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Analysis

Genuine Progress Indicator 2.0: Pilot Accounts for the US, Maryland, and City of Baltimore 2012–2014

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ABSTRACT

For over thirty years the Genuine Progress Indicator (GPI) has been used to evaluate economic performance, quantify benefits and costs of growth, and predict effects of policy changes on economic wellbeing. The popularity and use of the metric is increasing partially in response to new global demands for metrics that go beyond Gross Domestic Product (GDP). However, because the basic GPI accounting protocols have yet to be consistently updated to respond to theoretical critiques, new valuation methods, and new data sources a proliferation of studies at the global, national and sub-national level contain widely divergent methodologies. Because of this, GPI practitioners have called for a new, consistent framework to guide future GPI studies – GPI 2.0. This paper is an attempt to operationalize some of the concepts that have emerged from GPI 2.0 deliberations online and at recent workshops in the form of GPI 2.0 pilot accounts for the US, State of Maryland, and City of Baltimore. The goal is to demonstrate the feasibility of multi-scale GPI accounts that provide a more accurate measure of current economic welfare than GDP and that incorporate new methods and sources of information to replace many of the outdated aspects of the prevailing GPI approach.

1. Introduction

The Genuine Progress Indicator (GPI) remains one of the most ubiquitously applied alternatives to Gross Domestic Product (GDP) in sustainable development research and policy settings. Unlike GDP and related measures that have a dubious connection to economic welfare, the GPI attempts to measure it directly by accounting for the benefits of both market and nonmarket goods and services as well as the economic, social, and environmental costs of economic activity. Pioneered by Herman Daly and John Cobb in 1989, the basic structure and calculation methods for the GPI (known originally as the Index of Sustainable Economic Welfare) have changed relatively little despite theoretical refinements that have been suggested in recent literature and a proliferation of new methods and sources of data for many of the GPI's basic adjustments.

Recent GPI studies have been completed at multiple scales including the world as a whole (Kubiszewski et al., 2013), at the country level for Japan (Hayashi, 2015), Brazil (Andrade and Garcia, 2015) and Italy (Armiento, 2016), at the state or province level for Liaoning Province (Hou, 2016), Oregon (Kubiszewski et al., 2015), Hawaii (Ostergaard-Klem and Oleson, 2014), northeast Ohio (Bagstad and Shammin, 2012), Maryland (McGuire et al., 2012), Utah (Berik and Gaddis, 2014), Vermont (Erickson et al., 2013), Flanders (Bleys, 2013) and Tuscany (Pulselli et al., 2012) and at the city level for Baltimore (Posner and Costanza, 2011; Talberth and Weisdorf, 2014), Hong Kong (Delang and Yu, 2015), Singapore (Delang and Yu, 2015) and a group of six cities in China (Li et al., 2016). While all these studies replicate core elements of the original methodology, they also reflect a wide divergence in some important details, for example, regarding whether nor not to include the social cost of carbon emissions or assign value to the spillover benefits of higher education.

At the same time, the GPI and other sustainability indicators are facing increasing demands for use in justifying green economy interventions, monitoring economic performance, and guiding public budgets and investments. The outcome document "The Future We Want" from the 2012 Rio + 20 Conference on Sustainable Development plus a set of Sustainable Development Goals adopted by the UN highlight the urgency of using robust quantitative sustainability metrics that go beyond GDP (Bartelmus, 2013). In response to these new demands and to help ensure that the GPI remains policy relevant practitioners worldwide have called for greater consistency and a uniform framework to guide future GPI studies – GPI 2.0 (Bagstad et al., 2014).

There are several theoretical and methodological issues that GPI 2.0 ought to resolve. Among the most fundamental is the question of what the GPI is intended to measure and what purpose it serves. Is the GPI a measure of sustainability, a measure of current welfare, or a bit of both?

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What role can it play in economic policy making? Another significant issue is the basis for valuation. The existing literature offers ambiguous and sometimes conflicting guidance for assigning monetary values to various positive and negative adjustments that are nonmarket in nature. GPI 2.0 should establish a uniform protocol for this.

Bagstad et al. (2014) provide a thorough review of methodological issues GPI 2.0 should address and propose a list of modifications, many of which have already appeared in one or more recent studies. Among the most significant include inversion of certain adjustments (ecosystem services and leisure) to measure benefits remaining rather than costs of depletion, development of a less arbitrary adjustment for income inequality, removal of certain indicators that lack a solid theoretical basis, and adoption of more rigorous metrics for calculation of others.

On December 19th, 2013 Center for Sustainable Economy launched an online discussion forum to engage the community of GPI researchers and practitioners worldwide on these theoretical and methodological challenges in order to more thoroughly explore alternatives for GPI 2.0. Center for Sustainable Economy (CSE) is a non-profit environmental economics think tank based in Portland, Oregon. Among other issues, CSE specializes in sustainability indicators, including the GPI, and their application in policy settings.[1] The forum is still active, and, to date has engaged fifty-two researchers, practitioners, and public agency partners with varying degrees of involvement and experience with the GPI. Detailed technical papers were submitted and discussed, as well as lengthy posts on 22 distinct topics that were grouped under headings such as definition, architecture, externalities, human capital, local scale adaptations, inequality adjustment and column-by-column methods and data sources. In addition to these online discussions, the Gund Institute for Ecological Economics at the University of Vermont and think tank Demos hosted GPI 2.0 workshops during this period. This paper attempts to operationalize some of the consensus that emerged from these discussions. It addresses both theoretical and methodological issues with conventional GPI accounting and presents a set of pilot accounts for the United States, State of Maryland, and City of Baltimore that incorporates specific refinements discussed in detail. The pilot accounts also include suggested refinements that have yet to be discussed at length, but which could serve as a platform for future research.

The remainder of this paper is organized as such. In Section 2, we revisit some of the theoretical foundations of the GPI and make suggestions for refining its definition and purpose, valuation basis and mathematical representation. In Section 3 we provide an overview of suggested components and high-level indicators for GPI 2.0 and highlight major differences from conventional GPI accounting at this conceptual level. Important finer-scale differences from conventional GPI accounts are discussed in detail in Appendices A and B. In Section 4 we present and discuss results. In Section 5, we conclude by discussing how this suggested framework, if adopted, could be further improved and identify several important areas where consensus should be sought before a GPI 2.0 methodology can be fully embraced.

2. Theoretical Refinements

The GPI's theoretical foundations have been thoroughly articulated and defended, primarily by Daly (1979), Daly and Cobb (1994) and Lawn (2003, 2008). But connecting the dots between this theoretical foundation and actual components, indicators, and metrics used in many GPI studies has been a somewhat less rigorous undertaking – a shortcoming that has helped fuel the trend towards divergent methodologies (Bagstad et al., 2014) as well as a number of criticisms about the GPI's apparent arbitrariness (e.g. Neumayer, 1999, 2000). In this section we flag three theoretical aspects that could benefit from additional refinement and describe where we landed for each in the context of the GPI 2.0 pilot accounts.

2.1. Definition and Purpose

Throughout its history, a precise definition of the GPI has eluded practitioners. Despite the GPI's prominence in sustainability indictor applications, there has never been a clear consensus on how the metric is defined, what purposes it serves, and what basic architecture is thus justified for organizing its various components. Since its inception, the GPI has been variously defined as (1) an index of sustainable economic welfare, most closely aligned with the notion of maximum sustainable income defined by Hicks (1946); (2) an experiential social welfare measure based on the concept of net psychic income as set forth by Fisher (1906), or; (3) a "somewhat ad hoc" collection of indicators that provide useful information about both current welfare and sustainability not presently reflected in national income and product accounts (Hanley et al., 1999). This definitional murkiness, in turn, has led to various mathematical representations, such as those displayed in Fig. 1. While there are many common elements, these expressions have many important differences in their treatment of government expenditures, changes in capital stocks, and types of capital addressed by each. A precise definition will help resolve these differences.

While wordsmithing is somewhat of an art, we believe that the theoretical foundations of the GPI require that any proposed definition capture four basic attributes, or restrictions (1) an emphasis on final consumption of both market and nonmarket goods and services by a given (geographically specified) population; (2) an emphasis on current economic welfare generated by that consumption; (3) a restriction that all benefits and costs tabulated in GPI accounts be causally related to economic activity, and (4) a restriction that monetization of all adjustments be carried out using peer reviewed methods, consistent valuation rules, and best available data. Restriction 1 makes it clear that the most important purpose of the GPI is to tell us about the condition of individuals and households within a given economy in terms of economic welfare as experienced as opposed to other economic dimensions measured by gross domestic product, stock indices, trade balances and such. Of four fundamental economic activities – production, consumption, trade and investment – it emphasizes consumption because here is where the rubber meets the road from an economic welfare perspective. As succinctly stated by Daly and Cobb (1994, p. 77)) "GNP is a measure of production, not consumption, whereas economic welfare is a matter of consumption." Benefits and costs associated with other economic activities factor in GPI assessments, but solely in terms of how they ultimately affect the welfare derived from consumption.

Restriction 2 reflects what appears to be a growing consensus among practitioners that the GPI cannot measure both sustainability and current welfare at the same time and should thus focus on the latter (Harris, 2008; Lawn, 2008). Sustainability – which is more about nondeclining per capita stocks of capital in its broad sense – is better addressed through separate accounts that measure this directly. Importantly, restriction 2 also emphasizes the experiential nature of economic welfare as measured by Fisher's concepts of psychic income and psychic outgo – terms synonymous with benefits and costs both financially and viscerally experienced by individuals within a given economy (Lawn, 2008). In essence, the restriction requires that all GPI adjustments be traceable to hypothetical ticks on a psychic income or outgo meter. Restriction 3 creates economic sideboards for all GPI adjustments. While there are many other dimensions to welfare, the GPI's domain is restricted to welfare gains or losses that stem from economic activity. Restriction 4 limits GPI adjustments to those that can be reliably measured and evaluated in monetary units, but with the recognition that this may change as new methods and sources of data emerge. If this is an accurate description of the GPI's domain, then perhaps some form of the following formal definition could be adopted:

[1] A summary of Center for Sustainable Economy's work on the GPI can be found here: http://sustainable-economy.org/genuine-progress/. Last accessed 6/5/17.

Hoffrén and Rättö (2008)

GPI = Cadj. + P + G + W - D - E - N

Cadj. = consumer expenditure adjusted for income inequality
P = non-defensive public expenditures
G = growth in capital and net change in international position
W = non-monetary contributions to welfare
D = private defensive expenditure
E = costs of environmental degradation
N = depreciation of natural capital

Lawn (2008)

GPI = C + SCD - ECD + PY - PO - LNCS

C = current consumption
SCD = psychic services stock of consumer durables
ECD = current expenditure on consumer durables
PY = sum of additional pyschic income items
PO = sum of psychic outgo items
LNCS = cost of lost natural capital services

Brennan (2013)

GPI = s[Ck/D + Fk + Lt] + nΔFk - ds[Ck + Fk + Lt]-oEk

s = services derived from …
ds = disservices flowing from …
Ck = final consumer goods/services capital
D = income distribution
Fk = durable fixed capital
Lt = non-market labor or social-environmental activities
nΔ= net change or investment in …
oEk = depreciation of ecological capital

Bagstad and Shammin (2012)

GPI = Cadj. + G + W - D - S -E - N

Cadj. = personal consumption adjusted for income inequality
G = growth in capital and net change in international position
W = non-monetary contributions to welfare
D = defensive private expenditures
S = depletion of social capital
E = costs of environmental degradation
N = depletion of natural capital

Kubiszewksi (2015)

GPI = Cadj. + Gnd + W - D - E - N

Cadj. = personal consumption adjusted for income inequality
Gnd = non-defensive government expenditures
W = non-monetized contributions to welfare
D = defensive private expenditures
E = costs of environmental degradation
N = depreciation of natural capital stocks

Fig. 1. Various mathematical representations of the GPI.

2.1.1. GPI 2.0 Definition

The Genuine Progress Indicator is a monetary measure of economic welfare for a given population in a given year that accounts for benefits and costs experienced by that population in association with investment, production, trade, and consumption of goods and services.

Defined as such, the purposes of the GPI are made more evident. It can serve as a per capita measure of economic performance that can be compared across cities, regions, and nations. It offers a welfare-based profile of a given economy, for example, by describing the relative contributions of unpaid labor, defensive expenditures, and consumption of market-based goods and services. The GPI is also increasingly relevant for policy analysis, capable of being used in both backcasting and forecasting GPI growth with and without certain policy interventions such as trade agreements, climate action, stormwater, or land use plans and programs (Talberth and Bohara, 2006; Talberth and Wysham, 2014; Talberth, 2015; Bagstad and Shammin, 2012). Perhaps most importantly, the GPI provides critical information about how an economy stands with respect to its optimal scale. In particular, at some point, the deleterious effects of growth in economic activity overwhelm genuine progress benefits, rendering any additional expansion "uneconomic" (Lawn, 2016). Knowing where this inflection point lies will help decision makers know when to pull the plug on expansionist policies and redirect attention towards improving the economic welfare of existing workers, businesses, and households.

2.2. Basis for Valuation

As an experiential measure of current welfare, the basis for valuation of individual GPI 2.0 adjustments ought to be anchored in the concepts of consumer surplus (CS), willingness to pay (WTP) for a welfare gain or to prevent a loss, or willingness to accept (WTA) compensation for a loss. CS is simply the difference between WTP and costs actually incurred for obtaining a good or service and thus provides "the best measure of the total benefit to society" associated with consumption and economic policy interventions that affect it (OMB, 1992). However, CS estimates for most goods and services consumed is lacking, and so WTP by itself is used as an approximation under the assumption that the consumer surplus an average consumer receives from a good or service is more or less equal to WTP. In GPI accounts, market prices, non-market valuation studies, and, in many cases, government expenditures (i.e. per capita costs of supplying certain public goods and services) provide sources for WTP values. WTA is simply the inverse – it measures what compensation individuals need to receive to be made whole in response to a welfare loss incurred. Conceptually, these valuation concepts should underlie all welfare contributions and deductions included in GPI 2.0 accounts. Tying each adjustment to its WTP/WTA foundation will help distinguish between ideal, second best, and invalid valuation approaches. For example, existing GPI studies reflect a mix of techniques for valuing the costs of pollution – those based on WTP to reduce impairment of air and water quality, and those based on marginal damages. The former may constitute an ideal approach and the latter second-best because of its more indirect connection to current welfare.

2.3. Mathematical Framework

Another implication of restricting the GPI to a measure of current welfare and not sustainability is that the GPI's mathematical representation can be tightened up to fit firmly within the framework offered by social welfare functions and the concepts of utility and disutility (Daly, 2007). Expressing the GPI as a social welfare function will help resolve some of the randomness illustrated by equations in Fig. 1 and clarify the theoretical basis for each adjustment. The standard textbook representation of a consumption-based Utilitarian or Benthamite social welfare function is simply:

$$W_t = \frac{1}{N}\sum_{i=1}^{N} U_i(C_i) \tag{1}$$

In this expression, per capita welfare of a particular (geographically specified) population (W) in a given year (t) is the sum of individual utilities (U_i) derived from consumption (C_i) of goods and services for a population of N individuals. The (t) subscript has been omitted from the right hand side for convenience. But as long recognized by GPI accounting, utility derived from consumption is impeded by a litany of undesirable social, economic, and environmental conditions and trends caused, at least in part, by economic activity, thus making U_i a net figure. Both local and non-local economic activity may be the source of these irksome conditions and trends. Homelessness and noise pollution are examples primarily associated with local economic activity. Water pollution is often caused by non-local economic activities far upstream – such as nutrient runoff from farmlands. Regardless, a term reflecting the disutility associated with these conditions and trends is required.

But most people also care about adverse effects local economic activity may have on other communities. For example, people value reductions in greenhouse gas pollution not only out of concern for climate change damages in their communities but globally (Kotchen et al., 2013). People also care about conditions and trends facing their children and future generations. Concern for the leaving the next generation's welfare as least as great as our own is of course the driving force behind international sustainable development programs that illustrate quite well people (and states) are not only willing to pay but have generously done so to ensure this result. The Seventh Generation Principle – the idea that decisions we make today should result in a sustainable world seven generations into the future – is a "governing ethic" among many indigenous nations (Graham, 2008). As such, disutility associated with local economic activities that jeopardize that future must be reflected in the GPI. Social welfare functions have often been adapted to model altruism for others and the next generation through the lens of environmental sustainability (Fleurbaey, 2009; Heal, 2005). Within the GPI context, and to keep things simple, relevant adaptations can be expressed as:

$$W_t = \frac{1}{N}\sum_{i=1}^{N}[U_i(C_i) - dU_i(UCT + (-\Delta W_{ROW}) + (-\Phi\Delta W_{t+1}))] \quad (2)$$

In Eq. (2), we've added the component (dU_i) to reflect disutility associated with undesirable conditions and trends (UCT) as well as economic activities that cause welfare losses to the rest of the world ($-\Delta W_{ROW}$) and future generations ($-\Phi\Delta W_{t+1}$). Here, ($t+1$) is simply a convenient way to express next generation impacts. A discount factor (Φ) is included as well to represent the rate of social time preference (arguably zero in sustainable development settings) as well as uncertainty over if, when, and in what form the externalized costs will manifest.

Another basic feature of GPI accounting is to distinguish between the utility derived from consumption of market-based goods and services and nonmarket services derived from underlying stocks of capital. The latter can be disaggregated from U_iC_i and included as a separate GPI component:

$$W_t = \frac{1}{N}\sum_{i=1}^{N}[U_i(C_i) + U_i(\hat{s}(K)) - dU_i(UCT) + (-\Delta W_{ROW}) + (-\Phi\Delta W_{t+1})] \quad (3)$$

Here, the term $U_i(\hat{s}(K))$ represents the utility associated with services (and some goods) produced by various types of essential capital discussed below. If this is an acceptable mathematical framework, then the GPI can be thought of as a specific form of a social welfare function that takes into account both utilities and disutilities of economic activity and one that can serve as a foundation for justifying, arranging, and valuing both existing and potentially novel GPI components and indicators. What follows is one path forward for GPI 2.0 based on this foundation.

3. GPI 2.0 Pilot Accounts—Architecture, Components and Indicators

Before we describe the pilot accounts a little nomenclature housekeeping is in order to help differentiate between the various data aggregation levels that exist within the GPI framework. So for purposes of this paper we will refer to the GPI as a measure (of economic welfare) built upon an architecture of components, indicators and sub indicators within these components, and metrics (raw data) that feed into the overall model. Eq. (4) presents a model for GPI 2.0 that fills in the three major components described by Eq. (3) with indicators that are standard in GPI accounting as well as suggested additions:

$$GPI_t = \frac{1}{N}\sum_{i=1}^{N}\left[\begin{array}{l} U_i((HBE_i - DEFR_i - HI_i) \times INQ + PP)_i + \\ U_i(\hat{s}(KH_i + KS_i + KB_i + KN_i)) - dU_i(DKN_i + POL_i + SC_i + RU_i) \end{array}\right] \quad (4)$$

Fig. 2 defines these indicators. Overall, the architecture involves 3 major components and 13 indicators. In the pilot accounts presented below, the architecture includes an additional 67 sub indicators and over 400 individual metrics. Below, we briefly describe and justify the indicators within each component and highlight major differences from previously published GPI studies. In Appendices A and B, we offer more detail on methods, sub indicators, and metrics.

3.1. Utility Derived From Final Consumption of Market-based Goods and Services

Ideally, the GPI would begin with a measure of aggregate consumer surplus (CS) for the economic region of interest since this is the most widely and generally accepted proxy for utility derived from consumption of goods and services with a market price (Varian, 1992). In practice, this is not feasible because requisite demand curves have not been estimated, nor would the time and expense of such an undertaking be readily achieved – at least for GPI purposes. Instead, final consumption spending is used as a convenient proxy (Lawn, 2003). In earlier GPI accounting, this term is filled out by first extracting the personal consumption expenditure (PCE) line item from national income and product accounts (NIPA) or sub-national equivalents, if available, and then adjusting this figure to account for inequality under the assumption that a highly skewed distribution of consumption in favor of the wealthy makes less of a contribution to total welfare than a more equitable one. The inequality adjustment is an index based on current year departure from an historical Gini coefficient baseline. Defensive and regrettable expenditures and spending on consumer durables are then backed out since these have zero or negative welfare effects or represent the current costs of investing in future benefit streams. For GPI 2.0, we suggest six modifications to this basic approach.

First, and demonstrated by Bagstad and Shammin (2012), we suggest that practitioners search for alternatives to NIPA PCE data since there are far more detailed data available fully scalable from the national down to the city level. But this might not be the case in every locale. We've relabeled PCE to household budget expenditures (HBE) to note this change, and also to recognize that a significant amount of spending included in PCE actually has nothing to do with welfare-improving final consumption. Secondly, we recommend that the list of defensive and rehabilitative expenditures ($DEFR$) be broadened to include additional items such as insurance, following Lawn (2013). Third, the list of household investment expenditures (HI) should be extended beyond consumer durables to other items that represent investments in future benefit streams – items such as home improvements, retirement contributions and higher education. Fourth, and to correct a mathematical error present in many GPI accounts, the inequality adjustment (INQ) should be applied to net expenditure on final goods and services (Fig. 3) and not gross spending. It is easy to show that doing the latter would result in artificially inflated deductions for $DEFR$ and HI. Fifth, we suggest use of an inequality adjustment (INQ) based on diminishing marginal utility of income, rather than one tied to some baseline year. We think this more closely aligns with the original intent of this adjustment (Daly and Cobb, 1994) and is an approach now feasible to estimate using new methods and data (Layard et al., 2008). Finally, and this may not be an issue in NIPA accounts in other countries, public provision of goods and services by governments and non-profits (PP) should be added. In the US at least, PP associated with federal, state, and local government spending is not included in PCE and so it underestimates the true value of final household consumption and welfare. Appendix A,

Theoretical component	Utility from consumption of market-based goods and services	Utility derived from the services of essential capital	Disutility associated with undesirable conditions and trends and externalities
Functional form	*U((HBE-DEFR-HI)*INQ+PP)*	*U(ŝ(KH+KS+KB+KN))*	*dU(DKN+POL+SC+RU)*
Indicators	HBE - household budget expenditures	KH - services from human capital	DKN - depletion of natural capital
	DEFR - defensive and regrettable expenditures	KS - services from social capital	POL - pollution
	HI - household investments	KB - services from built capital	SC - social costs of economic activity
	INQ - inequality adjustment	KN - services from natural capital	RU - welfare losses from risk and uncertainty
	PP - public provision of goods and services		

Fig. 2. Structure of GPI 2.0 pilot accounts.

Sections A.1 to A.5 and Appendix B provide more detail on these refinements.

3.2. Services From Essential Capital

All economic activity is made possible by various stocks of capital and the services they perform. Goodwin (2003) categorizes these capital stocks as human, social, built, natural and financial and we follow this convention by including relevant terms (less a term for financial capital) in Eq. (4) to represent services they provide: *KH*, *KS*, *KB*, and *KN*. Human capital stocks are the skills and knowledge that enable humans to convert natural resources into useful artifacts and to express themselves culturally and artistically. Social capital is about relationships and goodwill – it manifests as people performing valuable services for one another, for example, in the context of volunteering and other forms of unpaid labor. Built capital services are those provided by consumer durables and home improvements as well as both public and private transportation, water, and communications infrastructure. Ecosystem services from natural capital include all the economically valuable functions – such as provision of foods and medicine and pollination of crops – communities and industries would have to pay for if native forests, wetlands, and other ecosystems were depleted beyond critical thresholds. Financial capital is not a basic (or essential) form of capital, but merely a vehicle of exchange for market-based goods and services and, as such, the value of services it renders is already baked into the GPI's market-based component. It is thus excluded from the second component of Eq. (4).

GPI accounts that are fully aligned with Fisher's concepts of psychic income (utility) and capital, are internally consistent with other components, and meet all of the definitional restrictions discussed in Section 2.1 would measure public economic benefits above and beyond any facet captured in market-based transactions generated by investments in: (a) creating a highly educated, technically skilled and culturally diverse population (human capital); (b) goodwill and supportive relationships (social capital); (c) household, water, transportation, and other types of infrastructure (built capital), and (d) conserving and protecting native ecosystems (natural capital). It is the psychic income (utility) generated by these investments that ought to be measured by the GPI and not sustainability in terms of changes in underlying capital stocks. Stock-related changes and sustainability should be treated with a separate set of biophysical indicators accounts suited for that purpose (Neumayer, 2004; Lawn, 2013). As such, a consensus has emerged to delete two adjustments that traditionally appear on GPI studies – net capital investment and net foreign lending and borrowing – because they are not relevant to current welfare but instead relevant for valuing changes in capital stocks. We suggest that GPI 2.0 accounts reflect this change.

3.2.1. Changes to Social (KS) and Built (KB) Capital Indicators

We also suggest expanding the list of sub indicators associated with social and built capital. In standard GPI accounting, services from social capital are typically measured by the value of volunteer work, housework, and childcare and the services from built capital measured by the value of consumer durables and roads. In the pilot accounts we expand the range of sub indicators for social capital to include non-family caregiving away from home, the value of leisure time and the value of Internet services not captured in market transactions. For built capital services, we add sub indicators reflecting the value of water infrastructure, home improvements, and transportation infrastructure other than highways and streets. Most significantly, we have added placeholder values for the services of human and natural capital. A brief justification for all these adjustments is offered below.

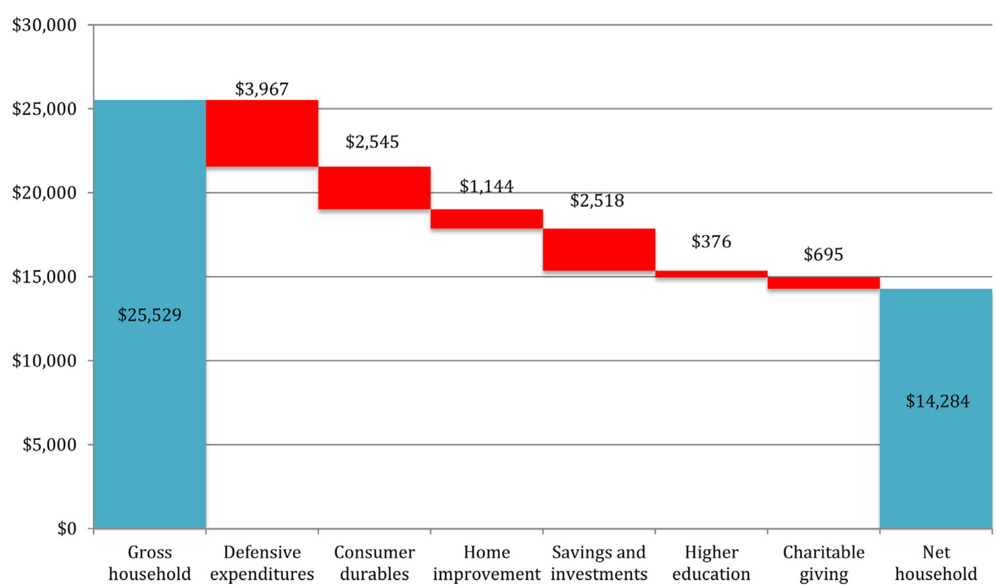

Fig. 3. Gross vs. net household consumption. (US GPI 2014, $2012)

Table 1
Genuine Progress Indicator 2014 ($2012 per capita). Contributions in black. Deductions in red.

Indicator	Indicator/subindicators	United States	Maryland	Baltimore
	Market-based welfare			
HBE	Household budget expenditures	*$25,529.42*	*$32,426.03*	*$20,499.55*
DEFR	Defensive and regrettable expenditures	*$3,966.90*	*$5,094.49*	*$3,261.01*
	Costs of medical care	$745.42	$922.60	$572.40
	Costs of legal services	$73.10	$97.76	$66.30
	Costs of food and energy waste	$782.34	$1,108.06	$727.87
	Household pollution abatement	$258.83	$327.26	$200.94
	Insurance	$1,713.79	$2,151.59	$1,336.25
	Welfare neutral goods	$241.08	$290.81	$215.66
	Household security	$13.86	$17.75	$10.08
	Costs of family changes	$138.48	$178.67	$131.51
HI	Household investments	*$7,278.06*	*$9,276.49*	*$5,536.68*
	Consumer durables	$2,544.60	$3,087.93	$1,925.30
	Household repairs and maintenance	$425.56	$542.44	$336.92
	Home improvement	$718.53	$926.48	$494.47
	Higher and vocational education	$375.76	$529.73	$332.09
	Savings, investment and retirement	$2,518.32	$3,305.68	$1,936.53
	Charitable giving	$695.28	$884.23	$511.38
INQ	Costs of income inequality	*$3,121.57*	*$3,987.65*	*$2,075.97*
PP	Public provision of goods and services	*$7,025.23*	*$7,437.49*	*$7,437.49*
	Federal nondefense	$1,060.20	$1,060.20	$1,060.20
	State and local	$4,960.86	$4,960.86	$4,960.86
	Non profits	$1,004.17	$1,416.44	$1,416.44
	Total market based welfare	*$18,188.12*	*$21,504.90*	*$17,063.38*
	Services from essential capital			
KH	Services from human capital	*$5,223.68*	*$6,481.84*	*$5,068.42*
	External benefits from higher education	$3,755.56	$5,135.39	$3,559.33
	External benefits from manufacturing jobs	$364.82	$165.56	$175.43
	External benefits from green jobs	$1,103.30	$1,180.90	$1,333.66
KS	Services from social capital	*$12,856.93*	*$14,066.86*	*$13,927.36*
	Value of leisure time	$4,046.01	$5,030.19	$4,656.35
	Value of unpaid labor	$8,249.72	$8,475.50	$8,709.84
	Internet services	$561.20	$561.17	$561.17
KB	Services from built capital	*$6,041.57*	*$7,265.58*	*$4,970.38*
	Value of transportation infrastructure	$929.18	$929.36	$929.36
	Value of water infrastructure	$296.49	$296.55	$296.55
	Services from household capital	$4,815.90	$6,039.67	$3,744.47
KN	Services from protected natural capital	*$1,554.65*	*$394.34*	*$625.16*
	Marine, lakes, estuaries, and rivers	$41.60	$17.65	$373.67
	Deserts, dunes, beaches	$1.80	$0.09	$73.02
	Deciduous forest	$44.84	$22.26	$108.35
	Evergreen forest	$351.22	$8.63	$0.00
	Mixed forest	$11.67	$1.96	$22.23
	Shrub and scrublands	$57.82	$0.38	$0.00
	Grasslands, tundra, herbaceous cover	$18.34	$0.07	$27.44
	Woody wetlands	$584.20	$167.05	$0.00
	Emergent herbaceous wetlands	$443.15	$176.26	$20.45
	Total services from esssential capital	*$25,676.65*	*$28,208.63*	*$24,591.32*

	Environmental and social costs			
DKN	Depletion of natural capital	$6,495.60	$5,040.15	$4,974.14
	Costs of land conversion	$659.32	$51.87	$0.00
	Replacement costs of nonrenewable energy	$5,658.63	$4,956.51	$4,956.51
	Replacement costs groundwater depletion	$8.84	$0.00	$0.00
	Productivity losses due to soil erosion	$168.81	$31.77	$17.63
POL	Costs of pollution	$3,714.65	$4,402.97	$2,770.46
	Criteria air pollutants	$316.80	$294.37	$205.35
	Greenhouse gas emissions	$637.70	$312.57	$346.75
	Noise pollution	$2,272.75	$2,448.79	$1,872.82
	Water pollution	$471.84	$1,311.73	$322.35
	Solid waste	$15.56	$35.51	$23.19
SC	Social costs of economic activity	$5,195.44	$6,397.06	$6,816.37
	Costs of homelessness	$73.63	$53.38	$164.69
	Costs of underemployment	$1,213.80	$1,461.90	$2,158.47
	Costs of crime	$173.55	$229.56	$1,130.99
	Costs of commuting	$1,770.02	$2,698.84	$2,960.76
	Costs of vehicle accidents	$1,964.44	$1,953.39	$401.46
	Total environmental and social costs	$15,405.69	$15,840.18	$14,560.97
	GPI per capita total	$28,459.09	$33,873.35	$27,093.73
	Per capita (GPI/GDP)	0.54	0.60	0.45
	(GPI/GDP) from most recent GPI study	0.41	0.65	0.33
	Change	+0.13	-0.05	+0.12

Including the value of caregiving to non-family members is made possible by detailed American Time Use Survey (ATUS) data, which has been regularly available since 2003. Including the value of leisure time – as noted earlier – has been a bone of contention since the GPI's inception, in part, due to its dubious connection to welfare in some cases (i.e. unemployment) or economic activity, and because inclusion of such a term would "overwhelm" all other GPI components (Daly and Cobb, 1994). Despite this, standard GPI accounting incorporates the value of leisure in terms of its loss from a baseline year. In the pilot accounts, we flip this adjustment and count the benefits of leisure time as one of the valuable services from social capital, but only that portion of leisure time attributable to economic decision-making. There are four reasons for doing this.

First, and as depicted in standard textbook treatments, it is clear that at least some leisure time comes at the expense of lost wages and thus represents an economic tradeoff rightly included in GPI accounting. Indifference curves illustrating the leisure-income tradeoff are one of the bedrock lessons in labor economics coursework (Borjas, 2013). Secondly, enjoyment of one's leisure time often comes at the expense of extra labor hours for another to take on duties left behind both at work and at home, and this reallocation of labor also counts as a form of economic activity. Third, at least some leisure hours are attributable to work-at-home and paid leave policies of employers. Finally, ATUS data now makes it possible to segregate out the portion of leisure time taken during workdays vs. holidays and weekends. Limiting the valuation of leisure time to the former provides a much better reflection of the actual economic tradeoff involved than including the value of all leisure time. Limiting it as such also addresses the magnitude problem noted by Daly and Cobb (1994). In the pilot accounts, including the value of workday leisure under social capital is debatable, but since a good portion of it depends on the goodwill of others and employers it seems reasonable to include here.

Another addition we suggest is the value of Internet services above and beyond any value captured in payments for these services. Economist Hal Varian estimates that based on time savings (i.e. more efficient searches) alone, a typical Internet user receives about $500 of consumer surplus benefit per year (The Economist Magazine, 2013). Brynjolfsson and Oh (2012) found that the value of free Internet goods and services amounted to $740 per user per year in the US. We include the value of free Internet services as one associated with social capital, mainly because so much of this value is generated by the networking, socializing, organizing, and dissemination of knowledge the Internet and social media applications make possible.

The adjustments we make for built capital seem intuitive. For the very same reasons the services from consumer durables, highways, and streets are included we include additional terms for the services provided by other forms of transportation infrastructure (i.e. mass transit and bike lanes), water infrastructure (water and sewers) and home improvements (i.e. solar greenhouses). Appendix A, Sections A.7 and A.8 provide details on how these changes to social and built capital indicators were incorporated into the pilot accounts.

3.2.2. Addition of a Human Capital Services Indicator (KH)

The most experimental adjustments reflected in the pilot accounts are terms that reflect the value of services from human and natural capital. In the GPI context, the value of services from human capital – stocks of knowledge and skills present in a given population – manifests in the form of WTP for the privilege of living in more educated, technically skilled and culturally diverse communities. It is not the private benefit – i.e. higher salaries or increased productivity – this adjustment represents since these are already captured by the GPI's market-based component. Nor, for the same reason, does it include reduced costs of crime or the housing price premium paid for living in upper-strata school districts. Nor does it include the benefits of lower income inequality, but not because there is no effect. As noted by Thomas Piketty, "[k]nowledge and skill diffusion is the key to overall productivity growth as well as the reduction of inequality both within and between countries" (Piketty, 2014, p. 21). However, this benefit is addressed by the existing inequality adjustment (*INQ* in Eq. (4)), for the most part. So no further adjustment seems needed here.

Given all this, what the human capital services adjustment we propose is meant to measure is the positive externality not captured elsewhere in GPI accounts, including, for example, the value of a wide range of free cultural (i.e. arts festivals) and educational services (i.e. tutoring and mentoring) made possible by higher levels of educational attainment and cultural diversity in a community as well as the benefit associated with "people living in ways that contribute more to civic activity and good governance" (Blomquist et al., 2009, p. 6). In a study of household WTP for the Kentucky Community and Technical College System directly through stated-preference surveys Blomquist et al. (2009) measured the magnitude of this education externality and found that the social value of expanding the system substantially exceeds private value by approximately 50%. The social value ranged from $70,000 per pupil for men and $144,000 per pupil for women. But this includes several benefits that may already be captured in other GPI adjustments, including reduced costs of crime, more volunteering, and higher productivity for household labor. Several recent GPI studies have used a much lower figure from Hill et al. (2005) to represent this higher education externality – about $16,000 per college graduate. It seems prudent to keep this lower estimate intact, for now, in order to guard against double counting and so we have done so in the pilot accounts and keep it as a sub indicator for human capital services pending more detailed research on this issue.

But a healthy human capital stock is not just about having lots of college graduates around. Communities also benefit and are willing to pay significant sums over and above job training costs (which is a form of investment and thus excluded as the basis of a GPI benefit) to retain or attract people with certain skill sets – those with manufacturing or green job skills, for example. As with education, there is a private gain associated with a higher diversity of skills already baked into other GPI components but also a social welfare gain that is more difficult to measure, but nonetheless significant and worthy of consideration in GPI 2.0 accounts. It manifests in many ways, for example, in the form of nonmarket time spent helping neighbors and friends with otherwise difficult or expensive tasks (i.e. auto repair, troubleshooting computers) or less tangible benefits such as community stability and adaptive capacity in the face of outside shocks and stresses. A proliferation of policy initiatives on green jobs at the national, regional, and city level reflect this desire to have, in house, skills sets responsive to the challenges posed by climate change, resource scarcity, and pollution as well as the opportunities associated with green growth (Bowen, 2012). So the utility of having these desirable skills sets embodied in a population should be included in GPI accounts. In the pilot accounts, we used recent data on the level of subsidies to retain and attract manufacturing and green jobs as WTP placeholders for this benefit. More detail is provided in Appendix A, Section A.6.

3.2.3. Addition of a Natural Capital Services Indicator (KN)

In the online discussion forum and materials submitted as part of that process the proper way to incorporate ecosystem services from natural capital was debated. Current GPI accounts represent the cost of lost forests, wetlands, and farmlands as a function of the ecosystem services that society would be receiving if those resources were still intact. In a given year, the cost is based on the cumulative loss of these natural capital stocks from an historical baseline. We suggest two fundamental changes to better align with the GPI's theoretical foundations and definitional restrictions. The first is to retain the natural capital depletion adjustment, but change how it is measured. We believe that a discounted (or not if you believe in zero discount rates) stream of forgone future benefits associated with marginal losses is what ought to be valued as a cost – and not the cumulative loss of ecosystem services from a baseline year in the past. The year to year loss of places used and valued by the population probably has a more direct connection to current welfare than ecosystem services that have long since disappeared or been replaced by technological substitutes. More details on this adjustment are offered in Section 3.3 and Appendix A, Section A.10. The second is to add a term reflecting the value of services generated by natural capital stocks that remain. One of the concerns in doing so is that services from these lands and waters have nothing to do with economic activity and thus ought not to be valued. They exist despite, and not because of economic activity and are thus precluded by the GPI's definitional restrictions.

But a substantial area of terrestrial and aquatic ecosystems in most countries is in one way or another managed under private or public entities with predictable and measurable impacts on ecosystem services these habitats provide. This management comes with real economic costs, including, for example, acquisition of land, implementation of game and fish management programs, provision of recreational access, costs associated with ecological restoration and, more indirectly, opportunity costs of forgone development. We believe that GPI 2.0 accounts should include the return on these conservation investments in terms of the value of ecosystem services that are maintained or enhanced.

But counting all ecosystem services from all lands and waters seems unjustified. For example, the provisioning services provided by commercial agricultural and forestlands are already reflected in consumer expenditures on food, wood, and paper products. In addition, most of these lands are highly degraded, devoid of biodiversity and generating heavy pollution loads so any social benefit of maintaining these lands in their current uses may be entirely canceled out. We also are wary of including most ecosystem services from natural, but unprotected lands, except for provisioning services. These lands exist in their natural state not because of any allocation of economic resources to maintain them as such: stated simply, development hasn't yet caught up with these lands to force an economic tradeoff and concomitant investments in conservation.

For these reasons, our approach to ecosystem services in the pilot accounts is to count the services from protected areas alone and leave the issue over provisioning (or perhaps other) services from unprotected lands and waters for future refinements. Including the value of services from protected areas and, eventually, the value of provisioning services from unprotected lands has several advantages over the existing loss-from-baseline approach: (1) it establishes symmetry with how other capital investments (i.e. consumer durables and infrastructure) are treated; (2) it measures utility actually enjoyed by a given population associated with existing natural capital stocks rather than the disutility associated with stocks that have long since disappeared – the latter a weaker link to current welfare; (3) the method is less arbitrary since it does away with the need to select somewhat arbitrary historical baselines for calculating cumulative loss of ecosystem services; (4) it provides an estimate of the monetary payoff from natural capital investments in the past, thus aiding in evaluation of environmental policy, and (5) it makes GPI accounting relevant for nonmarket economies dependent on ecosystem services.

3.3. Disutility Associated With Undesirable Conditions, Trends, and Externalities

The third major component included in Eqs. (3) and (4) is the disutility associated with a variety of undesirable conditions, trends, and externalities experienced by a given population or passed on to the rest of the world or future generations. Standard GPI indicators include the costs of crime, family breakdown, loss of leisure time, underemployment, commuting, vehicle crashes, noise, water and air pollution, loss of wetlands, farmland and forests, nonrenewable resource depletion, greenhouse gas emissions and ozone depletion. All of these adjustments are well justified theoretically and are retained under the depletion of natural capital (*DKN*), pollution (*POL*), and social costs (*SC*) indicators included in Eq. (4). However, in Appendix A, we suggest a number of modifications to the valuation methods and data sources to bring these adjustments up to date.

The only significant modifications were to flip the lost leisure time indicator to the benefits of workday leisure as discussed in Section 3.2.1, include family breakdown costs not as a separate indicator but as one of the defensive expenditures (*DEFR*) removed from *HBE*, and to drop the ozone depletion cost as suggested by Bagstad et al. (2014) given that this problem has been largely resolved. We also broadened the scope of adjustments for *DKN* to include loss of other natural capital stocks (i.e. grasslands), aquifer depletion, and soil erosion, and for *POL* to include solid waste. For social costs, we added one additional term: costs of homelessness. Details are provided in Appendix A, Sections A.10–A.12.

The one adjustment not included in the pilot accounts but included in Eq. (4) is the costs of risk and uncertainty (*RU*). Including a term that reflects society's WTP to reduce the economic risks associated with, for example, climate change, public and consumer debt, trade dependence and extractive industry dependence – all of which fuel economic volatility or which may represent major cost burdens for future generations – seems justified for consideration as part of GPI 2.0. Prospect theory and related literature have well documented individual's willingness to accept lower income streams that are guaranteed relative to higher income streams that are more risky – even to an irrational extent (Kahneman and Tversky, 1979; Barberis, 2013). An economy that is high risk – such as one that depends largely on a single export – thus generates a disutility that could be measured in GPI accounting. Climate change research has focused directly on this issue and has been used to quantify the benefits of interventions to reduce climate risks (Costello et al., 2010). Eventually, the GPI 2.0 adjustment could take the form of a weighting factor, much like that for inequality, that is based on the prevalence of a number of risk factors for which WTP/WTA values can be assigned. For highly risky economies, like small island nations facing inundation from sea level rise, the weighting factor could represent a major (or even dominant) GPI adjustment. But we leave this as an open question for now pending future research and exclude any estimate of *RU* from the pilot accounts.

4. Results and Discussion

The results of our GPI 2.0 accounting exercise appear in Table 1 and Figs. 4, 5 and 6. For the US, Maryland, and Baltimore Table 1 reports values for each component, indicator and sub indicator in $2012 constant dollars per capita in 2014 as well as the total per capita GPI. For ease of communication, we have renamed the three components in

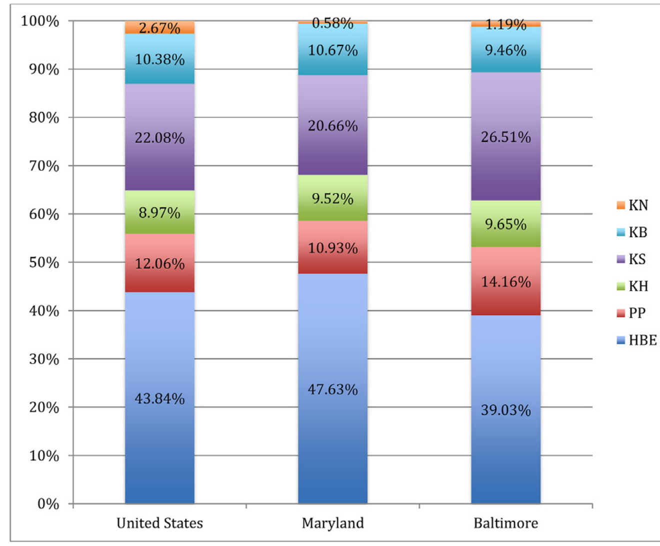

Fig. 5. Allocation of GPI contributions (2014).

terms of more common language rather than the utility/disutility labels from Fig. 2. Adjustments in red are GPI deductions and those in black are positive GPI contributions. Table 1 also indicates how the total GPI per capita figures compare with previous (GPI 1.0) studies at each scale in terms of the ratio of GPI to GDP and its state and local variants. Fig. 4 shows the trend in total per capita GPI vs. GDP and its state and local variants at each scale over the 2012–2014 period. Fig. 5 displays the allocation of GPI contributions and Fig. 6 the allocation of GPI deductions at each scale for 2014.

There are several key insights offered by these results. First, they underscore the importance of nonmarket contributions to economic welfare and the need to augment NIPA accounts accordingly. At each scale, the value of nonmarket services from essential capital was greater than the services associated with final consumption of market-based goods and services. This is a departure from the results of previous GPI accounts, which show the market-based consumption component still dominating. This is not surprising, however, since the pilot accounts reflect a more comprehensive approach to backing out net from gross consumption (Fig. 3) and add several new indicators and sub indicators for each type of capital. But the important point is that the results amplify the need for research by BEA and other entities to update NIPA accounts to take this dimension of economic welfare into account (e.g. Landefeld et al., 2009).

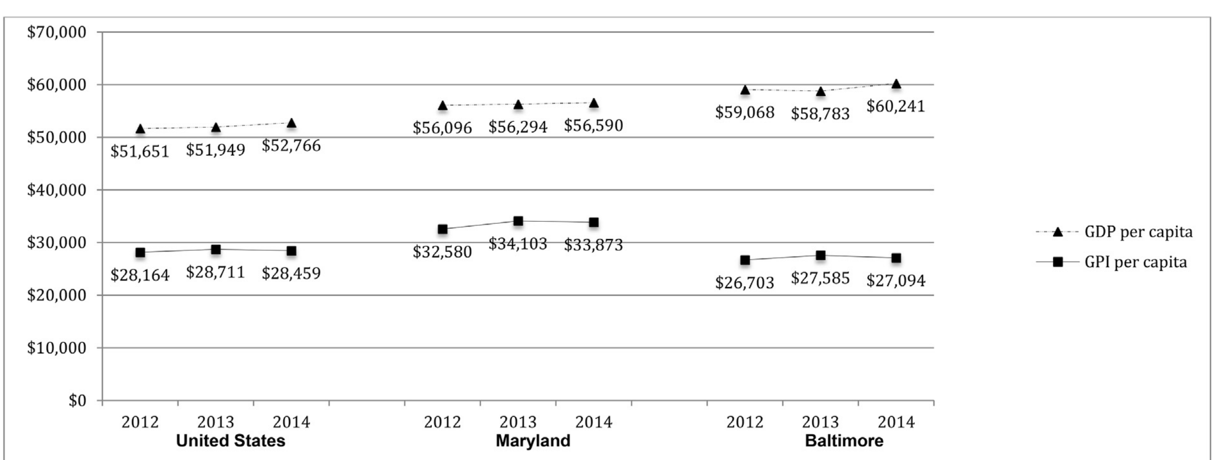

Fig. 4. GPI vs. GDP per capita 2012–2014.

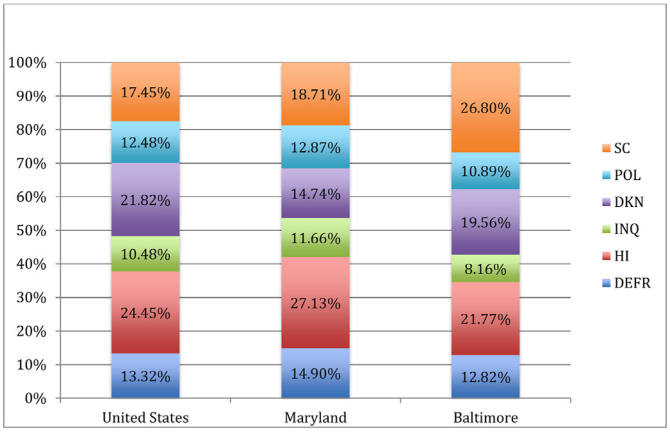

Fig. 6. Allocation of GPI deductions (2014).

Secondly, the results do not drastically depart from previous GPI studies in terms of the comparison between GPI and GDP. Comparing indicator values is less useful given the major methodological changes. In each case, the results were within 14% (±) of the most recent GPI studies for the US (Talberth et al., 2007), Maryland (McGuire et al., 2012) and Baltimore (Posner and Costanza, 2011). Table 1 provides the GPI/GDP ratios for the pilot accounts and these previous studies. The underlying message is the same across the methodologies: that GDP grossly overstates true economic welfare, roughly by a factor of two. Third, the results concur with all previous studies that establish different rates of growth in GPI vs. GDP, confirming that growth in the volume of economic activity may have little to do with growth in economic welfare, and vice versa. While three years is certainly not an adequate sample size, the variations in growth are important, and informative. For example, in Maryland, GPI growth over the 2012–2014 period (3.97%) outperformed GDP growth (0.88%) by a large factor. In such situations, public officials may have the opportunity to cast new light on official, less rosy reports of economic progress by offering an alternative narrative from the GPI standpoint. For example, Maryland's GPI growth during this period was driven by a reduction in income inequality, an increase in higher educational attainment, more workday leisure and improvements in water infrastructure.

Lastly, the accounts demonstrate the benefits of departing from the practice of downscaling state and local metrics from national data and instead using locally reported equivalent metrics whenever possible. In particular, regional variations in the GPI become more distinct and capable of corroborating other measures regularly reported at various spatial scales. For example, the poverty rate in Baltimore is an extremely high 23.8%, based on persons living below the poverty level from 2009 to 2013 Census data. Maryland's level is 9.8%, well below the national rate of just above 15%. In the pilot accounts, Baltimore's relative level of economic distress is corroborated by several key economic and social sub indicators: it has the lowest per capita household budget expenditures, household investments and built capital services and the highest per capita costs of homelessness, underemployment, and crime. In previous GPI studies, several of these sub indicators would have the same values regardless of spatial scale thus making the GPI less useful for multi-scale comparisons.

5. Concluding Thoughts and Priorities for Future Research

In this GPI accounting exercise, we attempt to operationalize many of the concepts and recommendations for GPI 2.0 offered in the literature and through an online discussion forum that engaged 52 practitioners from around the world since 2013. Some of the changes embodied in the pilot accounts will garner more consensus than others, and so future GPI 2.0 studies will be invaluable in refining the overall approach and substituting more rigorous methods and sources of data in places now occupied by placeholder values. Based on previous published work as well as dialogue among practitioners online and at the GPI 2.0 workshops, we believe that there is strong consensus for the following: (1) redefining the GPI as a measure of current welfare and not sustainability; (2) restricting the GPI's domain to measuring the benefits and costs of economic activity; (3) adopting consumer surplus, willingness to pay, and willingness to accept compensation as the primary basis for valuation; (4) expressing the GPI mathematically as a social welfare function that includes both utilities and disutilities associated with economic activity; (5) adding components for public provision of goods and services and for nonmarket services from human and natural capital; (6) broadening many existing adjustments (i.e. built capital services) to include additional sub indicators that are made possible by improvements in methods and data sources; (7) enhancing the GPI's multi-scale applicability by phasing out the practice of downscaling national data; (8) abandoning outdated data sources, some over three decades old; (9) removing net foreign lending and borrowing, net capital formation, and costs of ozone depletion from the accounts, and (10) flipping adjustments for leisure and ecosystem services to measure current benefits and not cumulative losses.

More research will prove invaluable to help clarify whether or not a number of additional innovations we suggest are useful. We expanded the list of defensive and rehabilitative expenditures (*DEFR*) but more careful sorting of household budget data is warranted to determine if expenditures on additional items or some share thereof should also be included. Also with respect to *DEFR*, we made some key assumptions – for example, that all medical and insurance expenses are defensive, by definition – that should be revisited. We developed a new inequality adjustment based on diminishing marginal utility of income but it is not settled whether or not this is preferable to one based on a departure from an ideal income distribution. As noted in Section 3.3, we have not included an adjustment to account for risk and uncertainty but clearly any measure of economic welfare that is not risk-adjusted overestimates genuine welfare, possibly by a large margin. The key here will be to develop measures of economic risk that people are willing to pay to reduce and which can be translated into a GPI deduction or weighting factor. Far more work also needs to be done on human and natural capital services indicators. We included placeholder values for both based on simplistic approaches. For human capital, much more work needs to be done on defining and measuring the relevant stock of knowledge and skills and its social value over and above any portion already captured in the GPI's market component. For ecosystem services, we believe the case for including services from protected areas that are established and maintained as a result of an allocation of economic resources (i.e. land acquisition) is strong, but also believe at least some services from unprotected landscapes ought to be included, especially provisioning services that require substantial labor inputs to enjoy. In the pilot accounts, we maintained the ubiquitous approach of valuing nonrenewable energy depletion via replacement costs, but as noted, there are several perspectives on how to better link this adjustment to welfare loss and questions over whether to include this adjustment at all and so more investigation on this sub indicator would prove valuable. Finally, many of the individual valuation choices discussed in Appendix A need to be validated, updated, or replaced with more rigorous metrics – for example, the social costs of homelessness, per VMT damage costs of noise pollution and groundwater replenishment costs.

The GPI has been used for over thirty years to supplement GDP and related measures used in monitoring overall economic performance, profiling the economy of a given region, and evaluating the net public benefits of policy interventions. Improving the accuracy of the GPI as a current welfare measure will accelerate these uses, but also open the door to others: for example, providing important data about where an economy stands with respect to its optimal scale and when that threshold may be breached, if not already. We hope the innovations suggested as part of these GPI 2.0 pilot accounts prove useful in achieving this end.

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