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Designing for Economic Success: A 50-State Analysis of the Genuine Progress Indicator

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DESIGNING FOR ECONOMIC SUCCESS:
A 50-STATE ANALYSIS OF THE GENUINE PROGRESS INDICATOR

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ABSTRACT

The use of Gross Domestic Product (GDP) as the primary measure of economic progress has arguably led to unintended consequences of environmental degradation and socially skewed outcomes. The Genuine Progress Indicator (GPI) was designed to reveal the trade offs associated with conventional economic growth and to assess the broader impact of economic benefits and costs on sustainable human welfare. Although originally designed for use at the national scale, an interest has developed in the United States in a state-level uptake of the GPI to inform and guide policy. However, questions exist about the quality and legitimacy of the GPI as a composite indicator. These questions include concerns about the underlying assumptions, the monetary weights and variables used, statistical rigor, magnitude of data collection required, and lack of a transparent governance mechanism for the metric. This study aims to address these issues and explore the GPI through a design-thinking lens as both a design artifact and intervention.

The leading paper in this dissertation offers the first GPI accounting for all 50 U.S. states. State GPI results are introduced and compared to Gross State Product (GSP). Then an analysis of the components to GPI reveals which drive the differences in outcomes, including examining the sustainability aspects of the state-level results. The second paper investigates the quality of the GPI as a composite indicator by testing its sensitivity to numerical assumptions and relative magnitudes of components, with particular attention to the possible unintended policy consequences of the design. The third paper seeks to answer the question of both efficiency (data parsimony) and effectiveness (comparatively to other indicators) by analysis of correlations between GPI components and with other state-level indicators such as the Gallup Well-Being Indicator, Ecological Footprint, and UN Human Development Index. To garner insight about possible GPI improvements, goals, and governance gaps in the informal U.S GPI network, the final paper dives into processes, outputs, and outcomes from the community of practice as revealed through a facilitated U.S. GPI workshop.

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CHAPTER 1: INTRODUCTION

In recent years there has been an uptick in demand for and proliferation of sustainability metrics. Undeniably, indicators define a problem and direct its solution. Without measuring the balance of economic, social, and environmental outcomes, organizational leaders and governance bodies cannot actively manage for sustainability as an objective. As Donella Meadows, renowned systems thinker, points out, "Missing information flows are among the most common causes of system malfunction" (Meadows, 2008, p. 157). By obtaining more accurate information about sustainability, decisions makers at all levels may be able to prevent system malfunction or collapse. At the governance scale, this would be facilitated by a consistent metric to measure policy impacts towards the goal of higher sustainability and higher well-being.

In the absence of a widely-used, consistent metric, many alternative sustainability metrics have been developed by various organizations, including the Global Reporting Initiative (www.globalreporting.org), Carbon Disclosure Project (www.cdp.net), Human Development Index (UNDP, 1990), Ecological Footprint (www.footprintnetwork.org), Inclusive Wealth Index (UN, 2012), and the Genuine Progress Indicator (GPI) (Cobb, Halstead, & Rowe, 1995) to name only a few. In addition, many cities and regions are developing their own economic, social, and environmental indicators to support policymakers in understanding policy impact though the lens of sustainability (www.starcommunities.org).

Many of these sustainability indicators have been posed as an alternative to traditional metrics of economic welfare. Since the Great Depression, the primary information tool that governance bodies have used to gauge the progress of societies and the impact of policy choices is the Gross Domestic Product (GDP). In fact, this information is so critical that the U.S. Department of Commerce christened the development of the national income and product accounts as "its achievement of the century" (BEA, 2000). GDP was originally developed as a tool for communicating to policy makers information about production and consumption. However, over many decades, growth of GDP has been conflated to the goal of policy with the implicit assumption that growing GDP indicates an increase in societal well-being. Shifting GDP from an information flow to a goal moves it into a much more powerful role, one of the highest leverage points for system change according to Meadows (2008).

In an 'empty world' with plenty of untapped natural resources and small population, maintaining GDP as the metric of success may have been appropriate. And indeed, up to a certain point, well-being and GDP can increase in tandem. However, GDP has long been criticized as an insufficient metric for understanding success in a 'full world,' especially in developed countries. In recent decades multiple environmental and social critiques of GDP as a measure of economic welfare have emerged (e.g., Ayres, 1996; Dale & Townsend, 2002; Daly, 1977; 1996; Hamilton, 2003; Jackson, 2011; Schor, 2010; Speth, 2008) including a Commission on the Measurement of Economic Performance and Social Performance chaired by Nobel prize winning economists Joseph Stiglitz and Amartya Sen (2010). Much of the criticism of GDP revolves around a lack of differentiation of costs from benefits of economic growth, including for example the costs of inequality, regrettable defensive expenditures, uncounted environmental externalities, depletion of natural resource assets, and trade-offs with non-work uses of time.

The challenge identified early on by economists is to develop a composite indicator that can gauge the sustainability of the economy to contribute to human welfare. Two notable efforts that attempted to build on GDP to this end include the Measure of Economic Welfare (MEW) by Nordhaus and Tobin (1972) and the Index of Sustainable Economic Welfare (ISEW) by Daly and Cobb (1989). The MEW is essentially GDP corrected for "regrettable" defensive expenditures and income distribution. The ISEW expanded on this work by deducting further environmental costs, as well as considering a broad range of social costs and tradeoffs with GDP growth. The ISEW correlated with GDP for developed countries through the 1970s, a finding that is supported by the original MEW work. However, beginning in the late 1970s the GDP continued to grow, while the trajectory of ISEW flattened. In the 1990s, the ISEW was modified by Cobb et al. (1995) into the Genuine Progress Indicator (GPI). ISEW and GPI build on the concept of welfare-equivalent income or psychic income, first formulated by the economist Irving Fisher (1906) referring to the welfare households derive from their consumption activities. This definition of income moves the focus away from the goods (income) produced in a given year to the services that these goods provide for the consumers, net of their full, integrated production costs (Lawn, 2003).

The GPI is a multi-dimensional composite indicator that accounts for the impact of the embedded economic system on the larger social and environmental systems, as well as the distribution of benefits and burdens, in a single monetary number through a series of 24 adjustments to standard GDP accounts. It has been developed and modified over the last two decades utilizing mixed methods from environmental economics (e.g. pollution and climate change costs), natural resource economics (e.g. depletion costs), and various heterodox approaches to other social and economic adjustments. These methods are detailed in several publications, including the original ISEW method from Daly and Cobb (1989), national-level GPI studies originally done for the US (Talberth, Cobb, & Slattery, 2007), and the original state-level GPI method developed by Costanza and colleagues (2004).

The development of GPI represents a significant shift in thinking regarding how to measure economic progress. Peter Senge, author of *The Necessary Revolution,* commented that "the deep problems we face today are not a result of bad luck or a greedy few. They are the result of a way of thinking whose time has passed" (Senge, 2008, p. 7). This "way of thinking" is based upon the implicit belief that economic growth is always good. On the contrary, economic growth often consumes finite resources, degrades renewable resources, and can be unbalanced between rich and poor, underworked and overworked, and can bring about more costs than benefits, especially in a 'full world.'

GPI was designed to reveal the tradeoffs associated with conventional economic growth, and signal when costs outweigh the benefits of growth; what Daly considers uneconomic growth. When uneconomic growth occurs, GPI begins to decline, despite a continued increase in GDP. In essence this represents a 'well-being gap' where degradation in social and environmental conditions more than offset the value of economic growth. This idea is distilled by Max-Neef's (1995) "threshold hypothesis," that growth contributes to well-being only up to a threshold income level. Specifically, GPI may be thought to be seeking to answer the question, “Have we surpassed the optimal scale of the economy?” It is therefore based on the assumption that there may be a time when countries (or other regional scales that use metrics) may need to turn away from the conventional economic growth objective and instead target a broader more holistic objective focused on balanced improvement of social, environmental, and economic outcomes (or what some may term sustainable development). In addition to scale, GPI also includes another mainstay of ecological economic theory – distributive equity – through its income inequality adjustment. A further foundational concept embodied in GPI is the ‘principle of internalization’ with Daly and Cobb (1989) stating, “[i]t is not a question of choosing whether to pay or not pay external costs. The costs are there and will be paid by someone.” In other words, GPI is designed as a tool that can help quantify the tradeoffs associated with economic growth to understand if *sustainable* development is occurring.

The development of GPI reflects the concern for sustainable development in international and national policy communities. The idea of sustainable development migrated from a relatively unknown article from International Union for the Conservation of Nature and Natural Resource in 1980, through several popular ‘green’ books, culminating in 1987 as the central organizing concept of the Brundtland Commission Report which defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Jamieson 1998; Williams & Millington 2004). The concept of “sustainability” is at best ambiguous, simultaneously being located in many fields: economics, public policy, ethics, biological and social sciences (Stables & Scott 2002). However, it is exactly the ambiguity of the term “sustainability” that makes it an ideal place to initiate policy discussions. Ehrenfeld (2005) suggests that, “sustainability can serve as an umbrella, sheltering and bringing together in dialogue people with widely divergent views who nevertheless share some common principles” (p. 34). As an ambiguous concept, “sustainability” is in good company – for centuries societies have been attempting to define such core values as freedom, equality, and justice with outcomes including such documents as the United States Constitution (Padoch & Sears, 2005). Values are “an inextricable part of defining and operationalizing” sustainability; sustainability can be defined only with reference to specific objectives and specific world views (Lele & Norgaard 1996, p. 361).

GPI was intended to embody the values of ‘weak sustainability’ or the “ecologically efficient production of human well-being” (Paehlke 2005, p. 36). ‘Weak sustainability’ advocates realize that “this well-being is at least partly determined by the natural environment” (Lele & Norgaard 1996, p. 355). But weak sustainability does not focus primarily on the environment, choosing instead to focus on human survivability and the avoidance of ecological disaster (Jamieson, 1998). Therefore, the weak sustainability version of sustainability is more about “sustaining human well-being rather than sustaining environment, nature, ecosystems, or the Earth’s life support system” and assumes a degree of substitution between human and natural capital (Williams & Millington 2004, p. 100). Ultimately, one of the goals of the GPI is to acknowledge that there are tradeoffs between the three pillars of sustainability - economics, social, environment - as they affect our aggregate welfare which is consistent with the weak sustainability foundation: it is possible to moderately deplete natural or social capital, while expanding income and consumption to produce rising per capita *genuine* progress.

The measurement of genuine progress can be enriched by applying a “design thinking” paradigm. Design thinking encourages us to, “approach a large scale change as two simultaneous and parallel challenges – design of artifact and design of intervention that brings it to life – you can increase the chances it will take hold” (Brown & Martin, 2015, p. 5). A ‘design artifact’ can be a product, tool, or system – in this case, GPI is the artifact. A ‘design intervention’ is related to iterative prototyping and “empathy with the user.” The intervention is ultimately what leads to effective uptake or use of the artifact (Kolko, 2015, p. 68). Within this rational, in order for GPI to be successfully absorbed into governance culture, it must be exposed to many users, in this case policy makers, and modified to meet their needs.

Originally, GPI was designed as composite indicator for national policy makers; however, in service of that desired outcome and in alignment with design thinking theory, an intervention has been initiated to spur national GPI adoption by propagating implementation through a threshold number of U.S. states. By using a ‘GPI in the States’ intervention, in particular if it is across all 50 states, the GPI prototype will be able to be improved upon by the feedback of multiple users and also, hopefully, become a tool that is user-friendly and supportive of user needs leading to more adoption. Indeed, Haggart (2000) notes that “government support is a major reason why the GDP was accepted, becoming the most widely used indicator. Only government can give an indicator program the recognition, the resources, and the data base needed to make an indicator anything more than a semi-authoritative number designed to fit the needs – ideological, financial or otherwise – of its creator."

Interest in calculating subnational GPI has led to multiple applications to date including Vermont (Costanza et al., 2004), the San Francisco Bay Area (Venetoulis & Cobb, 2004), Northern Forest (Bagstad & Ceroni, 2007), Ohio (Bagstad & Shammin, 2012), Maryland (Posner & Costanza, 2011; McGuire, Posner, & Haake, 2012) Hawaii (Ostergaard-Klem and Oleson, 2014), Utah (Berik & Gaddis, 2011), and the Canadian provinces of Alberta (Anielski, 2001) and Atlantic Canada, (http://www.gpiatlantic.org). The subnational GPI measures in Vermont and Maryland go beyond only computation and are being considered an opportunity for understanding policy outcomes.

As GPI accounting has moved from development and advocacy to implementation and policy application, there is a growing need to reassess its theoretical foundations and standardize estimation procedures. Many researchers have raised questions about the quality and legitimacy of the GPI as a composite indicator for sustainable human welfare including concerns about the underlying assumptions and the monetary weights and variables used, statistical analytic rigor, extent of data collection required, and lack of a governance mechanism for the metric (e.g., Atkinson, 1995; Neymayer 1999, 2000; Lawn, 2003, 2005; Brennen, 2008; Beca & Santos, 2010). Fundamentally, the question is whether GPI is effectively and efficiently measuring the sustainability quality of economic growth.

An accepted approach for evaluating composite indicators can be found in the OECD 'Handbook for Constructing Composite Indicators' which provides clear guidance on performing methodology quality assurance and standard for ensuring indicator legitimacy. Echoing design thinking's emphasis on 'user empathy,' the OECD defines the 'quality' of a composite indicator as "fitness for use" in terms of users' needs, "The most important quality characteristics depend on user perspectives, needs and priorities" (OECD, 2008, p. 44). 'User empathy' suggests both that policy options are implied by metric design and that the process required for generating the metric may affect user uptake. The OECD recommendations also support the design thinking notion of thoughtfulness about the implementation or intervention used for the 'artifact' or composite indicator, "Too often statistician do not pay enough attention to this fundamental phase [dissemination], thus limiting the audience for their products and their overall impact" (OECD, 2007, p. 49).

This dissertation seeks to systematically investigate the operational features of GPI based on insights derived from the 50 U.S. state GPI estimates. Using these data, it is possible to compare GPI and GSP outcomes and also characterize both individual component and aggregate GPI sensitivities, variance, and correlations. From these results, conclusions can be drawn about possible improvements and future steps for GPI adoption.

The first paper in this dissertation reviews the methodology of GPI and offers the first estimate of GPI as a composite indicator for each of the 50 states in the US for one year using a consistent methodology. State GPI results are introduced and compared to state GSP results. Then analysis of the components themselves reveals key drivers of GPI and which components drive the differences between the states. The paper concludes with an examination of the sustainability aspects of the state-level results.

The second paper, grounded in applying recommendations of OECD 2008 Handbook of Constructing Composite Indicators, scrutinizes the underlying assumptions and the monetary weights and variables used in GPI. This is accomplished by testing whether the indicator is dominated by a single component and how sensitive GPI outcomes are to assumptions embedded in the component calculations. Since a primary goal of GPI is to support sustainable policy choices, investigating these sensitivities reveals possible unintended policy consequences of the indicator design and highlights the need for a holistic predictive GPI model where important interdependencies between the components can be quantified.

The third paper is based on the idea that in order for GPI to become a legitimate, widely accepted metric for success it must have a reputation for being statistically rigorous and transparent. Therefore, this paper seeks to address the efficiency of GPI (data parsimony) by analyzing correlations between components, as the OECD guidance prescribes. This paper also uses correlations to explore GPI's effectiveness as a sustainability indicator compared to other state-level indicators such as the Gallup Well-Being Indicator, Ecological Footprint, and UN Human Development Index.

The final paper provides insights about possible GPI methodology improvements and governance gaps in the U.S. GPI network. It investigates processes, outputs, and outcomes from the network, as revealed through a facilitated U.S. GPI workshop. The workshop highlighted the current lack of a governance mechanism for the metric. Building on the insights from the workshop, a network governance model for the GPI is explored by applying lessons from two tools: Gross Domestic Product and the Global Reporting Initiative.

Collectively, these papers seek to characterize the nature of GPI by investigating whether GPI is operationalizing sustainable human welfare both effectively and efficiently. Ultimately, this study reveals (1) the challenges of converting a national-level metric to the state level, (2) opportunities for improved data parsimony, (3) insights about the sensitivity of assumptions embedded in the component calculations, (4) the need for a predictive GPI model to guide policy choices, and (5) the prerequisite for clear GPI governance to empower future adoption.

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CHAPTER 2: GENUINE ECONOMIC PROGRESS IN THE UNITED STATES: A 50-STATE STUDY AND COMPARATIVE ASSESSMENT

2.1 Introduction

Gross domestic product (GDP) has been the primary metric used by national and state governments to gauge standard of living and help guide economic and social policy. Prior to the development of national income accounting in the 1940s, governments had sparse and incomplete data on the size and direction of the macroeconomy, contributing to uncertainty about the role and impact of policy (BEA, 2000). Today, national income and product accounts are sacrosanct to policy-making, declared as the "achievement of the century" by the U.S. Department of Commerce (BEA, 2000). However, as an artifact of the mid-20th century, the usefulness of GDP as a metric of progress in the 21st century has been subject to much discussion, debate, and proposals for both modifications and alternatives.

In recent decades multiple environmental and social critiques of GDP as a measure of economic welfare have emerged (e.g., Ayres, 1996; Dale & Townsend, 2002; Daly, 1977, 1996; Hamilton, 2003; Jackson, 2011; Schor, 2010; Speth, 2008) including a high profile Commission on the Measurement of Economic Performance and Social Performance (2009) chaired by Nobel prize winning economists Joseph Stiglitz and Amartya Sen. Much of the criticism revolves around a lack of differentiation of costs from benefits of economic growth, including the costs of inequality, regrettable defensive expenditures, uncounted environmental externalities, depletion of natural resource assets, and trade-offs with non-work uses of time. One composite indicator that addresses many of these issues through a lens of sustainability is the Genuine Progress Indicator (GPI).

Developed at both the national and sub-national level, GPI provides a general assessment of the quality of economic growth through a series of 24 adjustments to standard GDP accounts. GPI developed as an extension of the earlier work of Daly and Cobb (1989) on the Index of Sustainable Economic Welfare (ISEW). Initial studies were conducted for the US at the national scale (Anielski & Rowe, 1999; Talberth, Cobb, & Slattery, 2007) and have since spread to over 17 national applications (Kubiszewski, Costanza, Franco, Lawn, Talberth, Jackson, & Aylmer, 2013). However, due to a lack of federal policy uptake, recent attention of both the academic and advocacy communities has turned to state-level application and adoption. In the US, following the lead of Maryland and Vermont, there are now over a dozen state estimates of GPI, and an informal network of practitioners is working towards standardizing accounting procedures and sharing policy applications (e.g., Bagstad & Shammin, 2012; Erickson, Zencey, Burke, Carlson, & Zimmerman, 2013; McGuire, Posner, & Haake, 2012).

As GPI accounting has moved from development and advocacy to implementation and policy application, there is a growing need to reassess theoretical foundations and standardize estimation procedures. In this vein, this study provides the first estimate of GPI for each of the 50 states in the US for one year using a consistent methodology. The goal is not to provide commentary on specific states or promote a winners and losers analysis. Rather, this paper seeks to provide insights that can arise from 50 case studies of GPI that use the same data and methodology to support a richer understanding of the "design artifact" of GPI, leading to a deeper potential for a "design intervention" (Brown & Martin, 2015).

Following a review of the current state of analysis and critique of GPI, with particular focus on U.S. state applications, we provide an overview of methodology and database development for the 50-state study. Results of the study are then presented, including discussion of lessons learned through a 50-state application. The paper concludes with suggestions for further research and next steps to consolidating a consistent methodology.

2.2 GPI in the States

Peter Senge, author of *The Necessary Revolution,* commented that "the deep problems we face today are not a result of bad luck or a greedy few. They are the result of a way of thinking whose time has passed" (2008, p. 7). This "way of thinking" is that economic growth is only ever good. Indeed, economic growth brings costs as well as benefits, especially in a 'full world,' long argued by ecological economists such as Herman Daly (e.g., Daly, 1987; 2005).

GPI, and its pre-cursor ISEW, were designed to reveal the trade offs of conventional economic growth. Daly (1987) refers to "uneconomic growth," when marginal costs outweigh the marginal benefits of the next increment of growth, as a phenomenon that is now occurring in many developed nations. This is seen in numerous GPI studies at national and state levels as a widening 'well-being gap' between GDP and GPI with a turning point of maximum GPI achieved as early as the 1970s in nations such as the US (Anielski & Rowe, 1999; Talberth et al., 2007). The strength of GPI has been this comparability with GDP, providing an avenue of inquiry on the desirability and quality of growth. Ultimately, one of the ambitions of the GPI is to gauge the interrelatedness of the three pillars of sustainability - economic, social, environment - as they affect aggregate welfare, albeit an indicator of 'weak sustainability' that allows for full substitution between all variables (Neumayer, 1999).

Originally designed as a national composite indicator and policy lens, in recent years GPI has been estimated and adopted at sub-national levels in the US and Canada. The first U.S. state-level study was conducted for the State of Vermont (Costanza et al., 2004). The State of Maryland became the first government-sanctioned GPI effort with a 2010 executive order of former Governor Martin O'Malley. In 2012, the Vermont state legislature passed, "An Act Related to the Genuine Progress Indicator," which mandates yearly updates to Vermont GPI in cooperation with the University of Vermont's Gund Institute for Ecological Economics. Thus, with the involvement of governments and academia, both the practitioner and academic spheres have been directly or indirectly contributing to this broad, state-level intervention (Brown & Martin, 2015).

A loosely cohesive "GPI in the States" initiative (GPIinthestates.com) was launched by representatives from 20 states at a series of meetings convened by the Governor of Maryland in October 2012 and June 2013 with assistance from Demos, a progressive policy organization. A follow-up meeting with GPI practitioners was convened at the Gund Institute for Ecological Economics at the University of Vermont in Spring 2014. For this meeting, an initial GPI estimate for 50 states was produced by a graduate ecological economics class to be used as the springboard for innovation towards a new standard, often referred to as "GPI 2.0."

2.3 The 50-State GPI Study

The GPI is a composite index of the quality of economic activity arrived at through mixed methods from environmental economics (e.g., pollution and climate change costs), natural resource economics (e.g., depletion costs), and various heterodox approaches to other social and economic adjustments. These methods are detailed in several publications, including the original ISEW method from Daly and Cobb (1989), national-level GPI studies (Talberth et al., 2007), and the original state-level GPI method developed by Costanza et al., 2004.

In summary, the GPI is a linear equation in which 7 benefits and 18 costs sum to a single monetary measure of economic welfare (summarized in Figure 1.1). GPI is grounded in Fisherian concept of income, a net "psychic income" that deducts harmful aspects of consumption from useful components (Lawn, 2003). Each of the components is reflected in monetary terms which facilitates the simplicity of the equation and the ultimate single monetary output. A business parallel may be that GPI accounts for both welfare-enhancing revenues as well as expenses or debits that demonstrate welfare decline. GPI components can also be grouped into the three pillars of sustainability: economic, social, and environmental components. Parsing the components into the sustainability pillars results in six economic, nine social, and ten environmental components.

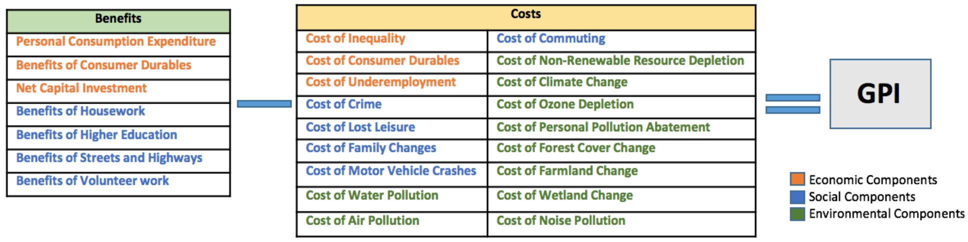

Figure 2.1 GPI Benefit/Cost Component Equation

Using the same baseline as GDP of household personal consumption expenditure (PCE) as a proxy for material welfare, the GPI methodology then adjusts this expenditure by 24 variables starting with income inequality based on the Gini coefficient, resulting in an equity-weighted basis of PCE. The foundation of an inequality-adjusted PCE reflects both the assumption that consumption denotes an individual's ability to improve their own well-being and the hypothesis that the marginal well-being benefit of an increase in income is larger for lower income compared to high income individuals. Net capital investments is considered the foundation to future production for future consumption and therefore are included. Also, by including both the services and costs of durables, GPI attempts to reward household level investments (durables) that last longer and therefore will not require more resource consumption through premature replacement in the future.

In addition to inequality not being considered in GDP calculations, positive nonmarket services that enhance social cohesion and well-being are also excluded. To correct this and reflect the value of social sustainability, GPI adds in the value of nonpaid household and volunteer labor using wage rates to value these welfare-enhancing hours. GPI does not initially include government expenditures because they are assumed to be primarily defensive expenditures; however, some common pool assets are added back in, including services of highways and streets and positive externalities of higher education.

It can be argued that household labor, volunteer time, higher education, and services of streets and highways support and foster stronger families and engaged communities, while other social components of GPI identify metrics that demonstrate that society is experiencing a decline in social coherence or a lower level of well-being including costs of crime, commuting, automobile accidents, underemployment, family breakdown and lost leisure time. These welfare losses, or regrettable expenditures, are monetized using various valuation methods and then subtracted.

Costs of the erosion of social sustainability is added to the costs of the loss of natural resources and environmental quality including the cost of non-renewable resource depletion, air pollution, water pollution, loss of wetlands, loss of forests, and loss of farmland. Daly and Cobb (1989) saw such resource liquidations as "economic liabilities" (p. 379). Other negative environmental externalities of consumption and production included in GPI are the cost of ozone depletion, cost of climate change, and the cost of noise pollution. The regrettable expenses on waste reduction at the household level is included separately through the personal pollution abatement component.

These components of GPI were first established in national level studies, then modified for state-level estimates beginning with the decadal estimates for Vermont from 1950 through 2000 (Costanza et al., 2004). Since then many disparate GPI U.S. state-level studies have been completed using diverse methodologies often reflecting local datasets, local geographies, or to catalyze relevance for local policy. GPI estimates have been published for subnational levels for at least seven other locales, including Vermont, Chittenden County, Burlington (Costanza et al., 2004); Northern Vermont (Bagstad & Ceroni, 2007); Northeast Ohio (Bagstad & Shammin, 2012); Baltimore City, Baltimore County, and Maryland (McGuire et al., 2012; Posner & Costanza, 2011); Oregon (Kubiszeski et al., 2015); Hawaii (Ostergaard-Klem & Oleson, 2014); and Utah (Berik & Gaddis, 2011). There are also state-level GPI studies written by researchers or state employees that have not been published in peer reviewed journals, including for Minnesota (Minnesota Planning Environmental Quality Board, 2000), Michigan (Michigan State University), Colorado (Stiffler, 2014), Missouri (Zencey, 2015), Washington (Results Washington, 2013), Massachusetts (Erickson et al., 2014; Assumption College), Hawaii (Hawaii Department of Health, 2013), and Alberta (Anielski, 2002).

Each state-level study has resulted in modifications to the GPI methods, reducing comparability between studies. Two general standards have emerged, including studies using the "Vermont/Maryland" method (Bagstad & Ceroni, 2007; Constanza et al., 2004; Erickson et al., 2013; Posner & Constanza, 2011) and the "Ohio/Utah" method (Bagstad & Shammin, 2012; Berik & Gaddis, 2011). Based on insights from this variance in state-level methods, Bagstad, Berik, & Gaddis (2014) published suggested updates for a GPI 2.0. Some of the key methodological differences between the two dominant state models include:

(1) Cost of climate change in the UT methodology is based on consumption of consumer goods in addition to energy to include embedded emissions in products

generated outside of the state;

(2) Calculating the value/benefit of ecosystem services in the UT method rather than the cost of ecosystem service loss in the VT method against a selected baseline year estimate;

(3) Personal consumption expenditure is lowered further in the UT method with deductions of spending on tobacco, alcohol and junk food;

(4) The value of higher education is not a component in the UT method because it is assumed to already be captured;

(5) UT uses different values and sources for air and water pollution to those used in the VT method; and

(6) American Time Use data is used in the UT method for household labor, volunteer work, leisure time, underemployment, commuting, and family breakdown, plus the UT method uses a 128% multiplier of the average hourly wage rate to value leisure time.

The Vermont/Maryland methodology as summarized for the Vermont state legislature in Erickson et al. (2013) was used as the basis for this study. The year with the most complete dataset was 2011, including new state-level estimates for Personal Consumption Expenditure by the Monetary units were converted into 2011 U.S. dollars using regional Consumer Price Indices (CPI) from the U.S. Bureau of Labor Statistics for the Northeast, South, Midwest, and West. Table 2.1 summarizes data incorporated for each sub-indicator, including data ranging from all state-level, to partially state-level, to fully national-level scaled by state population.

Table 2.1

Summary of Variable and Valuation Data for 50-State GPI Study

Component	Variable Dataset	Scale	Valuation Dataset	Scale
Personal Consumption			State-level BEA	State
Inequality			State Gini by US Gini baseline	State & National
Benefits of Consumer Durables			National percentage of income spent on consumer durables, state-level income	State & National
Costs of Consumer Durables			*National percentage of income spent on consumer durables by state-level income*	National & State
Underemployment	State (un-, under) employment rates, (also using national hours spent searching for work in new model), State labor force	State & national	State average wage	State
Water Pollution	State data on waters degraded		U.S Average Value of Degraded water	National
Air Pollution	Ozone depleted days of the state values by state population	State	National damages from Freeman (1982)	National
Cost of Forest	*USDA State forest cover. Estimates of pre-colonial state forest cover*		Forests: $318/acre (Pearce et al. 2001)	
Cost of Wetland	State agency estimates of current wetland. Estimates of pre-colonial state wetlands.	State	2 national numbers (pre-1949, 1950 onwards)	National

Cost of Farmland	State farmland acres by VT:US productivity coefficient	State	$404/acre	National
Cost of Climate Change	State Data Coal, natural gas, petroleum, wood and waste multiplied by CO2 intensity	State	National social cost of carbon	National
Cost of Ozone	CFC emissions by state	State	National cost by state population	National & State
Cost of Family Change	State divorce rate. National average number children per divorce State households with children National hours of TV		National cost of divorces and social cost of TV viewing	
Cost of Crime	State crime numbers	State	National costs to victims by type of crime	National
Cost of Lost Leisure	State unemployment rate. State fully employed rate by constant national number of hours lost by fully employed	State & National	State average wage rate	State
Benefit of Higher Education	Population college-educated in state	State	National value of positive externalities from education	National
Cost of Commuting	State average travel time to work; American Community Survey numbers of commuters per state	State	Average hourly wage in state State public fare revenues instead of entire operational cost of public transit National cost per mile driven	State & National
Benefit of Volunteer work	Constant national volunteer hours per year rate by state population15 and over	National & State	Average hourly wage in state	State
Benefit of Household labor	National ATUS – time on housework by state population over 15	National & State	Average hourly wage of domestic/cleaning personal in state	State

Costs of nonrenewable resource depletion	State consumption state of coal, oil, gas, nuclear, solar, wind	State	National replacement costs	National
Benefit Net Capital Investment			National by state population	National
Cost of Noise Pollution	State Urban to Rural population, Ratio state/national population	State	National cost	National
Cost of Personal Pollution Abatement	State new registered vehicles; State households with septic, sewer. Residential waste national number by state population	State & National	National costs of air filters, septic, sewer. National Cost of disposal of ton of residential waste	National
Services of highways and streets	State stock of US highways and streets Ratio of State highway miles to National	State & National	National US service value	National
Cost of Motor Vehicle Crashes	State fatalities, injuries, property damage	State	National costs of fatalities, injuries, property damage	National

The basic 50 State GPI table shared and explored in this paper was produced as part of a small graduate-level course supported by the Gund Institute of Ecological Economics held at the University of Vermont in the spring semester of 2014 under the supervision of Professor Jon Erickson and Daniel Clarke, a visiting scholar from the U.N. Statistic Division. Using the Vermont GPI spreadsheet as a template, graduate students populated assigned components with relevant data, culminating in an estimate of the 2011 GPI for all 50 states and the District of Columbia (DC). The class met weekly to discuss findings and data challenges. Members of the class presented preliminary results to the U.N. Statistic Division in May 2014. After the course ended, quality assurance checks led to a re-calculation of state GPIs to correct the estimates for errors. While the class calculated the 50 states and DC, results do not include DC due to its different governance scale.

2.4 Results

The 50 state results are for 2011, using regional CPI inflation adjustments when multiple years are required in calculations (for example, services and depletion of capital stock investment). Results are reported in per capita numbers in order to control for state population size. An appendix includes detailed results for each state's components and calculations. A master spreadsheet is available on request. This section will first introduce the state GPI results and compare state-level GPI and GSP results. It will then move from state-level aggregate GPI estimates to analysis of the components themselves from both from the state-level and as one average for the U.S. to reveal which components drive the differences in GPI. Finally, this section will dive deeply into investigating the sustainability aspects of the state-level results.

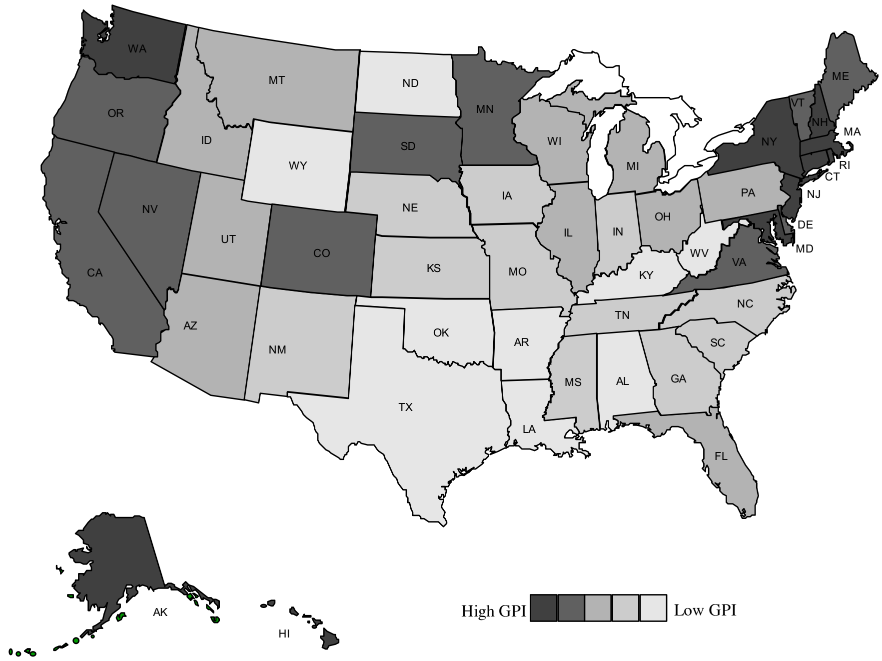

Figure 2.2 Fifty State Genuine Progress Indicator

The results from the GPI estimate reveals that Alaska has the highest GPI while Wyoming has the lowest, with a range of $97,192 value per acre per year. Alaska's GPI is a significant outlier as the only state with negative costs for wetlands, i.e., the cost of wetland change component switched from a cost to a benefit for Alaska. Seven states have negative GPIs (AR, MS, AL, WV, ND, LA, WY) suggesting that total costs of annual consumption in those states outweigh the benefits. The mean GPI is $16,430 and the median is $16,968.

GPI state rank results are, not unexpectedly, positively correlated with GSP state rank (r = 0.50); however, analysis of individuals states demonstrates some interesting divergences. No state has higher GPI than GSP; it would be possible for GPI to be higher than the GSP if the value of the benefits of economic growth far exceeded the costs.

Alaska is ranked number 1 in both GSP and GPI, while Wyoming is number 4 in GSP but 50 in GPI (again, in per capita terms). This difference illustrates that the costs of economics growth in WY are outweighing the benefits. A pattern of high GSP and low GPI continues with another extraction based state, North Dakota, being ranked 3 in GSP and 48 in GPI. In figure 2.3, the states' GPI and GSP rank results were divided in half with the bottom 25 states placed in the "low" category and the top 25 states placed in the "high" category for each indicator. States with low GPI and high GSP are shaded in white, including WY, ND, NE, IA, TX, LA. In other words, this group performs well when measured as total state output per capita, however deducting environmental and social costs tells a different story. Meanwhile the states that have high GPI and low GSP are in the darkest shade, including ID, AZ, WI, FL, VT, ME. These states over perform in GPI terms given their comparatively low economic output per capita. States shaded in the lightest gray perform well regardless of selected metric, and those in the next shade of grey before poorly also regardless of GSP or GPI.

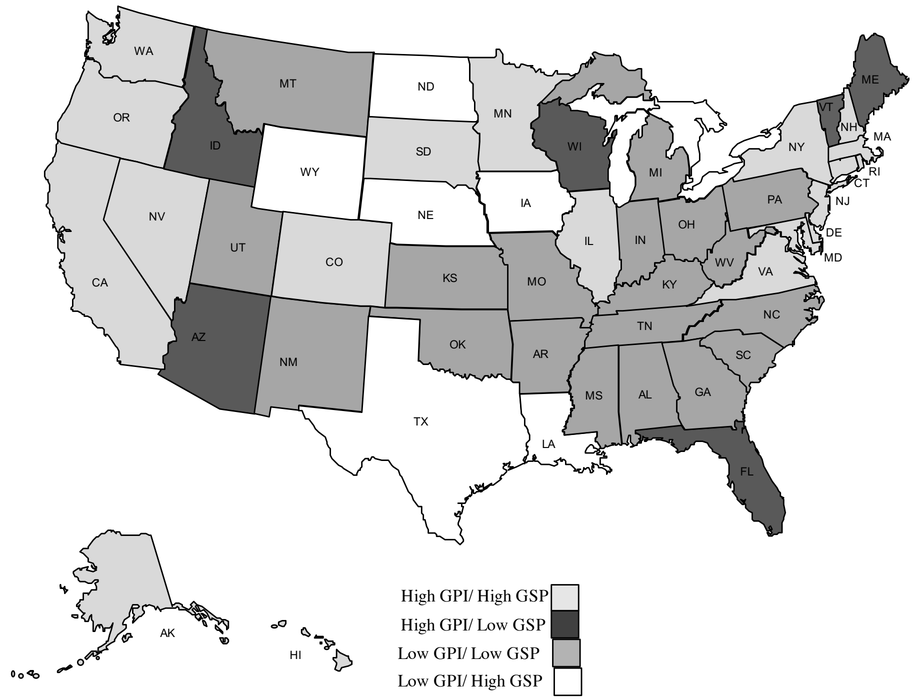

Figure 2.3 Four High and Low GSP and GPI Groupings

2.4.1 Key Drivers of the Genuine Progress Indicator

Analysis of individual components, or sub-indicators, of GPI can help identify key drivers of results. First, exploring the variance between the states and the components provides evidence for whether the GPI results are dominated by a few indicators and may also explain the relative importance of the components of GPI as a composite indicator. Figure 1.4 illustrates the variance of the 'middle 80%' of each of the states' GPI components by removing the top 10% (up to rank 5) and bottom 10% (from rank 46 to 50) states' results for each component. Looking at this 80% range across each component demonstrates the cross-state variability of each component without the results being skewed by outliers. The left side of the figure shows how much less than the median each component's 5th lowest score lies and the right how much higher than the median each component's 5th highest score lies.

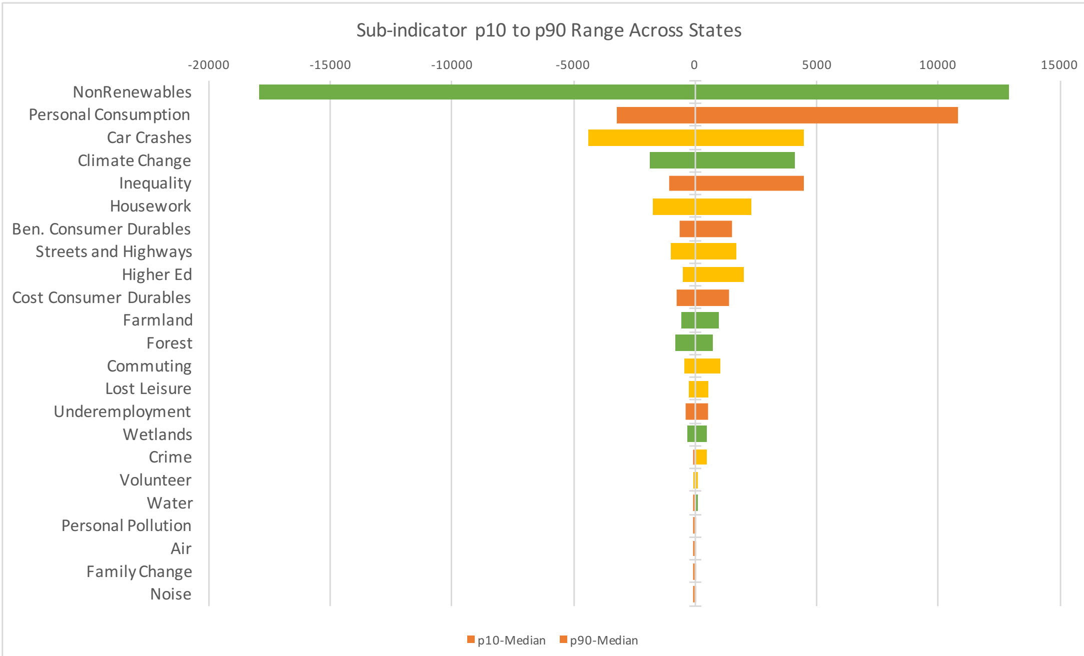

Figure 2.4 Component 10th and 90th Percentile Range Across States

This analysis illustrates clear dominance by the nonrenewables component for the difference between the states' GPIs. In fact, over 90% of the variance can be accounted for by the combination of nonrenewables, PCE, and motor vehicle crashes. This leads to the finding that differences between the 50 case studies may be overly dominated or driven by few components. While each of these components may be seen to represent one of the three sustainability pillars, their significant contribution to the difference between the states begs the question: "Are these the three most important components from the perspective of sustainable welfare?"

The other side of the key drivers question is to look at components that are relatively uniform across the states and therefore contribute very little to the difference between the states, including noise pollution, cost of family change, personal pollution abatement expenditures, air and water pollution, volunteer labor, and cost of crime. The OECD handbook for composite indicators suggests that such components be deleted as "individual indicators that are similar across counties [states] are of little interest and cannot possibly explain differences in performance" (OECD, 2008, p. 26). Given the challenges of data collection, using less data would allow more efficient GPI calculation and perhaps greater comparability.

Another way to understand the relative importance of the components of GPI is to analyze which components, on average, provide the biggest boost or serve as the biggest drag on GPI. Figure 2.5 includes data for the components of all states added together and then divided by U.S. population to get a population weighted average for the US for each component. On average, the biggest boost comes from PCE and benefits of housework, while the biggest drag comes from the cost of nonrenewable and the cost of inequality. Individually most of the environmental components contribute very little to the GPI.

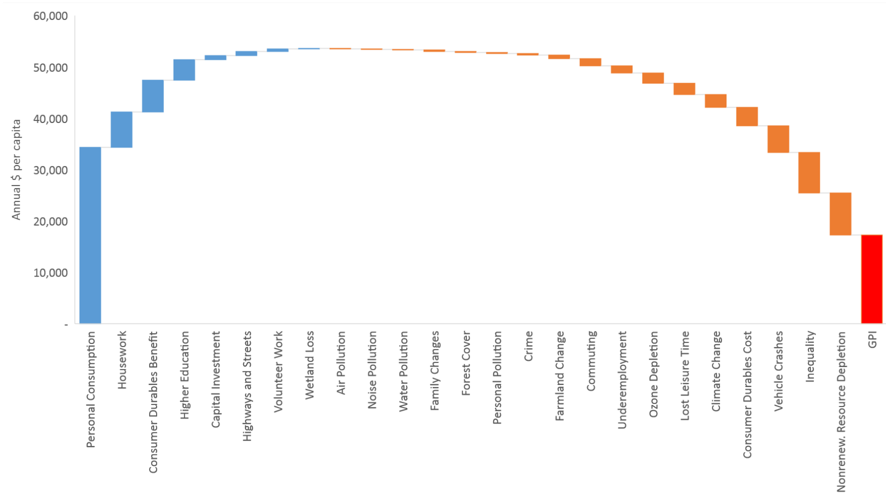

Figure 2.5 Component Quantitative Significance U.S. Population Average GPI

Finally, another way in which to search for key drivers of GPI results is to assess any patterns within the leader and laggard groups. For instance, the different in inequality statistics between states is striking. The state with the most equal income distribution (lowest cost), Wyoming, has the lowest GPI, while the state with the highest cost of inequality, New York, has the sixth highest GPI. Massachusetts and Connecticut are also ranked high (number 2 and 3) for the cost of inequality, yet also ranked number 2 and 3 for GPI per capita. This may be a reflection of the significance of a large PCE in the high inequality states, serving as a counter balance to the cost of inequality (and also may be directly related to the large inequality). This result may be of concern as GPI was designed with this belief in mind "it is urgent to replace the GNP with a measure that does not encourage the growing gap between the rich and the poor" (Daly & Cobb, 1989, p. 379). Ultimately, this outcome points to the possibility that good performance in one indicator (especially PCE, the largest component of both GSP and GPI) can mask poor performance in another, so-called "weak sustainability."

A deeper look into the list of the top performing cases, we do see high equality helping with overall GPI performance. For example, Hawaii, ranked 4 on GPI, has a more moderate PCE but more equality. It is also notable that Hawaii has the highest contribution from housework and the lowest service of streets and highways. This leads to the question: "Are we trying to increase housework in the states, or just provide for a better accounting of unpaid work?" Another question that Hawaii's composition begs is should smaller states with few streets and highways be punished in GPI because they have low services of streets and highways? On the other side of the size spectrum, is Alaska's reward for having so many wetlands appropriate? Indeed, it is the only state to have increased wetland cover from the pre-colonial baseline and thus the only state to experience the cost of wetland change as a positive number. This indicator may be another example where the large size (and comparatively low population density) of a state is privileged in GPI.

2.4.2 Sustainability Pillars

An advantage of GPI is that, in addition to providing an aggregate indicator that produces a single monetary metric, it is also easily decomposable into constituent economic, social, and environmental sustainability categories. Breaking down the indicator in such a fashion helps illustrate the 'weak sustainability' principle that natural and social and economic components are substitutable once put in a common monetary metric. For example, it is possible to deplete natural or social capital while expanding consumption and increasing GPI. It also further demonstrates the notion of costs and benefits to economic growth. While all environmental components are framed as “costs” it is noteworthy that there are some states that have positive environmental components. For example, ND, KS, MT, TX, NE, CO, AZ, HI, CA, NV, UT, SD, NM, ND, AK all have positive forest cover change, meaning that each state has more forest cover now than it did during the pre-colonial baseline. However, overall, Alaska stands out as the only state to have a positive aggregate environmental pillar due to the net benefits of wetland change. The social category holds a collection of costs and benefits and overall ten states end up with more social component costs than benefits, including TN, KY, LA, OK, WV, SC, AR, AL, WY, MS. These states also rank as the lowest 15 GPIs.

To help visualize differences in state performance along environmental, social, and economic dimensions, Figure 2.6 displays green for the top third in the category, yellow for the middle third, and red for the bottom third. Generally, if a state scores well on economic components then it likely scores well on environmental and social as well. In other words, economically depressed states also rank poorly in social and environmental attributes.

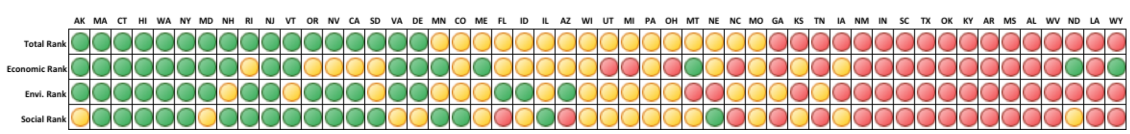

Figure 2.6 Sustainability Pillars Traffic Light Diagram –Outcomes Split into High (Green), Middle (Yellow), Low (Red)

Figure 2.6 illustrates that tradeoffs among sustainability pillars are rarer than triple successes or triple failures and that there may be more synergies between the components. The general pattern of high economic performance coming with high social and environmental performance may point to an externalization of consumption impacts to other states. It also suggests that the environmental Kuznets curve holds true (i.e., wealth allows for social and environmental sustainability). The states that break with the Kuznets pattern include ND and WY which have high economic components but low environmental and social components. In these states, economic growth may occur at the cost of the environmental and social outcomes, as the designers of GPI hypothesized. MT also has a high economic component and low environmental component, but mid-range social component. All three of these states' economies rely on extractive industry practices.

The environmental pillar has the largest range at $91,074, driven by Alaska's wetland component. Without the wetland sub-indicator included, the range is $52,524 between highest and lowest aggregate environmental deduction. The economic pillar has the next greatest range at a substantially lower amount of $13,597. The social pillar is the least variable at a difference of $10,989 between the highest and lowest states. It is also noteworthy that none of the highest individual social indicator ranges are higher than the top three environmental ranges.

The divergence in environmental deductions highlights the consequence of choice of environmental assets included in state accounts, and whether to focus on accumulated costs from loss or degradation of assets, or instead calculate the benefits from ecosystem services of existing assets. Specifically, Alaska's extreme wetland component points to the questions of choice and accuracy of baseline. Should GPI be based on historic, presettlement baselines of environmental assets, and thus forever carry costs for staying below those baselines? Or should GPI instead be based on annual flows of benefits from diverse ecosystems? The Utah and Ohio methods have veered towards considering the value of ecosystem services from a range of environmental assets, beyond just wetlands, forests, and agriculture (Bagstad & Shammin, 2012; Berik & Gaddis, 2011). In this case, states that have other types of ecosystems may get a boost in GPI in addition to the general increase that would result from the inclusion of ecosystems services as benefits. The question over human-made environmental systems versus natural states is also debated. For example, states in the arid West such as CA, NE, CO, AZ, NV, UT, and NM have all increased their forest cover from pre-colonial times. Yet, they do not have a hospitable climate and water to naturally support forest landscapes. GPI as it is designed now may encourage them to increase forest land in a way that is unsustainable.

Current design may also be seen to prioritize the environmental pillar above the economic and social pillar due to the larger range in environmental pillar results because the difference in the aggregate environmental results is the primary driver of which states do well and which states so poorly on GPI ranking. It is also noteworthy that none of the highest social component ranges are higher than the top three environmental component ranges. Therefore, it may be proposed that state policy makers ought to focus on environmental factors if they want to change their state's relative ranking.

2.5 Discussion

The OECD handbook for composite indicators recommends that the most compelling indicators have a clear objective or desired direction of change. Perhaps the objective for GPI could be interpreted in relation to GSP – the divergence between the metrics indicating uneconomic growth. An alternative GPI driven goal for the states is to view the results as an optimization challenge aiming for larger ‘benefits’ and smaller ‘costs’ driven by state policies. Ultimately though, GPI experiences non-linear changes and tradeoffs which are challenging to model. More thorough analysis of the data variables and values, relationships with other indicators, and key assumptions that influence the results are provided in chapters three and four of this dissertation in order to elaborate on the consequences of indicator design choices and resulting policy trade-offs.

Another challenge of the state-scale GPI output is how to accurately account for resource and waste imports and exports. For example, one state may bear the costs of depleted natural capital (lowered GPI) while another state may count the consumption of this natural capital in their PCE as a positive in their GPI (as described in Lawn & Clarke, 2008). In essence, one state’s higher GPI may be artificially high because it is externalizing costs to another state. As Posner and Costanza (2011, p. 1976) commented, “The failure to properly account for resource and waste imports and exports creates indicator bias in GPI toward exporting the costs of economic growth to other locations — not a sustainable outcome.” This conundrum is partially addressed in the national-level GPI methodology by the inclusion of “net exports,” but this was not actionable at the state scale.

As a state policy driver, GPI requires state level data to produce an accurate reflection of the consequences of state-level policy. Data that has been scaled down from the national level dilutes or distorts impacts of state-level policy and thus does not provide direct feedback or precise insights to state legislators. In order to empower or support sustainable policy changes at the state scale, legislators must be able to enact policy that directly impacts either the GPI variable (e.g., amount of volunteer time) or the GPI valuation (e.g., state minimum wage). Specifically, since 90% of the variance between the states can be accounted for by the combination of nonrenewables, PCE, and motor vehicle crashes, it is particularly important to identify whether state differences on these components are policy driven, i.e., can the variables and valuations of the data sets used to calculate these components be modified by state level policy action or at they simply privileging fixed attributes of the states (e.g., land mass)? Unfortunately, one complication of using state level valuations is that the resulting 'weights' will be inconsistent across the case studies and across time scales – as these valuations could (and hopefully would) change over time as more welfare enhancing policy is implemented. Therefore, chapter three of this dissertation aims to understand the power of selected values and weights through a sensitivity analysis – how sensitive is the GPI result to these choices?

2.6. Conclusion & Future Research

The results of this 50 state GPI study point towards opportunities for improvement for the indicator and further questions about implementation and policy relevance. Policy makers may be interested in exploring what types of policy levers are available to drive changes in GPI such as changes in taxes, infrastructure investment, land use planning, and minimum wage. The GPI research community now has 50 case studies using consistent methodology to investigate how sensitive the GPI is to various assumptions about variables, quantities, and values selected in this iteration of the calculation. Speculation about what type of attributes may be privileged by the GPI methodology can be put to rest by testing state characteristics against GPI results. Fundamentally, a 50 case study table also provides the opportunity to test the 'sustainability credentials' of GPI by comparing the 50 GPI outputs to other 'quality of life' or 'well-being' metrics.

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CHAPTER 3: TESTING GPI'S SENSITIVITY TO CALCULATION ASSUMPTIONS

3.1 Introduction

The use of Gross Domestic Product (GDP) as a measure of economic progress has arguably led to unintended consequences of environmental degradation and socially skewed outcomes. At GDP's inception in 1943, the primary architect of the indicator, Simon Kuznets, warned that it would be imprudent to elevate GDP growth to an indication of growth in human welfare. In his words, "The welfare of a nation can scarcely be inferred from a measurement of national income" (Kohler & Chaves, 2003). Disappointed by the global propagation of a focus on quantity of growth (spurred by a focus on GDP) rather than quality of growth, Kuznets declared, "Goals for more growth should specify more growth of what and for what" (Kuznets, 1962, p. 29).

The Genuine Progress Indicator (GPI) seeks to grasp the quality of economic growth. To fill its role as a potential direct replacement for GDP, GPI provides one monetary result to measure the sustainability of the economy's contribution to human welfare. As with the creation of GDP, the GPI research, advocacy, and policy community has also questioned the ability of GPI to measure welfare and the unintended consequences of its design in policy outcomes. For example, concerns over the underlying assumptions and implications of monetization of welfare benefits and costs have been discussed by Neumayer (1999), Lawn (2003; 2005), Dietz and Neumayer (2006), and Bleys (2007). These studies suggested that minimal modifications to the component valuation methods would have a substantial impact on the outcomes.

This study will break down the components of GPI to explore if the current calculation methods support policies that are in alignment with GPI's goal to measure sustainable human welfare. The central question is 'What type of policy behavior might GPI incentivize?'. The aim is to investigate the quality of the GPI as a composite indicator for sustainable human welfare by testing whether the indicator is dominated by particular components and how sensitive the GPI outcomes are to assumptions embedded in the component calculations, with particular attention to the possible unintended policy consequences of the design.

3.2 Methods

This study is built on data from the 50 state GPI study introduced in chapter 2 and grounded in applying recommendations of OECD 2008 Handbook of Constructing Composite Indicators. The handbook was developed to support policy-makers, academics, and the media in constructing and using composite indicators. In particular, the handbook contains specific quality assurance guidance for constructors of composite indicators. GPI is considered a 'composite indicator' according to the OECD because it is an indicator that "is formed when individual indicators are compiled into a single index on the basis of an underlying model" (OECD, 2008, p. 13). The OECD urges designers to focus on "fitness for use" for perspectives and priorities of metric users as the primary indicator of composite indicator quality, therefore, keeping the practical implications for policy makers of GPI is paramount.

According to the handbook there are several pros and cons to composite indicators. One of the benefits is that they tend to be easier for the public to interpret than a collection of indictors on a dashboard. They can also be supportive in setting policy priorities and monitoring impacts. This study will focus on mitigating three of the cons or criticisms associated with composite indicators:

1. Policy Alignment. Does the composite indicator empower the policy changes in alignment with its foundational theory?
2. Weighting of Sub-Indicators. How are components weighted when the composite indicator is compiled? The perceived "arbitrary nature of the weighing process" is often a primary objection to implementing composite indicators (Sharpe, 2004) which may delegitimize GPI and lead to political disputes.
3. Transparency and Rigor. To what degree are the estimation procedures transparent and statistically robust?

Sensitivity analysis can be used to allay some of these concerns by testing the robustness of composite indicator and improving transparency (OECD, 2008, p. 34). Through sensitivity analysis we can see "significant and insignificant differences thereby minimizing the risk of misinterpretation and misuse" (OECD, 2008, p. 49). And we can represent the impact of each weighting assumption or variable choice on the GPI outcome.

For the statistical sensitivity of GPI, we used the population weighted average from the 50 state GPI table described in chapter 2. The population weighted average GPI can be thought of as the U.S. GPI or component scores excluding the District of Columbia. To calculate the table, we used the Vermont/Maryland GPI method (Costanza et al., 2004; McGuire, Posner, & Haake, 2012) and aimed to use state-level data for as many variables as possible.

An exhaustive sensitivity analysis should explore all potential sources of uncertainty and assumptions embedded in a composite indicator including “selection of individual indicators, data quality, normalization, weights, aggregation method” (OECD, 2008, p. 34). The OECD Handbook offers a few options to test if the GPI is “overly dominated by a small number of indicators” including inclusion/exclusion of components and evaluating different plausible values for weights or variables. Employing these recommendations, this sensitivity study explores the level of: (1) Quantitative significance of different components represented in the aggregate GPI; (2) Changes in GPI resulting from elimination of each component; (3) GPI outcomes resulting from different variables and valuation weights for a handful of highly significant components; (4) GPI’s sensitivity to increasing each component by 10%.

3.3 Results

3.3.1 Quantitative Significance

Table 3.1 displays each component’s contribution to GPI as a percent of the U.S. population weighted averaged GPI based. Personal consumption expenditure (PCE) contributes the most at 38% of the average GPI outcome. The top 10 components contribute to 90% of average GPI, while the bottom 12 contribute less than 5% of the total. Table 3.1 further illustrates the relative magnitude of each component’s contribution to the composite, plus the ratio of costs and benefits.

Table 3.1 *Component Contribution as Percent of the U.S. Population Weighted Average GPI*

Average U.S. Per Capita Component	Absolute	Rank	Percent of GPI	Cumulative Contribution
Personal Consumption Expenditures	34,372	1	38.2%	38%
Cost of Nonrenewable Energy Resource Depletion	8,172	2	9.1%	47%
Cost of Inequality	7,885	3	8.8%	56%
Benefits of Housework	6,864	4	7.6%	64%
Benefits of Consumer Durables	6,238	5	6.9%	71%
Cost of Motor Vehicle Crashes	5,179	6	5.8%	76%
Benefits of Higher Education	3,942	7	4.4%	81%
Cost of Consumer Durables	3,618	8	4.0%	85%
Cost of Climate Change	2,496	9	2.8%	88%
Cost of Lost Leisure Time	2,216	10	2.5%	90%
Cost of Ozone Depletion	2,018	11	2.2%	92%
Cost of Underemployment	1,393	12	1.5%	94%
Cost of Commuting	1,319	13	1.5%	95%
Net Capital Investment	828	14	0.9%	96%
Cost of Net Farmland Change	769	15	0.9%	97%
Benefits of Highways and Streets	755	16	0.8%	98%
Benefits of Volunteer Work	569	17	0.6%	99%
Cost of Crime	250	18	0.3%	99%
Cost of Personal Pollution Abatement	239	19	0.3%	99%
Cost of Net Forest Cover Change	223	20	0.2%	99%
Cost of Family Changes	217	21	0.2%	100%
Cost of Water Pollution	143	22	0.2%	100%
Cost of Noise Pollution	101	23	0.1%	100%
Cost of Air Pollution	48	24	0.1%	100%
Cost of Net Wetland Change	10	25	0.0%	100%

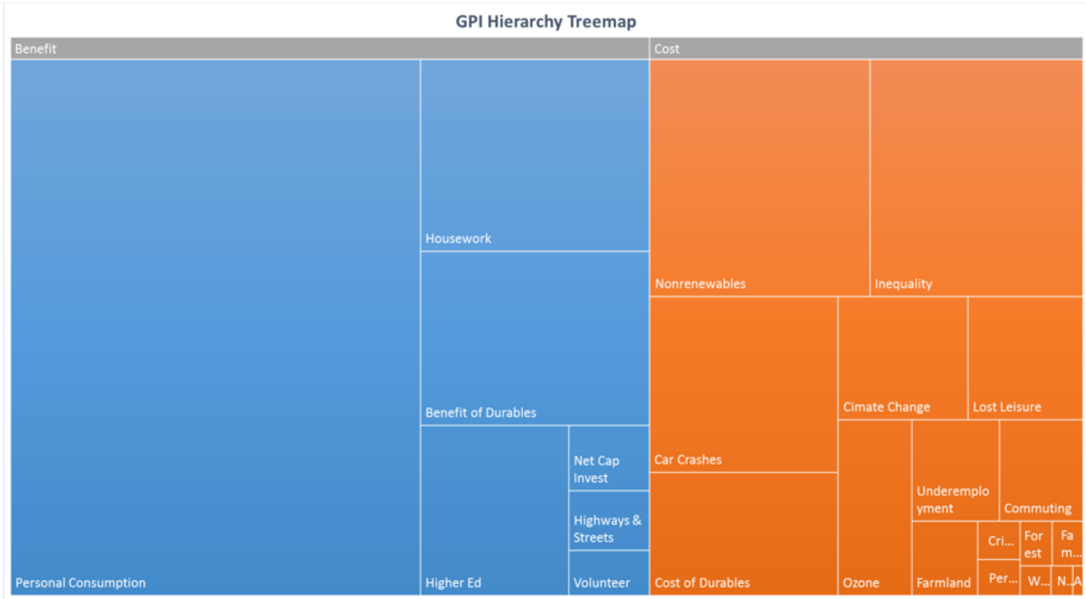

Figure 3.1 Costs and Benefits Component Contributions to U.S Population Weighted Average GPI

With only the 10 largest components there would be six costs and three benefits compared to the current number of 18 and 7. The list would include four social indicators (cost of lost leisure time, benefits of housework, benefits of higher education, cost of motor vehicle accidents), two environmental indicators (cost of climate change, cost of nonrenewable resource depletion), and four economic indicators (PCE, cost of inequality, benefits of consumer durables, cost of consumer durables). Bleys (2007) suggests a quantitative significance threshold of 5% contribution, which would result in including only 6 components, or 78% of the current aggregate GPI score.

While streamlining the GPI would have benefits to data parsimony, a concern related to the user experience is a more limited focus on the components with the highest quantitative significance rather than looking at the GPI as a non-linear system.

Additionally, since all components are monetized and thus substitutable with one another, each marginal improvement to GPI (no matter the aggregate size of the components) should be judged against the marginal cost of the policy intervention. In addition, some of the small sub-indicators may be due to previous policy choices (e.g., Clean Air Act in the case of comparatively low cost of air pollution). Rather than rely solely on an argument that small cost or small benefit implies dropping a component, it is important to consider the policy relevance of each part of the overall composite and any unintentional consequences of action to improve.

For example, consider the environmental cost of net forest cover change. The aggregate component number for cost of net forest cover change would have to increase by a factor of 10 in order meet a 2.5% contribution threshold of significance. To meet this arbitrary threshold, marginal valuation of a forest acre could have to increase tenfold. Alternatively, to reduce this cost to zero (a 1% increase to average U.S. GPI), an additional 166 million acres of new forest would have to be planted or regenerated to reach the pre-colonial settlement baseline (itself a questionable policy goal). This is approximately 260,003 square miles of new forest land in the US which is more than twice the land mass of CO. What would be the opportunity cost of this much reforestation for a gain of 1% in GPI? In addition, is it sustainable for certain states (specifically the arid West) to be incentivized to increase forest cover beyond the pre-colonial estimate?

An example to consider for a relatively small social indicator is the cost of family change. Similarly, this cost would have to increase by a factor of 10 in order meet a 2.5% contribution threshold. This indicator is composed of both the cost of divorces and the cost of television viewing (an artifact of the GPI's original design in the late 1980s). Both have been difficult to justify giving changing societal norms around marriage and the difficulty in distinguishing the costs versus benefits of "screen time". The Utah study has revised the estimate to consider the social cost of "excessive" television to be greater than two hours per day per family (Berik & Gaddis, 2011). Additionally, a more modern context of the social cost of "screen time" would have to include the benefits and costs of computer games, smart phones, etc. For the social cost of divorce, the definition of a "family unit" has changed considerably in the last few decades. Without an established decision body to vet these questions, and given the comparatively small cost of this component, this has been an example that has been dropped by some recent state studies.

3.3.2 Exclusion or Elimination

Another way to explain the relative importance of the components of GPI is to exclude the component and note how much the GPI outcome changes. The question here is "if this component were eliminated or brought to zero, what happens to GPI?" Table 3.2 shows the percent increase or decrease to U.S. average GPI after specific indicators are zeroed out.

Table 3.2 Percent Change to U.S. Populations Weighted Average GPI of Component Exclusion

Eliminated Sub-indicator	Rank	Percent change in GPI if this cost/benefit were eliminated?
Cost of Nonrenewable Energy Resource Depletion	2	47% increase
COST of Inequality	3	46% increase*
Benefits of Housework	4	40% decrease
Benefits of Consumer Durables	5	36% decrease
COST of Motor Vehicle Crashes	6	30% increase
Benefits of Higher Education	7	23% decrease
COST of Consumer Durables	8	21% increase
COST of Climate Change	9	14% increase
COST of lost leisure time	10	13% increase
COST of Ozone Depletion	11	12% increase
COST of Underemployment	12	8% increase
COST of Commuting	13	8% increase
Benefit Net Capital Investment	14	5% decrease
COST of Net Farmland Change	15	4% increase
Benefits of Highways and Streets	16	4% decrease
Benefits of Volunteer Work	17	3% decrease
COST of Crime	18	1% increase
COST of Personal Pollution Abatement	19	1% increase
COST of Net Forest Cover Change	20	1% increase
COST of Family Changes	21	1% increase
COST of Water Pollution	22	1% increase
COST of Noise Pollution	23	1% increase
COST of Air Pollution	24	0% change
COST of Net Wetland Change	25	0% Change

* This component is calculated as a 'change in inequality' from a baseline; therefore, this result reflects "no change" from the baseline rather than "zero inequality." If one were to use a Gini of '0' to reflect complete equality, the formula would require us to divide by zero.

For the top 10 highest components, GPI changed by large percentages when each was eliminated – the GPI is highly sensitive to these components contributions. For example, if the cost of nonrenewable energy resource depletion were brought down to zero (or the component were simply cut from the GPI calculation) average U.S. GPI would increase by 47%. If the benefits of housework were not included, the GPI would decrease by 40%. On the lower end, if we eliminated the cost of air pollution, the GPI would not change by a noticeable percentage.

This exclusion or elimination sensitivity test reveals what happens to GPI if a state manages to lower a cost component down to zero – eliminating air pollution, for example. It shows that eliminating or zeroing crime, personal pollution abatement, forest change, family change, water pollution, noise pollution, air pollution, and wetland change each would only increase the GPI by 0-1%. Though we do not know the per unit cost of 'zeroing' these components, doing so would impact at state's GPI negligibly, essentially highlighting the concern of "whether any essential property for the problem being tackled has been lost" (OEDC, 2008, p. 52). On the other hand, looking 20 to 50 years into the future would focus on reducing nonrenewable resource depletion, inequality, motor vehicle crashes, climate change, and lost leisure while increasing housework and higher education (the most significant components of GPI) be the most desirable path to sustainable human welfare?

3.3.3 Applying Different Assumptions

When designing a composite indicator, the designer must make choices as to not only what components to include or exclude, but also the variables and valuations or weights that build the selected components. These choices manifest as embedded assumptions and depending on the choices made may contribute to sources of uncertainty in the indicator outcome. For example, a change in dollar valuation (weight) could change the rank of components and also the value of the GPI outcome. Also, several environmental indicators use baseline assumptions from which to calculate the loss of various environmental resources. The sensitivity of GPI to these assumptions, particularly among the larger components, is critical to evaluate. To illustrate, below we test the sensitivity of a handful of key assumptions.

3.3.3.1 Average wage. The average wage rate affects 4 of the 25 GPI components, including cost of underemployment, cost of lost leisure time, cost of commuting, and benefits of volunteer time. Thus, the GPI outcome may be sensitive to the monetary number used to value each of these components, even working in the opposite direction between indicators. For example, a higher wage rate will increase the benefit of volunteer time, but also increase the cost of lost leisure time. However, the aggregate relationship between GPI and wage rate is inverted. If the average wage was increased by 10% across all 50 states, the average U.S. GPI would decrease by 2.5%.

Outside of any countervailing impacts on personal consumption expenditure, consumer durable purchases, and inequality, there is a perverse incentive for policy makers to seek to decrease the average wage to keep certain costs down. This seems like an "internal contradiction" that the OECD handbook warns against when analyzing weights (OECD, 2008, p. 49). Increasing the current federal minimum wage from $7.25 by 10% would result in $7.98. An increase in the current national average hourly wage from \$21.50 by 10% would result in \$23.65 per hour. These increases would likely boost consumption expenditures, but also increase the costs that use average wage rates. Specifically, wages are simultaneously tied to spending power (e.g., PCE) and the opportunity cost of idle time (e.g., underemployment). Any policy analysis would need to consider these countervailing changes. Consideration of the optimal balance of time between positive impacts from work, leisure, family, and volunteer time introduces similar policy dilemmas that GPI brings to light.

3.3.3.2 Cost of inequality. The creators of the pre-cursor to GPI, Daly and Cobb, declared "it is urgent to replace the GNP with a measure that does not encourage the growing gap between the rich and the poor" (1989, p. 379). The original GPI set 1969 as the baseline for an appropriate level of inequality to the US. The year 1969 was the lowest level of inequality in recent U.S. history. The GPI basis for measuring inequality is the Gini Coefficient. A Gini coefficient of 0 reflects full income equality while 1 reflects complete inequality.

In the 50 state GPI study, the cost of inequality is calculated by finding the dividing each 2011 state-level Gini coefficient by the average U.S. 1969 Gini coefficient (0.36). The result from this Gini equation is then used as the denominator an equation with the state PCE to produce an 'adjusted PCE' which is subtracted from the PCE to yield the state's cost of inequality. To test the sensitivity to a higher Gini baseline, the 1999 U.S. Gini of 0.43 was selected. This change drops the component cost of the inequality adjustment from 8.8% of average U.S. GPI to 3.0% (with a fall in rank from 3rd largest component to 8th). Average GPI increases by 31% with this new, more unequal, baseline. To test a change in the baseline in a more equal direction, a lower Gini sensitivity was based on survey research by Norton and Ariely (2011) that suggests Americans prefer inequality levels even lower than the 1969 record, similar to levels in Sweden today. This would be equivalent to setting the baseline value at 0.3, resulting in a nearly 26% decline in average GPI, raising the component's share of GPI to 13.1%, and increasing its rank to number 2.

The choice of baseline is an important precept for GPI, especially if it is meant to demonstrate a socially desirable or sustainable level of inequality. A state or nation could incur zero cost of inequality if there was no change from the 'base year' inequality. It is also possible to produce a negative cost (or a benefit) if the state has less inequality than the baseline. Therefore, a more descriptive name for the indicator would be "cost of the change in inequality since 1969 levels". Also, since each state's Gini coefficient is compared to a national baseline, there may be a case for developing individual state baselines or goals. In addition, a focus only on income inequality obscures other manifestations of inequality, such as gender or racial inequality. For instance, the Gini can decrease, but the gendered difference in income may increase at the same time.

3.3.3.3 Cost of climate change. As shown in chapter 4, the cost of climate change component inversely correlates with the GPI at a rate of 0.79 and is the third most variable component amongst the 50 state estimates. It also falls into the top nine most quantitatively significant components, with average U.S. GPI increasing by 14% if the cost of climate change is decreased to zero. Sensitivity analysis for this component is also important due to variability in estimates of the social cost of carbon. The current study uses a level of $128/tonne, which is the mean value from a 2005 meta-analysis of 103 separate studies (Tol ,2005).

To test the sensitivity of the social cost of carbon, on the low end, consider recent prices of carbon on the European Union at $10 per ton or the mid-range of the White House 2013 cost estimates of $40 per tonne (Whitehouse, 2013). The market prices of $10/t results in average GPI increasing by 13% and dropping the relative rank of the component from 9th to 21th. At $40/t, average GPI increases by 9.9%, ranking as the14th most significant component. If the primary policy lever to address climate change is by reducing demand for fossil fuels, it is possible that a significantly higher carbon price will be required. This may lead the GPI to using an expected price of carbon rather than current price. A recent study published in *Nature* applied a social cost of carbon of $220 per tonne (Moore & Diaz, 2015). Applying this price, the GPI decreases by 10% and the component rank moves up to 7. Agreeing a consistent carbon price expectation in GPI could be a politically charged topic amongst U.S. states, with this one factor potentially blocking any adoption of GPI amongst many state legislatures and governors.

An argument can be made that this is a low estimate given only energy related CO2 emissions are currently included, ignoring the costs of other greenhouse gas emissions including those from livestock and agriculture. Taking this into account, on the emission quantity side of the cost calculation, consider scaling up emissions by a factor of 1.2 to account for EPA estimates that CO2 is 80% of total greenhouse base emissions (EPA, 2016). This sensitivity decreases average GPI by 3.6% and maintains the relative ranking of the component at 9th.

The sensitivity of the cost of climate change can also be explored by changing the mix of fuels between coal, oil, natural gas, biomass, and renewables. However, changing fuel mixes would also influence other GPI components, including the cost of nonrenewable resource depletion and air pollution. Finally, the cost of climate change is currently framed as an external cost on the world, not the particular state where the emissions occur. An alternative formulation would be to base costs on state-specific impacts or vulnerability from climate change, bringing the benefits of climate policy action closer to home.

3.3.3.4 Cost of nonrenewable resource depletion. The cost of nonrenewable resource depletion is the second highest quantitative contribution to average GPI and the component with the most variation across the 50 states (Chapter 4). Removing this one cost would increase the GPI by 47%. It is calculated using replacement cost estimates for nonrenewables used inside and outside the electric sector based on Makhijani's (2007) report "Carbon-Free and Nuclear Free." When Daly and Cobb (1989) first conceptualized this component they choose to have the replacement cost for nonrenewables increase by 3% each year, reflecting a growing scarcity cost of nonrenewable depletion. However, the replacement cost of renewable energy technologies has declined substantially over the last decade and is expected to continue declining with anticipated technological advances (e.g., IPCC, 2011).

To test the sensitivity of GPI to lower replacement costs, consider the 2015 barrel equivalent cost of wind energy (the least expensive renewable energy in 2015) as a proxy for the cost of replacing nonrenewable energy depletion with a renewable alternative (assuming electricity as the low cost alternative for transportation fuels). This cost of renewable replacement of a barrel of oil is $33 less than the original cost, the kwh replacement cost is $0.05 less resulting in a 13% increase in GPI. This change drops the quantitative significance of this component from the second highest contributor to average GPI to the fifth highest contributor. Therefore, while this component is significant now, if the calculation is modified to reflect current market prices of renewable replacements for nonrenewables, it will become less material. While this observation runs counter to the original logic of including this indicator (to reflect growing scarcity or rent costs), the observed reduction in replacement cost is a real phenomenon, and it would be appropriate for the GPI to reflect that fact.

As with the cost of climate change, another sensitivity choice for this component could be modifying the energy mix to see how this potentially policy driven change could affect GPI and other GPI components. Finally, this component could be modified based on implementing a state-level boundary related to extraction; in this formulation the component's foundation would be based on production/extraction of nonrenewables rather than consumption based. As Bagstad, Berik, & Gaddis (2014) state, "The external benefits and costs of production are felt mostly in the state where extraction occurs and should therefore be counted using the same boundary condition."

3.3.3.5 Cost of motor vehicle crashes. The cost of motor vehicle crashes is the component that correlates most closely with average GPI (0.85). It is also the most variable social component and falls into the top 6 most quantitatively significant contributors to GPI. Without the cost of motor vehicle crashes included, GPI would increase by 30%. It is also a challenging component to vary because the costs of fatalities, injuries, and property damage may be more fixed based on insurance claims than other weights. Therefore, consider a sensitivity to the number of crashes that resulted in these costs. A reduction by 50% would increase GPI by 15%, and reduce its rank from 6 to 8 among components. The policy implication would be to reduce the rate of car accidents as well as the resulting cost (fatality, injury, property damage) by adopting new car technologies (e.g., self-driving cars), implementing safety measures (as done in the past by requiring seat belts and airbags), changing speed limits, or investing in law enforcement.

3.3.3.6 Benefit of household labor. If the benefits of household labor as it is calculated currently were to be eliminated, the average U.S. GPI will drop by 40%. This is the highest ranked social component in terms of contribution to GPI. It is also the 5th most variable component among states. Consider a sensitivity analysis of assumptions in response to two economic concepts. One is a feminist economics response to household labor being valued at the "feminine" wage associated with "maids" as opposed to the "masculine" janitor's wage. The other is the idea that household labor results in an opportunity cost for the individual (operationalized as the average wage) rather than the cost of paying the market rate for another individual to perform the labor. It is notable that many of the other hourly rated social components (underemployment, commuting, and leisure time, volunteer hours) use the average wage rate.

Using the higher janitor's wage to value household work, the average GPI increase by 5.9%. Using each state's average wage rate, the GPI outcome increased by

44%. Clearly valuing this work at the low maid wage leads to it not being considered as valuable as volunteer time or leisure time. GPI would be 44% higher if all three of these options for spending time were valued as equally important to sustainable human welfare.

On the quantity side of the valuation, one way to increase this component would be to increase the number of hours spent on housework. However, there are clear gender equity implications to such a shift. Women's entry into the workforce led to a decrease in hours spent on housework; for example "as families shift to preparing meals that require less time or eating out to a greater extent, cleaning house less frequently, placing their children in daycare" (Berik & Gaddis, 2011, p. 38). Consequently, an increase in women's workforce participation would be counted as a negative development in the GPI indicator and policies that support women's workforce participation, like publicly subsidized childcare costs, may be viewed negatively through the GPI policy. However, since GPI endeavors to capture trade-offs in monetary terms, the increase in workforce participation would increase incomes and PCE, perhaps offsetting the decrease in household work.

3.3.4 GPI's Sensitivity to Percent Change

A final framing for sensitivity analysis is to test for the percent change in the outcome when each component changes by a consistent percent. Rather than assessing the impact of specific and variable weighting or valuation assumptions, this test systematically compares how sensitive the GPI outcome is to the uniform percent changes in components. In order to reveal any notable change in GPI, the components were increased by 10%.

Table 3.3 *Percent Change to U.S. Populations Weighted Average GPI of 10% Increase Component*

Component Increased by 10%	% Change in GPI
Personal Consumption Expenditures	16.6%
Cost of Nonrenewable Energy Resource Depletion	-5.0%
Cost of Inequality	-4.8%
Benefits of Housework	3.8%
Benefits of Consumer Durables	3.5%
Cost of Motor Vehicle Crashes	-3.1%
Benefits of Higher Education	2.2%
Cost of Consumer Durables	-2.1%
Cost of Climate Change	-1.5%
Cost of Lost Leisure Time	-1.3%
Cost of Ozone Depletion	-1.2%
Cost of Underemployment	-0.8%
Cost of Commuting	-0.8%
Net Capital Investment	0.5%
Cost of Net Farmland Change	-0.4%
Benefits of Highways and Streets	0.4%
Benefits of Volunteer Work	0.3%
Cost of Crime	-0.1%
Cost of Personal Pollution Abatement	-0.1%
Cost of Net Forest Cover Change	-0.1%
Cost of Family Changes	-0.1%
Cost of Water Pollution	-0.1%
Cost of Noise Pollution	-0.1%
Cost of Air Pollution	0.0%
Cost of Net Wetland Change	0.0%

The outcome of this test is that GPI is most sensitive to a percent change to PCE which is an economic component. However, the following two most sensitive components are an environmental component (Cost of Nonrenewable Resource Depletion) and a social component (Cost of Inequality) which illustrates that the GPI outcome is sensitive to all three pillars of sustainability. Therefore, according to this test (which does not take into consideration the cost of marginal increases) in order to increase GPI it may be recommended to focus on increasing PCE, decreasing the use of nonrenewable resources, and decreasing income inequality. This test further emphasizes the lack of impact of many of the components through demonstrated that a 10% change in those components does little to affect GPI.

3.4 Discussion

The sensitivity analysis leads to takeaways related to data parsimony, the potential for unintended policy consequences, gender equity implications, and national versus state assumptions. All of these insights could spur methodology improvements for an updated GPI, GPI 2.0. Ultimately, the study recommends following the OECD guidelines of adopting clear inclusion and exclusion criteria for components as well as conducting a thorough assessment of possible values for weights or variables.

With “fitness of use” being a primary goal of a quality composite indicator according to the OECD, it is important to inquire about whether the amount of data used in the GPI is necessary. High levels of data are expensive and time consuming and may deter adoption, so understanding the marginal effect on GPI of some indicators may suggest opportunities for data parsimony. Also, it may not be worth the effort (time, money, energy) for legislators to eliminate component costs that would not change GPI by significantly.

Another take away that considers the user perspective is to question the possible unintended policy consequences of the current design. One example is that a relatively small increase to the wage rate used for several components leads to a substantial decrease in GPI. However, without a comprehensive, predictive GPI model that considers the relationship between wage increase on all other components (e.g., PCE, inequality), this could lead to the inadvertent outcome of not adopting policies to increase the minimum wage. While wage rate is an area where policy can have a clear impact, it is notable that some indicators may not empower policy change based on the available choices embedded in the component calculations. For example, to reduce the cost of family change with the current methodology, the only alternatives for policy makers are to seek policies that decrease the number of divorces (or, inversely, marriages) or decrease the number of television viewing hours – neither of these options are straightforward to legislate on.

A third takeaway involves other dimensions of equity that current GPI methodology ignores, such as gender dimensions. For example, the value of housework was included in the GPI to demonstrate the importance of caring labor in producing a sustainable society, and to be more explicit about the trade-off between valued workplace work and unvalued household work. However, the idea that housework hours are weighted or valued at the gendered maid's wage not only indicates a built in bias but also indicates that this caring labor is still not as valuable as volunteer time or leisure time which are both weighted by the average wage. This directly addresses the objection raised about composite indicators of the "arbitrary nature of the weighing process" (Sharpe, 2004). Based on how caring labor is valued in the GPI it can also be interpreted that an increase in women's workforce participation which accompanies a decrease in caring labor hours would be counted as a negative development. Might this lead to policies that encourage women to stay home rather than alternative policies that provide care for families but are valued at the average wage? Metrics can be viewed as prescriptive of policy options, therefore, it may be argued that an indicator of genuine progress and sustainability ought to directly reward states that achieve more gender equality.

Finally, the GPI offers policy makers opportunities to create policies that affect both the weights (monetary values) and the variables (hours spent volunteering, tons of carbon, acres of farmland). Yet, in practice if national weights are used for a state level policy lever, this disempowers the state legislators as it will not reward their action on the topic. However, policies that affect the weights may be easier to achieve and to design than policies that affect the variables like the number of hours spent commuting, volunteering, experiencing leisure, or being underemployed.

3.5 Conclusion

This study scrutinized the quality of GPI as a composite indicator for sustainable human welfare by testing how sensitive GPI outcomes are to valuation and variable assumptions embedded in the component calculations. Investigating the sensitivities led to revealing possible unintended policy consequences of the design that are compounded by the fact that GPI is not a simple linear model. In "the real world," some of the alternative values or variables also impact other components in the GPI. These effects can be captured after-the-fact by GPI; however, it is possible to use GPI estimates as a leading indicator through building predictive econometric models akin to those developed for GDP. So formulated, the GPI could be considered an optimization model which, while more complex and less easy to predict than GDP, would be more suitable for designing holistic policy that considers social, environmental and economic characteristics.

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CHAPTER 4: ASSESSING GPI'S EFFICIENCY AND EFFECTIVENESS

4.1 Introduction

A growing number of composite sustainability and well-being indicators are being used to compare country performance. At least since the World Commission on Environment and Development's report on "Our Common Future" (1987) – the "Brundtland report" – sustainability has been an important lens for policy development, analysis, and communication. The dominant composite indicator that is used to understand policy impacts and as a barometer of human welfare for the public is GDP. However, GDP was not designed to gauge the sustainability of the economy, nor as a complete measure of human welfare. Many researchers have described in detail GDP's shortcomings as a well-being indicator including England (1998), Talberth (2008), Costanza et al. (2009), Van den Bergh (2009), and Stiglitz and Fitoussi (2010).

An often cited alternative designed to be comparable to GDP is the Genuine Progress Indicator (GPI), created to assess the impact of conventional economic growth on sustainable human welfare. GPI addresses broader dimensions of sustainable economic welfare then consumption alone by aggregating 25 monetarized economic, social, and environmental benefits and costs of economic activity. While GPI and its pre-cursor, the Index of Sustainable Economic Welfare (Daly & Cobb, 1989), have been estimated for dozens of nations and sub-national territories over the last 25 years, there has been little evidence of uptake by policy-makers or governments. The few exceptions include U.S. states that have instituted GPI metrics by executive action (Maryland) or by law (Vermont).

A community of practice has emerged through the years, including academics, non-profit organizations, and sub-national governments, with a self-critique of the choice of metrics and methods that underlie GPI (e.g., Dietz & Neumayer, 2006; Clarke, 2007; Lawn, 2003; Lawn, 2005; Neumayer, 1999; Talberth, Cobb, & Slattery, 2007). Neumayer (1999), Dietz and Neumayer (2006) and Bleys (2007) have expressed criticism of GPI's statistical analytic rigor which challenges the legitimacy of GPI as an evenhanded and high quality metric leading to questions of its viability as an alternative for GDP. If the goal is for GPI to become a legitimate, widely accepted central metric for success, then it must have a reputation for being statistically rigorous and transparent. Another barrier to uptake is the large amount of multi-dimensional data required, spanning the missions of multiple data collection efforts by states and nations. Therefore, data parsimony and streamlining may entice both the data crunchers and policy makers who are left to interpret the outcomes.

Ultimately, the question is whether GPI as a composite index is operationalizing sustainable human welfare both efficiently and effectively. This study aims to answer the question of both efficiency (data parsimony) and effectiveness (comparatively to other indicators) by applying recommendations from a handbook of the Organization for Economic Cooperation and Development (OECD) which provides "a set of technical guidelines that can help constructors of composite indicators to improve the quality of their outputs" (OECD, 2008). This research focuses primarily on descriptive statistics, general multivariate analysis, analysis of variance of both the overall GPI as well as the

25 components in order to evaluate whether the GPI can be simplified, where double-counting may be a problem, and what other indicators track well with GPI.

4.2 Methods

The foundation of this paper is an estimate of the GPI for all 50 U.S. states for 2011, summarized in Chapter 2. The Vermont/Maryland methodology was followed to calculate these results (Constanza et al., 2004; Posner & Constanza, 2011). The formulas for each environmental and social sub-indicator lent themselves to using varied state and federal data sets and mixed methods drawing from environmental economics (e.g., pollution, climate change), natural resource economics (e.g., depletion costs), and various heterodox approaches to other social and economic adjustments. Availability of data for each formula was a limitation of the process, but state level data was used whenever available, and national data or regional data was adjusted by state population if necessary. This data set provides 50 case studies utilizing a uniform methodology allowing for statistical exploration of the overall structure of the GPI and its 25 components.

A useful framework for evaluating the quality of composite indicators is the 2008 OECD "Handbook on Construction Composite Indicators: Methodology and User Guide." The handbook provides a step-by-step process to evaluation, including guidelines for quantitative assessment such as descriptive statistics, general multivariate analysis, analysis of variance, robustness tests, and sensitivity analysis. While recommending particular analysis, the OECD Handbook also cautions, "Analyzing the underlying structure of the data is still an art" (OECD, 2008, p. 25).

The statistical tests are divided into two groups based on how the data are parsed. First, U.S. population-weighted averages of 50 state data are used to explore component-to-component correlations to address the concern of 'double counting'. Then, estimates of GPI for each of the 50 states are used to calculate Spearman's correlations with components, GPI forward stepwise regression, component variation, component state outliers, and component cluster analysis to identify linkages between components and GPI outcomes in the context of state-to-state comparisons.

Finally, the OECD handbook emphasizes the value of possible revelations revealed through comparisons with other published indicators because "the credibility of the indicator can benefit from its capacity to produce results which are highly correlated with the reference data" (2008, p. 49). Therefore, the 50 GPIs are compared with other state-level indicators such as the Gallup Well-Being Indicator, Ecological Footprint, and UN Human Development Index to answer some important macro-level questions about whether GPI correlates with other metrics of well-being and sustainability.

4.3 Results

4.3.1 Component Correlations

According to the OECD Handbook, in order to maintain a high quality composite indicator, "Correlation and compensability issues among [components] need to be considered and either be corrected for or treated as features of the phenomenon that need to retained in the analysis" (2008, p. 15). The Handbook warns that components with high correlations *may* indicate double-counting as correlation is a measure of the linear relationship between two variables or the degree to which variables move together.

Therefore, it is necessary to examine the nature of those components that are highly correlated. Acknowledging that there will almost always be some correlation between different measures in the same index, the OECD recommends the use of a test 'threshold' for correlations beyond which the components should be examined for potential 'double counting.' A high correlation may result from an intentional design choice related to the measured phenomenon (here, sustainable human welfare) in which case those components do not need to be deleted or be calculated differently.

One risk of excluding components simply because they are highly correlated is that correlation merely indicates that the variation in the two data sets is similar – not that a change in one necessarily leads to a change in the other. Therefore, a policy action could lead to a divergence in the components that would preclude them from moving together. Exclusion of a component for 'double counting' concerns is not unprecedented in the GPI; however, it has not been statistically driven. The Ohio and Utah GPI studies addressed perceived double-counting by excluding benefits of higher education from their GPI calculations because "the personal consumption component of GPI already includes tuition payments and, to the extent that college education contributes to higher earnings, it is also reflected in higher personal consumption levels" (Bagstad, Berik, & Gaddis, 2014, p. 480).

Figure 4.1 provides the correlations between the components of the U.S. population weighted GPI. If the correlation threshold for testing for possible double counting were set above 0.8, sixteen relationships (highlighted below) would have to be addressed – five of which are high correlations with PCE and five of which are high correlations with benefits of consumer durables. This represents only 5% of the possible component correlations. One critical purpose of attending to these correlations is to tackle the possible criticism that “individual indicators are sometimes selected in an arbitrary manner with little attention paid to the interrelationships between them” (OECD, 2008, p. 25).

	Genuine Progress Indicator	Personal Consumption Expenditures	Cost of Inequality	Benefits of Consumer Durables	Cost of Consumer Durables	Cost of Underemployment	Net Capital Investment	Cost of Water Pollution	Cost of Air Pollution	Cost of Noise Pollution	Cost of Net Wetland Change	Cost of Net Farmland Change	Cost of Net Forest Cover Change	Cost of Climate Change	Cost of Ozone Depletion	Cost of Nonrenewable Energy Resource Depletion	Benefits of Housework	Cost of Family Changes	Cost of Crime	Cost of Personal Pollution Abatement	Benefits of Volunteer Work	Cost of Lost Leisure Time	Benefits of Higher Education	Benefits of Highways and Streets	Cost of Commuting	Cost of Motor Vehicle Crashes
Genuine Progress Indicator	1.00																									
Personal Consumption Expenditures	0.56	1.00																								
Cost of Inequality	0.22	0.54	1.00																							
Benefits of Consumer Durables	0.49	0.85	0.54	1.00																						
Cost of Consumer Durables	0.42	0.83	0.41	0.95	1.00																					
Cost of Underemployment	0.56	0.48	0.52	0.48	0.28	1.00																				
Net Capital Investment	0.02	0.01	0.08	0.03	0.02	0.07	1.00																			
Cost of Water Pollution	0.22	0.15	0.03	0.10	0.06	0.08	0.01	1.00																		
Cost of Air Pollution	-0.27	-0.20	0.17	-0.06	-0.07	0.18	0.10	-0.07	1.00																	
Cost of Noise Pollution	0.37	0.41	0.47	0.46	0.37	0.64	0.07	0.26	0.29	1.00																
Cost of Net Wetland Change	-0.51	-0.05	0.27	-0.07	-0.16	-0.07	0.02	0.02	0.13	0.07	1.00															
Cost of Net Farmland Change	-0.30	-0.33	-0.37	-0.34	-0.32	-0.33	-0.03	-0.05	-0.20	-0.55	0.22	1.00														
Cost of Net Forest Cover Change	-0.19	-0.18	-0.15	0.02	0.00	-0.13	-0.01	-0.06	-0.07	-0.40	-0.22	0.32	1.00													
Cost of Climate Change	-0.63	-0.22	-0.42	-0.21	-0.01	-0.53	-0.04	-0.23	0.09	-0.37	-0.20	0.04	0.25	1.00												
Cost of Ozone Depletion	-0.04	-0.04	0.00	-0.02	-0.02	-0.03	0.01	-0.03	0.01	-0.02	-0.01	0.04	0.03	0.04	1.00											
Cost of Nonrenewable Energy Resource Depletion	-0.60	-0.23	-0.41	-0.19	0.01	-0.52	-0.04	-0.23	0.10	-0.36	-0.26	0.02	0.29	0.99	0.04	1.00										
Benefits of Housework	0.58	0.71	0.44	0.64	0.57	0.58	0.02	0.14	-0.21	0.43	-0.10	-0.34	-0.13	-0.32	-0.07	-0.32	1.00									
Cost of Family Changes	-0.19	-0.39	-0.39	-0.37	-0.37	-0.23	-0.05	-0.05	0.06	-0.48	-0.28	0.07	0.34	0.32	-0.01	0.31	-0.28	1.00								
Cost of Crime	-0.25	-0.37	0.15	-0.30	-0.35	-0.04	0.02	0.02	0.33	0.09	-0.10	-0.19	0.07	0.08	0.02	0.15	-0.34	0.14	1.00							
Cost of Personal Pollution Abatement	-0.04	0.27	-0.06	0.21	0.26	0.10	0.00	0.15	-0.02	0.28	0.07	-0.12	-0.11	0.21	-0.04	0.18	0.22	-0.03	-0.13	1.00						
Benefits of Volunteer Work	0.64	0.84	0.59	0.87	0.79	0.70	0.05	0.11	0.02	0.58	-0.20	-0.42	-0.03	-0.33	-0.03	-0.31	0.71	-0.38	-0.21	0.09	1.00					
Cost of Lost Leisure Time	0.56	0.83	0.31	0.89	0.91	0.37	0.01	0.06	-0.11	0.37	-0.20	-0.25	-0.04	-0.14	-0.02	-0.13	0.56	-0.37	-0.45	0.16	0.85	1.00				
Benefits of Higher Education	0.58	0.84	0.47	0.82	0.77	0.46	0.01	0.11	-0.15	0.37	0.07	-0.20	-0.22	-0.43	-0.04	-0.43	0.57	-0.44	-0.46	0.08	0.81	0.87	1.00			
Benefits of Highways and Streets	-0.34	-0.14	-0.40	-0.27	-0.03	-0.64	-0.06	-0.11	-0.22	-0.47	0.02	0.29	-0.13	0.52	0.02	0.48	-0.34	0.10	-0.14	0.28	-0.49	-0.14	-0.24	1.00		
Cost of Commuting	0.51	0.75	0.65	0.84	0.74	0.61	0.06	0.13	0.08	0.59	0.00	-0.43	-0.05	-0.40	-0.04	-0.37	0.67	-0.45	-0.14	0.04	0.91	0.76	0.77	-0.55	1.00	
Cost of Motor Vehicle Crashes	-0.77	-0.57	-0.37	-0.63	-0.49	-0.64	-0.04	-0.22	0.09	-0.59	0.07	0.28	0.17	0.66	0.03	0.65	-0.63	0.40	0.37	0.02	-0.71	-0.65	-0.68	0.55	-0.69	1.00

Figure 4.1 Component to Component Correlations

Some high correlations are an artifact of the multi-dimensional nature of GPI and the reliance on clusters of similar data. For example, a handful of components are calculated using the state population: cost of water pollution, net capital investment, cost of ozone depletion, benefits of housework, cost of family change, cost of personal pollution abatement, cost of air pollution, and benefits of volunteer work. And some components use the same weighting or valuation mechanism, for example, cost of underemployment, cost of lost leisure, cost of commuting, and benefits of volunteer time all use the state's average wage rate. This is appropriate in the case of GPI because the relative importance of each component, or weight, is represented by the size marginal monetary additions of costs and benefits.

With a correlation of 0.84, the relationship of the benefits of higher education component and the PCE is highlighted for further examination by the double counting test threshold. As the Ohio and Utah GPI studies point out, there is also a connection between the benefits of higher education component and higher PCE. Therefore, removing the higher education component is an example using both the statistical correlation test and then deeper dive into understanding the relationship to eliminate a component.

The relationship between the costs and benefits of consumer durables is another one pulled forward by the double counting test threshold with a high correlation of 0.95. However, this is an intentional compensation feature of GPI since one is a cost and the other a benefit. It may be possible to reduce the number of components by combining these two components into one aggregate consumer durables component.

The highest correlation is 0.99 between the cost of non-renewable energy depletion and cost of climate change. One reason this correlation is high because the foundation of both is non-renewable energy data, including coal, natural gas, and petroleum consumption. But, since each is measuring a separate cost – one a pollution cost and the other a depletion cost – and this can be regarded as an intentional feature of a design. A way to avoid counting two almost identical components twice would be to address the cost of climate change differently, as Bagstad et al. (2014) suggest, “If the costs of extreme events, natural disasters, and water scarcity are included as separate components, the climate change costs component may need to be revised” (p. 481).

4.3.2 GPI Correlations with Components

Another way to explore the data in order to understand what is driving the GPI results is to explore which components of the 50 states correlate highly or minimally with that state’s GPI results. To investigate, Spearman’s correlation was used to compare the rankings of variables, and thus less affected by outliers. Table 4.2 provides the Spearman’s coefficient measure on rank order or how closely the GPI ranking of a state correlates with each state’s ranking for the tested component. State GPI rank correlates most closely with state motor vehicle crashes with a spearman’s coefficient of 0.8493. The following eight component ranks correlate with state GPI rank at an absolute value of 0.7 or higher: Cost of Climate Change, Benefits of Personal Consumption Expenditure, Cost of Non-Renewable Resource Depletion, Benefits of Housework, Benefits of Higher Education, Benefits of Volunteer Work, Cost of Commuting, Cost of Lost Leisure Time.

Table 4.1

GPI Spearman's Correlation with Components

Component	Correlation
Cost of Motor Vehicle Crashes	0.8493
Cost of Climate Change	-0.7892
Benefits of Personal Consumption Expenditure	0.7778
Cost of Non-Renewable Resource Depletion	-0.7758
Benefits of Housework	0.7737
Benefits of Higher Education	0.7631
Benefits of Volunteer Work	0.7552
Cost of Commuting	0.7151
Cost of Lost Leisure Time	0.7061
Cost of Underemployment	0.6634
Cost of Net Forest Cover Change	-0.6037
Benefits of Consumer Durables	0.6036
Benefits of Highways and Streets	-0.5472
Cost of Noise Pollution	0.5256
Cost of Net Farmland Change	0.4252
Cost of Crime	-0.4045
Cost of Net Forest Cover Change	-0.2901
Cost of Family Change	-0.2712
Cost of Inequality	0.2230
Cost of Water Pollution	0.1988
Cost of Air Pollution	0.1988
Cost of Personal Pollution Abatement	0.1538

It may be expected that the PCE, as the foundation of GPI, would have the strongest rank order correlation with GPI; however, it only holds the third highest Spearman's coefficient score behind a social component and environmental component. The state rankings for cost of motor vehicle crashes was the most similar to the states' GPI rankings with a notably high Spearman's coefficient of 0.8493. This is because the seven components that most strongly correlate with GPI are the same components that most closely correlate with the Cost of Motor Vehicle Crashes. Might the attributes of social, economic, and environment all intersect in the outcome of cost of motor vehicle crashes? Of the eight component ranks that correlate with state GPI rank at an absolute value of 0.7 or higher, five are social components (Benefits of Housework, Benefits of Higher Education, Benefits of Volunteer Work, Cost of Commuting, Cost of Lost Leisure Time). The cost of climate change and the cost of nonrenewable resource depletion both show up in the top four rank order correlations with GPI. This is not surprising as they are also correlated strongly with each other and have high quantitative significance. For a composite indicator that was designed around the idea that inequality is a problem that ought to be addressed by societal indicators of success – it is striking that the states' ranks for inequality and the state ranks for GPI only have a Spearman's coefficient of 0.2230 – one of the lowest results for the tested components.

4.3.3 Component Outliers

The OCED suggests the extreme or outlier component values should be scrutinized because this can lead to unintended benchmarks. To answer this call, state-level data was used to note all the states for each component that fall over 2-standard deviations away from the mean in both directions – above and below.

Only six components have low outliers (Water, Underemployment, Personal Pollution Abatement, Noise, Forest, and Inequality). While all components barring Water and Noise Pollution have high outliers. Cost of Commuting and Cost of Farmland Change have four outlier states each. The highest outlier of all is Alaska's cost of wetland change which is over 4 standard deviations from the mean and the only state to have a positive contribution to GPI for this component.

Table 4.2

State-level Data Component Outliers

Component	High Outliers (+ 2 SD)	Low Outliers (- 2 SD)
Cost of Water Pollution	None	ME
Underemployment	CA NV	ND
Cost of Personal Pollution Abatement	NV WY	UT
Cost of NonRenewable Resource Depletion	WY, ND	None
Cost of Noise Pollution	None	VT, ME
Cost of Wetland Change	AK	none
Cost of Net Forest Cover Change	AR	NV, UT, NM
Cost of Net Farmland Change	VT, ID, IA, MS	none
Cost of Motor Vehicle Crashes	WY, ND	none
Cost of Lost Leisure Time	MA	none
Cost of Inequality	NY, MA, CT	WY
Cost of Family Changes	AR, OK, WV	none
Cost of Crime	LA	None
Cost Consumer Durables	CT, MA	none
Cost of Commuting	NY, MD, NJ, MA	none
Cost of Climate Change	WY, ND	none
Cost of Air Pollution	CA, TX	none
Benefits of Volunteer Work	MA	none
Benefits of Housework	HI, NY, MA	none
Benefits of Highways and Streets	ND, SD, MT	none
Benefits of Higher Education	MA	none
Benefits of Consumer Durables	CT, NJ, MA	none
Benefits of Personal Consumption Expenditure	MA, CT	none
Cost of Ozone Depletion	NA	NA
Net Capital Investment	NA	NA
GPI	AK	WY

The central concern about outliers is that they may initiate spurious variability to the data or lead to unintended benchmarks. Many of the states that end up ranking on the high end or low end for GPI appear in the list of outlier states. For example, Massachusetts, which ranked 2nd in GPI, appears nine times and Wyoming, ranked 50th in

GPI, appears five times. Certainly, the most concerning outlier is Alaska's cost of wetland change which is over 4 standard deviations from the mean. The method for calculating this component uses a baseline that shows Alaska having increased wetland drastically. Perhaps the baseline needs to be examined or the foundational idea revisited that more landmass could lead to higher scores – an attribute that state policy-makers cannot control. This extreme outlier could also be seen to call for an adjustment in practice of calculating wetland to reflect the services provided to humans by wetlands; many of the wetlands in Alaska are in remote regions.

4.3.4 Component Variability

Components that have the largest variation across states are noteworthy because they explain the differences in states' GPI outcomes. According to the OECD, having components with large variation across case studies (in this case state GPIs) is "a desirable property for cross-country [or state] comparisons" (OECD, 2008). In order to get a snap shot of which components may be responsible for the differences among states, the highest four states and lowest four states for each component were removed with the aim of eliminating outliers that may lead to over estimation of the ranges, or the variance, between the states' results for each component. Removing outlying states to explore variability provides us with more accurate insights into the general structure of GPI. Thus, the results in Figure 4.2 show the variance between 80% of the states' results for each component.

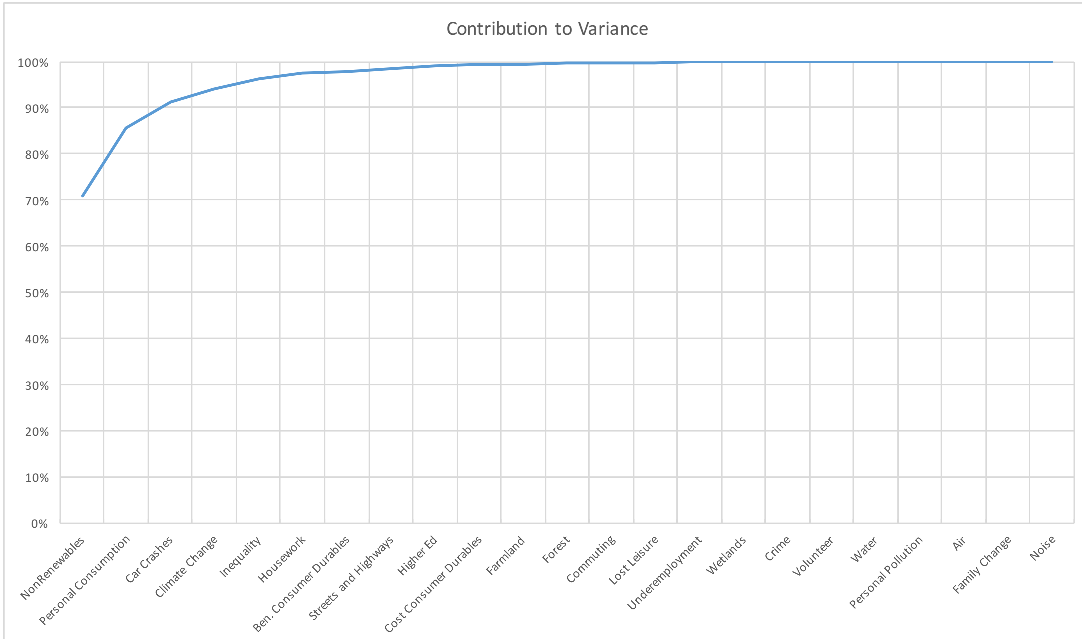

Figure 4.2 Component Contribution to GPI Variance

The clear prevailing component driving the differences between the states is cost of non-renewable resource depletion which is responsible for 70.9% of the variance between the states' GPIs. The next closest component, PCE, only contributes to 14.6% of the variability. With the top three most variable components (cost of nonrenewable resource depletion, PCE, and cost of motor vehicle crashes) accounting for over 90% of the difference between the states' GPIs. Perhaps if data efficiency were prioritized for a longitudinal 50 state GPI comparison study perhaps these three components (one environmental component, one economic component, and one social component) could be used as a quick proxy. However, although they contribute to the most differences between the states it is unclear is state GPI rankings would change if this 'GPI proxy' were calculated using only those three components. Another less drastic option for embracing parsimony in terms of data requirements for a state-to-state comparison would be to remove the seven components that show up as contributing 0.0% to the differences between the states. However, it is critical to highlight that each component that is excluded is an opportunity for a state's policy to affect GPI.

4.3.5 Correlations with Other State-Level Well-Being and Sustainability Indicators

The OECD Handbook suggests that the quality and meaning of composite indicators can also be assessed through comparison with other indicators through simple cross-plots and data-driven narratives. Indeed, testing against other state level sustainability or well-being indicators can test the hypothesis that GPI is a better indicator of sustainable human welfare than GSP and address the question of "whether GNP [GDP] is a satisfactory guide for those who are genuinely concerned to improve human economic welfare" (Daly & Cobb, 1989, p. 377). Here we compare both the GPI and GSP to four other state-level indicators that claim to measure some aspect of sustainable human economic welfare: Gallup Well-Being Index, UN Human Development Index (HDI), life expectancy, and Ecological Footprint. These indicators were selected because they are each available at the state level and because relate to proponents of GPI claim that is a better indicator of sustainable human well-being than GSP due the inclusion of both social and environmental costs and benefits of economic growth. Figure 4.3 summarizes the correlation results with more details for each indicator provided in forthcoming graphs.

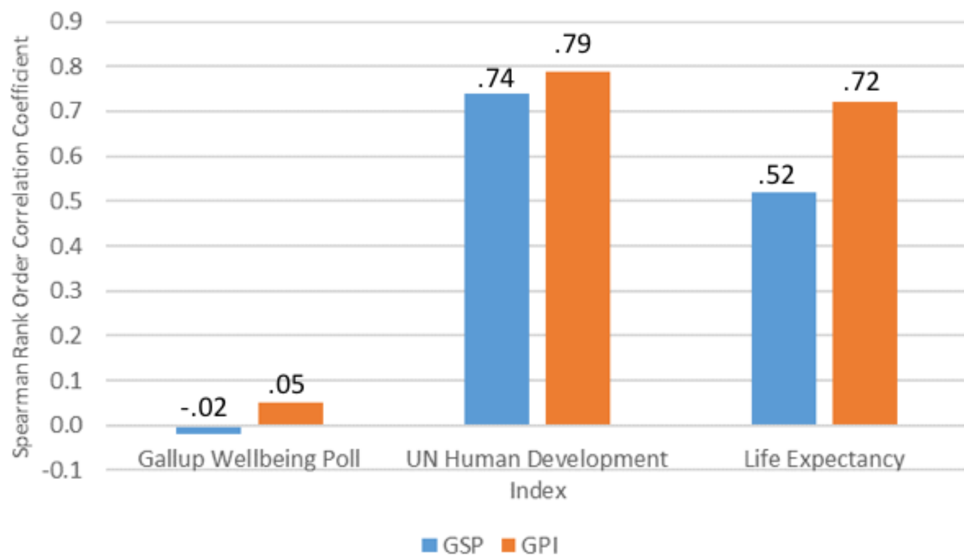

Figure 4.3 Summary GSP and GSP Correlations with Other Indicators

The 2011 Gallup Well-Being Index was created from a survey that asks questions about individuals work environment, emotional health, life evaluation, physical health, health behaviors, optimism and access to safety. Figure 4.4 plots both per capita and rank order of GPI and GSP against the Gallup index. Results indicate no relationship, with correlation coefficients near zero for both GPI and GSP. This result supports the claim that GSP is not a measure of human welfare, however, it does not support the claim that GPI is *better* measure of human welfare than GSP. This lack of correlation may be due to the vast difference in methodology: Gallup index captures a subjective measure of broad well-being based on population surveys, beyond only economic components. As Berik and Gaddis (2011) stated, “It is important to recognize that GPI is not a direct measure of well-being identified by declarations of individuals in surveys” (p. 18). Along that vein, the Gallup index is a strong candidate for testing correlation because it does not use any of the same data sets as GSP or GPI. However, is seems that Gallup's definition of well-being and GPI definition of economic welfare may not align, or perhaps one of them measures the concept well and the other does not.

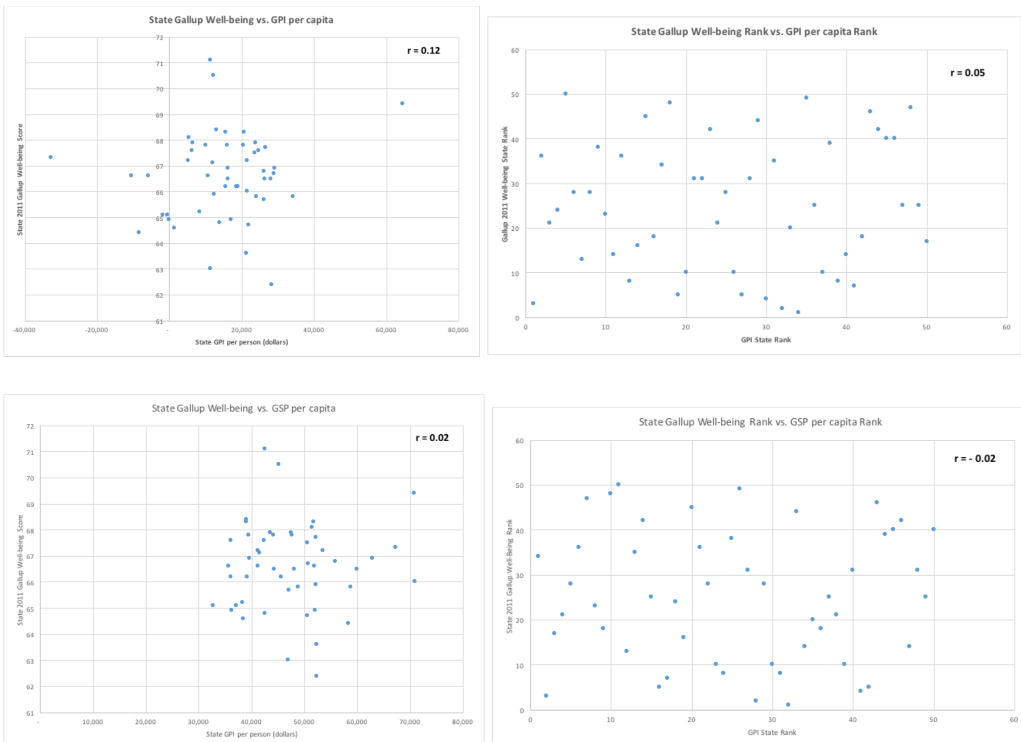

Figure 4.4 State Gallup Well-Being vs. State GPI and GSP

The UN HDI includes life expectancy at birth, mean of years of schooling for adults aged 25 years, expected years of schooling for children of school entering age, and a standard of living dimension measured by logarithm of gross national income per capita. The U.N. Human Development Index is intended to "emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone” (undp.org) which is similar to the GPI’s goal. Similar to questions posed in the GPI literature, the HDI “can be used to question national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes” (undp.org). Measuring the correlation between states’ GPI and states’ HDI results in an r of 0.62 with GSP coming in slightly higher at an r of 0.63. The rank correlation r for GPI versus HDI is 0.79 – GSP is slightly lower at 0.74. The strong relationships are not surprising given both indicators include income. However, a clear difference between the two measures it that HDI does not include environmental factors.

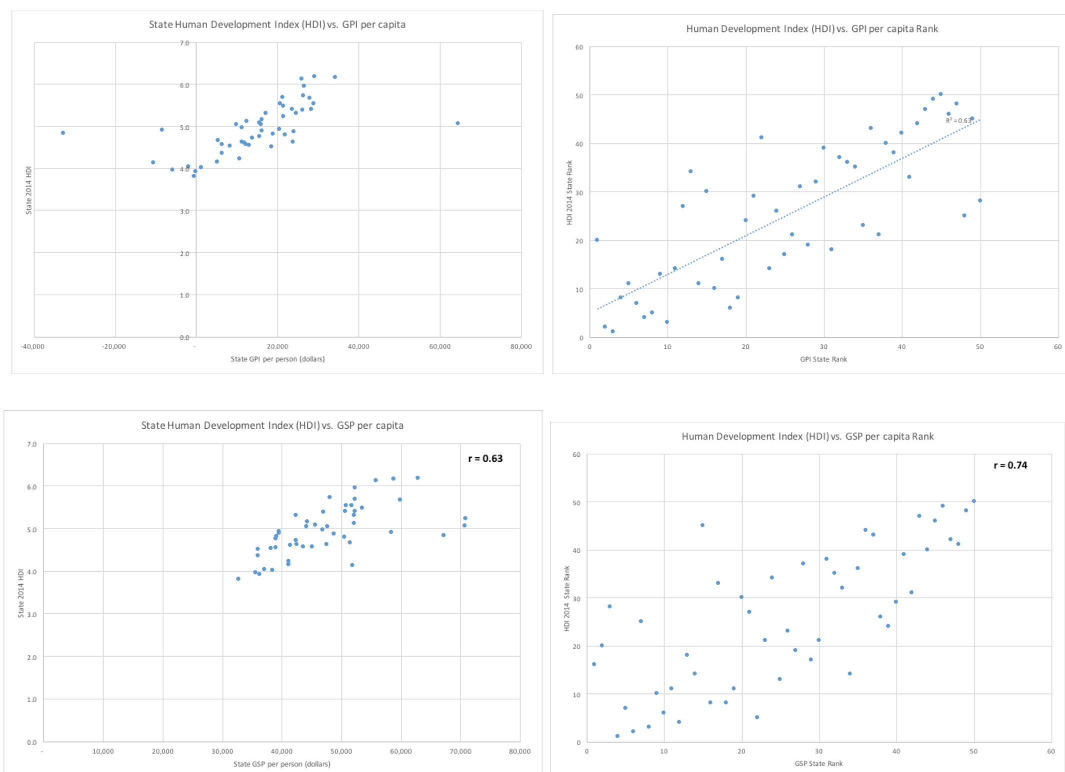

Figure 4.5 State Human Development Index vs State GPI and GSP

Life expectancy reflects the average number of years a newborn is expected to live if current age-specific mortality patterns continue into the future. A higher life expectancy in a state may be thought to indicate higher levels of human welfare as opposed to a state in which humans die younger. Life expectancy in a state and the state's GPI correlate at an r of 0.57 – GSP's relationship is weaker with an r is 0.46. The rank of state's life expectancy compared to the rank of the state's GPI results in an r of 0.72 – GSP's rank r squared is 0.52. The state rank of life expectancy and state rank of GPI is more similar than GSP's state ranking with life expectancy ranking; perhaps this result is related to the inclusion of environmental factors in GPI that ultimately affect human health outcomes.

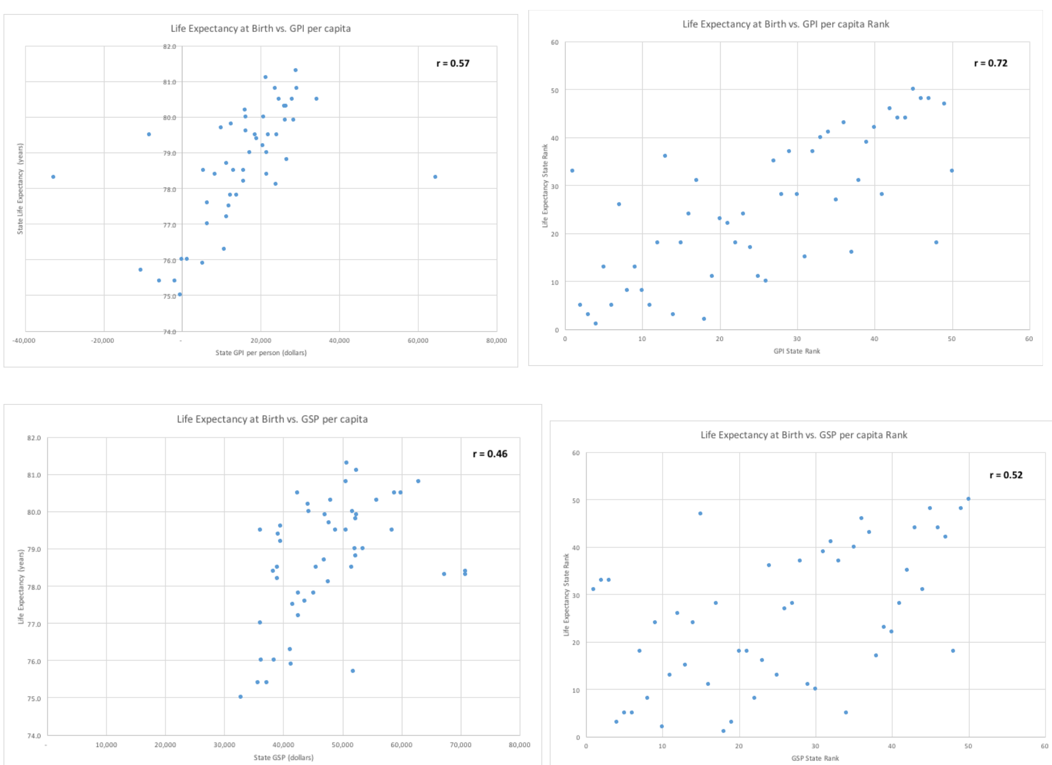

Figure 4.6 State Life Expectancy vs State GPI and GSP

Finally, the state's ecological footprint is intended to be a measure of the sustainability of the state's total consumption of natural resources per person based on the bio-capacity of the state. Since GPI seeks to include components that reflect environmental sustainability of economic growth, ecological footprint is a compelling metric to compare to GPI. The correlation between the state's ecological footprint and the GPI provides a low result of no correlation (r 0.02); while it correlates with GSP at a level of 0.24. The rankings of the states for GPI and ecological footprint also had no correlation (r =0.02) while GSP had a much strong relationship with an r of 0.50.

These results may seem unexpected because the ecological footprint is based on the bio-capacity of the state which is an environmental concept that GPI desires to exemplify. However, the ecological footprint may be viewed as a purer measure of the environmental impact of consumption because it measures the resource requirements of consumption and then compares this to the state's bio-capacity, thus gets closer to assigning "embedded" pollution and depletion costs to the consumer in each state. In fact, Berik and Gaddis (2011) may not find this result surprising as they claim that "the Ecological Footprint is a better indicator of sustainability in terms of total consumption by a population" (p. 18). Since GSP is a direct economic measure of consumption in the state and Ecological Footprint is a purely environmental measure of consumption in the state, it may be logical that they correlate more closely than a more convoluted and holistic collection of components found in GPI.

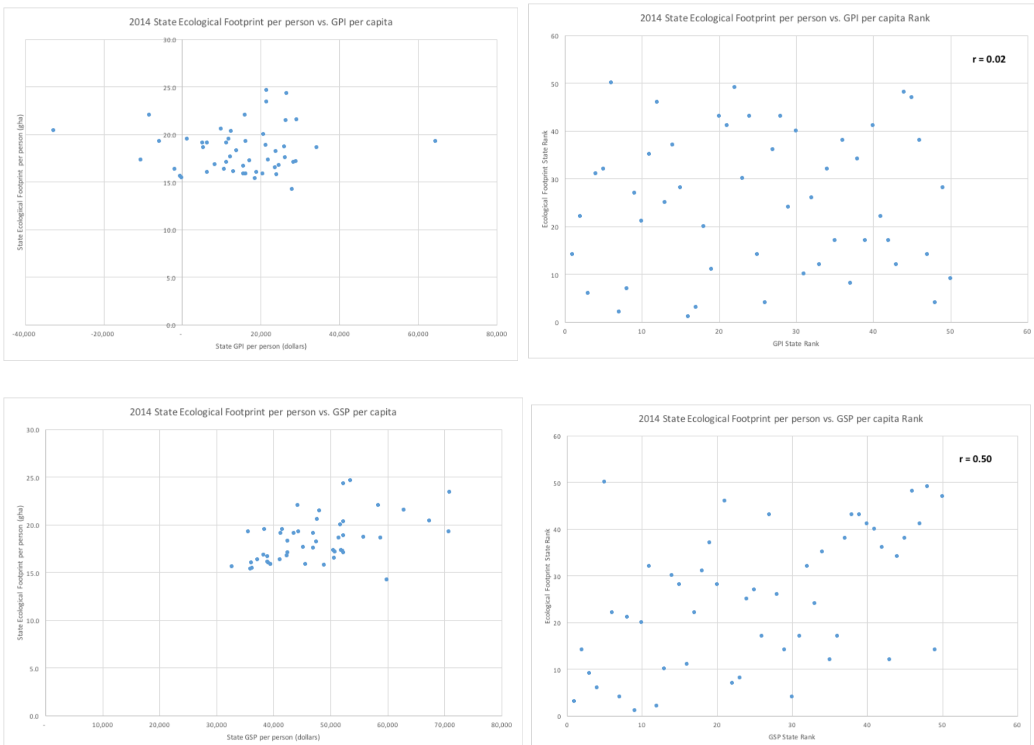

Figure 4.7 State Ecological Footprint vs State GPI and GSP

While the other tests were about prioritization of data needs, double counting, and parsimony, this set of tests is focused on seeking clarity about whether GPI is capturing elements of well-being addressed by other indicators. A question that the GPI may benefit from answering is, "What *do* we expect GPI to positively correlate with?" as, according to OECD, relevance and interpretability of GPI results can be strongly reinforced (or not) by comparison to other appropriate indicators. But the concern is not only whether GPI correlates with various other measures of sustainable human welfare, but also whether GPI correlates with them better than GSP. The GPI literature is peppered with comments that echo this hope, for example Posner and Costanza (2001) affirmed, “GPI is an imperfect measure of full progress, but a significant improvement over GDP as a measure of sustainable human welfare” (p. 1977). However, the results from the correlations in this section call this into question with neither GPI or GSP correlating closely with the Gallup Well-being results and both of them correlating at similar rates to the HDI. The GPI did correlate more strongly with life expectancy than GSP, but it’s relationship with the ecological footprint was considerably weaker.

4.4 Discussion

GPI as an index has largely been used to track the performance of a particular state or nation over time, but this is the first study to compare a large collection of GPI results calculated using an identical method. One of the driving questions in this paper is whether GPI can be simplified for the purposes of state-to-state comparisons. For example, since Cost of Ozone Depletion and Net Capital Investment are calculated by allocating national numbers to the states, they do not contribute differentiating information to the state GPI results and therefore may not need to be included when comparing states. Eight components (Cost of Consumer Durables, Cost of Water Pollution, Cost of Lost Leisure Time, Cost of Crime, Cost of Air Pollution, Cost of Personal Pollution Abatement, Cost of Family Changes, Cost of Noise Pollution) each contribute to less than 1% to the variance between the states. Therefore, it could be suggested that collecting data for these components may not be necessary for the purpose of state-to-state comparisons. However, there may be compelling policy or temporal reasons to include these smaller contributors to GPI.

The cost of nonrenewable resource depletion is highly quantitatively significant and is responsible for 70.9% of the variance of the states' GPIs. When joined by the cost of motor vehicle crashes and PCE, over 90% of the difference between the states' GPIs can be accounted for. Another way this component was highlighted in the statistical tests was in relation to a concern about 'double counting' because it correlated so highly with the cost of climate change (r=0.99.) As a dominant component that shows up in as a stand out in multiple statistical tests, the cost of nonrenewable resource depletion ought to be calculated thoughtfully and accurately and therefore be re-examined by the community of practice.

A critical issue to raise with the community of practice is that the GPI metric does not pass the 'explanatory power' test put forth by the OECD handbook which is essentially viewed as a test of 'effectiveness.' Indeed, the lack of correlation with Gallup Well-Being and Ecological Footprint calls into question whether the GPI is measuring what it claims to measure: sustainable economic welfare. The OECD handbook (2008) asserts that "relevance and interpretability of the results can be strongly reinforced by such comparison" (p. 49); but in this case GPI relevance and interpretability are drawn into question.

It is espoused that because GPI includes environmental and social components GPI is a more accurate tool for gauging welfare than GDP; however, if we consider welfare and well-being to be closely related, the low correlation of GPI and GDP to the Gallup Well Being poll refutes this claim. It turns out that GPI may not be the "significant improvement over GDP as a measure of sustainable human welfare" that

Posner and Costanza (2011, p. 1977) declare. One possible reason that state GPIs may not correlate strong with state Gallup Well-being results is because they are based on different definitions of well-being. However, since the creators of GPI did not provide a clear definition of well-being or welfare, we cannot compare the theoretical foundations of the tools. Indeed, the lack of a clear theoretical framework from which to base the selection of components may responsible for these surprising correlation outcomes.

The OECD suggests that data-driven narratives about the tested composite indicator (GPI) can be created based on positive results, but the narrative supported by the results is that GPI does not correlate closely or more strongly than GSP with other state-level well-being indicators and an indicator that measures bio-capacity consumption. One narrative that may be supported by these results is that GPI rewards states who are able to maintain high consumption, but externalize the cost of that consumption on other states.

4.5 Conclusion

Attempting to measure sustainable economic welfare with one monetary metric may be compared to asking someone to measure a chair with one metric – do you include height, depth, color, materials, softness, price, etc.? And without transparency about the precise selection criteria used to select the particular 25 components and attentiveness to the interrelationships between these components, the selection could be seen to be based purely on the prejudices of the creators. For example, explanation is needed for why income inequality is included and gender inequality is not; it seems arbitrary without clarification of criteria. Indeed, without a transparent inclusion and exclusion criteria, it may be hard to respond to criticisms of GPI legitimacy, such as a recent article in Forbes magazine that asks whether, "GPI is trying to code in a particular world view rather than being an objective measure?" (Worstall, 2014). Certainly the same question has been asked about GSP, the indicator which is portends to replace.

The OECD recommends "involvement of experts and stakeholders" in the creation of the selection criteria and also directs that "it should be as precise as possible" (OECD, 2008, p. 20). A goal of future inclusive GPI collaboration could be to compile a list of precise selection criteria for the components. Individual studies have inquired about attributes of sustainability that are important but not currently captured by GPI (Bagstad et al., 2014; Berik & Gaddis, 2011; Talberth et al., 2007). For example, Berik and Gaddis (2011) suggest that water scarcity (not just water pollution) ought to be included because it has "profound impacts on our way of life in addition to our quality of life" (p. 109). However, it is vital to consider, as Mahbub ul Haq the pioneer of the HDI said, "for any useful policy index, some compromises must be made" (Haq, 1995, p. 59 in OECD, 2008, p. 138). This is why it is key for the GPI designers to make the compromises clear and its inclusion and exclusion criteria apparent.

Besides applying the statistical outcomes of this study to develop the criteria, another approach would be to reevaluate the component list to confirm that it embodies current social science, environmental science, and economic research about the key attributes of social, environmental, and economic factors contributing to sustainable human welfare. In line with this approach, Bagstad and colleagues (2014) point out "the cost of ozone depletion could be removed as a component given the consensus that this problem has been largely resolved through phase-out of ozone-depleting substances by the 1987 Montreal Protocol" (p. 428). Ultimately, whatever method is selected for component inclusion and exclusion, the development of this explicit selection criteria for GPI components may be seen as an opportunity for BEA/UN collaboration in support of the UN MDGs and not only state-level but global sustainable human welfare.

A GPI in the states community of practice (CoP) has emerged in the US which may be able to answer the call upon to compile a list of precise inclusion and exclusion selection criteria for the components and to reevaluate whether GPI components reflect current the social science, environmental, and economic research about sustainable human welfare. This CoP can answer statistical design questions raised in this about about double counting and the relative importance of certain indicators.

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CHAPTER 5: Exploring U.S GPI Governance

5.1 Introduction

Since its original development by Daly, Cobb, and Cobb (1989) as the Indicator for Sustainable Economic Welfare (ISEW), the Genuine Progress Indicator (GPI) has garnered broad interest from government, social and environmental advocates, and macroeconomic researchers as in alternative indicator of economic welfare to Gross Domestic Product (GDP). The GPI is a multi-dimensional, monetary, composite indicator of the sustainability of the macroeconomy, including estimates of the impact of the embedded economic system on the larger social and environmental systems, as well as the distribution of benefits and burdens of economic growth. Originally, the GPI was designed for use at the national scale, but it has not yet been adopted by national governments. In the face of national barriers, an interest has developed in state-level adoption and policy application in the US.

In order to promote uptake of this alternative indicator, an informal community of practice in the US has been working to improve the credibility, legitimacy, and application of the GPI in the states. States such as Maryland and Vermont have helped lead this effort in conjunction with executive and legislative branch action. However, due to the lack of decision-making processes in the broader community of practice, GPI is facing inertia and potential fragmentation on its way to defining the next generation of methodology and application to policy analysis, often called “GPI 2.0”. A better understanding of the dynamics in the network and could offer governance insights that may help community cohesion and more effective advocacy for metrics in pursuit of sustainable economic development.

To garner insight about possible GPI improvements, goals, and governance gaps in the U.S. GPI network, this paper dives into processes, outputs, and outcomes from the network as revealed through a facilitated U.S. GPI workshop at the University of Vermont. An estimate of a 50 state GPI account was used to catalyze discussion about state-level GPI uptake with opportunities for collaboration and co-identification of obstacles and opportunities to developing a new GPI 2.0 standard, as well as seeking supporting governance mechanisms.

In this paper we first characterize the GPI community of practice and network. We then deepen the analysis by studying elements of this community through a facilitated workshop process. Building on the insights from the workshop, we investigate a network governance model for the GPI by applying lessons from the governance of both the Gross Domestic Product and the Global Reporting Initiative.

5.2 GPI Community of Practice and Network

The GPI has evolved from Daly and colleagues (1989) research and proposal for an Index of Sustainable Economic Welfare (ISEW). Significant research has explored the indicator's design, theoretical assumptions (e.g., Dietz & Neumayer, 2006; Lawn, 2003, 2005; Neumayer, 1999), and application at different scales (e.g., Bagstad & Shammin, 2012; Berik & Gaddis, 2011; Costanza et al., 2004; Posner & Costanza, 2011). It has been calculated at various scales by both researchers inside and outside of academics, some supported by advocacy organizations and other tasked by governments that are seeking both compliments and alternatives to traditional macroeconomic indicators.

Those who participate in the U.S. GPI discussion and research may be considered to comprise an informal, loose U.S. GPI community of practice (CoP). One way to define a CoP is a group that has: (1) similar interests and goals, (2) physical or virtual space to interact directly with one another, and (3) a common set of practices (Wenger, 1998). The U.S. GPI CoP meets these criteria to varying degrees. First, there is a common interest of offering an alternative metric to GDP that encompasses social and environmental considerations. However, as demonstrated through the CoP workshop outcomes described below, specific goals have not yet been agreed upon within the informal network.

Second, there is a Google group listserv which may be considered a virtual meeting space for members (who have been invited) to interact directly with one another and support ongoing dialogue. There have also been some in-person meetings of subgroups within the GPI network, recently including workshops convened by Demos and the Governor of Maryland in October 2012 and June 2013, at the University of Vermont in April 2013, and through annual meetings of both regional and international professional societies of ecological economics. Not all those in the GPI network were present or invited to each of these events. In addition, a network of university classes has helped with data collection and analysis for various state studies, including, for example, the University of Vermont, Portland State University (Oregon), Washington University (Missouri), University of Massachusetts (Boston), and Oberlin College (Ohio).

Finally, while GPI estimation may be considered a common practice by outsiders, those on the inside of the informal network agree there is no common set of practices that have been agreed upon. Ultimately, however, the collection of participants who contribute to the U.S. GPI discussion does comfortably meet Wenger's (1998) requirements of being a "social learning system where practitioners connect to solve problems, share ideas, set standards, build tools, and develop relationships with peers and stakeholder" (p. 17). The aspects where the U.S. GPI CoP falls short of Wegner's three criteria, highlight the potential for a stronger CoP with more governance mechanisms. Without a more deliberate CoP, the U.S. GPI may flounder by relying on only path dependency where outcomes are predicated on "the result of certain combinations of activities that take place over time" (Pierson, 2004, p. 34).

Another broader analytic classification for the group that participates in the U.S. GPI discussion and research is to view them as a network. In fact, a network can be a CoP or can be comprised of multiple CoPs. This GPI community could fall into three types of network classifications: (1) Problem definition networks that "mobilize around aligned view of the scope, severity and cause of the problem" (Kingdon, 1984); (2) Policy design and planning networks that "mobilize to examine policy alternatives and/or plan for implementation of policy tool or suite of tools" (Bovaird, 2005); and/or (3) Policy coordination networks that enhance "communication and coordination among government agencies and programs that had common goals but lacked opportunities to interact with each other" (Koliba, Meek, & Zia, 2010). Through applying network analysis, we can ask questions like: Where is power situated in the network? Who has it and how is it used? What are the challenges associated with the functioning of this network? And how do actors in this network hold each other accountable?

One of the analytic tools used when studying networks is to classify nodes or actors in the network according to affiliations and activities they perform. Applying this convention in the case of the U.S. GPI CoP, four types of activity classifications emerged for the nodes, nicknamed: 'data crunchers' who are calculating GPIs for various nations and states; 'policy elites' who are implementing GPI and using it for policy at various scales (state, national, international); 'advocates' who are advocating for the adoption of GPI at these scales; and 'data designers' who are innovating and modifying the methodology for calculating the GPI. Many nodes in the network could be classified as belonging to more than one of these groups, and few nodes belong to all four groups.

At this time a cohort of data designers, data crunchers, advocates, and policy elites are attempting to update the U.S. GPI methodology to "GPI 2.0" without any network governance mechanism. The design of GPI 2.0 will affect each of these groups differently and each has insights to offer in the development of GPI 2.0. For example, data crunchers know about data availability, policy elites know about policy levers embedded in the indicator, and advocates know about barriers to adoption and communication. According to Hezri and Dovers (2006), in order for an indicator to be used in governance it must be salient to core values of the users. Therefore, particular attention to the policy elites input may be important. Ultimately, industry is another stakeholder in the GPI process, although involved to a lesser extent through, for example, socially responsible business groups with missions more in line with the GPI's inherent critique of economic growth.

With these various forms of expertise and perspectives comes a push and pull among the groups. Without any network governance mechanism, it is unclear how decisions are getting made or ought to be made to resolve these conflicts. According to Harrison (1970), most organizational conflicts can be resolved at the "structural level" (i.e., clarification of goals, roles, responsibilities, priorities, policies, rules, expectations, social contracts) rather than needing to dive deeply into group dynamics, interpersonal, or intrapersonal levels. Without a governance mechanism, it may be difficult to develop a structure that could prevent unhelpful group dynamics and interpersonal or intrapersonal driven conflicts that can derail progress.

Nodes can also be described by the sector affiliations, for example, non-profits, governments (or global governance structures), universities, businesses, and the media. Highlighting GPI network participants' affiliations may provide insight about network power dynamics. Besides activity and sector, nodes can be classified by geographic location or geographic/scale specialization. This classification may be especially useful for the 50 state model introduced in Chapter 2. Individual nodes may also contribute different types of capital to the network, including financial, physical, natural, human, social, political, cultural, and intellectual (Koliba et al., 2011). These may be considered attributes of the nodes or, if operationalized in a certain way, can also be considered flows or ties within the network.

5.3 Studying the U.S. GPI Community of Practice

To glean a deeper understanding of relationships and goals within the U.S. GPI CoP, as well as the processes, outputs, and outcomes from the network, we facilitated a U.S. GPI workshop at the University of Vermont for two days in April 2014. The workshop was designed by University of Vermont graduate students who developed a GPI estimate for all 50 states in a class led by Professor Jon Erickson and Daniel Clarke of the U.N. Statistics Division. Using a participatory facilitation framework, the workshop was intended to support the transition to GPI 2.0 by providing dedicated time to collaborate in person and beginning a dialogue about governance among the CoP. The Gund Institute for Ecological Economics provided funding for travel, accommodations, and meals, and the University of Vermont's Rubenstein School for Environment and Natural Resources provided the meeting space. The preliminary estimate of a 50 state GPI served as the bases of the conversation to spur insights and evolution of the indicator.

The workshop was designed as "action research," a research method involving collaboration with a community to implement research processes and outcomes towards a common goal (French & Bell, 1999). Representatives from government, nonprofit advocacy, and universities with active GPI projects or research were invited, including participants from the previous 'GPI in the States' gatherings in Maryland. The list was then expanded to include the students in the GPI graduate class and other participants involved in the annual Vermont GPI study legislated by the State of Vermont. Undeniably, the inclusion or exclusion process of inviting participants into the CoP via in person events or to join the Google group is a space for considering unconscious bias, input legitimacy, and power in the CoP. However, the full U.S. GPI CoP is a relatively small group of known individuals. Table 5.1 summarizes the general "node characteristics" of those who were able to participate in the workshop in person. The graduate students (not included in the table) served as moderators of break-out groups, note-takers, and presenters of the 50-state study, and included four females and four males. Some of the CoP who were not able to attend in person were able to view first day presentations via teleconference, and were also included in follow-up communication and the expansion of the Google group.

Table 5.1

Node Characteristics of Participants in the UVM GPI Workshop

Gender	Sector	Geography	Activity	Travel Requirement
Male	Academia	Vermont	Designer Cruncher Advocate	Local
Female	Government	Utah	Cruncher Advocate Designer	Traveled
Male	NonProfit	Colorado	Cruncher	Traveled
Male	Academia	Vermont	Cruncher	Local
Male	Academia	Vermont	Advocate	Local
Male	Government	Oregon	Policy Cruncher Advocate	Traveled
Male	NonProfit	Oregon	Designer Cruncher Advocate	Traveled
Male	Government	Vermont	Designer Cruncher	Local

The facilitators applied tools to support collaboration among those in the CoP who saw different aspects of the GPI problem with the aim of seeking solutions that "go beyond their own limited vision of what is possible" (Gray, 1989, p. 5). The first day of the workshop opened with a visioning exercise that involved silently soliciting and sharing views via post-it notes in order to: (1) share what factors participants want to see incorporated in GPI; (2) perform appreciative inquiry about bright spots in the GPI; (3) react to a proposed definition of GPI; and (4) co-create the indicators of success for the workshop. Using silent interactions is a facilitation technique that can help bring all voices into the room at the outset and allows introverts to contribute to the conversation while avoiding dominant personalities from controlling the discourse. The facilitators also set clear boundary conditions for the conversation, for example, the focus was not international GPI, but rather GPI in the 50 U.S. states with comparability between state-level estimates as a priority.

During the GPI visioning exercise, there was unity around emphasizing equity in multiple forms – including gender and income – with the suggestion that linking to equality movements could be a possible avenue for GPI uptake. Many participants emphasized that GPI should be an 'objective measure.' Several post-it notes identified that benefits of ecosystem services ought to be more explicitly included in GPI, rather than only the costs imposed by damage, conversion, or destruction of natural resources. There was tension between wanting GPI to improve continuously and the need for states to have consistent measures over time. A key takeaway from this exercise relating to CoP governance was the importance of the process in developing GPI, not only the final numerical output.

The next step was to solicit positive aspects of the current state of practice surrounding GPI research and application through appreciative inquiry. This facilitation technique has been called one of the most important advances in action research (Bushe, 1995). Cooperrider and Whitney (2001) define appreciative inquiry as an “intervention [that] gives way to the speed of imagination and innovation; instead of negation, criticism, and spiraling diagnosis, there is discovery, dream, and design” (p. 3). The goal was to seek the bright spots in the artifact – in this case GPI – to see what is working and what the CoP would want to keep. For example, there was consensus on maintaining one monetary number to compare to GDP that can be disaggregated into components and translated to different governance scales. Many were also pleased that GPI currently draws attention to the complexity of the idea of progress and illustrates the idea of tradeoffs which, as stated by one participant, “introduces a way to have these more meaningful conversations that our political system is starving for right now.”

The fourth component of the opening exercises was to gauge reaction to a common definition of GPI as a “monetized indicator of sustainable economic welfare.” This stimulated a fair degree of disagreement. Some expressed concern over the word ‘sustainable’ and worried about its connotation with some important constituencies, while others held that it is a scientific, objective term. A desire was voiced for the definition to distinguish between well-being and welfare and that ‘quality of life’ may be too broad of a term for the intentions of a macroeconomic indicator. An appeal was also made for the definition to include ‘boundary conditions’ in relation to consumption versus production, in other words, being clear about whether the responsibility of the external costs of economic activity (such as pollution) should be born on the consumer or producer of goods and services. The request to include ‘benefits and costs’ in the definition received some support. Some participants departed from the proposed definition and pushed back on the use of the word ‘progress.’ Despite disagreement, many appreciated that a clear definition puts limitations on what the GPI is and is not. Without consensus on the definition of GPI, it will be difficult for a dispersed CoP to advocate for adoption.

In the final component of visioning, the facilitators aimed to provide clarity of purpose for the workshop but, in alignment with action research convention, also sought to empower the community to adapt, amend, and co-create its own sense of purpose. Therefore, the facilitators posed the question: “What are the indicators of success for this workshop?” This question was answered in the context of time scales – immediate, 2-3 months, and 6-plus months. Among the many immediate goals, the group sought to better understand what each other was doing and working towards in the context of GPI to “build the team of practitioners.” Participants also expressed a need for consensus around a definition that could inform a new standard (i.e., GPI 2.0) to avoid “branching and non-comparability of GPI” between different state estimates, and to leave the meeting with a clear work plan.

Clearly, these representatives of the broader CoP desired to nurture social capital and explicitly generate the structural framework that Harrison (1970) claims can avert personality conflicts: clarification of goals, roles, responsibilities, priorities, policies, rules, expectations, social contracts. One member of the group declared that we were in pursuit of the "Burlington Consensus." The group specifically called for governance mechanisms for the U.S. GPI network. For instance, one participant offered the example of the American Society of Mechanical Engineers that "decides what engineering regulations and standards exist; GPI needs something similar within a year." In the medium term, this CoP wanted to achieve a clear roadmap to standardize GPI with an agreed upon working definition for GPI 1.5 and GPI 2.0 – a goal that set the CoP on track to meet Wenger's (1998) criteria for the CoP to possess a common set of practices.

With the intent to bolster social capital, the next phase of the workshop was to capitalize on a primary benefit of an in person gathering of the CoP, namely the opportunity to build a foundational knowledge for the group by asking participants to share intellectual capital and to learn of and celebrate other members' successes. In this spirit, participants were asked to share four prepared slides in four minutes highlighting the current state of their GPI work and thoughts. The graduate students then revealed their preliminary work on estimating a 50 state GPI estimate and shared their insights on policy relevance and consistency between state datasets. This table was seen by the group as a vehicle for moving the current state of practice demonstrated by the Vermont/Maryland method to a more uniform and agreed upon standard as a common point reference going forward.

Leaning on the practice of "facilitative divergence to convergence" developed by Kaner (2014), the next step in the workshop was to brainstorm improvements for GPI through a roundtable discussion with the aim of creating logical groupings for the coming day's conversation. Figure 5.1 captures the facilitators' visual representation of K's process, including guiding participants from the "divergence zone" into the "groan zone" in order to reach the "convergence zone" with agreed upon themes to focus break-out groups for the following day.

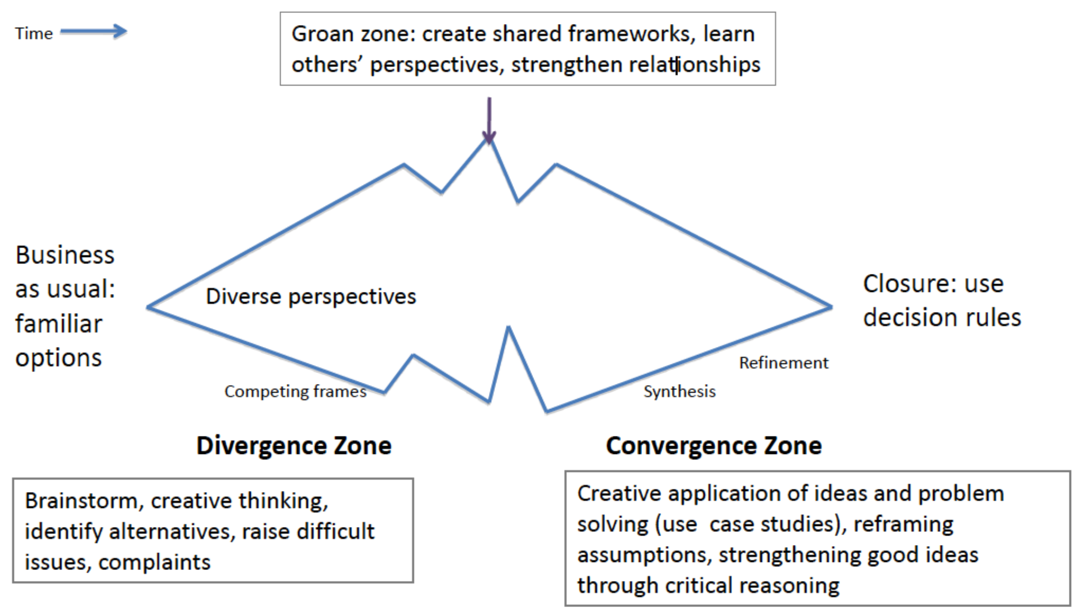

Figure 5.1 Kaner's Group Decision-Making Participatory Process

The outcome of this facilitated process was two different types of conversations for the final day of the workshop, both involving the topic of governance. One conversation focused on overarching themes or principles including: agreement on GPI purpose; boundary conditions for the scope of measurement; the use of cumulative accounting of costs versus annual charges; distinguishing between benefits and costs of economic activity; measuring externalities from consumption or production of goods and services; evaluating trade-offs between fewer versus greater number of sub-indicators;

determining indicators through degree of policy relevance; and specifying guiding design principles for future work. The second conversation focused on creating work plans for relatively well-defined tasks including: analyzing the usefulness of an ecosystem services approach to estimating benefits versus subtracting costs for land-use conversion; exploring the expanded use of the American Time Use Survey; and incorporating a fuller assessment of climate change costs and assignment of responsibility (again, consumer versus producer).

The conversation on GPI principles was framed around the question: “If you were President Obama’s GPI Czar, what would you declare?” The group broke into four small teams tasked with creating a skeletal National GPI standard for U.S. GPI 2.0 in one hour. The teams were given the following design parameters: one ultimate number, monetized; possible to calculate at both the national and state scale; comparable to GDP and GSP; and has policy relevance and levers. The teams were asked to consider five primary topics during their conversation: (1) What is the purpose of GPI?; (2) What are the boundary conditions?; (3) How does GPI consider consumption or production-based estimates of benefits and costs?; (4) How many sub-indicators should GPI contain?; and (5) How can GPI be policy relevant? Teams also collected items for later consideration (i.e. the parking lot) that contributed to crafting the larger working plan. The outcome from this process was a concise but not exhaustive list of initial guiding principles. Due to lack of consensus some gaps still existed. However, capturing areas of agreement presented foundational guidance for GPI 2.0, summarized in Table 5.2 as a draft of a “Burlington Consensus.”

Table 5.2

"Burlington Consensus" – GPI Principles

Principle	Areas of strong convergence
Purpose	• GPI is a gauge of net impacts of economic decisions though which policy can be evaluated. • Potential words to include: sustainable, holistic, quality of life, well-being, and welfare.
Boundary Conditions	• GPI is an annual number designed for use at the national and state level. • GPI does not use cumulative accounting and avoids double counting. • It gives priority to recent base years and up-to-date, consistently available data sources and valuation numbers.
Consumption/Production Benefits/Costs	• No clear defined consensus on consumption vs. production standard. • Externalities included in GPI are those internal to the geographic boundaries (climate change is currently a special case). • GPI is a net measurement, with both costs and benefits of economic activity included.
Number of Sub-Indicators	• GPI sub-indicators can be grouped into useful sub-categories. • GPI ought to have a core set of consistent sub-indicators and elective supplementary sub-indicators.
Policy Relevance	• GPI outcomes ought to be able to be communicated via a policy note, similar to current fiscal notes attached to macro-economic, economy-wide legislation, policies, or budgets. • GPI must be actionable, with objective sub-indictors able to be influenced by policy levers at the geographic level of study.
Design Guiding Principles	• GPI ought to be as unbiased as possible. No double counting. Parts must sum to the whole. Calculated annually.

During the second facilitated conversation on the final day of the workshop, participants sought to create work plans for eight GPI content areas, summarized in Table 5.3. These work plans suggested leadership, working groups, and timelines.

Table 5.3

Framing for Work Plans for Eight GPI Content Areas

Content Area	Framing for Work Plan
Expedient Items to Pursue (i.e., low hanging fruit)	Problem statement: Many small improvements have been identified, and should be incorporated. Outcomes: Consensus statement on incorporation of these identified improvements within GPI CoP.
American Time Use Survey (ATUS)	Problem statement: Current methodology recognizes time use in a manner inconsistent with governing bodies, and may be double counting. Outcomes: Consensus statement on use of ATUS within GPI CoP.
Principles	Problem statement: Lacking common ground and agreement within a currently decentralized GPI community of practice. Outcome: Consensus statement of principles within GPI CoP.
Architecture 2.0	Problem statement: Lacking consistent architecture for future GPI 2.0. Outcome: One consistent architecture available for use by all states or calculations.
Climate Change	Problem statement: Lack of consensus on scale of measurement and valuation for the cost of climate change. Outcomes: Identification of best methodology to include the social cost of climate change in GPI.
Ecosystem Services	Problem statement: Lacking consensus on the incorporation of ecosystem service valuation in GPI. Outcomes: Identification of best approach to incorporating ecosystem service valuation in GPI.
Communications	Problem statement: GPI 2.0 lacking consistent accessible message to various audiences. Outcomes: Proposal for language on accessible messaging (translation), including terminology, operational definitions, themes, clusters, statistics, and freely available information.
Governance	Problem statement: Lacking clear decision making body (with legitimacy, transparency, accountability, and evaluations) that represents interests of diverse stakeholders. Outcome: Identification of legitimate process or mechanism or system of governance for GPI.

Two types of work plans emerged – those that required working groups (e.g., climate change, ecosystems services, communications, governance) and those that required a basic 'summarize-review-revise-ratify-disseminate' governance process (e.g., near-term straightforward tasks, incorporation of the American Time Use Survey [ATUS], guiding principles, overall architecture). Therefore, the discussion culminated in the aspiration of an interim set of governance decision-making processes. This decision making process hinged on communicating about the work plans on two email lists: one for the workshop participants and one for the broader U.S. GPI CoP. Thus the first step, prior to accomplishing the work plans was for the workshop group to identify the participants for the national CoP email list. Participants came to a consensus that for the reviewing process the community of practice should include researchers who have published on GPI topics, individuals who have estimated state GPIs, and Lew Daly from the policy advocacy organization Demos.

It is critical to note that some of these decision making steps necessitate that a clear, official governance mechanism be selected as denoted by the "post govern" designation. Therefore, the work plan for the governance group is of particular interest, and included steps to: (1) Describe the existing network of practitioners; (2) Clarify the function of current governance structure and gaps; (3) Identify best practices and options for future governance; and (4) Consider the convention or decision-making structure to approve governance. The group agreed to meet next at the 2015 conference of the U.S. Society for Ecological Economics. The following section will focus in particular on the aspects of governing a GPI CoP going forward, including lessons learned from similar efforts in designing, implementing, and sustaining indicators projects.

5.4 Towards a Network Governance Model for the Genuine Progress Indicator

The workshop participants coalesced around a call for a system of governance to remedy that lack of a clear decision-making body that represents interests of diverse GPI stakeholders. However, there was less conversation on how to structure or institutionalize governance of what has been an informal coalition of independent actors, with their own inherent biases, motivations, and experience with alternative macroeconomic indicators. To advance this dialogue, here we provide some guidance from the network governance literature, as well as introduce two contrasting governance cases of the Gross Domestic Product and the Global Reporting Initiative for lessons and advice going forward.

Choice of governance structure can be evaluated through many dimensions, for example levels of democratic participation, efficiency, legitimacy, and accountability (Keohane, 2001). For instance, if the GPI community desires to prioritize accountability, Scholte (2008) suggests four principal aspects to consider: transparency, consultation, evaluation, and correction. If the community desires to prioritize legitimacy, Brassett and Tsingou (2011) claim that a legitimate governance system "can rest on tradition, authority, democratic mandate, social signs and symbols, charisma of a leader." The CoP could consider both input legitimacy which "refers to the decision-making process and the extent to which the interests of the broader community are included," and output legitimacy which concerns "the capacity of rule-makers to produce outcomes which resolve problems and achieve collective goals in line with accepted and shared preferences or norms of the community" (Underhill & Zhang, 2008). Finally, if the community desires to privilege democracy, Coleman and Porter (2000) provide "six underlying principles of democracy: transparency, openness to participation, quality of discourse, effectiveness, fairness."

5.4.1 Lessons from GDP

The development of the Gross Domestic Product (GDP) as part of a System of National Accounts (SNA) provides an illustration of the evolution of governance of the main indicator which GPI practitioners seek to critique. GDP was developed in the United Kingdom and United States of America in the 1930s and 1940s. The major step towards gaining legitimacy for GDP was when President Franklin Roosevelt requested a macroeconomic measure be designed to illustrate economic capacity to supply the military buildup for WWII while maintaining production of consumer goods and services (Marcuss & Kane, 2007). GDP's global use as a measure of economic progress was later solidified at the Bretton Woods Conference with the establishment of the International Monetary Fund (IMF) and International Bank for Reconstruction and Development (World Bank). The US and UK Treasuries' GDP methodologies for analyzing economic activity informed much of the discussion at Bretton Woods and the strength of the US economy and currency became the benchmark for which to gauge all other countries (Constanza et al., 2009). Being valued and up held by these powerful institutions was a significant avenue toward legitimacy for GDP.

The GDP became a definitive international norm with the establishment of the SNA, housed in the U.N.'s Statistical Commission (UNSC), as "the internationally agreed standard set of recommendations on how to compile measures of economic activity" (http://unstats.un.org/unsd/nationalaccount/sna.asp). Essentially, the SNA provides the internationally agreed upon definitions and accounting rules for national GDP. The SNA set up the Intersecretariat Working Group on National Accounts (ISWGNA - comprised of Eurostat, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations, and the World Bank) to enhance cooperation among international organizations working within the UNSC and therefore the SNA. According to the ISWGNA website, it has been mandated by the UNSC to: "(1) provide strategic vision, direction and coordination for the methodological development and implementation of the SNA... (2) revise and update the SNA and develop supporting normative international statistical standards on national accounts... (3) promote development of databases at international, regional and national levels on national accounts statistics... (4) promote implementation of the SNA... (5) promote the use of national accounts in policy formulation." Each of these tasks may be perceived to match up to different activity groups within GPI.

Thus, the ISWGNA is the foundational global governance body for the SNA where decisions are made for methodology and revision through various processes. In 1995 a transparent information service for the ISWGNA was developed to communicate activities, including posting all meeting minutes online. However, within countries, GDP accounts are measured and maintained by a national government statistical agency (i.e., the Bureau of Economic Analysis in the US), which may adopt or modify the SNA standards for their country.

Similar to how executive action in the US catalyzed GDP, the former Governor of Maryland, Martin O'Malley, instructed the development and use of GPI. Under a 2013 executive action the state identified the need for a state coalition. It is notable that this GPI momentum in the state was largely tied to a specific Governor and not by state law through the legislature, which leaves the future of GPI in Maryland in a tenuous position.

In contrast to executive action, the Vermont state legislature passed a law requiring the annual development of GPI accounts and incorporation in state policy making. While the GPI was supported through the legislative branch, ultimately it was never publicly embraced by the Governor. Although Vermont recently developed a Comprehensive Economic Development Strategy in which GPI targets feature prominently alongside traditional metrics such as employment and Gross State Product (http://accd.vermont.gov/economic-development/major-initiatives/ceds). GPI is now slowly becoming institutionalized as a state metric in Vermont, across different governors; however, it lacks any dedicated funding or long-term institutional support, two essential components for the development and uptake of GDP. Unlike the GPI narrative of Maryland's executive action or Vermont's legislative action, the narrative of GDP included perceived necessity, urgency, sustained top down authority, funding and the focus of the economics profession working to support the needs of the president.

5.4.2 Lessons from GRI

The Global Reporting Initiative (GRI) is a reporting framework for organizations that promotes economic, environmental and social sustainability. It is considered the world's leading voluntary, non-financial corporate reporting scheme. GRI developed from a similar goal to GPI: providing sustainability focused measurements that are different than the dominant, conventional, monetary focus of business financial or government economic reports. GRI's design began as a non-profit initiative only nineteen years ago, providing a more modern example for GPI of evolution of governance. In contrast to GDP which found its success from an initial top-down government mandate, GRI's global success was achieved from a bottom-up non-profit and partnership approach.

GRI was created in 1997 under the initiative of two Boston based NGOs: the North American Coalition for Environmentally Responsible Economies (CERES), and the Tellus Institute. In 1999, the United National Environmental Program (UNEP) joined as a partner to assure an international perspective and "enhance its legitimacy, access to funding, and administrative and intellectual support" (Brown, DeJong, & Lessidrenska, 2009; Marimon, del Mar Alonso-Almeida, del Pilar Rodriguez, & Alejandro, 2012). GRI reporting guidelines were published in 2000. CERES formed GRI into a separate, independent non-profit institution in 2001, and in 2002, 2006, and 2013 GRI updated standards for organizations to follow when producing a sustainability report.

GRI's governance structure is designed to maintain multi-stakeholder representation. The governance structure includes four key bodies: board of directors, technical advisory committee, and stakeholder council. Four different constituencies sit on the board, including business, civil society organizations, labor, and mediating institutions (e.g., the UN, Deliotte, Ernst, & Young). Following recommendations from the advisory committee and stakeholder council, the board makes the final decision about the release of framework material. The stakeholder council provides advice on strategic and policy issues, and deliberates proposed changes to the overarching GRI framework content; as representatives of GRI's wider network, "they provide a balanced, expert view that lends credibility to GRI's guidance" (www.globalreporting.org).

The GRI arrangement can be examined through multiple lenses including democracy and legitimacy. As suggested by Underhill & Zhang (2008) these concepts are linked through the parsing of legitimacy into input and output. Brown et al. (2009) point out that GRI's explicit goals of "inclusiveness, multi-stakeholder participation, and recurrent empirical testing were necessary to create a broad-based support and the atmosphere of neutrality, to elicit the best ideas, to assure that the project serves both reporters and future users ... to create legitimacy, and to set in motion the evolution of self-replicating societal network." If the focus were placed purely on the concept of democracy, GRI may receive high marks because of its inclusivity and transparency. This prioritization of input legitimacy is stressed by one of the founders, Bob Massie who said that it was the "vision that the reporting guidelines would be a living document, produced 'by the users and for the users'" (Brown et al., 2009). From the perspective of output legitimacy, the GRI has a high level of influence on user practices according to participating companies claiming it has great influence on their social responsibility practices (Berman, 2003). However, it is not clear that GRI has caused changes in behavior, even though the number of people reporting on social and environmental topics has increased. In addition, another weak aspect of output legitimacy for GRI is the lack of data assurance (Weber et al., 2016).

GRI was set up to form its legitimacy on many levels including building on previously accepted financial reporting frameworks and connecting with powerful organizations, including large multinational corporations and the UN. Table 4.5 provides a snapshot of the chronology of the GRI that can provide some insight into the development of governance for the GPI CoP. The timeline ends in 2008 because much of the fundamental governance steps were completed within this ten-year window.

Table 5.4

GRI Governance Timeline

1997	Project department set up to develop the framework at non-profits CERES and the Tellus Institute. Established a multi-stakeholder Steering Committee to develop the organization’s guidance.
2001	CERES formed GRI into a separate, independent non-profit institution based on Steering Committee recommendation.
2002	Becomes UNEP collaborating organization. Second generation of the Guidelines, G2, released at the World Summit on Sustainable Development and referenced in the World Summit’s Plan of Implementation.
2003	Organizational Stakeholders (OS) Program including GRI's core supporters in corporations, civil society, business, mediating institutions, academia, labor, public agencies and intergovernmental agencies. OS Program members declare support for GRI's mission, supply expertise, provide to governance , contribute financially. Initial meeting of Stakeholder Council (SC) - appoint Board members and recommend future policies
2005	Technical Advisory Committee (TAC) established for overall quality and coherence by providing high-level technical advice and expertise to Board and Secretariat
2006	Third generation of Guidelines, G3 - Over 3,000 experts from business, civil society and labor contributed insights
2007	Setting up regional offices (Focal Points) - first launched in Brazil. Application Level Service offered to support organizations.

Similar to GRI’s evolution though a non-profit model, the national U.S. GPI was once housed in the non-profit Redefining Progress. Ultimately, because the non-profit was pushing against the power structures of Washington rather than finding diverse stakeholder buy in, the efforts were side-tracked when the government turned over. While the GRI example demonstrates the value of legitimization through vast and diverse stakeholder engagement, GPI has lacked input legitimacy having no clear inclusive development process through which to seek broad insight and buy in from diverse stakeholders and users. Rather, GPI may have desired to seek only output legitimacy and then work to catalyze buy in. Unfortunately, the output legitimacy of GPI has been called into question by many authors (Chapter 3, 4; Dietz & Neumayer, 2006; Lawn, 2003, 2005; Neumayer, 1999) and the current lack of governance process makes input legitimacy hard to achieve.

5.5 Conclusion

In the intervening years since the workshop, the CoP largely continues as an informal network bolstered by occasional publications, meetings at conferences, and releases of state studies. An official or agreed upon governance process has not taken hold to support the development and propagation of GPI 2.0. This paper offered two possible governances of both the design of the artifact (GPI metric) and intervention (GPI uptake) models for GPI: GRI and GDP.

If the GPI were to closely follow the GRI model, the first step would be to house GPI within a non-profit with an inclusive and dedicated steering committee. After focused incubation, a GPI non-profit with a separate council of stakeholders who advise the board and appoint board members would be created with the sole focus of creating the metric and also the intervention strategy for disseminating GPI as a tool. Importantly, a collaboration with an externally legitimate organization would be established along with an overt announcement of buy-in and financial support from GPI's organizational supporters through a formal program. The GPI organization would then seek further both input legitimacy and technical legitimacy by establishing a formal advisory committee responsible for providing technical input in design into the next iteration of GPI. With all these governance mechanisms in place, a new GPI framework could be released and then to support the intervention aspect of the process regional offices could be established along with services support for people who are calculating GPI.

If GPI were to go down the government-initiated road of GDP, the first step would be to seek a directive from the executive branch thereby utilizing executive administrative powers to request the incubation of the metric within the executive office of the president, one of the appropriate federal agencies, or an appropriate department like the Department of Commerce Economics and Statistics Administration (home of the Bureau of Economic Analysis, BEA). Unlike GDP's story, the GPI advocates could seek to spur action directly within one of agencies or departments or another government-based alternative to the executive path would be to target the legislative branch to pass a bill directing the Department of Commerce to incubate GPI. The next step after the metric was designed would be to achieve global use like GDP through being written into program measurements at the IMF or the World Bank. After the strategic intervention achieved its goal of global use, the management of the metric would be moved to be housed in the UNSC's SNA where GPI would become part of the national accounts curated and governed by the ISWGNA. This organization would be tasked with providing "strategic vision, direction and coordination for the methodological development and implementation" of the GPI going forward. The current intervention strategy is to reach a threshold of state uptakes that would push the U.S. government to accept GPI as a metric – the new 50 state results may help this movement. However, this intervention strategy does not have a clear home for the incubation of the "design artifact" – the metric itself does not have a governance mechanism in the meantime to provide legitimacy, consistent development, and authority.

The Genuine Progress Indicator Community of Practice has an opportunity to morph what is considered "successful" policy away from a purely consumption driven narrative that is blind to environmental and social impacts towards a more sustainable option. However, this impact can only be manifested if the GPI is considered legitimate and has a cohesive and dependable framework. In order to achieve this goal, the CoP must unify through a governance mechanism to create such a definitive and influential metric. This need is seen within the U.S. GPI CoP and a desire to seek governance options has been expressed. There are multiple options and templates for the GPI CoP to follow to start making decisions and solidifying the GPI 2.0 framework. Additional research can be conducted to understand the network composition of the US or global GPI CoP and tools like Delphi decision making process can be applied to seek more consensus. However, ultimately, a governance mechanism that provides accountability and authority to the GPI framework must be adopted if GPI is going to step into its potential role as the dominant metrics for global policy excellence.

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CHAPTER 6: CONCLUSION

6.1 Introduction

The abundance of new sustainability metrics for various action arenas – international, national, state, city, corporate – may be seen, through a hopeful lens, as revealing the current zeitgeist. A zeitgeist that deems this moment in history as requiring innovation, initiative, and a redefinition of progress if humans are to thrive on 'Spaceship Earth.' Each of these numerous indicators defines the sustainability problem and, through shining a light on certain aspects of the problem, directs actions towards the solution, guiding us towards a distinctive future. But there is a risk in applying new metrics and seeking new, untested goals – if these goals, these metrics are poorly designed without an inclusive process, without explicit design principles, without systems thinking, they may lead us into a future of unintended consequences, one that does not move us towards a more sustainable human existence.

The Genuine Progress Indicator (GPI) is an example of one of these sustainability metrics. Recognizing how powerful GDP is as a national goal in the global system, the designers of GPI sought to create an alternative economic metric that incorporated broader social and environmental considerations and measure both the sustainability of economic growth and its contribution to human well-being. However, inclusive process, explicit design principles, and systems thinking were not directly employed in the creation of this metric. Rather the creation stemmed from an appendix in a thought-provoking book (*For the Common Good*) and developed without broader consensus on a consistent theoretical framework or rigorous statistical testing of the design.

Through the lens of 50 state case studies and with guidance from OECD composite index expertise, this research sought to test the quality of GPI as a composite indicator of sustainable economic welfare. In light of the results, this conclusion provides two groupings of insights. The first is a compilation of specific improvements for the current iteration of GPI. The second set of insights is an offering of deeper design suggestions including: advocating for maintaining an alternative GDP indicator, creating a stronger theoretical framework and embracing an inclusive design process.

6.2 Current GPI Improvement Recommendations

While the ultimate learning from this research is that 'tinkering at the edges' of the indicator is unlikely to provide the legitimacy, theoretical foundation, and buy-in needed for GPI to replace GDP as a macroeconomic metric of success, there are various modifications that could improve the current metric from the perspective of statistical rigor and quantitative quality as supported by OECD guidance. For example, it appears that it is possible to be a 'GPI rich' state by externalizing environmental and social costs onto other states. Therefore, an initial suggestion is to incorporate trade and interstate externalities into the measure to internalize the full impacts of a states' consumption.

In addition, to more deeply understand the effect of state policy choices in GPI, a space-for-time substitution could be pursued by using the 50 case studies in one year to test for the impact on GPI of different variable sustainability policies. For example, the impact on GPI from the presence or absence of a state renewable portfolio standard could be evaluated. Another research focus would be following the lead of GDP predictive econometric models to test for system optimization of budget allocation for GPI, for example, the cost of a 1% change in GPI or the change in GPI caused by $1 marginal investment in specific components. Ultimately, a GPI optimization model would further expose the driving components of GPI revealing whether policy makers would be incentivized to direct towards sustainability driven policies if GPI were to replace or even supplement GDP/GSP.

Based on how many of the current components are designed without focused attention on policy relevance, GPI does not necessarily encourage policies of reinvesting in social and natural capital in a sustainable way: policy action is prescribed by design. This section provides criticisms of specific components from this perspective.

6.2.1 Including Inequality

GPI can increase when personal consumption expenditure grows, even as income inequality rises. On aggregate the cost of inequality only correlates with the GPI with an r of 0.22. While addressing income inequality is one the driving goals of the designers of GPI, some of the most unequal states (NY, MA, CT) are 'winning the GPI game' because they have high PCE and some states that have higher income equality (WY) perform poorly under GPI.

Another flaw with the inequality component is that is does not account for gender or race inequality. For example, gender inequality can be masked by using a 'household' based Gini. Genuine progress cannot be achieved without an eye towards gender and racial equality. GPI ought to reflect this fact.

6.2.2 Baselines & Prescriptive Natural Priorities

The dominant state outliner GPI is Alaska. This extreme outlier highlights the problem with the practice of calculating natural capital components of GPI using "baseline" depletions costs rather than ecosystem service benefits. Firstly, the selection of baseline imposes a less transparent bias by laying the outcome of those components on the baseline methodology. The Alaska outcome also calls into question the fact that many of the wetlands in Alaska are in remote regions and do not directly service Alaska's state populations. (Though they can be seen to service the global population from the perspective of carbon sinks and possible biodiversity.) Following UT's recommendation to including ecosystem service benefits for natural capital components of GPI remedies these problems. It also remedies the problem of regional ecosystem diversity and prescriptive natural priorities – the fact that deserts, marine systems, etc. are not included in the current iteration of GPI. It may also alleviate the problem of prescribing unsustainable natural priorities like the fact that it is counted as a positive contribution that the arid West has more forests than the pre-colonial time. Different land uses are sustainable in different regions – i.e., forests may not be sustainable without adequate water. The suggestion of including region appropriate ecosystem services may support the idea that the GPI may have a core set of components with a methodologically consistent dashboard of additional components. Though this choice leads to less comparability between states. Another suggestion is the development of a 'GPI wiki' that would house local variants and methodologies to support flexibility.

6.2.3 Variability Power

With the top three most variable components (cost of nonrenewable resource depletion, PCE, and cost of motor vehicle crashes) accounting for over 90% of the difference between the states' GPIs it suggests that the most important policy actions the differentiate between the states are on those topics. PCE does not require additional calculations, but cost of nonrenewable resource depletion and the cost of motor vehicle crashes do. If GPI were to be employed as a tool to compare state-to-state outcomes, it is imperative that these components rely on sound formulas that use robust data and have clear policy leverage points. Additionally, it is fair to question whether these are the components on which the states ought to be differentiated for a sustainability indicator.

6.2.4 Wage Rate Weights

Weighting social costs and benefits by wage rates makes sense. It can be argued that it makes sense for each hour to receive equal monetary value or should there be differentiate value based on the activity. Or should leisure time be considered more essential and therefore given a designated a wage rate than household labor, as is currently the case? This assumption was tested in the sensitivity paper by weighting household labor like the other social hour components with the average wage rate and lead to a 44% increase in GPI. Feminist economists would argue that household labor is foundational to the reproduction of society and that undervaluing it under values caring labor and women. A possible way to explore this question of weighting the value of time for society would be to ask designers to use Budget Allocation Process or Analytic

Hierarchy Process to decide on weights. However, this takes the weighting mechanism out of the market and create an outcome that does not produce policy options.

From a policy lever perspective, it may be concerning that if the average wage increases, three costs (commuting, leisure, underemployment) increase. This may create a perverse incentive by narrowly be used as a reason to not increase the minimum wage. Another policy lever question is whether policy action can increase the benefit of household labor. The idea that the government could and should legislate to create more household labor hours is troubling.

6.2.5 Fossil Fuel Fixes

Addressing the risks of a fossil fuel economy is clearly a concern of the designers of GPI. Non-renewable energy data, including coal, natural gas, and petroleum consumption are included in the indicator in two components cost of non-renewable energy depletion and cost of climate change leading to a component correlation is 0.99 – the OECD guidance would see it as imperative to clearly address this correlation. A response is that each is measuring a separate cost – one a pollution cost and the other a depletion cost. However, counting identical components twice seems imprudent, unnecessary, and leaves the indicator open to criticism particularly from red states. Rather seeking to count the cost of climate change differently through disaggregating its affects including the "costs of extreme events, natural disasters, and water scarcity" suggested by Bagstad, Berik, and Gaddis (2014, p. 481) may remove a political red herring and avoid the loaded choice of selecting a social cost of carbon.

6.3 Deeper GPI Improvement Recommendations

Having a possible alternative indicator to GDP ‘waiting in the wings’ is highly valuable from a ‘policy window’ perspective. For a policy window to open three streams must converge: the ‘problem stream’ where attention shifts towards evidence of a problem; the ‘politics stream’ where policymakers have the motivation and willingness to act to solve the problem; and the ‘policy stream’ where an acceptable solution to the problem is available for policy makers (Kraft, 2015). If both the problem and political conditions arise, GPI could fulfil the ‘policy stream’ condition and complete the policy window. To quote an unlikely ally, Milton Friedman (2009), “When [a] crisis occurs, the actions that are taken depend on the ideas that are lying around. That, I believe, is our basic function: to develop alternatives to existing policies, to keep them alive and available until the politically impossible becomes the politically inevitable” (p. xiv). Therefore, an alternative to GDP that is thoughtfully designed, politically palatable, and straight-forward to adopt, ought to be “lying around” when an ‘policy entrepreneur’ (those who see or help create ‘policy windows’) is seeking a ‘policy stream’ solution. GPI may be this alternative, but its current iteration may not be robust enough to stand up to intense scrutiny. Its foundational weakness lies not simply in the precise criticisms of specific current component calculations but in the vague theoretical foundation and the legitimacy of the design process.

The OECD guidance on how to produce a high-quality composite indicator begins with emphasizing the supreme importance of a clear theoretical foundation as a necessity and touchstone for a quality composite indicator stating, “What is badly defined is likely to be badly measured" (OECD, 2008, p. 21). In the interest of pursuing concrete, statistical outcomes, the papers that compose this dissertation focused on implementing the quantitative statistical test for quality prescribed in the handbook, rather than addressing the qualitative question of the theoretical framework. However, the ambiguous theoretical framework is the Achilles' heel of this indicator and may be responsible for the weak correlation with metrics like the Gallup Well-Being poll.

By embodying that it is possible to deplete natural or social capital while expanding income and consumption to produce rising per capita GPI, it is clear that GPI is loosely based in the philosophy of weak sustainability. However, Daly and Cobb (1989) did not directly provide this language at the starting point in the construction of GPI, but instead relied on the basic assumptions of welfare economics embodied by GDP. Other scholars, including Lawn (2003) and Talberth, Cobb, & Slattery (2006), have described their perspectives about the theory on which GPI is based post factum, however, originally, little text or attention was given to the theoretical underpinnings of the GPI beyond its relationship to GDP and welfare economics. Therefore, no clear, strict inclusion or exclusion criteria were developed for the initial components which, due to an academic form of path dependency, have mostly remained the components parts of GPI. Rather, it appears that the collection of components was pulled from the preferences, values, data availability, and context of the creators, e.g., the inclusion of forest but not desert land. This lack of transparency and clarity is particularly troubling when trying to justify the choice for the 6 economic, 9 social, and 10 environmental components or defend the balance of 7 benefits and 18 costs. The process appears to be arbitrary without a theoretical touchstone to substantiate it; ideally, what is included as a cost or a benefit is a consistent, theory-based choice implemented with statistical standards.

The OECD recognizes that composite indicator development involves stages where subjective judgments must be made especially in the selection of component parts (OECD, 2008). But these judgments are made more transparent by an explicit theoretical framework. Even the U.S. GPI community of practice could not agree on what touchstone to use with divergences on whether to use key words such as “sustainability,” “well-being,” “welfare” in the definition of GPI. These experts do not agree on a clear definition of what is being measured; according to the OECD handbook this is a problem for the relevance, legitimacy, and interpretability of GPI (OECD, 2008).

Arriving at a consensus for a theoretical foundation of an indicator of sustainability is a challenge because the concept of “sustainability” is at best ambiguous (a reason that some in GPI U.S. CoP were weary of using it), simultaneously being defined in many fields, e.g., economics, public policy, ethics, biological and social sciences. Indeed, the verb, ‘to sustain,’ connects a subject, the one who is doing the sustaining, to an object, the thing being sustained. However, as a noun, “sustainability” must contain both the subject and the object, the “who” and the “what” within its definition. Thus, there are a variety of ways that “sustainability” can be constructed, a plethora of “who” and “what” combinations – this is where the ambiguity lies. A sound theoretical framework for GPI would declare choices about the combination of “who and what” which should point to possible logical economic, social and environmental dimensions to be included. In the construction of a more transparent and cohesive theoretical framework for GPI there is also the opportunity to connect GPI methodology to theories that challenge welfare economics including socio-ecological systems theory, feminist theory, and stakeholder theory.

This theoretical framework ought not be selected by a single individual. As design thinking thought leaders Brown and Martin (2015) suggest, “If [a designer] simply imposed his own ideas, buy-in would depend largely on his authority – not a context conducive to social transformation” (p. 7). Both best practices in design theory and the OECD handwork mandate the involvement of experts and stakeholders at this step. Therefore, it would be incongruent with this philosophy to suggest a new or revised theoretical framework in this paper. Ideally, a diverse design team would endeavor to understand the users’ needs, priorities and perspectives. Certainly, an obvious way to do this would be to explicitly include users in the process. An official inclusive process is in alignment with the participatory philosophy of ecological economics and could not only produce consensus on a theoretical foundational for GPI, but may also lead to buy-in and prompt the problem and political streams necessary for GPI adoption. As Senge (2008) argues, “Bringing about significant changes in larger systems requires building […] networks connecting many different organizations, and even different types of organizations” (p. 225).

Fortunately, design theory recognizes that it is rare to get a prototype “right” in the first iteration – GPI is not beyond repair, it is simply the first iteration. In fact, GPI can be seen itself as an iteration of GDP, both suffering from a top-down development process. While it would be contrary to the spirit of inclusion and the best practices of design to offer a fully formed “new GPI,” there are some key design principles that should be considered in that process:

1) Champion inclusion, collaboration, and diversity in the design process;
2) Prioritize creating a transparent governance process;
3) Commit to a theoretical framework;
4) Seek comparability between outcomes;
5) Highlight policy lever and policy relevance; and
6) Maintain ease of comparability with GDP.

GPI may be viewed as a transition tool away from the GDP paradigm that rewards and spurs consumption towards an outlook that recognizes and considers the impact of consumption on Earth’s life-support system and the human psyche. A helpful path-dependence analogy is comparing GDP to coal and GPI to natural gas. GPI may be viewed as a bridge to a new low-consumption, systems-thinking paradigm as natural gas is often painted as a bridge-fuel away from coal towards a lower carbon energy future. However, despite its lower carbon footprint, natural gas is still a fossil fuel like coal. Likewise, despite its inclusion of social and environmental components, GPI is still a consumption-based metric like GDP. This of course is both the strength and the weakness of natural-gas and GPI. Because they sit at the edge of the dominant paradigm they are easier, faster, and simpler to adopt in the short-term, but they do not immediately shift the paradigm. They do not serve to directly push the strongest leverage point in the system: the birth of a new paradigm. However, as Senge (2008) reminds us in systems thinking, “… an ultimate solution is exactly what is not needed. No one had a plan for the industrial revolution. No ministry was put in charge. No single business led the way. Instead, countless acts of initiative and daring created a critical mass of unstoppable changes" (p. 11).

Nudges, like new metrics, still shift how resources are allocated in a system and may 'slow the bleeding' enough to generate the occasion and fodder for a more foundational shift. Perhaps the increased global generation of sustainability metrics can be seen as an indication of a foundational shift brewing. After all, a new metric goal is a leverage point for change in a system. Perhaps the proliferation of these metrics is itself an illustration of a watershed paradigm shift, a new zeitgeist. Indeed, incremental progress ought not be dismissed as useless or insignificant. In aggregate, even small re-directions in a system that comes from multiple scales and spheres shifts the trajectory towards a new future.

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Appendix A: GPI and Component Results for Each State in Billions of U.S. Dollars (2011)

(Billions of $, 2011)	US	AL	AK	AZ	AR	CA	CO	CT	DE	FL	GA	HI	ID
GPI	5,378	(8)	47	105	(0)	890	106	104	20	362	111	40	29
PCE	10,689	136	25	222	80	1,405	178	150	34	695	305	51	49
Cost Inequality	2,452	32	3	48	18	351	38	39	6	173	74	8	8
Benefits Consumer Durables	1,940	25	5	34	15	251	33	32	6	116	54	8	8
Cost Consumer Durables	1,125	14	3	20	9	144	19	18	3	65	31	5	5
Cost Underemployment	433	5	1	9	3	79	8	6	1	26	14	2	2
Net Capital Investment	258	0	0	0	0	0	0	0	0	0	0	0	0
Cost Water Pollution	45	0	0	0	0	8	0	0	0	4	1	0	0
Cost Air Pollution	15	0	-	0	0	6	0	0	0	0	1	-	-
Cost Noise Pollution	32	0	0	1	0	4	1	0	0	2	1	0	0
Cost Net Wetland Change	(3)	3	(45)	1	2	1	0	0	0	4	1	0	0
Cost Net Farmland Change	239	6	(0)	5	5	37	4	2	1	11	14	1	4
Cost Net Forest Cover Change	69	3	1	(2)	5	(1)	(3)	1	0	5	4	(0)	1
Cost Climate Change	776	19	5	13	10	49	12	5	2	33	23	3	2
Cost Ozone Depletion	627	10	1	13	6	76	10	7	2	38	20	3	3
Cost Nonrenewable Energy Depletion	2,541	67	17	47	32	171	37	21	6	108	73	8	7
Benefits Housework	2,135	29	5	40	17	281	35	28	6	123	58	14	9
Cost Family Changes	67	1	0	1	1	8	1	1	0	4	2	0	0
Cost Crime	78	1	0	2	1	10	1	1	0	5	3	0	0
Cost Personal Pollution Abatement	74	1	0	2	1	9	1	1	0	5	2	0	0
Benefits Volunteer Work	177	2	0	4	1	25	3	2	1	10	5	1	1
Cost Lost Leisure Time	689	8	2	13	5	89	13	10	2	37	20	3	3
Benefits Higher Education	1,226	15	3	23	8	155	26	18	4	72	36	6	5
Benefits Highways and Streets	235	6	1	4	6	10	5	1	0	7	7	0	3
Cost Commuting	410	5	1	7	2	57	7	6	1	21	12	2	1
Cost Motor Vehicle Crashes	1,611	45	4	41	27	139	22	11	5	119	61	5	8

(Billions of $, 2011)	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO
GPI	220	42	31	32	6	(48)	27	155	226	154	113	(1)	72
PCE	445	201	96	88	127	148	48	226	296	308	193	84	194
Cost Inequality	105	38	16	17	30	37	10	43	72	67	36	20	42
Benefits Consumer Durables	87	36	18	17	22	25	8	45	53	58	35	14	35
Cost Consumer Durables	49	20	11	10	13	15	4	26	31	31	21	8	20
Cost Underemployment	20	8	3	3	5	4	2	8	11	15	7	3	7
Net Capital Investment	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost Water Pollution	2	1	1	1	1	1	0	1	1	1	1	1	1
Cost Air Pollution	0	0	-	0	0	0	0	0	0	0	0	0	0
Cost Noise Pollution	1	1	0	0	0	0	0	1	1	1	0	0	1
Cost Net Wetland Change	1	1	1	0	0	3	1	0	0	2	3	2	1
Cost Net Farmland Change	6	7	7	3	3	2	2	3	1	7	7	7	4
Cost Net Forest Cover Change	3	6	1	(0)	4	4	0	1	1	5	4	3	5
Cost Climate Change	32	29	12	10	20	33	4	9	9	22	13	9	19
Cost Ozone Depletion	26	13	6	6	9	9	3	12	13	20	11	6	12
Cost Nonrenewable Energy Depletion	123	79	35	32	55	106	8	31	32	76	43	31	54
Benefits Housework	92	40	20	17	27	27	9	41	59	71	38	17	37
Cost Family Changes	3	1	1	1	1	1	0	1	1	2	1	1	1
Cost Crime	4	2	0	1	1	2	0	2	1	3	1	1	2
Cost Personal Pollution Abatement	3	2	1	1	1	1	0	1	2	2	1	1	1
Benefits Volunteer Work	8	3	2	1	2	2	1	4	5	6	3	1	3
Cost Lost Leisure Time	30	13	7	6	8	8	3	17	19	20	14	5	12
Benefits Higher Education	55	20	11	12	13	13	6	30	37	35	24	8	22
Benefits Highways and Streets	8	6	7	8	5	4	1	2	2	7	8	4	8
Cost Commuting	20	7	3	3	4	5	1	12	13	11	7	2	6
Cost Motor Vehicle Crashes	46	37	18	19	36	34	7	24	17	44	18	31	39

(Billions of $, 2011)	MT	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA
GPI	13	23	65	35	230	17	547	118	(6)	160	20	93	199
PCE	35	59	93	51	357	65	759	296	25	359	116	135	438
Cost Inequality	6	11	19	9	83	16	215	69	5	77	25	29	95
Benefits Consumer Durables	5	11	16	9	72	10	149	52	4	68	21	22	83
Cost Consumer Durables	3	7	9	5	40	6	87	30	3	38	13	13	48
Cost Underemployment	1	1	5	1	15	2	28	13	0	14	3	6	15
Net Capital Investment	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost Water Pollution	0	0	0	0	2	0	2	1	0	3	1	1	1
Cost Air Pollution	-	-	0	0	0	0	0	0	-	0	0	0	0
Cost Noise Pollution	0	0	0	0	1	0	2	1	0	1	0	0	1
Cost Net Wetland Change	0	1	0	0	0	0	0	2	1	1	1	0	0
Cost Net Farmland Change	1	2	1	1	2	1	9	17	1	7	1	3	7
Cost Net Forest Cover Change	(1)	(0)	(3)	0	1	(3)	3	5	(0)	6	0	0	4
Cost Climate Change	4	7	5	2	16	8	23	18	7	32	15	6	34
Cost Ozone Depletion	2	4	5	3	18	4	39	19	1	23	8	8	26
Cost Nonrenewable Energy Depletion	12	22	16	10	61	23	89	63	19	97	45	16	125
Benefits Housework	6	11	24	10	65	13	188	59	4	77	22	27	90
Cost Family Changes	0	0	1	0	2	0	4	2	0	3	1	1	3
Cost Crime	0	0	1	0	2	1	4	2	0	3	1	1	3
Cost Personal Pollution Abatement	0	0	1	0	2	0	5	2	0	3	1	1	3
Benefits Volunteer Work	0	1	1	1	6	1	13	5	0	6	2	2	7
Cost Lost Leisure Time	2	4	5	3	23	4	51	19	2	24	7	8	29
Benefits Higher Education	4	7	9	6	44	7	91	36	2	40	12	16	49
Benefits Highways and Streets	4	5	2	1	2	4	7	6	5	7	6	3	7
Cost Commuting	1	2	3	2	17	2	42	10	1	12	3	4	17
Cost Motor Vehicle Crashes	10	9	12	4	31	18	58	61	7	51	35	16	64

(Billions of $, 2011)	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
GPI	28	29	18	68	137	45	15	175	193	(11)	93	(19)
PCE	38	143	28	198	785	84	23	293	261	57	186	19
Cost Inequality	9	32	5	48	191	13	4	65	49	13	32	2
Benefits Consumer Durables	7	23	5	35	143	14	4	56	44	9	35	4
Cost Consumer Durables	4	14	3	20	90	8	2	33	26	5	20	2
Cost Underemployment	2	6	1	7	29	3	1	9	12	2	7	1
Net Capital Investment	0	0	0	0	0	0	0	0	0	0	0	0
Cost Water Pollution	0	0	0	1	2	0	0	1	1	0	1	0
Cost Air Pollution	0	0	-	0	3	0	0	0	-	0	0	0
Cost Noise Pollution	0	0	0	1	3	0	0	1	1	0	1	0
Cost Net Wetland Change	0	1	0	0	3	0	0	0	0	0	2	0
Cost Net Farmland Change	0	4	1	4	8	1	2	4	4	1	10	1
Cost Net Forest Cover Change	0	2	(0)	4	(8)	(4)	0	3	1	1	4	1
Cost Climate Change	1	12	2	15	103	9	1	14	10	13	14	9
Cost Ozone Depletion	2	9	2	13	52	6	1	16	14	4	12	1
Cost Nonrenewable Energy Depletion	5	49	6	49	329	25	4	49	29	34	43	23
Benefits Housework	8	29	5	38	146	16	5	52	51	12	37	4
Cost Family Changes	0	1	0	2	5	1	0	2	2	0	1	0
Cost Crime	0	2	0	2	6	0	0	1	1	0	1	0
Cost Personal Pollution Abatement	0	1	0	1	6	1	0	2	2	0	1	0
Benefits Volunteer Work	1	2	0	3	13	1	0	5	4	1	3	0
Cost Lost Leisure Time	3	8	2	12	55	6	2	21	17	3	13	1
Benefits Higher Education	5	16	3	21	89	10	3	40	31	5	21	2
Benefits Highways and Streets	0	4	5	5	18	3	1	4	5	2	7	2
Cost Commuting	1	4	1	7	30	3	1	13	10	2	6	1
Cost Motor Vehicle Crashes	3	41	6	47	150	12	3	38	23	17	29	7

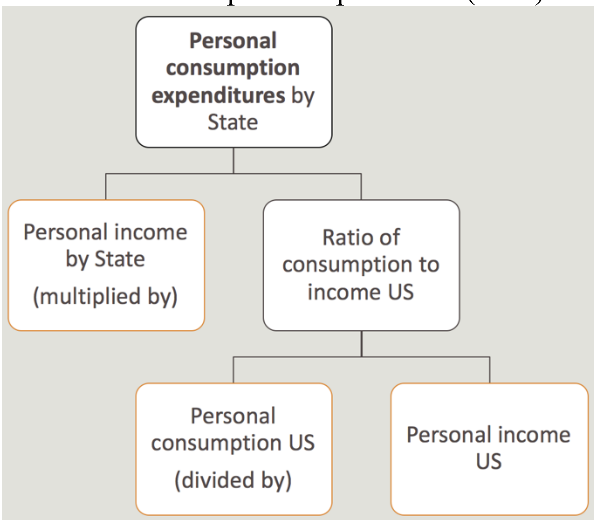
Appendix B: Benefit and Cost Components' Descriptive Statistics

BENEFIT Component	Mean	Median	Standard Dev	Max (Good)	State (Good)	Min (Bad)	State (Bad)
GPI	16430	16968	14490	65419	AK	-31773	WY
Personal Consumption	33980	34274	3730	44787	MA	27227	AR
Housework	6737	6434	984	9956	HI	5653	UT
Ben. Consumer Durables	6061	5929	915	8812	CT	4786	MS
Streets and Highways	1301	858	1361	7303	ND	184	HI
Higher Ed	3871	3713	717	5568	MA	2658	MS
Volunteer	545	527	69	711	MA	431	MS

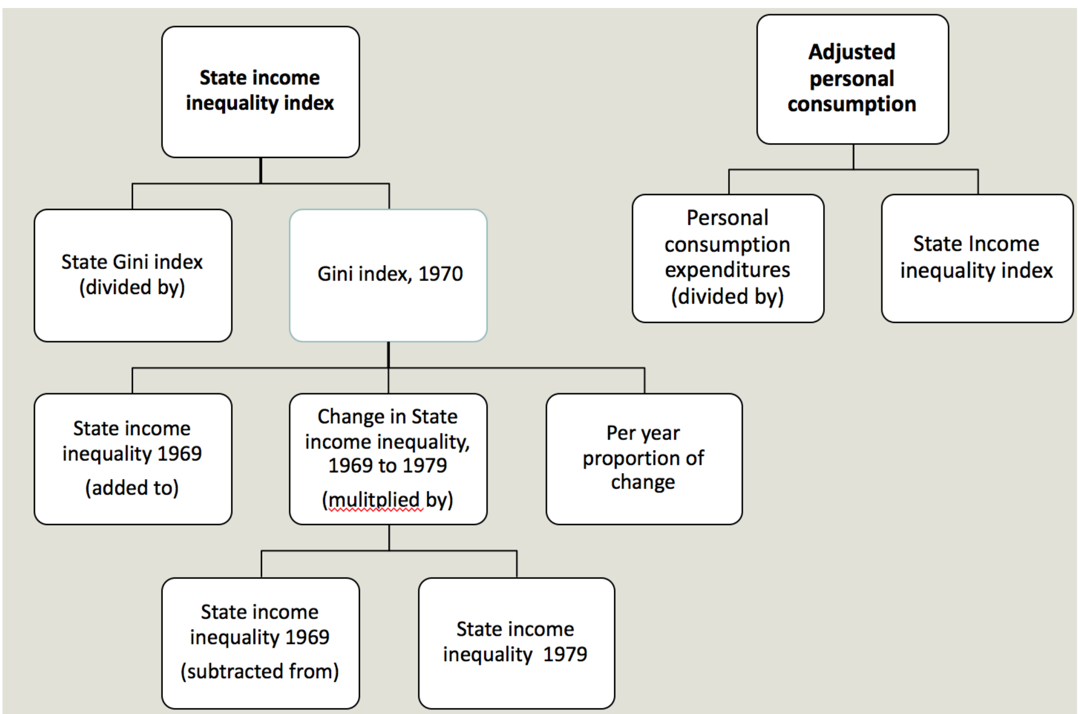
COST Component	Mean	Median	Standard Dev	Max (Bad)	State (Bad)	Min (Good)	State (Good)
NonRenewables	9969	7754	6697	41331	WY	4111	OR
Car Crashes	5890	5175	2360	11850	WY	2540	MA
Climate Change	3197	2470	2468	14983	WY	1160	NY
Inequality	7072	6969	1498	11008	NY	3957	WY
Cost Consumer Durables	3552	3501	526	4947	CT	2758	MS
Forest	256	287	651	1824	AR	-1631	NM
Farmland	893	693	618	2594	VT	-4	AK
Commuting	1182	1092	333	2135	NY	726	SD
Lost Leisure	2183	2134	344	2903	MA	1531	MS
Underemployment	1245	1191	318	2091	CA	563	ND
Wetlands	-1046	103	8896	1296	ND	-62666	AK
Crime	236	229	78	467	LA	121	VT
Water	139	148	55	222	HI	14	ME
Personal Pollution	239	239	24	302	NV	187	UT
Air	26	22	29	149	CA	0	-
Family Change	223	223	20	268	AR	192	IA
Noise	93	93	18	120	NJ	49	ME

Appendix C: Component Calculation Composition Diagrams
(Modified Graphics by Matt Burke)

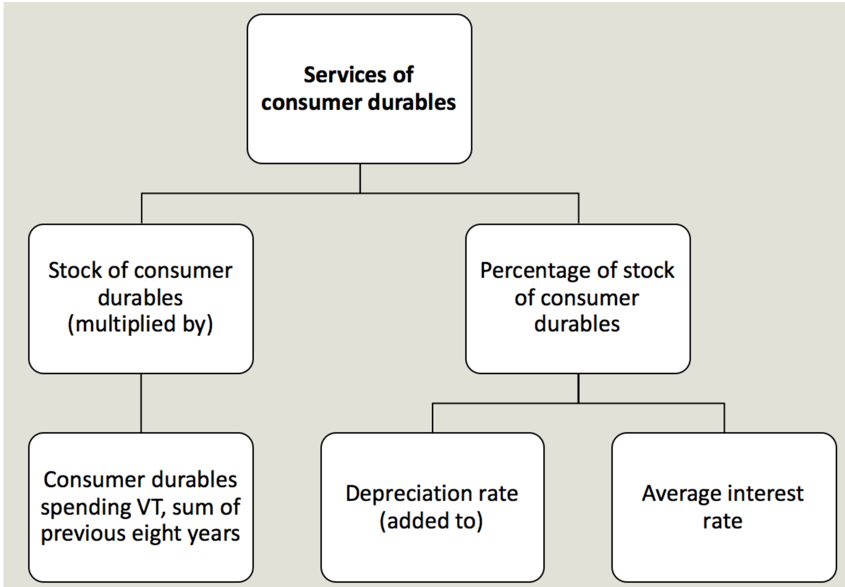
Personal Consumption Expenditure (PCE)



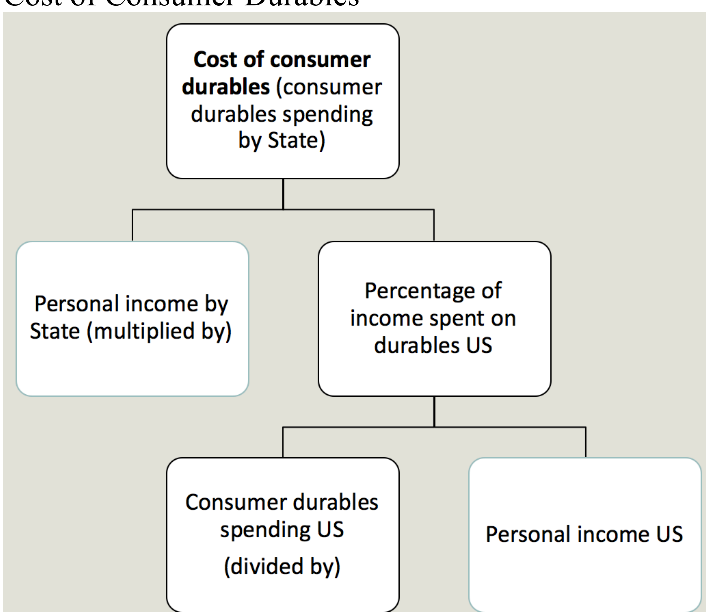
Inequality



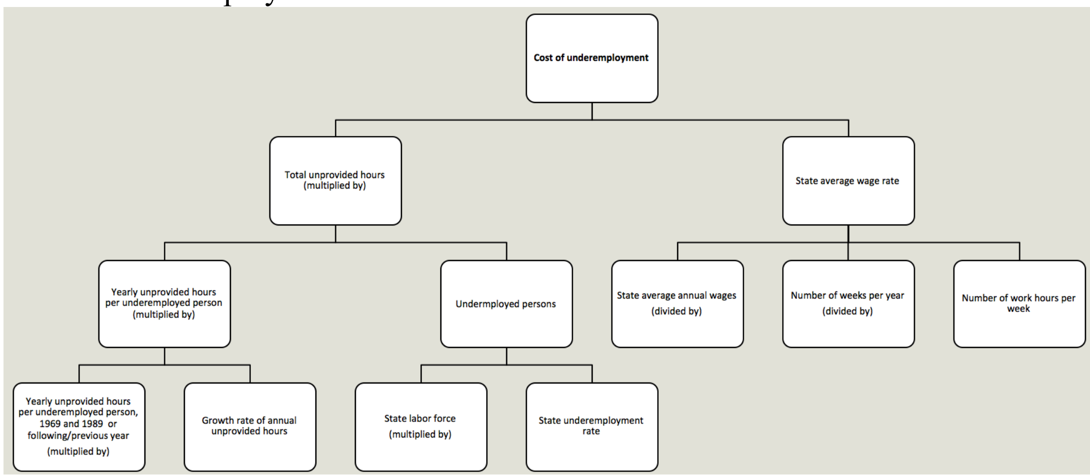
Benefits of Consumer Durables



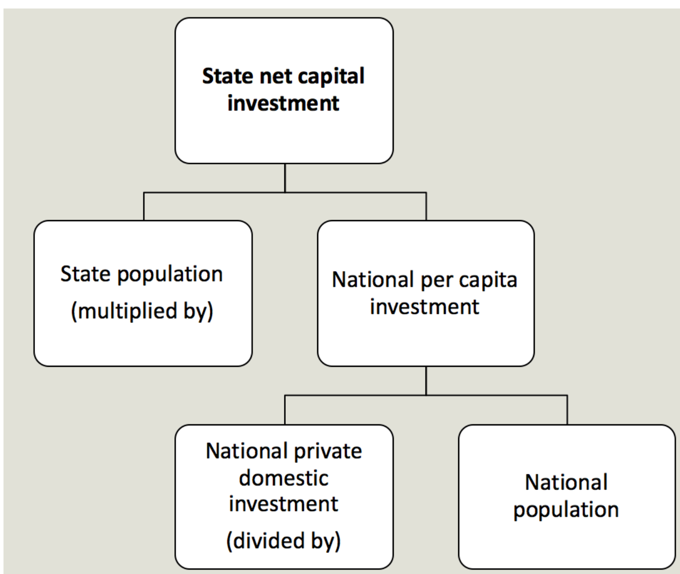
Cost of Consumer Durables



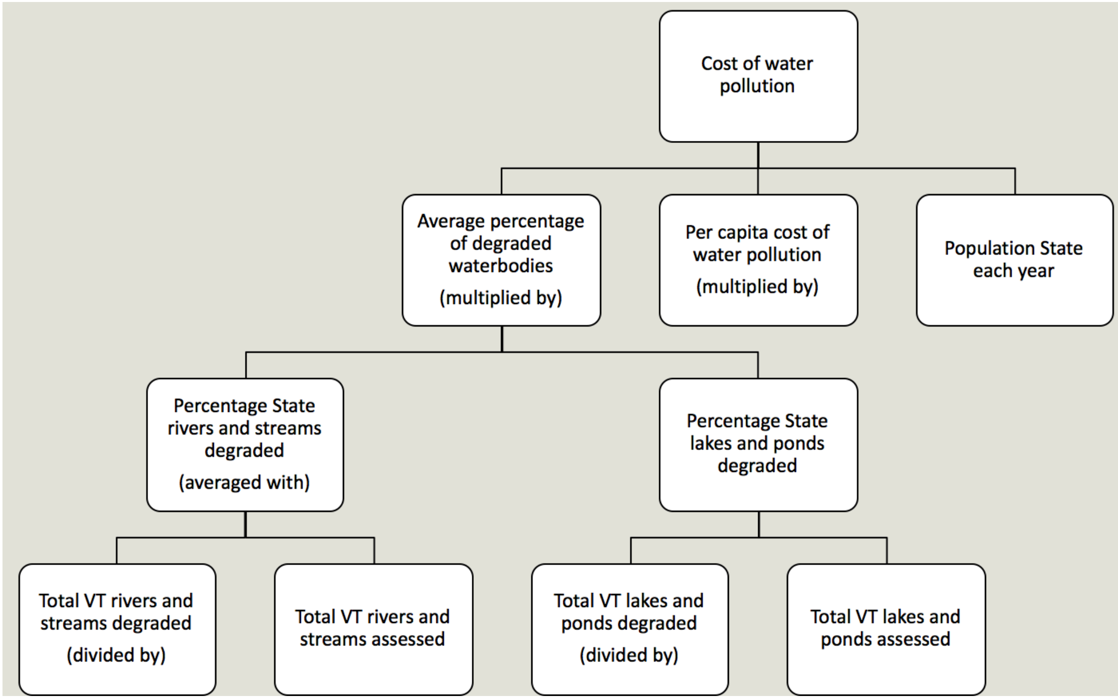
Cost of Underemployment



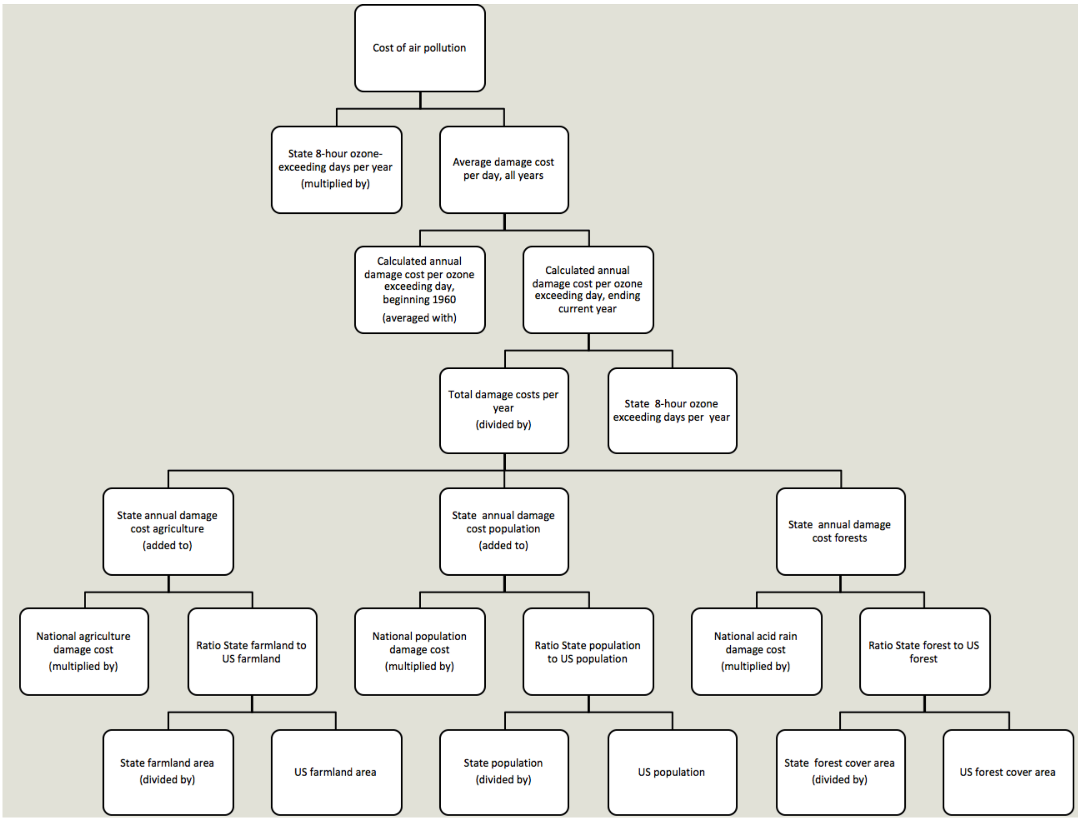
Net Capital Investment



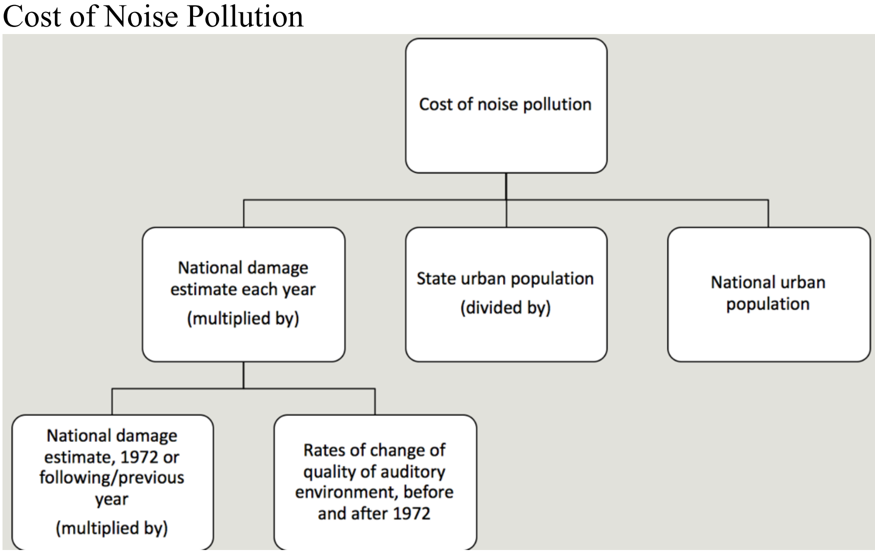
Water Pollution



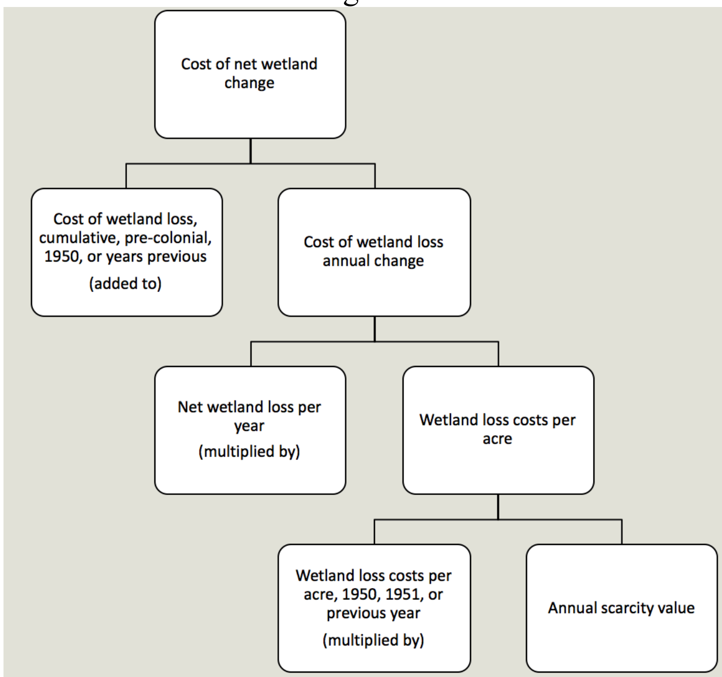
Cost of Air Pollution



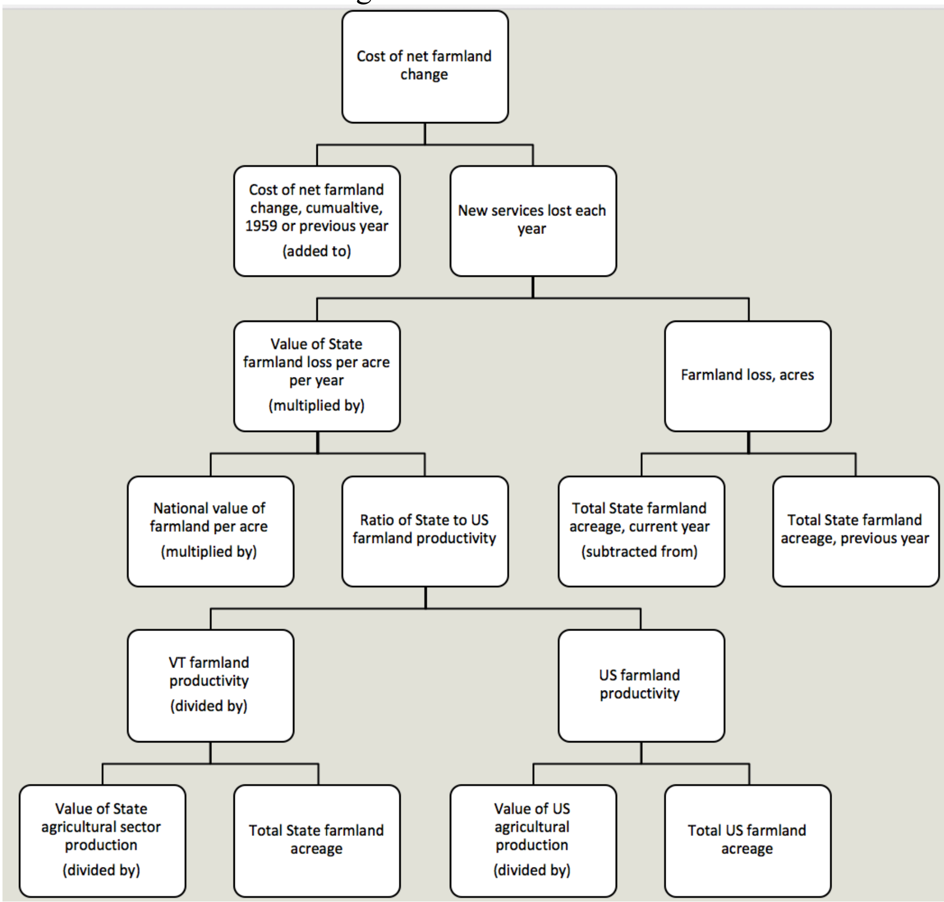
Cost of Noise Pollution



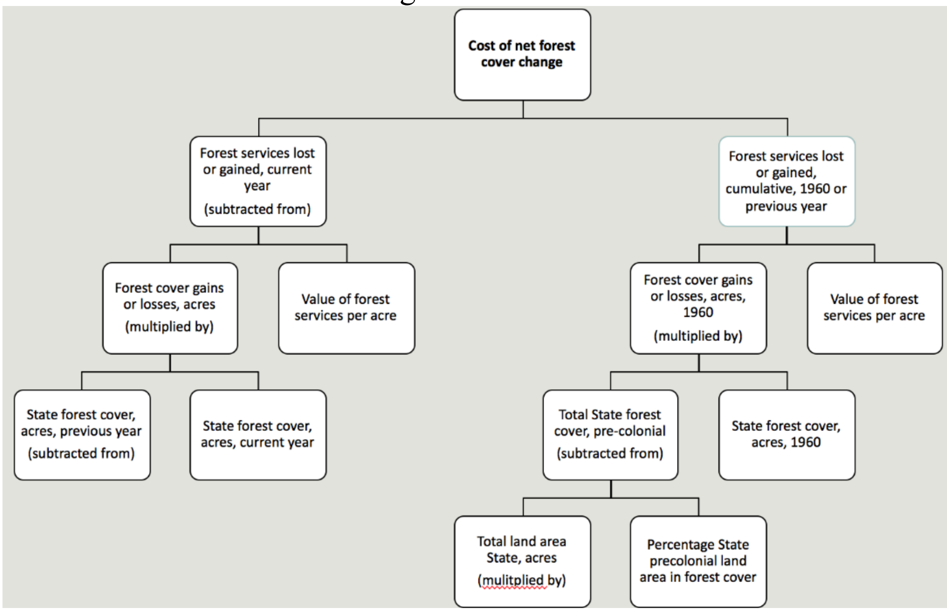
Cost of Net Wetland Change



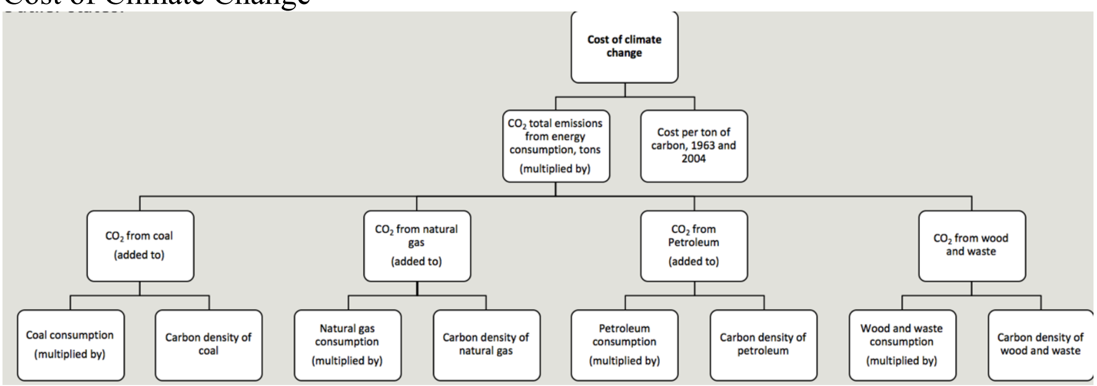
Cost of Net Farmland Change



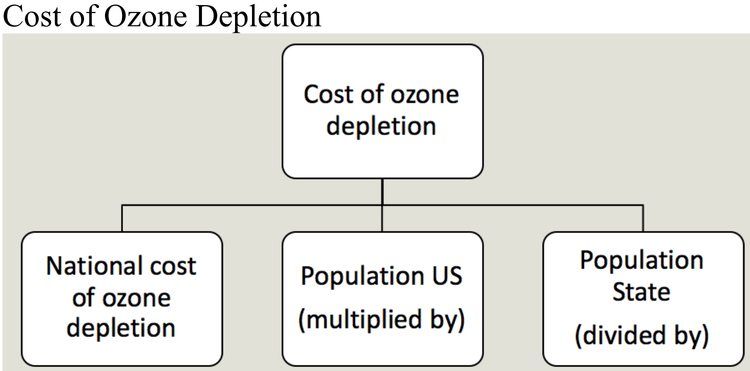
Cost of Net Forest Cover Change



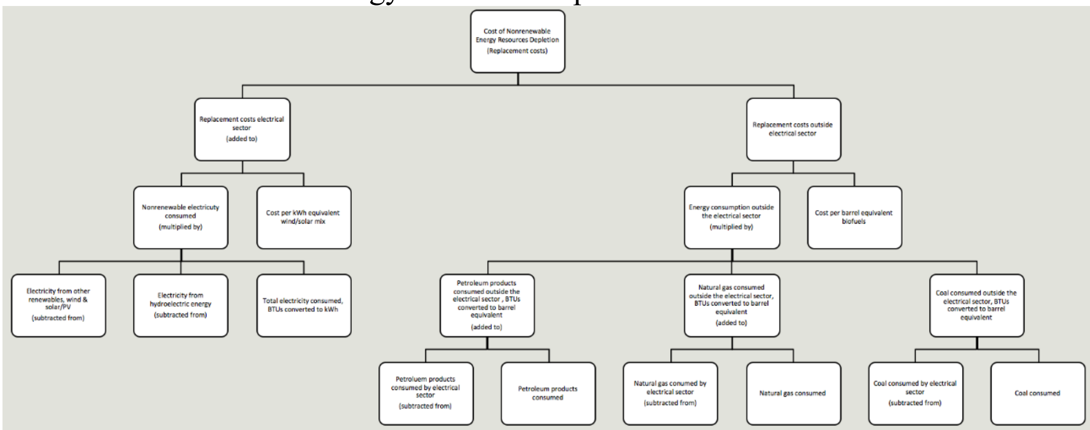
Cost of Climate Change



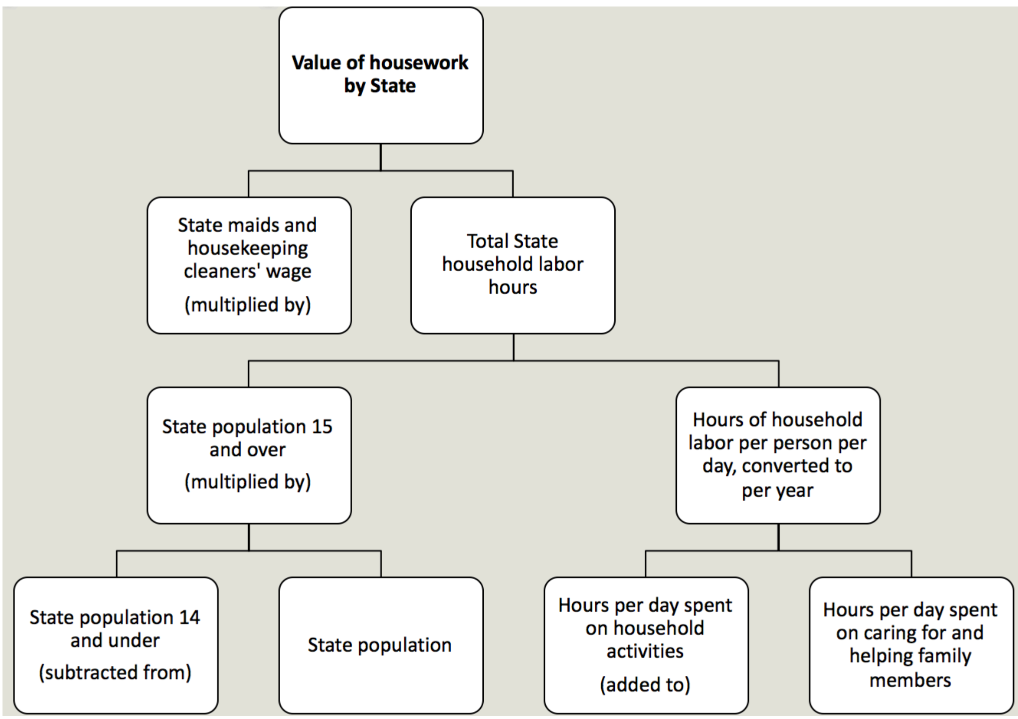
Cost of Ozone Depletion



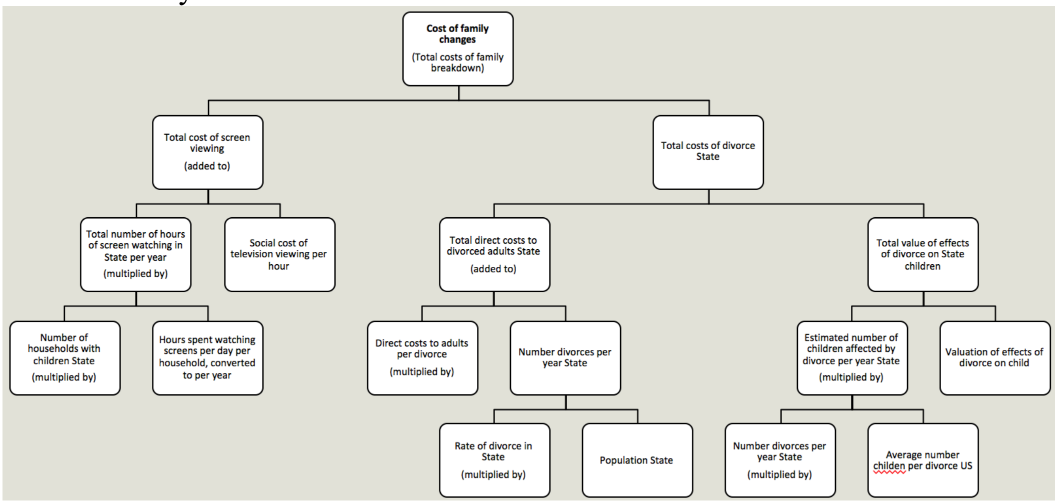
Cost of Non-renewable Energy Resource Depletion



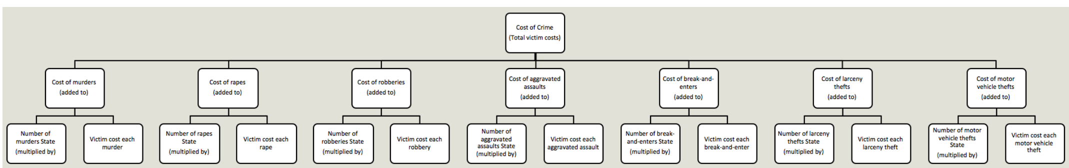
Benefits of Housework



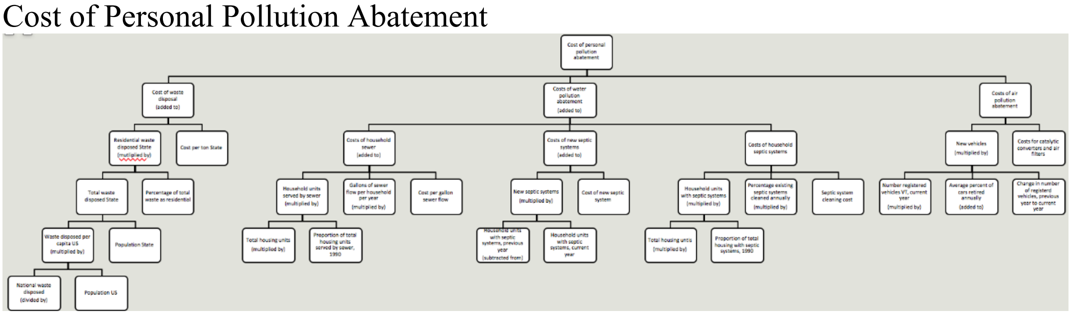
Cost of Family Breakdown



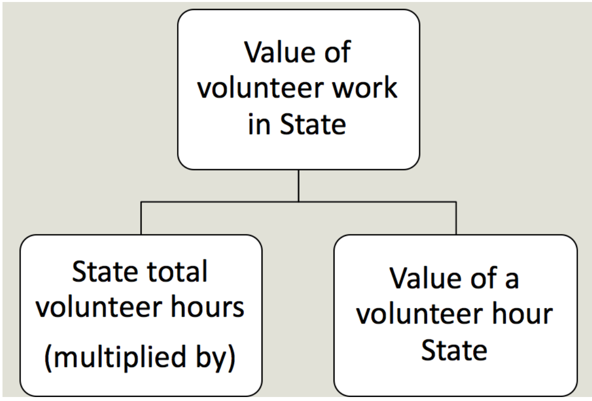
Cost of Crime



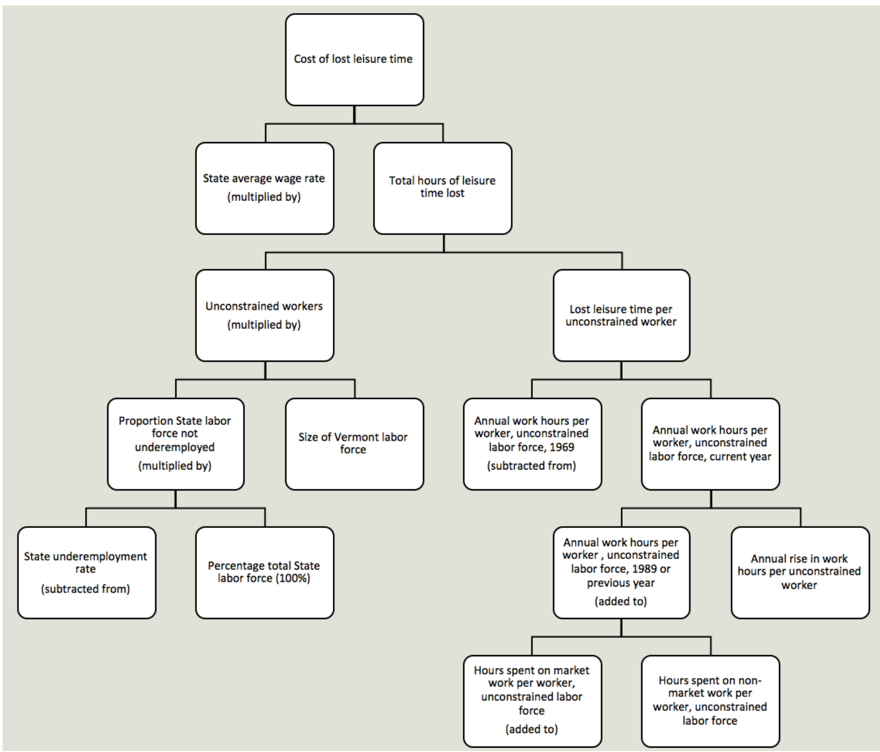
Cost of Personal Pollution Abatement



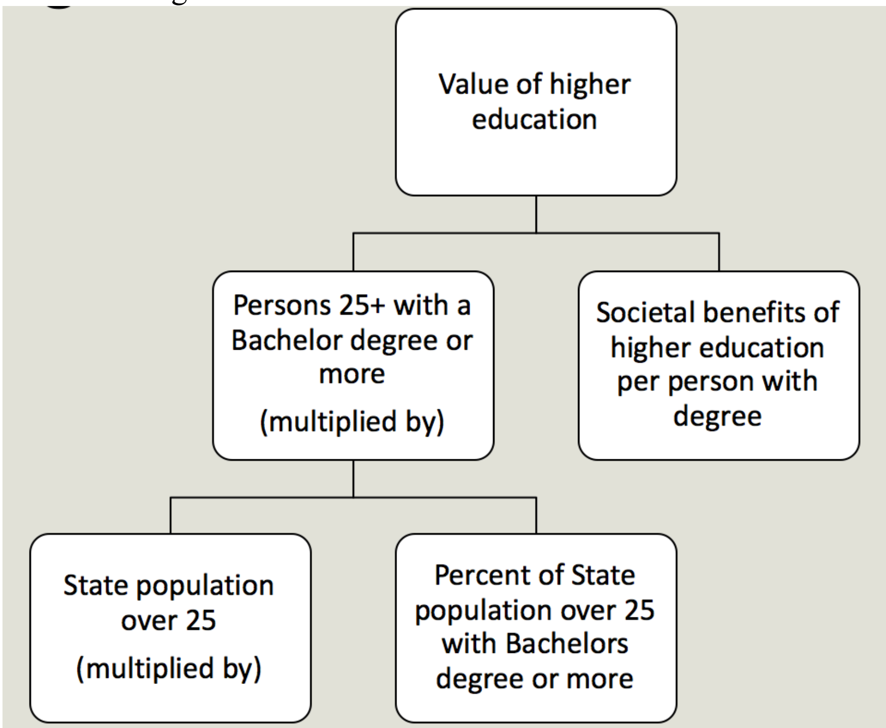
Benefit of Volunteer Work



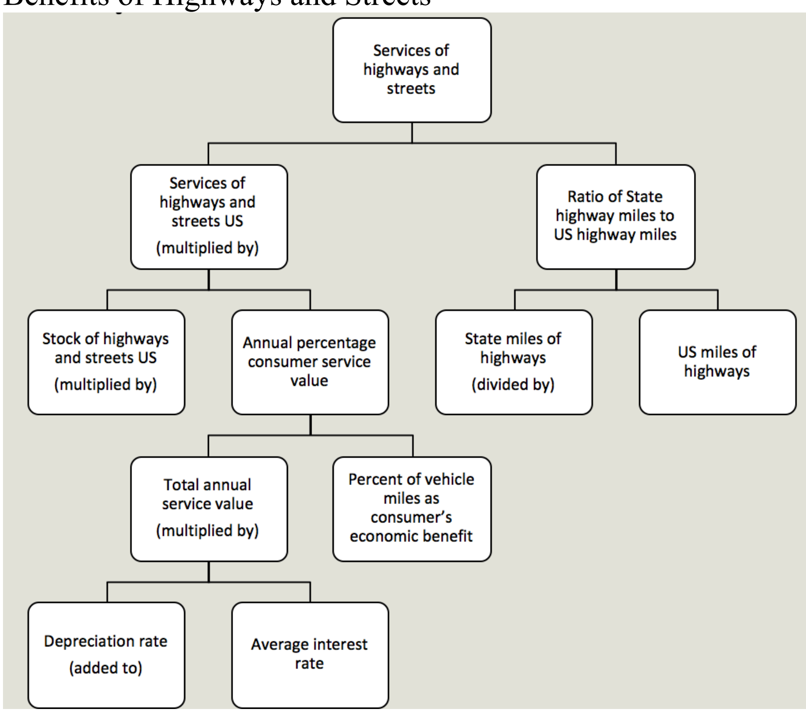
Cost of Lost Leisure



Benefit of Higher Education



Benefits of Highways and Streets



Cost of Commuting