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ALASKA SUSTAINABLE GROSS STATE PRODUCT

PREPARED BY

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Several other researchers have contributed to the results in this paper. Matt Berman helped developed the methodology to estimate sustainable gross state product for Alaska. Scott Goldsmith, Lexi Hill, Teresa Hull, and Steve Colt have all contributed to developing estimates of conventional gross state product. I retain responsibility for any remaining errors in this paper.

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I. INTRODUCTION

Over the past ten years, the idea of "sustainable development" has been promoted as a way to reconcile economic development and environmental protection. With this popularity has come many different -- and often conflicting -- definitions and interpretations of "sustainability." [1]

To help clarify the meaning of "sustainable development," this paper offers a very basic definition of sustainability. This particular definition is measurable and allows us monitor whether or not we are achieving sustainability. In this paper, I will first present the assumptions underlying the basic definition of sustainability and then describe the methods for measuring it using an indicator called "sustainable gross state product."

II. DEFINING SUSTAINABILITY

A. INTERGENERATIONAL EQUITY IS THE BASIC PRINCIPLE.

The first ingredient in this working definition of sustainable development is that each generation should have an equitable opportunity to meet its own needs. This fair treatment for succeeding generations is called "intergenerational equity" – the principle that each generation should have a comparable opportunity to ensure for their own well being.[2] There are certainly many other principles or goals that could guide development decisions, such as maximizing job creation, increasing state revenues, maintaining economic growth, allocating resources to their highest valued use, maximizing corporate profits, or following the most politically powerful agenda. *Sustainable development distinguishes itself by raising the principle of intergenerational equity to a higher (if not the highest) priority.*

B. BEQUEST CAPITAL TO FUTURE GENERATIONS TO ACHIEVE EQUITY .

One way to provide this equity is to ensure each that generation has the same access to all types of assets, capital, and other stores of value. In other words, each generation can use the capital and assets they inherit from earlier generations to meet their own needs. However, to ensure intergenerational equity, they must bequeath to the next generation *at least* the same amount of capital and assets they inherited. This passing-on of capital and assets from one generation to the next ensures that succeeding generations will have an equitable opportunity to meet their needs.

C. INCLUDE ALL TYPES OF CAPITAL AND ASSETS IN THE BEQUEST.

Capital and assets include all stores of value that provide income, benefits, goods, services, or other types of value. Capital and assets are come in three basic types:

- *Manufactured and financial capital:* The most familiar type of capital is made by people and includes all physical capital and financial assets: buildings, highways, the Trans Alaska oil pipeline, financial investments such as the Permanent Fund, and any other form of fixed asset or physical capital that people have made.
- *Human and social capital:* People and communities also have stores of value that can be passed from one generation to the next. People embody human capital in the form of knowledge, education, skills, training, and other valuable abilities. Also, communities are stores of social capital in the form of traditions, customs, organizations, laws, and institutions that are passed on to future generations.
- *Natural capital* includes all aspects of the natural environment that provide income, services, resources, or benefits. Natural capital includes raw resources such as oil, minerals, timber, and fish. It includes life support services such climate regulation, nutrient cycling, waste treatment, soil formation, and other ecological processes that keep us alive. Natural capital also encompasses hunting, subsistence, and outdoor recreation resources as well as aesthetic and cultural benefits derived from nature.

D. THERE IS SOME SUBSTITUTION POSSIBLE BETWEEN TYPES OF CAPITAL.

The next assumption is that manufactured, social and human capital can -- *to some extent* -- serve as a substitute for natural capital. It turns out this is one of the most controversial and debated aspects of sustainability pitting "strong sustainability" against "weak sustainability."

- *Strong Sustainability:* Some argue that natural capital cannot or should not be replaced by manufactured capital. They argue for "strong sustainability" which asserts there is little or no substitution possible. Strong sustainability is achieved when we pass on to future generations at least the same amount of natural capital, the same amount of manufactured and financial capital, *and* the same amount of human and social capital. Proponents of strong sustainability point to the fact that not all types of natural capital can be replaced or substituted by manufactured or financial capital. In particular, many life-sustaining benefits from the environment cannot be replaced by technology. Unique and irreplaceable parts of our natural environment cannot replaced by manufactured capital or technological inventions. Proponents of strong sustainability argue we need to sustain each particular type of capital from one generation to the next and not be content with substituting one type for another.
- *Weak Sustainability:* Others argue there is complete or nearly unlimited substitutability among different forms of capital. In other words, manufactured, financial, human, or social capital can take the place of natural capital. They argue

that with enough human ingenuity, we (and future generations) can convert natural capital into new technology that will ensure current and future well-being. Those who believe we can easily substitute one form of capital for another argue that we should focus on passing on the same *total* amount of all types of capital and assets to future generations. This type of intergenerational equity is called "weak sustainability." We achieve weak sustainability when the total amount of all of our capital and assets is maintained from one generation to the next.

For my basic definition of sustainability, I take the middle ground between weak and strong sustainability. I assume there is some substitution between natural capital and manufactured, human, or social capital. However, there are limits to this type of substitution -- requiring us to pass some of each type of capital.

E. We must decide how much to consume and how much to save .

Using this basic definition, we can think of sustainability as a year-to-year decision. Each year we inherit from the previous year a stock of manufactured, natural, human, and social capital. We must decide each year how much of this capital to consume and how much to save for next year. On the one hand we can consume it all, meet our own wildest dreams, and save none for the future. This is not consistent with intergenerational equity since the needs of future generations are not met. On the other hand, we could save it all and not consume anything for our own needs. However, this also is not consistent with intergenerational equity since our current needs are not being taken care of.

Somewhere in between these extremes is a place where we consume some and save some. I am going to present an indicator called "sustainable gross state product" that offers guidance about where that dividing line is. At this dividing line, if we consume some of our assets and save the rest, we achieve intergenerational equity by passing on an equitable share of our assets to future generations.

III. Measuring Sustainable Output

A. Gross State Product

Alaska's most substantial and valuable natural assets are reserves of oil and natural gas. Extracting and selling these assets gives us income to live our lives and drives our economy. If we want to achieve intergenerational equity, we need to consider how much of these assets to consume now and how much we pass on to future generations.

One way of measuring how much we derive each year from oil and gas is the economic measure called gross state product (or GSP). It measures the total value of goods and services produced in the economy. It amounts to about twenty-five billion dollars a year in Alaska. To focus the discussion even further, let's look at the portion of

GSP that is directly dependent on petroleum. This includes all oil and gas exploration, development, and production; the Trans-Alaska pipeline; as well as the portion of state government directly supported by taxes on oil and gas. Figure 1 shows GSP for the economy as a whole and the components of dependent on oil and gas. (Table A-1 in the appendix lists detailed estimates of GSP). Notably, petroleum-related GSP amounts to over eight billion dollars in recent years. At its peak in the 1980s, petroleum-related GSP amounted to about 40% of total GSP, but the share has declined in recent years as oil production has fallen.

The question we are trying to answer is, "How much of the value of all of these goods and services derived from Alaska's natural petroleum assets should we save, invest, or otherwise bequest to future generations to achieve intergenerational equity?" There are two ways of looking at this problem using standard economic techniques.[3]

B. Net State Product

The first approach treats non-renewable natural capital in the same way that we think about manufactured capital, like a building, a car, an oil pipeline, or another piece of capital that depreciates over time. For these types of capital, we usually take into account of the annual cost of depreciation. It has often called a "capital consumption allowance" by businesses or just plain "depreciation" by accountants. There is a standard adjustment to state gross state product that reflects the cost of depreciating manufactured capital. It amounts to about 15 % of the oil related GSP. The adjusted figures after accounting for the depreciation costs of manufactured capital is called "net state product."

C. Depreciation Approach

The same approach can be applied to measuring the cost of depleting finite non-renewable resources. Just like depreciating manufactured capital loses some of its value when it is used each year, finite non-renewable natural assets lose value as we deplete them. The adjustment can be thought of the cost of depletion, the cost of using up non-renewable resources, or the income that we forego by using up some of the principle of our natural asset. By including this adjustment, we properly account for the cost of depleting of our non-renewable resource endowment.[4] As shown in Figure 2, the adjustment for depleting non-renewable petroleum assets amounts to about 25% of oil-related GSP in a recent year. However, the adjustment varies from year to year depending on the amount of petroleum depleted and the amount of activity in the economy derived from petroleum.

D. Asset Approach

The other way to look at the issue is that our natural resources are a large financial asset that provides yearly interest or an annuity. The sustainable part is the annual interest that can be sustained without depleting the principle value of the asset. The adjustment to GSP is the amount that needs to be reinvested in the asset to sustain the principle of the asset at the same level from one generation to the next. Sustaining the principle will ensure each generation receives the same steady stream of interest payments.[5] As shown in Figure 2, the adjustment to GSP following this approach is about 25% to 30% per year, depending on the amount of oil used up and the economic activities dependent on the oil. These adjustments are different for each year depending on the specific accounting for that year.

C. Comparing Approaches

When we apply these adjustments to Alaska gross state product for the past forty years, the pattern of growth and change is different than when measured by conventional GSP. Figure 3 shows petroleum-related output measured by conventional GSP as well as the adjusted figures using the depreciation approach and the asset approach. Notably, the estimates using the depreciation and asset approaches are less than the conventional GSP in almost all years because they explicitly account for the cost of depleting non-renewable resources. Both alternative methods are more variable than the conventional method because there is greater imprecision in these measures. They attempt to account for depletion costs that are not typically measured and so the information on these costs is more difficult to obtain and measure reliably. The estimates for the asset approach display a notable departure from the other two methods in 1969 and 1977. When additions are made to our petroleum assets in the form of new reserves, the adjustment for the asset approach is positive. In both 1969 and 1977, new reserves were either leased for development or brought into production. The asset approach reflects these additions to our assets as a positive adjustment to GSP.

Figure 1: ALASKA GROSS STATE PRODUCT in Billions of Constant 1998 Dollars

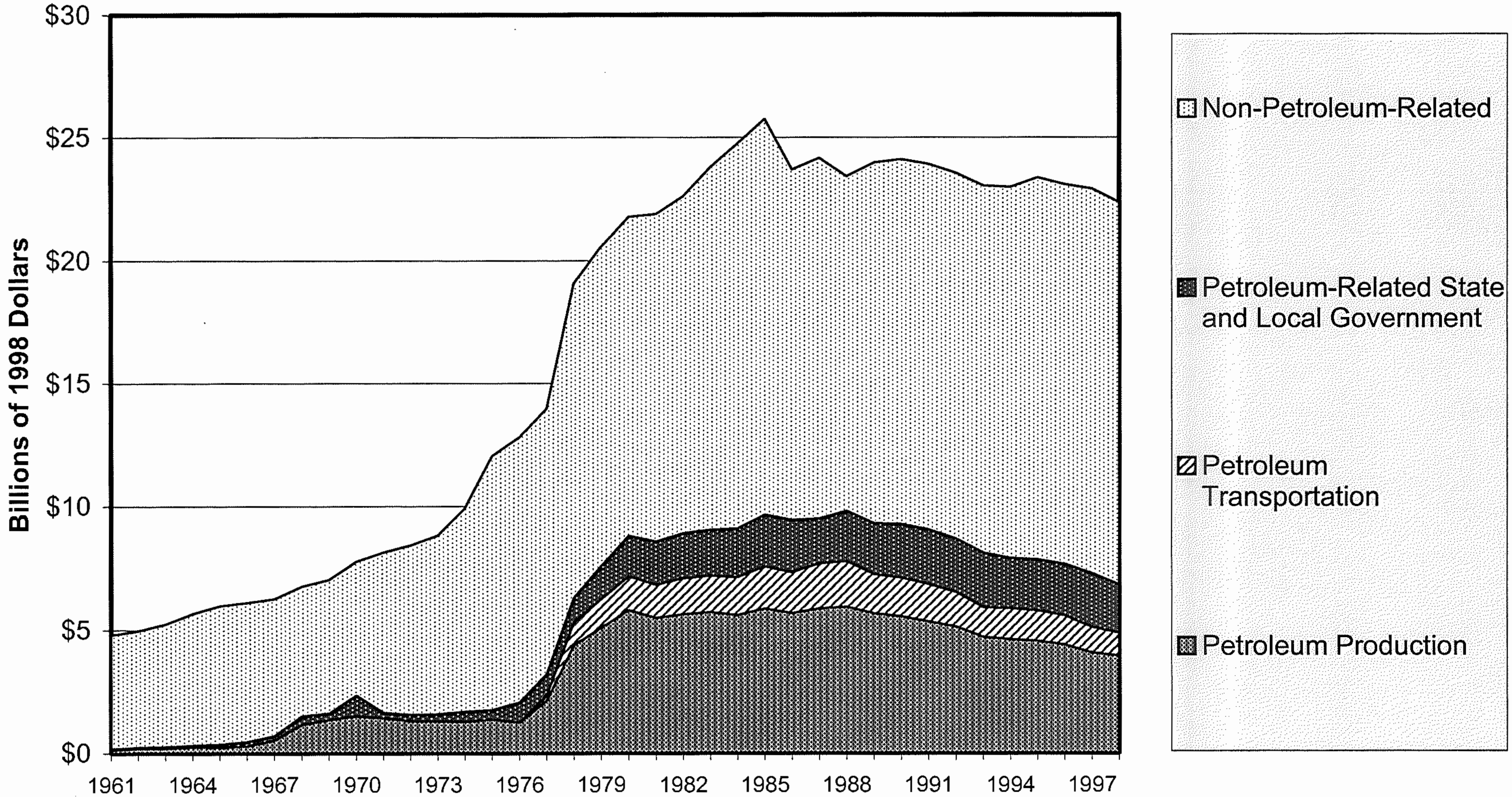


Figure 2: ADJUSTMENTS TO GROSS STATE PRODUCT in Alaska for Each Method in 1997

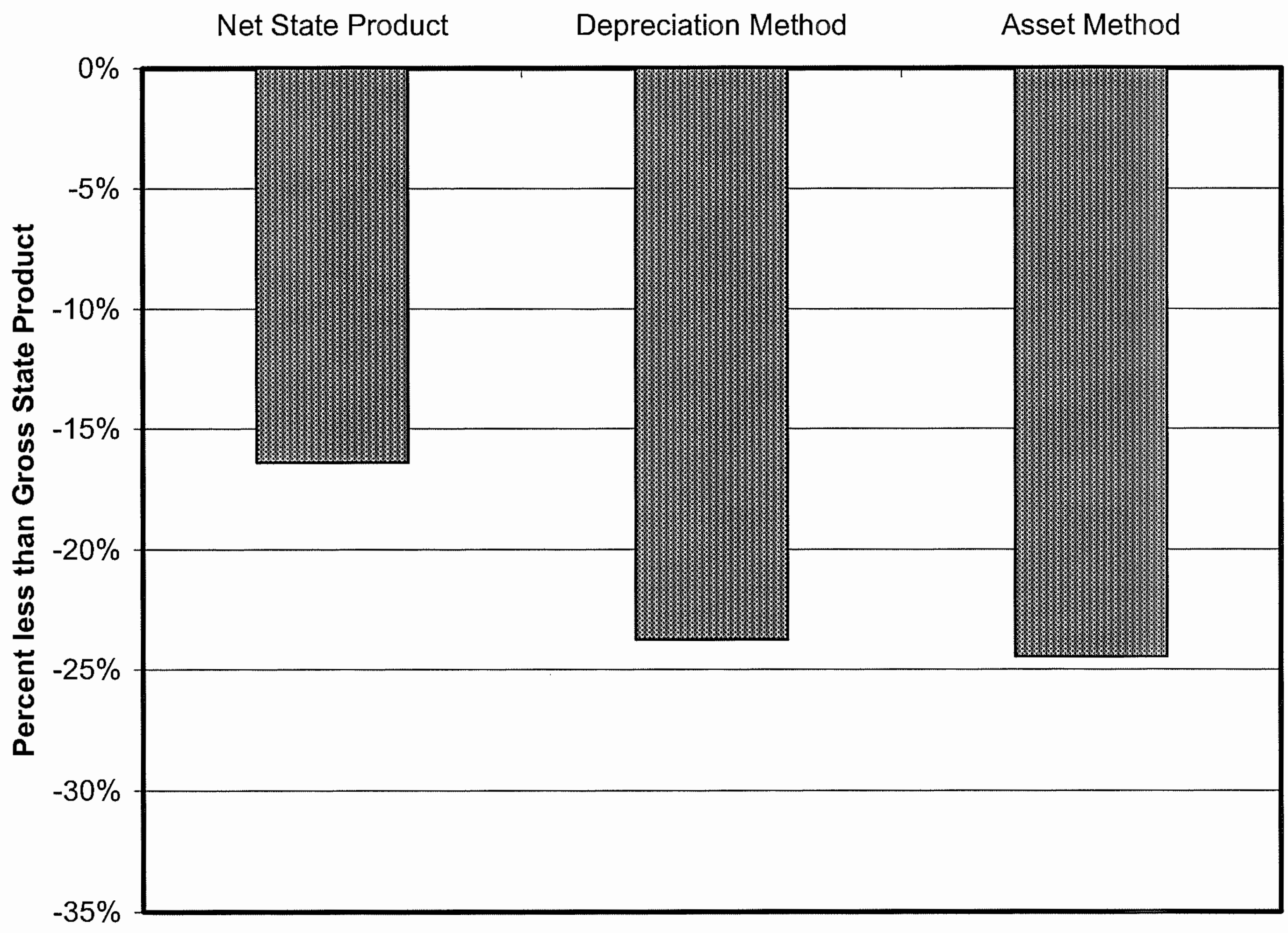
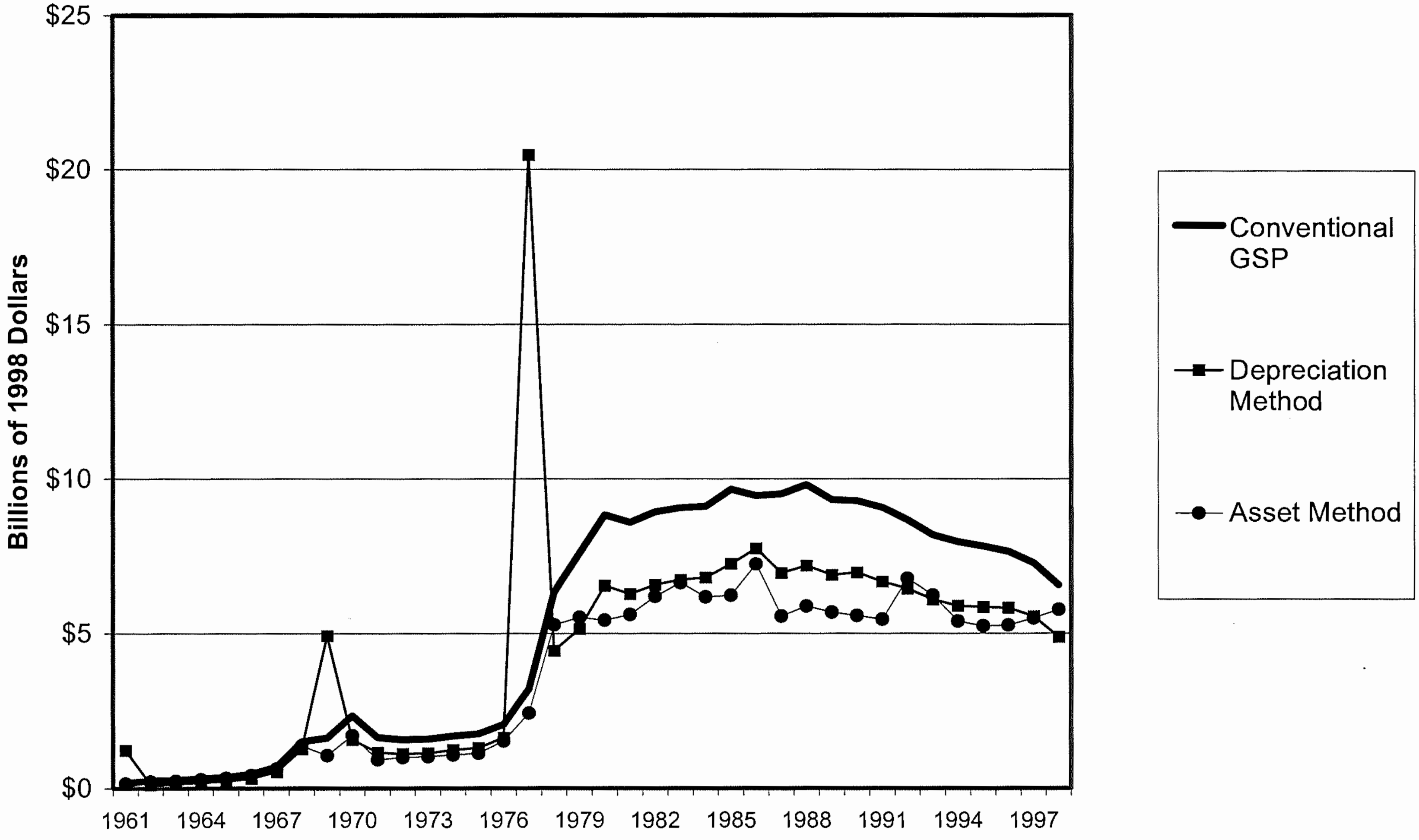


Figure 3: ALTERNATIVE MEASURES OF PETROLEUM-RELATED GSP in Alaska in Billions of Constant 1998 Dollars



IV. POLICY IMPLICATIONS

A. MORE ACCURATE MEASURE OF GROWTH

These alternative methods for measuring gross state product have two practical implications for public policy decisions. First, these alternative approaches provide a more accurate measure of economic growth since they include the costs of depleting natural assets. Conventional GSP may indicate we are growing when we are actually in decline and living off our dwindling natural assets. If we are going to make decisions based on measures of economic growth, we should include the costs of using up our asset base in those measures.

B. GUIDELINE FOR HOW MUCH TO SAVE OR INVEST

Another, more interesting, interpretation is that each year we inherit an endowment of natural assets. We need to decide how much of these assets to consume and how much to save or invest. The alternative measures of sustainable GSP indicate this break point between consuming and saving. Of all the oil related goods and services produced in Alaska each year, if we consume the level prescribed by the adjusted GSP figures and save the rest in some form, then we achieve intergenerational equity.

C. MUST DECIDE WHAT TYPE OF CAPITAL TO SAVE

These methods leave an important question unanswered: they do not say how we should invest or in what form we should save or pass-on assets to future generations. One the one hand, we could pass on the petroleum as a natural asset by leaving the reserves in the ground for future generations to do with as they wish. This would be a form of strong sustainability. Alternatively, we could extract the petroleum, sell it, invest the proceeds in a huge permanent fund, and live off the investment interest indefinitely. We could also invest the money in education, strengthening our communities, or helping people to enhance our social capital – thereby substituting social capital for natural capital. Replacing the natural petroleum assets with financial, manfuctured, social, or human assets would be form of weak sustainability.

The method I have presented does not answer the choice between strong and weak sustainability. The choice of how we save or what form of capital we save is economic, ethical, and political. The choice is economic because we want to consider the relative rates of return on different types of capital and invest in the one that gives the highest rate or return. The choice is ethical because we need to consider what types of capital future generations need to meet their needs. And the choice is political because the form of capital we save is largely shaped by who owns the capital and who makes the decisions about how to save.

VI. Extensions and Criticisms

A. Extensions

These alternative approaches are only a beginning. Several extensions could give a more complete view of the sustainability of the Alaska economy.

- **Multiplier Effects in rest of economy:** Petroleum has effects in more than just the industries I mentioned. Oil activity in the state has multiplier effects that support economic activity in many other sectors of the Alaska economy. In an earlier paper, we have developed estimates of how much of these multiplier effects are sustainable and how much should be saved for future generations to achieve sustainability.[6]

- **Other Resources Sectors of the Economy:** I have shown adjustments only for petroleum-related activities of the state. The same methods have been extended to other natural resource industries like mining, forestry, and fishing. [7]

- **Life Support Services:** The method could also be extended to life support services like breathable air, drinkable water, nutrient cycling, water storage, and ecological processes that keep us alive. Depletion of these assets through pollution or degradation should technically be counted as costs in our income accounts.[8] We should include these costs in our discussion of sustainability if we want to achieve intergenerational equity.

B. Criticisms

Critics of this approach argue it does not go far enough. While sustainable GSP is an improvement that adjusts for the costs of depleting non-renewable resources, it does not adjust for other substantial costs. According to these critics, the measure does not account for the costs of crime and family breakdown, long term environmental damage, or defensive expenditures. The measure also does not account for the value of household, volunteer, and subsistence activity that are not in the wage economy. It does not account for worsening income inequalities, and other social costs of development.

A group of researchers called "Redefining Progress" is trying to address these issues by creating a new indicator called the Genuine Progress Indicator that adjusts the Gross Domestic Product estimates for the US as a whole to reflect the social costs of development.[9] Another approach to this same criticism is to construct a variety of indicators that measure social and community conditions. Any GSP indicator, even with adjustments, focuses on the amount of goods and services produced but it does not capture changes in education, crime, families, traditions, and other social conditions. Sustainable indicators programs try to address this limitation by creating collections of indicators that include GSP or Sustainable GSP but do not put it center stage as it has been in the past.[10]

VII. CONCLUSIONS

Sustainable development is based on the principle of intergenerational equity: each generation should get a fair share of all types of capital to have a similar opportunity to ensure their own well being. Each year, we must decide how much to consume and how much to save in order to achieve this equity. One way to measure our progress toward this goal is with sustainable gross state product. This measure gives a more accurate measure of economic change by including the costs of depleting non-renewable resources. Sustainable gross state product also gives guidance about how much to save and invest so that future generations have an equitable opportunity to provide for their needs.

APPENDIX TABLES

Appendix Table A-1: Alaska Gross State Product and Petroleum-Related GSP in billions of 1998 dollars

Year	Total	Non-Petroleum Related	Petroleum-Related			
			Total	Petroleum Production	Trans-Alaska Pipeline	State & Local Government
1961	$4.80	$4.64	$0.17	$0.12	$0.00	$0.04
1962	$4.97	$4.73	$0.24	$0.19	$0.00	$0.05
1963	$5.24	$4.98	$0.26	$0.20	$0.00	$0.05
1964	$5.65	$5.34	$0.31	$0.26	$0.00	$0.06
1965	$5.97	$5.61	$0.36	$0.23	$0.00	$0.13
1966	$6.10	$5.65	$0.45	$0.28	$0.00	$0.17
1967	$6.26	$5.56	$0.70	$0.51	$0.00	$0.18
1968	$6.77	$5.26	$1.50	$1.14	$0.00	$0.36
1969	$7.04	$5.42	$1.61	$1.35	$0.00	$0.27
1970	$7.77	$5.44	$2.34	$1.51	$0.00	$0.83
1971	$8.15	$6.52	$1.64	$1.42	$0.00	$0.22
1972	$8.43	$6.87	$1.56	$1.30	$0.00	$0.26
1973	$8.83	$7.25	$1.58	$1.29	$0.00	$0.30
1974	$9.94	$8.26	$1.68	$1.27	$0.00	$0.41
1975	$12.03	$10.28	$1.75	$1.35	$0.00	$0.40
1976	$12.79	$10.74	$2.05	$1.23	$0.00	$0.82
1977	$13.96	$10.76	$3.20	$2.12	$0.22	$0.86
1978	$19.08	$12.78	$6.30	$4.37	$0.93	$1.00
1979	$20.57	$12.98	$7.58	$5.08	$1.15	$1.35
1980	$21.77	$12.96	$8.81	$5.79	$1.37	$1.65
1981	$21.88	$13.31	$8.57	$5.48	$1.35	$1.74
1982	$22.61	$13.70	$8.91	$5.62	$1.46	$1.83
1983	$23.78	$14.74	$9.04	$5.71	$1.49	$1.85
1984	$24.74	$15.65	$9.09	$5.59	$1.53	$1.97
1985	$25.75	$16.09	$9.65	$5.86	$1.70	$2.09
1986	$23.69	$14.25	$9.44	$5.66	$1.66	$2.12
1987	$24.16	$14.66	$9.50	$5.86	$1.82	$1.81
1988	$23.41	$13.61	$9.80	$5.92	$1.86	$2.02
1989	$23.97	$14.66	$9.31	$5.66	$1.59	$2.06
1990	$24.10	$14.82	$9.27	$5.54	$1.57	$2.17
1991	$23.91	$14.85	$9.05	$0.36	$0.00	$2.21
1992	$23.51	$14.85	$8.66	$5.34	$1.50	$2.16
1993	$23.07	$14.91	$8.16	$5.09	$1.41	$2.22
1994	$23.01	$15.07	$7.94	$4.75	$1.20	$2.05
1995	$23.31	$15.51	$7.80	$4.65	$1.24	$2.09
1996	$23.05	$15.42	$7.63	$4.50	$1.22	$2.10
1997	$22.88	$15.63	$7.26	$4.35	$1.17	$2.18
1998	$22.05	$15.51	$6.54	$4.04	$1.03	$1.97

Source: MAP model estimates of total GSP for all sectors from GSPMOD.WK4
ISER estimates of petroleum-related GSP from RENT10.XLS. See Berman (1992) for methods.

Appendix Table A-2: Alternative Measures of Alaska Petroleum-Related Gross State Product in billions of 1998 dollars				
Year	Gross State Product	Net State Product	Depreciation Method	Asset Method
1961	$0.17	$0.16	$1.23	$0.16
1962	$0.24	$0.22	$0.11	$0.22
1963	$0.26	$0.23	$0.12	$0.23
1964	$0.31	$0.29	$0.18	$0.29
1965	$0.36	$0.33	$0.22	$0.33
1966	$0.45	$0.42	$0.31	$0.42
1967	$0.70	$0.63	$0.52	$0.63
1968	$1.50	$1.37	$1.26	$1.37
1969	$1.61	$1.06	$4.92	$1.06
1970	$2.34	$2.16	$1.57	$1.70
1971	$1.64	$1.47	$1.16	$0.93
1972	$1.56	$1.40	$1.11	$1.00
1973	$1.58	$1.41	$1.13	$1.02
1974	$1.68	$1.52	$1.24	$1.08
1975	$1.75	$1.58	$1.30	$1.13
1976	$2.05	$1.89	$1.63	$1.52
1977	$3.20	$2.74	$20.47	$2.42
1978	$6.30	$5.18	$4.44	$5.27
1979	$7.58	$6.22	$5.14	$5.51
1980	$8.81	$7.26	$6.52	$5.42
1981	$8.57	$6.96	$6.25	$5.59
1982	$8.91	$7.27	$6.54	$6.17
1983	$9.04	$7.44	$6.70	$6.61
1984	$9.09	$7.50	$6.78	$6.15
1985	$9.65	$7.98	$7.23	$6.21
1986	$9.44	$8.46	$7.72	$7.23
1987	$9.50	$7.72	$6.93	$5.54
1988	$9.80	$7.96	$7.17	$5.86
1989	$9.31	$7.61	$6.87	$5.66
1990	$9.27	$7.65	$6.95	$5.55
1991	$9.05	$7.36	$6.64	$5.45
1992	$8.66	$7.10	$6.42	$6.75
1993	$8.16	$6.72	$6.08	$6.21
1994	$7.94	$6.51	$$5.87	$5.38
1995	$7.80	$6.44	$5.83	$5.23
1996	$7.63	$6.38	$5.81	$5.25
1997	$7.26	$6.06	$5.53	$5.48
1998	$6.54	$5.32	$4.88	$5.75
Source: ISER Estimates from RENT10.XLS, See Berman (1992) and Berman (1993) for methods				

REFERENCES

Alfsen, Knut, Torstein Bye, and Lorents Lorentson, "Natural Resource Accounting and Analysis: The Norwegian Experience, 1978-1986, Social and Economic Studies number 65, Central Bureau of Statistics of Norway, Oslo, 1987.

Berman, Matthew, "Sustainable Development and Sustainable Income for Remote Regions," Institute of Social and Economic Research, University of Alaska Anchorage, paper presented to the Western Regional Science Association, 1993 Annual Meeting, Wailea Hawaii, February 1993.

Berman, Matthew, Eric Larson, Bradford Tuck, "Natural Resource Depletion and Social Income Accounting: Sustainable Income in Petroleum-Dependent Economies," in *OPEC Review,* Winter 1992.

Bruntland Commission, World Commission on Environment and Development, *Our Common Future,* Oxford University Press, Oxford, 1987.

Center for Compatible Economic Development, *A Citizens Guide to Achieving A Healthy Community, Economy, and Environment,* Leesburg, VA, May 1996.

Center for Excellence of Sustainable Development, *Definitions and Principles Sustainable Development Principles,* from Northwest Report, Number 19, A Newsletter of the Northwest Area Foundation, January 1996, http://www.sustainable.doe.gov/overview/principles.html.

Center for Excellence of Sustainable Development, *Definitions and Principles Definitions of Sustainable Development,* from Northwest Report, Number 19, A Newsletter of the Northwest Area Foundation, January 1996, http://www.sustainable.doe.gov/overview/definitions.html.

Cobb, Clifford, Ted Halstead, and Jonathan Rowe, *The Genuine Progress Indicator Summary of Data and Methodology,* Redefining Progress National Indicators Initiative, September 1995.

Costanza, Robert, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon, Karin Limburg, Shahid Naeem, Robert O'Neill, Jose Paruelo, Robert G. Raskin, Paul Sutton, and Marjan Van den Belt, "*The Value of the World's Ecosystem Services and Natural Capital,"* in *Nature,* Vol. 387, No. 15 (May 1997), p 254.

Eisner, Robert, "Extended Accounts for National Income and Product, *"Journal of Economic Literature*, 26(4) December 1988, 1611-1684.

El Serafy, Salah, "The Proper Calculation of Income and Depletable Natural Resources," in Yusuf Ahmad, Slah El Serafy, and Ernst Lutz, *Environmental Accounting of Sustainable Development,* World Bank, Washington DC, 1989, 10-18.

Environmental Law Institute, *Sustainable Development Explored in Virginia*, Washington D.C. 1994 at http://www.eli.org/archive/planstat.htm.

Foy, George, Accounting for Non-renewable Natural Resources in Louisiana's Gross State Product," *Ecological Economics* 3 (1991) 25-41.

Hall, Darwin and Jane Hall, "Concepts and Measures of Natural Resource Scarcity with a Summary of Recent Trends," *Journal of Environmental Economics and Management,* 11, 363-379, 1984.

Keiner, *Blueprint for Sustainable Development of Virginia,* Environmental Law Institute, Washington, DC, 1993.

Landefeld, Steven, and James Hines, "National Accounting for Non-Renewable Natural Resources in the Mining Industries," *Review of Income and Wealth,* March 1985, 31(1), pp. 1-20.

Larson, Eric, "An Overview of Alaska's Natural Assets," prepared for Alaska Conservation Alliance, Institute of Social and Economic Research, University of Alaska Anchorage, December 1998, http://www.iser.uaa.alaska.edu/projects/SustainableDevelopment/index.html

Larson, Eric, "Methods and Approaches for Sustainable Development in Alaska," prepared for Alaska Conservation Alliance, Institute of Social and Economic Research, University of Alaska Anchorage, December 1998, http://www.iser.uaa.alaska.edu/projects/SustainableDevelopment/index.html

Leibman, Dena and Anna El-Eini, "The Sustainability Movement: Rhetoric or Reality?" in *Friends of the Earth,* Sept/Oct 1996, http://www.sustainable.doe.gov/articles/rhetoric.html.

Marin, A, "National Income, Wealth, and the Environment," *Review of Income and Wealth,* 24(4), December 1978, 415-428.

Minnesota Planning, *Investing in Minnesota's Future: An Agenda for Sustaining Our Quality of Life,* May 1998.

Nelder, Chris, *Envisioning a Sustainable Future,* at http://www.betterworld.com/BWZ/9610/cover1.htm.

Nordhaus, William D, and Edward C. Kokkelenberg, editors, *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*; Panel on Integrated Environmental and Economic Accounting, National Research Council, 1999 http://books.nap.edu/catalog/6374.html

Peskin, Henry, "A National Accounting Framework for Environmental Assets," Journal of Environmental Economics and Management 2(4), April 1976, 255-262.

President's Council on Sustainable Development, *Building on Consensus: A Progress Report on Sustainable America,* Washington, D.C., 1997, http://www.whitehouse.gov/PCSD/.

Redefining Progress *National Indicators Initiative,* San Francisco, CA, 1998, http://www.rprogress.org/progsum/nip/nip_main.html.

Repetto, Robert, William Magrath, Michael Wells, Christine Beer, and Fabrizio Rossini, *Wasting Assets: Natural Resources in the National Income Accounts,* World Resources Institute, 1989.

Resources for Sustainable Development, *Sustainable Development Principles,* http://iisd1.iisd.ca/sd/principle.asp.

Solow, Robert, "An Almost Practical Step Toward Sustainability," an invited lecture on the occasion of the fortieth anniversary of Resources for the Future, Resources for the Future, October 8, 1992.

Stauffer, Thomas, and Frank Lennox, *Accounting for Wasting Assets: Income Measurement for Oil and Mineral-Exporting Rentier States,* Pamphlet Series of OPEC and the New International Economic Order, No. 25, November, 1984.

U.S. Environmental Protection Agency, Sustainable Communities Program, "Sustainability: Holistic Perspective for the Next Century," CD-ROM, U.S. EPA Region 10, Seattle, WA, 1998.

United Nations General Assembly, *The Programme for the Further Implementation of Agenda 21*, Resolution adopted by the General Assembly, 11th plenary meeting, 28 June 1997, gopher://gopher.un.org:70/00/ga/recs/spec/RES-S19.2

Ward, Michael, *Accounting for the Depletion of Natural Resources in the National Accounts of Developing Economies,* OECD, Paris, 1982.

ENDNOTES

[1] For a sampling of the many different interpretations of sustainability, see Bruntland Commission (1987), Center for Compatible Economic Development (1996), Center for Excellence of Sustainable Development (1998), Environmental Law Institute (1994), Keiner (1993), Leibman et al. (1996), Minnesota Planning, (1998), Nelder (1998), Oregon Progress Board, (1997) President's Council on Sustainable Development, (1997), Redefining Progress (1998), Resources for Sustainable Development (1998) U.S. Environmental Protection Agency, Sustainable Communities Program (1998), or United Nations General Assembly (1997).

[2] See Larson (1998b) and Berman (1993) for a more detailed discussion of the definition of sustainability.

[3] For a discussion of the various economic techniques used to account for the depletion of non-renewable resources in national income accounts see Nordhaus et al. (1999), Berman et al. (1992), Solow (1992), Landefeld (1985), Marin (1978) Stauffer (1984), Alfsen (1987), Eisner (1988), El Serafy (1989), Foy (1991), Hall et al. (1984), Repetto et al. (1989), Stauffer (1984), and Ward (1982)

[4] For a more technical discussion of this methodology and detailed calculations, see Berman (1993) and Berman et al. (1992).

[5] For technical details about these adjustments see Berman (1993) and Berman et al. (1992)

[6] See Berman (1993) for discussion of these types of adjustments

[7] See Berman (1993).

[8] See Larson (1998a) for an inventory of Alaska's life support services and Peskin (1976) and Costanza et al. (1997) for a discussion of valuing life support services.

[9] See Cobb (1995) for details about the Genuine Progress Indicator.

[10] See Larson (1998b) for a discussion of alternative indicators programs.