEW to GDP and Sustainable MEW to NNP were examined to determine whether the trend of per capita GDP could satisfactorily serve as an indicator of economic welfare. From the outset, the authors are clear that MEW is a measure of economic and not social welfare. Finally, their concept of sustainability is distinctive (MEW net investment).

#### ***Actual MEW - Total Consumption***

MEW, like the GPI, uses personal spending on consumer goods and services as its starting point. Various additions, subtractions and imputations are then made in deriving a measure of total consumption deemed to generate economic welfare.

- 1? ***Personal Consumption Expenditures*** are as reported in the National Income and Product Accounts
- 2? ***Private instrumental expenditures*** represent personal outlays for commuting to work, banking and legal services. These expenditures are deducted as they regarded as "regrettable" contributing nothing to economic welfare.
- 3? ***Expenditures on consumer durable goods*** are replaced with an imputed value of services derived from the stock of consumer durable goods
- 4? ***Private spending on health and education*** are deducted from the current measure of economic welfare, and are then included as part of investment expenditures.
- 5? ***Services of consumer capital*** is an imputed value of the services derived from the stock of consumer durable goods

- 6? **Value of Leisure** is an imputed value of leisure time that adds to economic welfare. Its value is based on the opportunity cost of work.
- 7? **Value of Non-Market activities** represents an imputed value of services derived from unpaid housework, parenting and volunteer work
- 8? **Disamenity correction** is a deduction for estimated higher costs of urban dwelling. The differential between rural and urban wages is used as a proxy in the original U.S. measure. In the Canadian version we opted to use an aggregate of the urban disamenity elements that were estimated for the GPI, including cost of crime, auto accidents and pollution..
- 9? **Government Consumption** represents those elements of public current spending that are deemed to generate economic welfare. These are small representing recreation outlays and subsidies of the post office
- 10? **Services of Government Capital** is an imputed value of services to persons from the stock of public capital that generates economic welfare

$$\text{Actual MEW} = \text{Total Consumption} = 1-2-3-4+5+6+7-8+9+10$$

### ***Sustainable MEW***

*The sustainability component of MEW is the difference between the change in the net MEW capital stock and the growth requirement, which is the annual change in capital stock necessary to keep pace with changes in the size of the labour force and then adjusted for changes in productivity.*

***Mew capital stock is a measure of net public and private wealth consisting of four components:***

- 1? Net Reproducible capital representing investment in structures, machinery and equipment and inventories
- 2? Non-Reproducible capital consisting of the value of land and net foreign assets
- 3? Education capital - an estimated value of education spending invested in the labour force. An average cost per student is multiplied by the average years of educational attainment per individual in the labour force.
- 4? Health - cumulated public and private spending on health reduced by an annual exponential depreciation rate of 20 percent



The growth requirement represents the changes in net capital stock required to keep labour-capital ratios constant adjusted for changes in total factor productivity

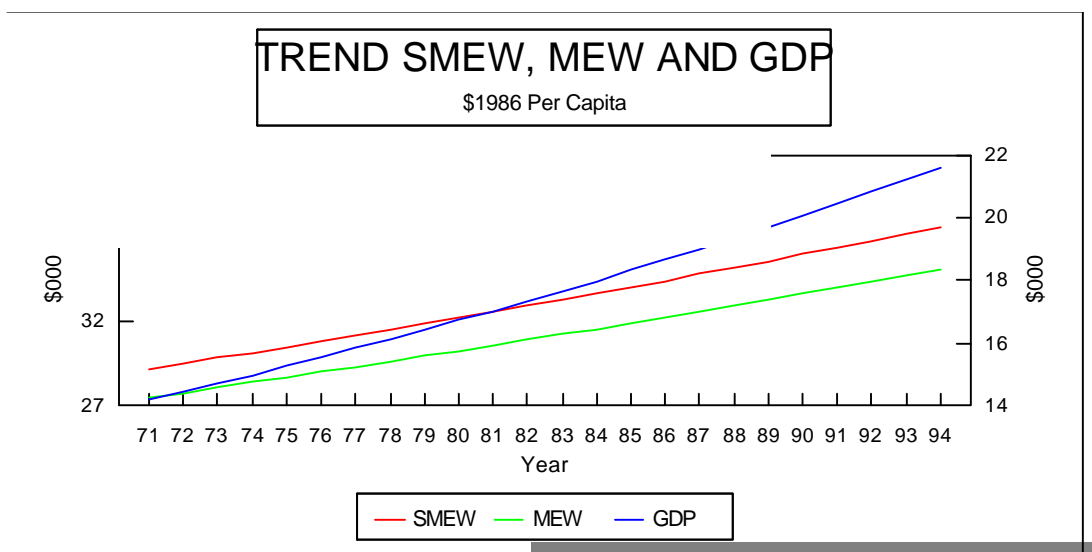
### Empirical Findings – United States, 1929-65

The authors, Nordhaus and Tobin concluded that there was sufficient positive correlation between the MEW and GDP to conclude that the latter was a reasonable macro barometer of changes in economic welfare. This observation was based on a time period of 1929-65 in the United States. The results, however, showed significant variation for smaller time segments over this period.

### Empirical Findings – Canada, 1971-94

Empirical results for Canada showed that the trend 1971-94 both the actual and sustainable MEW advanced at slower rate than GDP. The difference is largely attributed to the imputed value of unpaid housework, childcare, volunteer work and leisure which showed a slight downward trend. This result was predictable given the rapid increase in female labour market participation rates, which caused a shift from non-market to market production, and reduced leisure time. The trend of the Sustainable Measure of Economic Welfare (SMEW) was nearly identical to MEW indicating that growth in the capital stock kept pace with the investment growth requirement

**CHART 3 – Trend of MEW, SMEW and GDP – Canada, 1971-94**



## Criticisms of the MEW

- ***No adjustments for inequality in personal consumption*** – Personal expenditure is main building block of MEW. As a macro measure there is no indication of changes in welfare that may result from changes in the inequality of income and consumption.
- ***No accounting for changes in natural resource stocks*** – The MEW capital stock does not include natural resources, renewable and non-renewable. Nordhaus and Tobin assume that in the long run there is substitution between reproducible and non-reproducible capital and technology will take care of any potential shortfalls
- ***No adjustments for changes in quality of the environment*** – Global warming, ozone depletion and smog which pose serious concerns to the quality of health and agricultural products have all been attributed to expanding industrial production. These issues have largely emerged since Nordhaus and Tobin developed their MEW,
- **Imputed value of non-market activities (subjective)** - The total number of leisure hours for the working age population are weighted by the real average industrial wage rate, the opportunity cost of work. The value of this component, as such, is much larger than personal expenditure and the imputed value of unpaid housework, childcare and volunteer work. The latter is based on the lowest valuation of four assumptions developed by Statistics Canada. This is further discussed in section on the GPI. Valuing all leisure hours of the working age population as an opportunity cost is in itself subjective in that very few individuals have an unrestricted choice between hours of work and leisure. Furthermore, if all individuals opted to work considerably longer hours, it would put downward pressure on wages. Hence the imputed value for leisure in the MEW is positively biased.
- ***Investment in Human Capital*** - All public and private health spending is included in the MEW. The stock of health spending is depreciated at an arbitrary rate of 20 percent per annum. The change in net stock is regarded as an investment in human capital. This being the case, why is health spending on the elderly, who have left and are not expected to re-enter the labour market, included in the stock estimate? The Total Income System of Accounts (TISA, Robert Eisner, includes only 50 percent of health expenditures as a rough estimate to exclude health expenditures for the retired population. There should also be some factor of depreciation to account for the retraining requirements

### 3.2 *Genuine Progress Indicator*

The Genuine Progress Indicator was developed by a U.S. research group, Redefining Progress (Cobb, Halstead and Rowe). The indicator can be broadly split into two blocks: a measure of current economic welfare and a measure of sustainable economic development..

*A. Elements of Current Economic Welfare consist of the following:*

## **1. Consumer Spending**

*The fundamental building block of the GPI is Consumer Expenditures on goods and services as recorded in the National Accounts. This represents approximately 60 percent of total GDP*

1.1 Consumer spending is adjusted for changes in inequality in the distribution of personal income:

$$C_{ADJ} = C_{GDP} * \frac{(Y_{Q1,0} Y_{T,t})}{(Y_{Q1,t} Y_{T,0})} \quad \text{where,}$$

$C_{ADJ}$  = Consumer spending adjusted for changes in inequality

$C_{GDP}$  = Consumer spending component of GDP

$Y_{Q1}$  = Income received by families in lowest quintile (before tax, including transfer income)

$Y_T$  = Total family income

t represents year t and 0 represents the base year

1.2 Actual expenditures on consumer durable goods are replaced with an estimated value of services derived from the stock of consumer durable goods. This annual value of services is determined by the rate of depreciation of such goods and a rate of interest (the opportunity cost of income invested).

1.3 Consumer spending is discounted for items that are deemed to be intermediate or defensive in nature, namely:

Cost of commuting - cost of traveling to and from work using either public transportation or private vehicle, as well as an estimate of time use while commuting;

Cost of crime and automobile accidents - costs associated with medical and legal expenses, and expenditures related to lost or damaged property. Spending on crime prevention (alarm systems, locks etc.) are also deducted from consumer expenditures;

Cost of family breakdown - includes expenses for legal fees, counseling and the establishment of separate residences, as well as an estimated cost of damage to the well being of children;

Cost of household pollution abatement - represents expenditures on air and water filters and devices to improve air and water quality in the home

## **2. Government Spending**

*Government spending recorded in GDP is, with one small exception, all regarded as intermediate (defensive) expenditures that are required to maintain rather than enhance quality of life*

An estimated value of the services to persons generated by the stock of streets and highways is the only component of government current and capital spending that is contained in the Genuine Progress Indicator. It is deemed that all other public spending recorded in GDP is intermediate, protective, or defensive in nature.

### **3. Non-Market Production and Leisure**

*An estimated value of non-market production for unpaid housework, childcare and volunteer work is added to the current economic welfare components of GDP. The value of leisure is included in the sense that current economic welfare is discounted for leisure lost due to increased participation in the labour market, or more time spent on unpaid housework childcare and volunteer work.*

Value of household work and parenting - is determined by the number of unpaid hours spent on household tasks such as cooking, cleaning and child care multiplied by the average hourly earning of household domestic workers.

Value of Volunteer work - represents the estimated unpaid hours multiplied by the average real wage rate.

Loss of Leisure time - is the value of lost leisure in relation to the year of greatest leisure over the estimated time period (1950-94). Hours lost are valued by the average real wage rate.

### **4. External Factors**

*The current measure of economic welfare is reduced by costs associated with underemployment and pollution.*

Cost of Underemployment - represents the gap between full-time and involuntary part-time work, measured in hours and multiplied by the average real wage rate

Air pollution costs are based on damage to agricultural vegetation, materials damage, cleaning, acid rain damage (forests and aquatic), reduced urban property values, and aesthetics. Costs are adjusted annually by changes in indexes of air quality.

Water pollution adversely affects recreation, aesthetic, ecological and property values as well as the quality of household and commercial water supplies. The estimated value of these affects are adjusted annually for changes in water quality and siltation

An estimated value of noise pollution was made by the World Health Organization. This value is adjusted annually by changes in noise pollution based on the rate of industrialization and motor vehicle and traffic.

### **B. Sustainable Economic Development**

*The measure of sustainable economic welfare contained in the Genuine Progress Indicator consists of the following: depletion of natural resources (non-renewable energy and farmland); net investment in produced business fixed assets; net foreign lending/borrowing; long term environmental damage (“greenhouse effect” and ozone*

*depletion); and, long term ecological damage resulting from the loss of wetlands and the harvesting of old growth forests.*

### **1. Net Investment**

The cost of depletion of non-renewable natural resources - is determined by substituting current production of non-renewable energy by a barrel equivalent of energy derived from ethanol produced from corn. The quantity of corn required to replace conventional production of non-renewable sources (mainly oil and gas) is multiplied by a price per bushel to obtain a value. The estimated price of corn is substantially higher than present values reflecting increased demand and no agricultural subsidies. The price is then assumed to rise by 3 percent per annum due to increasing real production costs

Loss of farmland in the GPI is regarded as a conversion from capital to current income thus negatively affecting sustainable development. The value of lost farmland represents the value of farm acreage lost to urbanization plus a discounting of existing farmland as a result of deterioration in the quality of soil.

Net Capital Investment (produced business fixed assets) - is the difference between the change in the net stock of produced fixed capital (non-residential construction and machinery and equipment) and the amount of investment required to keep the net stock of capital per worker constant.

### **2. Net International Position**

Net foreign lending/borrowing - is the annual change in the U.S net foreign investment position

### **3. Long Term Environmental and Ecological Damage**

Costs of global warming (carbon dioxide emissions, "greenhouse effect") - is linked to the current consumption of fossil fuels and nuclear power. The long-term cost is estimated by multiplying a per barrel equivalent by an arbitrary price (a tax) on current production of non-renewable energy to compensate future generations for the economic damage of global warming.

Cost of Ozone depletion - is linked to world production of chloroflouorocarbons (CFC's) and other ozone-depleting chemicals. The long-term costs to health and ecological effects are determined by multiplying cumulative world production of CFC's by an arbitrary price per kilogram

Loss of Wetland - represents ecological damage valued as a product of the cumulative number of acres drained and an estimated cost per acre.

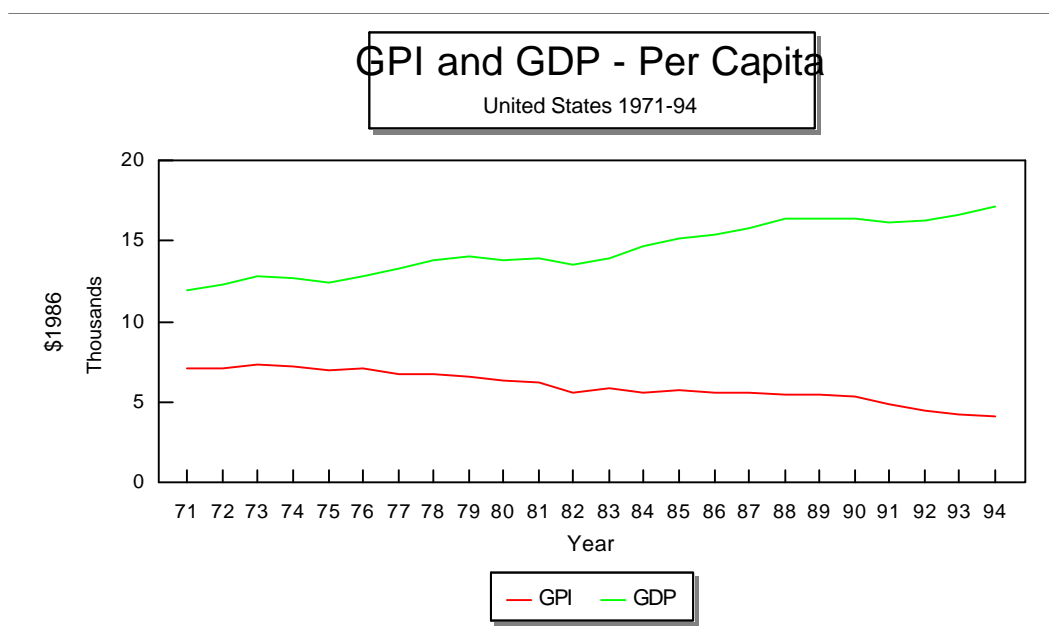
Loss of Forests - represents ecological damage valued as a product of the cumulative number of acres of "old growth" forests cut and an estimated cost per acre.

### **Summary of Findings in the U.S.**

The GPI was estimated from 1950 to 1994. From 1950 until the mid-1960's the index tracked real per capita GDP reasonably well. From the early 1970's, however, there was a

continual divergence, with the two measures actually moving in opposite directions. The GPI showed a pronounced downward trend over this period.

**CHART 3 - GDP and the Genuine Progress Indicator, United States 1971-94**



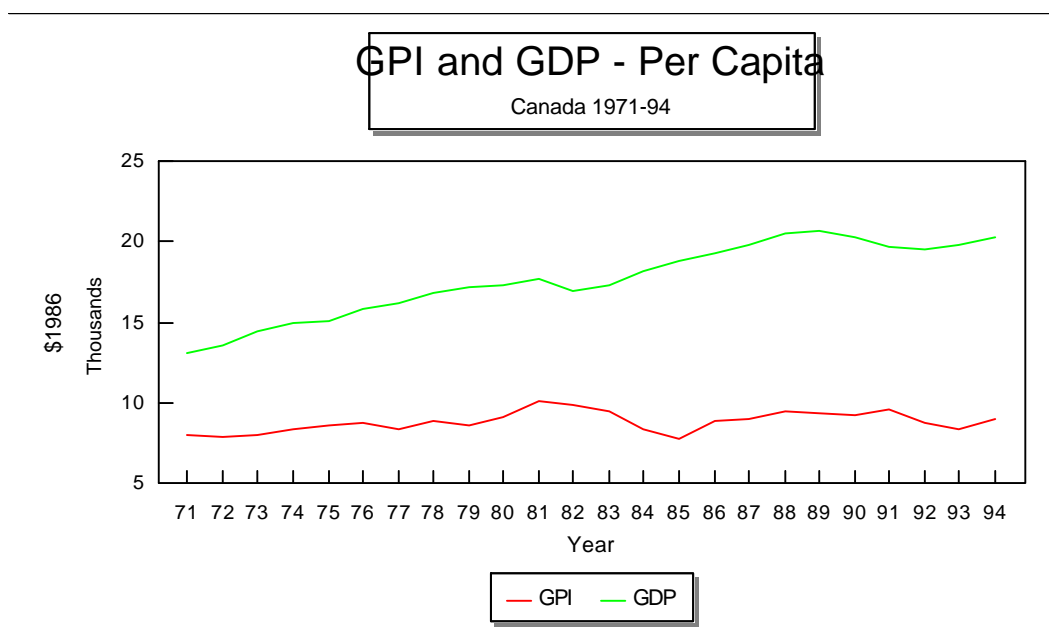
***The downward trend of the GPI over the past two decades is mainly attributed to:***

- Increased inequality in the distribution of personal income, discounting the value of consumer spending by about 30 percent by 1994;
- A substitution price of non-renewable energy depletion set at approximately five times the current world market price; and,
- An ever increasing cost of cumulative long-term environmental and ecological damage.

### **GPI - Canada, 1971-94**

A Canadian replication of the U.S. GPI was constructed at Statistics Canada as part of an experimental research program on composite progress indicators. ***This index, as in the U.S. diverged with growth in real per capita GDP but the Canada measure was relatively flat over this period as opposed to a downward trend in its US counterpart.***

**CHART 4 – Genuine Progress Indicator and GDP, Canada 1971-94**



The divergence between the GPI and GDP was mostly attributed to the sustainability components of the measure, which increasingly subtracted from the value of current economic welfare. The latter tracked reasonably well with GDP, although there was a gap that developed between the economic recessions of the early 1980's and 1990's.

### **Two major factors account for the difference between the Canada and U.S. GPI:**

- 1? Inequality in distribution of family income did not deteriorate in Canada as it did in the United States. In the latter case consumer spending was by in 1994 was discounted by 30 percent due to increased inequality in the distribution of income while in Canada it was virtually unchanged.
- 2? The cost of depletion of non-renewable energy resources in Canada were assigned a much lower price based on the economic feasibility of extracting mineral fuels from the massive stocks of the Alberta tar sands and Newfoundland off-shore oil reserves.

### **Criticisms of the Genuine Progress Indicator**

*Shortcomings of the GPI as a composite measure of sustainable economic welfare can be classed into three categories: selection bias, subjective weighting and measurement problems and limitations.*

### 1. Selection bias:

*The decision to include or exclude certain items in a composite measure of welfare can dramatically alter the message conveyed in the bottom line. The GPI is not consistent in its selection of components that contribute to economic welfare or those affecting sustainable development*

- **Government Spending Doesn't Count:** The GPI uses consumer spending as its fundamental building block, removing certain expenditures as intermediate, and treating expenditures on consumer durable goods as capital spending. Government current spending, however, is all treated as intermediate, generating no current welfare. As such, private spending on health and education are included in the GPI (with minor exceptions) while public spending in these areas is ignored. It is also difficult to simply exclude public spending on recreation, culture and social infrastructures on the basis that these do not contribute to the economic welfare of society. Furthermore, government spending in research and development should factor into a composite measure of sustainable economic development.
- **Natural Resource Stocks:** The GPI only includes the depletion of non-renewable energy resources, hence disregarding non-renewable metallic and non-metallic minerals, and renewable resources such as forestry and fishing.
- **Human Capital:** The GPI does not include net changes in the stock of human capital as part of investment required for sustaining economic development. Granted, this element of capital investment is difficult to measure, but simply ignoring it presents a serious problem given that public spending on education, training and health are excluded from the GPI.
- **Technology:** The GPI excludes public and private spending on research and development. Neither does the GPI adjust investment requirements for changes in productivity

### 2??Subjective Weighting

*All components of the GPI are valued in constant price dollar terms. This makes it simple to aggregate to a single measure. The prices of many components, however, are not determined in the marketplace and hence are somewhat arbitrary. This presents another means of manipulating the "bottom line".*

- **Non-Market Production:** Unpaid housework is relatively straightforward to value since there are parallel activities in the marketplace (cleaning, cooking, childcare, home repairs etc.). The GPI uses a wage rate for general domestic services. Recent work at Statistics Canada on unpaid housework came up with four different values (generalized wages, specialist wages, and pre and post tax opportunity costs)



- **Inequality:** The adjustment to consumer expenditure for inequality is based on the share of total family income, before taxes, received by households in the lowest income quintile. This measure of inequality falls short of its objectives for a number of reasons: (1) An after-tax measure would be more fitting since most countries have progressive personal income tax structures which in effect re-distribute income; (2) why target only the lowest quintile instead of a more broadly based measure such as the Gini Coefficient; and, (3) Needs (weighting) are not adjusted to account for different household characteristics such as family size, age, etc. Equivalence scales are often used as a means of determining variations in poverty thresholds and basic needs.
- **Non-Renewable Energy Resources:** The price of ensuring a sustainable source of energy in the GPI was somewhat arbitrary in terms of predicting a price of corn required as a bio-mass conversion of producing the barrel equivalent of energy currently consumed from conventional sources. The estimated price worked out to \$75US per barrel of oil in 1988 (about five times the world market price). This price is then increased by an arbitrary 3 percent per year in real terms. The GPI cost approach assumes that non-renewable must be replaced by renewable energy resources in order to ensure sustainable growth. Not only did this generate an estimated price that was several times the current world market price, but it also assumes that the cost of non-renewable energy replacement will increase in real terms through time as substitutes for non-renewable resources become scarcer. This method of valuing the depletion non-renewable resources is fundamentally different from that used in established “green accounting” practices [UN 1993]. First, the price is based on a current value as opposed to a hypothetical future substitution price; and, second, the net price is a resource rent (the market price less marginal extraction costs. Empirical measurement is by no means straightforward since marginal extraction costs can vary greatly by deposit (e.g. tar sands, off shore oil) making it difficult to adjust the value of the natural resource stock for new discoveries.
- **Long Term Environmental Damage:** The cost of greenhouse gas emissions are based on the consumption of fossil fuels and nuclear energy valued by an unexplained price per barrel equivalent. Similarly, the cost of ozone depletion attaches an arbitrary price to the world production of CFC’s. Long term environmental damage in “green accounting” is treated very much like non-renewable resource depletion (asset depreciation which becomes a future liability). The value is the product of annual emissions, and a present value, discounted price of future damage per unit of emission. The quantity components of these GPI measures are upwardly biased, for two reasons. First, they are measured as cumulative stocks, while most other components of the index are included as flows or changes in stocks. Second, cumulative stocks are derived from quantities of fossil fuels, nuclear energy and CFC’s produced as opposed to the emissions generated by their use. Scientific literature has been quite clear about the negative effects of global warming and ozone depletion, but to attach a present value to projected future damage is at best judgmental. Economic costs associated

with established health risks and agricultural yields would constitute a more meaningful measure of long term environmental damage.

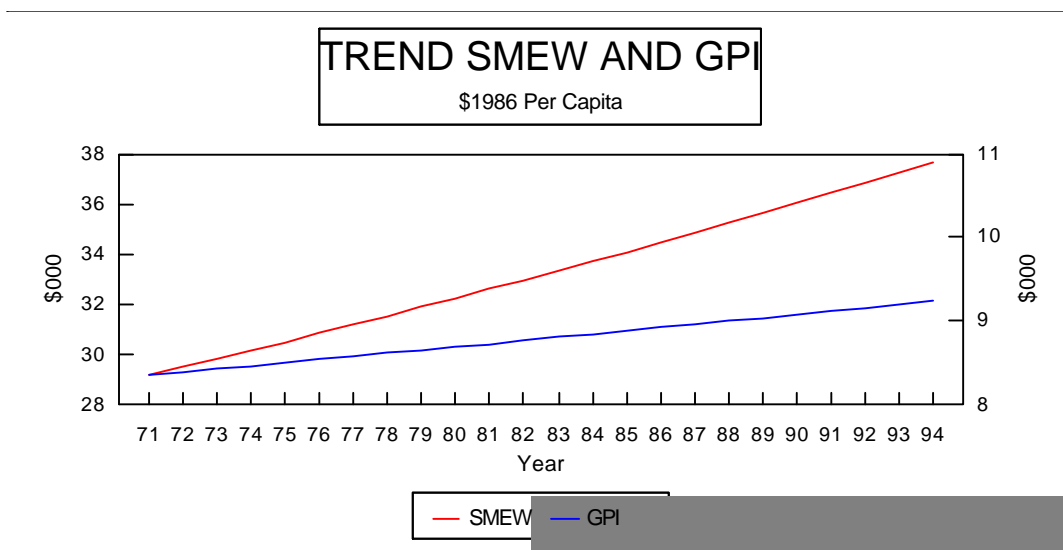
- **Long Term Ecological Damage** - The cumulative loss of wetland and 'old growth' forest acreage is multiplied by a price per acre (the unit cost of ecological damage). This principle of measuring ecological damage is similar to that of long term environmental damage in that cumulative stocks and not annual changes in stocks are used as the quantity component. Secondly, it is assumed that the erosion of ecosystems is directly proportional to acreage lost, and finally, the unit price is not only subjective, but is also unclear.

### 3. Measurement Problems and Limitations

A number of measurement problems and limitations relate closely to the issue of subjective weighting. Criticisms labeled as selectivity bias (e.g. ignoring human capital) are often a simple lack of available statistics. Of the 25 measured components in the GPI, only about one-third are based on actual annual data - mostly those extracted from the system of national accounts. Some time series are based on as little as two or three observed data points, with missing years interpolated and extrapolated to cover a period of more than four decades.

### Major Differences between GPI and MEW

**CHART 6 - Trend GPI AND MEW – Canada, 1971-94**



Our two empirical examples of composite measures of sustainable economic welfare were both outpaced by the growth of real per capita GDP. Both composite measures use consumer spending on goods and services as the fundamental building block and the adjustments for consumer durable goods, intermediate and regrettable expenditures are very similar in each case. Unlike the MEW, the GPI adjusts consumer spending for changes in the inequality of the distribution of personal income. Empirically this turned out to be of little consequence in Canada over the time period reviewed, but represented a major difference in the U.S. Government spending hardly factored in either indicator. The same imputed value for non-market production was used in both composite measures. An imputed value of leisure was included in MEW while the GPI only includes a net deduction for loss of leisure relative to the year of greatest leisure in the time series. This accounts for much of the difference between the current economic welfare component of the two measures.

The sustainability measure is dramatically different in the two indicators. The GPI makes no allowance for technology and ignores investment in human capital. Both these elements are addressed in the MEW, even though the methodology used in deriving the latter is questionable. The GPI does include measures for the depletion of natural resources and estimates effects of environmental and ecological damage. The way in which these measures derived, however, fall under severe criticism as discussed earlier. The MEW implicitly assumes that the pricing mechanism in the marketplace will ensure future availability of natural resources required to sustain growth. There is also an assumption of substitutability between reproducible and non-reproducible capital. The exclusion of environmental and ecological issues in the MEW is perhaps a sign of the times. The Nordhaus and Tobin work was well completed before the emergence of green accounting and the availability of appropriate statistics.

TABLE 1

## MEASURE OF ECONOMIC WELFARE - ACTUAL AND SUSTAINABLE

YEAR	Personal Spending	Private Instrumental Spending	Durable Goods Purchases	Private Health & Education	Services Durable Goods	Imputed Value for Leisure	Imputed Non-Mkt Activities	Disamenity Correction	Govt. Consumption	Services Govt. Capital	Actual MEW	MEW Net Investment	Sustainable MEW	Actual MEW per Capita	Sustainable MEW per Capita
	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$)	(\$)
1971	164.3	-9.3	-11.7	-9.2	15.6	354.7	105.7	-26.4	11.6	9.8	605.0	89.0	694.0	27466.5	31507.4
1972	176.7	-10.0	-13.5	-9.7	17.0	371.0	107.9	-29.6	12.3	10.6	632.6	-16.7	615.9	28386.1	27636.1
1973	189.9	-10.7	-16.1	-10.2	19.4	370.1	110.2	-29.5	13.6	11.5	648.1	15.6	663.7	28728.7	29418.5
1974	200.9	-11.3	-16.8	-10.6	22.2	384.2	112.7	-28.7	16.1	13.7	682.5	-82.1	600.5	29838.2	26250.4
1975	210.4	-11.8	-18.5	-11.2	23.8	403.4	115.4	-29.0	16.1	16.0	714.7	12.8	727.5	30795.0	31346.8
1976	224.1	-12.7	-19.0	-11.7	25.8	431.3	115.2	-30.1	15.8	18.0	756.7	81.3	838.0	32174.4	35631.7
1977	231.2	-13.4	-19.5	-12.5	28.0	441.1	120.1	-30.5	17.1	20.7	782.3	-39.6	742.7	32874.1	31210.2
1978	239.1	-13.8	-18.8	-13.3	30.3	432.0	12.3	-30.9	16.8	23.1	676.7	-46.1	630.6	28154.3	26235.9
1979	246.0	-15.0	-20.6	-13.2	32.3	432.9	124.4	-30.0	16.8	25.2	798.7	-1.7	797.1	32900.5	32831.7
1980	251.3	-15.9	-19.7	-13.8	33.8	448.7	126.7	-28.9	17.5	28.5	828.2	-1.5	826.7	33674.9	33615.1
1981	257.1	-16.5	-19.4	-14.1	35.0	450.7	129.8	-27.9	17.6	32.8	845.2	14.3	859.5	33943.8	34516.4
1982	250.3	-15.7	-16.1	-14.3	34.1	468.0	130.9	-27.3	17.1	37.9	865.0	-112.8	752.2	34324.3	29848.9
1983	258.9	-15.6	-18.7	-15.2	34.6	466.5	131.6	-27.3	17.7	40.8	873.2	167.6	1040.9	34303.4	40889.2
1984	270.9	-16.2	-21.4	-16.1	35.7	464.3	131.0	-28.2	17.7	44.2	881.8	42.4	924.2	34308.6	35956.9
1985	284.9	-17.6	-24.8	-16.4	37.7	462.1	133.0	-28.6	17.9	48.2	896.3	-55.4	841.0	34551.9	32417.8
1986	297.5	-19.6	-25.5	-17.0	40.4	457.2	132.3	-29.3	18.0	50.9	904.8	-19.9	884.9	34529.4	33770.0
1987	310.5	-21.9	-27.3	-17.5	42.8	453.0	135.1	-29.4	19.7	54.4	919.4	45.7	965.1	34628.6	36349.4
1988	324.3	-23.5	-28.8	-17.7	45.8	453.3	137.9	-30.0	19.3	59.3	939.8	-1.0	938.8	34945.3	34907.2
1989	335.3	-23.8	-28.4	-18.3	47.5	461.9	141.5	-30.0	19.8	65.9	971.4	-46.5	924.9	35478.1	33780.3
1990	338.7	-25.0	-27.2	-18.8	48.4	468.0	144.6	-31.3	21.2	71.6	990.3	-109.8	880.5	35635.2	31684.3
1991	333.4	-25.6	-25.8	-18.5	48.6	481.5	147.4	-31.4	21.1	74.7	1005.4	71.0	1076.4	35755.4	38280.6
1992	337.6	-25.7	-25.6	-18.9	49.2	504.4	152.3	-31.9	20.5	77.2	1039.1	35.8	1074.9	36540.7	37800.8
1993	342.9	-26.8	-25.7	-18.9	49.9	510.9	156.2	-32.5	20.3	79.7	1056.0	-19.0	1037.0	36726.5	36065.3
1994	352.9	-28.7	-26.4	-19.1	50.7	527.7	159.1	-33.1	19.7	83.3	1086.1	50.4	1136.6	37135.5	38859.4

TABLE 2

## GENUINE PROGRESS INDICATOR - CANADA \$1986

Year	Personal Consumption	Income Distribution	Weighted Personal Consumption	Value of House-work & Volunteer Work	Services of Consumer Durable	Services of Highways & Streets	Cost of Crime	Cost of Family Breakdown	Loss of Leisure Time	Cost of Under Employment	Cost of Consumer Durable	Cost of Commuting	Cost of House, Pollution, Abasement	Cost of Auto Accidents	Cost of Water Pollution
	A	B	C	DE+	F(+)	G(+)	H(-)		J(-)	K(-)	L(-)	M(-)	N(-)	O(-)	P(-)
	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)
1971	164.3	100.0	164.3	105.7	15.6	5.3	1.9	1.7	4.7	1.1	17.0	10.2	0.5	7.2	5.1
1972	176.7	99.2	178.1	107.9	17.0	5.6	2.1	2.0	6.7	1.1	19.9	11.9	0.6	8.5	5.9
1973	189.9	98.2	193.4	110.2	19.4	5.8	2.2	2.2	13.3	1.2	23.6	12.6	0.7	8.5	5.9
1974	200.9	97.5	206.1	112.7	22.2	6.0	2.3	2.3	13.8	1.2	25.4	12.6	0.8	7.7	6.0
1975	210.4	98.8	213.0	115.4	23.8	6.3	2.4	2.4	11.4	1.3	27.2	12.6	1.0	8.5	6.0
1976	224.1	98.8	226.9	115.2	25.8	6.5	2.5	2.5	11.1	1.3	28.9	13.7	1.1	9.1	6.0
1977	231.2	106.8	216.5	120.1	28.0	6.7	2.5	2.6	11.9	1.9	29.6	14.7	1.2	9.7	6.0
1978	239.1	94.6	252.8	122.3	30.3	6.9	2.6	2.8	17.1	2.3	30.9	15.4	1.2	10.2	6.0
1979	246.0	97.8	251.5	124.4	32.3	7.1	2.7	2.9	21.1	2.6	32.4	15.9	1.2	9.8	6.0
1980	251.3	101.2	248.3	126.7	33.8	7.3	2.8	3.1	19.1	2.6	32.3	15.9	1.2	8.8	6.0
1981	257.1	90.1	285.3	129.8	35.0	7.5	2.8	3.2	20.4	3.1	33.2	16.2	1.4	8.2	6.0
1982	250.3	101.6	246.4	130.9	34.1	7.6	2.9	3.3	6.3	4.5	29.0	15.8	1.4	7.9	6.1
1983	258.9	97.0	267.0	131.6	34.6	7.7	2.9	3.4	12.6	5.5	32.5	16.8	1.7	7.9	6.1
1984	270.9	103.1	262.7	131.0	35.7	7.8	3.0	3.5	17.7	5.5	36.8	18.1	1.8	8.5	6.1
1985	284.9	103.2	276.0	133.0	37.7	8.0	3.1	3.7	19.6	5.9	42.0	19.1	1.9	9.0	6.1
1986	297.5	96.9	307.1	132.3	40.4	8.1	3.1	3.8	21.0	5.7	44.6	18.8	2.1	9.3	6.1
1987	310.5	97.4	318.8	135.1	42.8	8.2	3.2	3.9	22.6	5.3	48.2	18.9	1.8	9.6	6.1
1988	324.3	98.3	329.9	137.9	45.8	8.4	3.3	4.0	25.4	5.0	51.4	19.8	2.0	9.7	6.1
1989	335.3	100.4	333.9	141.5	47.5	8.5	3.4	4.1	24.2	4.6	52.0	20.4	1.7	9.8	6.2
1990	338.7	100.4	337.2	144.6	48.4	8.7	3.5	4.1	20.9	5.2	50.3	20.5	1.5	11.5	6.2
1991	333.4	97.7	341.3	147.4	48.6	8.8	3.5	4.1	12.9	6.4	47.7	19.7	1.1	12.0	6.2
1992	337.6	101.1	334.0	152.3	49.2	8.9	3.5	4.1	12.6	7.9	48.0	20.4	1.2	12.6	6.2
1993	342.6	101.3	338.2	156.2	49.9	9.0	3.6	4.1	15.0	9.0	49.5	21.1	1.2	13.2	6.3
1994	353.2	100.2	352.4	159.1	50.7	9.1	3.6	4.2	16.7	8.6	51.9	21.9	1.3	13.7	6.3

TABLE 2 - CONT

## GENUINE PROGRESS INDICATOR - CANADA \$1986

Year	Cost Air Pollution	Cost of Noise Pollution	Loss of Wetlands	Loss of Farmland	Depletion of Non-renewable Resources	Long-term Environmental Damage	Cost of Ozone Depletion	Loss of Old- growth Forests	Net Capital Investment	Net Foreign Lending or Borrowing	Genuine Progress Indicated (GPI)	Per Capital (GPI)	Gross Domestic Product (GDP)	Per Capital (GDP)
	O(-)	R(-)	S(-)	T(-)	U(-)	V(-)	W(-)	X(-)	Y(+)	Z(+)	AA(sum)	AB	AC	AD
	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$ billions)	(\$)	(\$ billions)	(\$)
1971	10.4	1.4	6.9	8.2	14.5	12.3	8.7	2.6	2.2	-2.2	176.6	8018	287.0	13030
1972	10.9	1.5	7.1	8.6	16.8	13.3	10.6	2.6	0.4	-2.6	175.9	7894	303.4	13617
1973	10.6	1.6	7.3	9.1	19.5	14.5	12.1	2.7	0.8	-2.8	179.1	7941	326.8	14488
1974	10.4	1.6	7.4	9.6	20.3	15.6	13.6	2.8	2.4	-4.4	191.7	8379	341.2	14917
1975	9.5	1.6	7.5	10.0	19.5	16.8	14.9	2.8	4.4	-8.3	199.2	8583	350.1	15085
1976	9.8	1.6	7.6	10.5	19.4	18.0	16.4	2.9	4.6	-10.8	205.7	8749	371.7	15804
1977	9.4	1.7	7.7	11.0	20.5	19.2	17.7	3.0	4.0	-7.4	197.7	8309	385.1	16184
1978	9.2	1.7	7.8	11.6	21.1	20.4	18.9	3.0	1.9	-19.3	212.8	8853	402.7	16756
1979	8.6	1.7	7.9	12.1	24.0	21.7	20.1	3.1	2.3	-15.2	208.4	8584	418.3	17231
1980	8.4	1.7	8.0	12.7	23.8	23.0	21.3	3.2	7.5	-6.9	222.8	9058	424.5	17263
1981	7.7	1.7	8.1	13.3	22.9	24.2	22.5	3.2	15.9	-25.5	249.8	10031	440.1	17676
1982	7.3	1.7	8.2	13.9	23.8	25.4	23.7	3.3	14.6	0.0	249.2	9890	426.0	16902
1983	7.0	1.8	8.3	14.5	25.5	26.5	24.9	3.4	8.5	-7.7	240.7	9454	439.4	17263
1984	7.1	1.8	8.4	15.1	28.4	27.7	26.2	3.4	3.3	-7.9	213.7	8313	467.2	18176
1985	6.7	1.8	8.4	15.8	30.9	29.0	27.5	3.5	1.9	-21.3	201.3	7759	489.4	18867
1986	6.9	1.8	8.5	16.4	30.8	30.3	28.9	3.6	1.8	-14.9	233.0	8892	505.7	19297
1987	6.9	1.8	8.6	17.1	33.7	31.6	30.5	3.7	2.3	-14.2	239.6	9023	526.7	19839
1988	7.1	1.9	8.7	17.8	38.4	33.0	32.1	3.8	7.9	-6.2	254.2	9452	553.0	20560
1989	6.9	1.9	8.9	18.6	40.0	34.5	33.7	3.9	14.9	-17.1	254.2	9285	556.5	20691
1990	6.6	2.0	9.0	19.3	41.3	35.9	34.7	3.9	15.9	-21.9	256.6	9232	565.2	20336
1991	6.5	2.0	9.1	20.1	45.8	37.3	35.6	4.0	16.2	-18.6	269.8	9594	555.1	19739
1992	6.3	2.0	9.3	20.9	45.0	38.8	36.5	4.1	11.9	-28.5	248.4	8702	559.3	19596
1993	6.2	2.0	9.4	21.7	47.3	40.2	37.3	4.1	8.6	-29.1	241.6	8348	571.7	19755
1994	6.1	2.0	9.5	22.6	51.7	41.8	37.9	4.2	9.4	-14.6	262.1	8960	595.0	20341