The Genuine Progress Indicator as a measure of regional economic welfare: A case study for Northeast Ohio

Kenneth J. Bagstad and Md Rumi Shammin

Abstract
Although the Genuine Progress Indicator (GPI) and related Index of Sustainable Economic Welfare (ISEW) have been estimated at the subnational level, these estimates often rely on poor quality data and have rarely enabled intra- or inter-regional comparisons. We calculated the GPI for the State of Ohio, cities of Akron and Cleveland, and 17 Northeast Ohio counties for the years 1950-2005. These estimates use the highest quality data yet for a U.S. local study, and particularly for 1990-2005 can be considered robust estimates. We evaluate temporal and spatial GPI trends, including inter- (Ohio versus Vermont) and intra-regional (urban-suburban-rural) comparisons. From 1990-2005, we found that per capita GPI grew in eight counties but declined for nine counties, Ohio, Akron and Cleveland. Per capita GPI was greatest in suburban counties and lowest in urban areas, and was greater in Vermont than Ohio. These trends are largely driven by gains in personal consumption relative to rising environmental, social, and economic costs. Important costs include those of income inequality, climate change, nonrenewable resource depletion, and consumer durables. Sensitivity analysis shows that the local datasets used in this study played an important role in producing reliable results. Results are also greatly influenced by the assumptions that go into the calculations. Because GPI is so sensitive to changes in personal consumption versus other costs, it functions neither as a measure of strong sustainability nor as a perfect measure of social welfare. Yet consistently calculated local GPI estimates for different parts of a country can show how the costs and benefits of economic growth are distributed within a country, while engaging the public and decision makers in discussions about economic, social, and environmental goals and policies. Local academic and nonprofit organizations are using the GPI framework to advance discussions about sustainability and economic development in Northeast Ohio.

Keywords: Genuine Progress Indicator, Index of Sustainable Economic Welfare, urban-rural, social welfare, quality of life, regional development

1. Introduction

1.1 The GPI framework

As communities of all sizes have become more interested in measuring and promoting quality of life, the use of indicators for community well-being has grown (Haggerty et al. 2001). Numerous communities have developed suites of quality of life indicators (Sustainable Measures 2006) yet face the problem of creating an index from indicators with dissimilar units, such as rates of farmland loss, voter registration, and crime. At the national, state, and metropolitan area scales, gross domestic product (GDP) is still frequently used as a proxy measure for society's welfare, despite its many flaws. These have become evident through a growing body of literature suggesting that increased wealth and economic output alone do not always improve quality of life or subjective well-being for individuals or society (Diener et al. 1999, Eckersley 2000, Frey and Stutzer 2002, Kahneman 2004, Easterlin 2005). Economists and politicians, including some of the original architects of GDP accounting have also noted the misuse of GDP as a welfare measure.

Since at least the late 1960s, economists have attempted to adjust GDP to better measure society's well-being. In perhaps the most well-known of these early studies, Nordhaus and Tobin (1972) concluded that as of the early 1970s, economic growth was leading to improvements in quality of life in the United States. Daly and Cobb (1989) revisited Nordhaus and Tobin's findings with their Index of Sustainable Economic Welfare (ISEW), which was later revised as the Genuine Progress Indicator (GPI). The ISEW/GPI (hereafter referred to as GPI) begins with a measure of personal consumption, weighted to account for income inequality, and deducts or adds value for various monetized measures of built, human, social, and natural capital. This can be expressed in the form of the equation (adapted from Hanley et al. 1999):

$$GPI = C_{adj} + G + W - D - S - E - N \quad (1)$$

Where: C_{adj} = personal consumption adjusted to account for income distribution, G = growth in capital and net change in international position, W = non-monetary contributions to welfare (e.g., household labor, volunteer work), D = defensive private expenditures, S = depletion of social capital (e.g., cost of crime, family breakdown, lost leisure time), E = costs of environmental degradation, and N = depletion of natural capital.

The inclusion of these components makes GPI better suited than GDP to addressing questions of distribution, societal well-being, and sustainability within the economy. Daly and Cobb and subsequent authors found that GPI grew, though not as quickly as GDP, until the mid-1970s, and has since leveled off or declined slightly. These results agreed with Max-Neef's (1995) "threshold hypothesis," which states that economic growth improves quality of life up to a point, but eventually erodes environmental and social quality, reducing quality of life. Studies in numerous other nations corroborated these findings (Jackson and Stymne 1996).

Several components of GPI's theoretical framework have been questioned (Neumayer 1999, Neumayer 2000). Part of this controversy relates to what GPI is intended to measure – is it an indicator of sustainable (Hicksian) income, a pure replacement for GDP, an index of economic welfare, or an assessment of how well human needs are met? Lawn (2003) provides a theoretical basis for using GPI as an improved measure of welfare over GDP. Lawn uses a definition of income derived from Fisher - the utility or satisfaction consumers get from the economy - as opposed to Hicks' definition of income as the maximum a household or nation can consume without reducing its ability to do so in the future. However, Harris (2007) notes that these alternative views of income are typically misunderstood, and that both Hicksian and Fisherian income are consumption-based. Since Hicksian income is concerned with both present and future income, while Fisherian income focuses only on present income, Harris argues that Hicksian income is a better lens for evaluating sustainability (although many ecological economists might prefer Fisher's concept of income as "psychic flow" or utility, versus Hicks' concept of income as monetary-based). Further, Harris argues that there is a lack of evidence that the disamenities measured by the GPI are always caused by economic growth, or that transition to a steady-state economy is the only way to increase the GPI.

Neumayer (1999) also notes that because GPI aggregates the value of built, human, social, and natural capital, it does not serve as an indicator of strong sustainability. Since natural capital could be liquidated to increase consumption with potentially increasing GPI, for instance, GPI does not serve as a measure of strong sustainability. Despite these problems, Ziegler (2007) argues that the GPI has its greatest value as a "debunking index" useful in showing the limitations of the still-entrenched mindset of measuring and promoting GDP growth.

Like nations, sub-national political jurisdictions of all sizes are increasingly interested in measuring quality of life, and in developing policies to support social well-being. At least in industrialized nations, these economies are open and often small. Many fiscal, social, and environmental policy choices take place at the national level, and greatly affect well-being at local scales. Yet local jurisdictions also make similarly important decisions. For example, a state or province could use tax policy to encourage or discourage employment in certain economic sectors. A county or municipality can make land use or resource extraction decisions that liquidate natural capital in favor of sometimes short-term employment gains. In other cases, local jurisdictions may choose to adopt more stringent environmental or social goals than the national mandate. Since GPI aggregates a broad suite of economic, social, and environmental indicators, it can be used to compare well-being in between two or more regions with different policies. GPI's ability to aggregate an otherwise diverse set of indicators is an important strength as a measure of well-being.

1.2 Local measurements of GPI

Although GPI was originally developed as a national-level macroeconomic indicator, the costs and benefits of economic growth are not distributed evenly across a nation. Understanding these local and regional differences has been a justification for developing local-scale GPI studies. In the U.S., GPI has been estimated locally for Minnesota (Minnesota Planning Environmental Quality Board 2000), the San Francisco Bay area (Venetoulis and Cobb 2004), and Vermont (Costanza et al. 2004, Bagstad and Ceroni 2007). These studies found GPI to be consistently higher than the national average for these areas. This may be due to efforts in these regions to develop strong local economies while preserving environmental quality and social cohesion.

Outside the U.S., local GPI and ISEW studies have been conducted in Australia (Lawn and Clarke 2006), Canada (Anielski 2001), China (Wen et al. 2007), Italy (Pulselli et al. 2006, Pulselli et al. 2008), and the U.K. (Moffatt and Wilson 1994, Matthews et al. 2003, Jackson et al. 2006). These studies do not always provide comparisons to national-level figures, often due to differing data or methods. They also reveal limitations with using GPI at local or regional scales. For industrialized nations in particular, most data needed for the GPI are readily available at the national level. This is often not the case for local jurisdictions. In the U.S., historical data may be available only for decennial census years, or may simply not exist. In such cases, analysts have scaled down national or state values based on variables such as population or land area. While this method provides "filler" estimates, it also obscures the local differences that influence well-being, the main justification for undertaking these studies. Bagstad and Ceroni (2007) describe how to maximize the use of local data in GPI studies, particularly in the U.S.

Since GPI was developed as a national-scale indicator, local GPI studies face other limitations (Clarke and Lawn 2008). These include data availability and the need for consistent data sources and methods, the fact that GPI does not account for cross-boundary impacts of manufacturing, energy production, or resource extraction (Clarke 2007), and the fact that local governments do not have full power to set policy related to all of the GPI's component indicators. The first limitation can be overcome with careful and consistent data collection and management. The second limitation should be recognized, but can be addressed regionally by examining trends in GPI across urban to rural environments. As for Clarke and Lawn's third limitation, state and local governments in the U.S. do have important policymaking powers in regards to land use planning, energy use, and other relevant GPI components. This illustrates the potential value in using the GPI as a local and regional decision support tool, provided that estimates are accurate, timely, and reflect changing local conditions from year to year. Finally, given GPI's value as a "debunking index" that exposes the limitations of GDP (Ziegler 2007), its use at local scales is just as relevant as at national scales. Given the lack of dialogue in the U.S. about alternatives to GDP over the past 15 years (Cobb et al. 1995), this discussion may be more fruitful at the local level than the national level.

1.3 Objectives

In this paper, we expand on the work of Bagstad and Ceroni (2007) in developing the GPI for local and regional applications, particularly in the United States. Our objectives were to: 1) enable spatial and temporal GPI comparisons across a large urban-rural gradient and between regions within the U.S., 2) use sensitivity analysis to explore how use of local data and improvements to methods impact local GPI estimates, and 3) to develop and describe a nascent policy process for incorporating the GPI in local decision making. Sections 2, 3, and 4 provide the methods, results, and discussion, respectively for a GPI case study of the State of Ohio, cities of Akron and Cleveland, and 17 counties in Northeast Ohio. Section 5 describes a local policy process beginning in Northeast Ohio that uses the GPI to enable a more comprehensive understanding of regional well-being.

2. Methods

2.1 Study area

Our study area included a seventeen-county region in Northeast Ohio (Figure 1), stretching along Lake Erie from the Pennsylvania border to Sandusky Bay. This encompasses about 20,700 km^2, or 19.5% of Ohio's land area. The region's largest city is Cleveland, an important center for manufacturing and Great Lakes shipping. The area also includes a number of other medium-sized industrial and port cities, including Akron, Canton, Lorain, and Youngstown. Like many Midwestern manufacturing centers, these cities have lost population in recent decades. For example, Cleveland's population fell from 914,808 in 1950 to 449,995 in 2005. The causes of population loss include declines in manufacturing employment due to movement of industries from the U.S. to nations with cheaper labor costs, migration with the region from cities to the suburbs, and migration out of the region from the northern "rust belt" to the southern "sun belt." Regional population has remained relatively stable from 1960 to the present, however, ranging from 4.1 to 4.5 million. Against a backdrop of population migration and manufacturing decline, there has been growing interest in improving regional sustainability. Efforts underway include retooling of local industries to service the growing renewable energy industry and strengthening local agriculture and food systems.

Outside of Northeast Ohio's urban areas, land use was historically dominated by agriculture. Recent decades have seen both suburban expansion on the urban fringe and regrowth of forest cover following abandonment of marginal agricultural land. Statewide, agricultural land declined from 80% to 57% of all land area from 1950-2005 while forested land expanded from 19.5% to 30%. Northeast Ohio has seen similar trends in agricultural and forest cover change. Counties near Cleveland, such as Geauga, Lake, Lorain, and Medina have seen substantial population growth in recent decades, primarily as agricultural land and forests are converted into developed land. Outside these suburbanizing counties, however, land use today is still predominantly agricultural.

2.2 Construction of GPI estimates

To calculate the GPI for Northeast Ohio, we strove to maintain consistency with past local studies, following the methods of Bagstad and Ceroni (2007), who in turn follow Costanza et al. (2004). Methods for the services of household capital, cost of consumer durables, climate change, and ozone depletion follow Talberth et al. (2007), the most recent U.S. GPI study (Table 1). When improved data sources or methods were available, we noted these changes in Appendix B of this dissertation, which describes detailed data sources, methods, and assumptions. This appendix is also available online at http://www.uvm.edu/giee/special/gpi.htm. We briefly describe major changes to our methods below. Following past studies, we calculated values for the decennial years 1950-2000, but also for the year 2005, for all 26 GPI components. We converted monetary values into year 2000 U.S. dollars using the Consumer Price Index (CPI) from the U.S. Bureau of Labor Statistics. For the years 1990-2005, we used local CPI data for the Cleveland-Akron urban area as a deflator. We used national CPI values from 1950-1980, where local data were unavailable.

For the cost of crime, which previously only included the cost of property crime, we tested the impact of adding the cost of lost human life due to murder and manslaughter. Since the GPI already uses a conservative value of human life estimate for vehicle crashes, we applied the same value to the loss of life due to violent crime.

For wetland and forest loss, we compared the value of forest and wetland loss since presettlement times versus loss since 1940 only. The use of presettlement forest and wetland cover estimates is problematic for two reasons – the high uncertainty associated with the estimates, and the limited policy relevance for social well-being when using a presettlement baseline for natural areas cover.

For the cost of nonrenewable resource depletion, we used replacement costs for energy consumption at local scales. This cost accounts for the need for communities to transition to renewable energy, a topic of serious discussion for a growing number of communities. We divided energy consumption into transportation fuels that could be replaced using biofuels versus other consumption including electricity generation, which could be replaced by sources such as wind and solar. While there is much uncertainty surrounding technologies to scale up renewable energy use and their costs, Makhijani (2007) provides cost estimates for the widespread adoption of renewable energy sources.

For the cost of climate change, we compared two methods: 1) using methods from Talberth et al. (2007), but scaling down state-level CO_2 emissions data by sector using manufacturing employment, commercial employment, household spending on energy, and vehicle miles traveled for the industrial, commercial, household, and transportation sectors respectively; and 2) using Shammin and Bullard (in review), which assigns greenhouse gas emissions intensities to different categories of consumer spending, and multiplying these intensities by the spending totals for each spending category. Intensities are based on U.S. Department of Commerce Economic Input-Output Life Cycle Analysis (EIO-LCA) database (EIO-LCA 2006). These intensities include carbon emissions associated with both direct energy consumption (natural, gas, electricity, gasoline, etc.) and also indirect energy consumption (energy embodied in various goods and services, Shammin et al. in press). Table 2 summarizes the intensities used for our GPI calculations. By accounting for the CO_2 emissions intensities of consumption, we avoid the "open economy" problem in the GPI, where costs of consumption decisions are not borne locally (Clarke 2007). We did not accumulate the cost of CO_2 emissions, a controversial practice when estimating the GPI (Neumayer 2000).

Finally, we compared the cost of ozone depletion using accumulation (as opposed to nonaccumulation) of costs from year to year. We did this for ozone depletion but not CO_2 emissions because emissions of ozone depleting chemicals have basically stopped, while their social costs have not. CO_2 emissions and their social costs, however, both continue to rise.

Local data quality relevant to the GPI has improved considerably in recent years (Bagstad and Ceroni 2007). The American Community Survey now provides annual socioeconomic data for cities and counties with populations of 65,000 or more, along with pooled data over multiyear periods to provide estimates for cities and counties with smaller populations. ACS estimates contain a larger margin of error than the decennial census. This margin of error is due to ACS' smaller sample size, as it surveys only 1 in 40 households, versus 1 in 6 during the 2000 Census.

The Bureau of Labor Statistics' (BLS) American Time Use Survey (ATUS) can provide state-level time use data, enabling local adjustments to national time use data. Local wage rates from the BLS are also used in this study for all relevant GPI components. Finally, we included detailed county-level consumer expenditures data purchased from ESRI (ESRI 2008). These data are available from the BLS at national and regional scales, but are unavailable in the public domain at the state, county, or city level. As such we purchased consumer spending data on over 750 goods and services and combinations of goods and services for use in our analysis. Cumulatively, the use of these local data gives us confidence that results reflect local conditions for GPI components more so than past studies, which relied on less accurate, often scaled down data.

2.3 Temporal comparisons
We estimated the GPI for decadal years from 1950-2000, along with the year 2005. This enables us to compare time trends in the GPI. However, as noted by Bagstad and Ceroni (2007), considerably more confidence can be placed in GPI estimates from recent years, particularly from 1990 onward. This is because data from earlier years are often scaled down from state or national values or is extrapolated backward from more recent trends. As such we focused our analysis primarily on the 1990-2005 time series.

2.4 Spatial comparisons
Spatial comparisons can take place at an intra- or inter-regional scale. To evaluate results within the region, we can compare individual counties to each other or group counties as urban, suburban, and rural (Figure 2). Although these distinctions are subjective, they address the changing ecological and socioeconomic setting between a region's urban centers and rural hinterlands. We classified counties as urban, suburban, or rural based on 2005 population density and proximity to urban centers. Cleveland, Akron, and Cuyahoga County have Northeast Ohio's highest population densities, and we thus classified these as urban. Summit County (containing Akron) is substantially less dense than Cuyahoga, and is primarily suburban. Five counties surrounding Cuyahoga and Summit (Geauga, Lake, Lorain, Medina, Portage) have greater population density and urban proximity than the rural counties, and we designated them as suburban. Finally, the smaller cities of Canton and Youngstown support their own suburbs, along with county populations too large to be truly rural. As such we included Mahoning, Stark, and Trumbull counties as suburban. The remaining seven counties meet neither of these criteria for urban proximity or population density, and we designated these as rural. Some of the counties classified as "suburban" have substantial rural areas contained within them, while some of the "rural" counties contain one or more dense but small cities, though these cities generally lack suburbs. Also, some of the "suburban" counties had much more rural character prior to the last half century of suburbanization. As such it would be inaccurate to have called some of them suburban in earlier decades.

For inter-regional comparisons, we first adjusted the value of Bagstad and Ceroni's (2007) Vermont GPI estimates to ensure comparable methods and data sources. This allowed us to compare GPI results between Vermont and Ohio. We compared GPI at the state level (Ohio versus Vermont), for rural counties (average of seven rural Northeast Ohio counties versus six rural Northern Vermont counties), and for Chittenden County, Vermont's most urban county, versus an average of nine suburban Northeast Ohio counties. Since Vermont has no urban centers on the scale of those found in Northeast

Ohio, urban-urban comparisons were not possible. As local GPI studies are completed elsewhere in the U.S., further inter-regional comparisons will be possible, assuming that researchers use consistent methods and data sources. Regrettably, inconsistencies in data and methods preclude comparing results from Ohio and Vermont to earlier studies in Minnesota and the San Francisco Bay Area.

2.5 Sensitivity analysis

We used different data and assumptions to estimate GPI with above-described local data versus non-local data, which is often scaled down from national or state values (Table 1). Since added time and expense are needed to incorporate local data, we tested the relative value that local data adds in changing the overall estimates. Alternative data and assumptions described in section 2.2 were also examined for the valuation of human life and natural capital, which value these resources using more or less conservative methods.

3. Results

3.1 Temporal trends

Given the complexity of reporting all GPI components for 20 unique geographies across multiple decades, we report detailed results as supplemental online material at http://www.uvm.edu/giee/special/gpi.htm. We report per capita GPI values here using figures or tables as appropriate. Similar to national GPI trends (Talberth et al. 2007), GPI in most of Northeast Ohio rose for a period, in this case 1950-1990. Since 1990, GPI has remained stable, declined, or increased in different geographies (Figure 3). Regrettably, GPI values for earlier decades have large associated uncertainty due to the lack of local data. When local data is unavailable, extrapolation is required in order to obtain estimates for these early decades (Bagstad and Ceroni 2007). As such, we resist the temptation to present and evaluate GPI trends from 1950-1980, the period where data are generally much less reliable. We instead focus our analysis of temporal trends for the years 1990-2005.

From 1990-2005, per capita GPI grew in eight counties and declined in nine counties, the cities of Akron and Cleveland, and the State of Ohio (Table 3). During this period average per capita personal consumption increased \$4,504, or 23%. Contributing to the declines in per capita GPI were increasing costs of consumer durables (average county deduction of \$1,794), increasing income inequality in many geographies (average -\$1,324), increasing costs of leisure time loss (average -\$973) and climate change (average -\$777), declines in the value of household labor (average -\$673), rising costs of nonrenewable resource depletion (average -\$516), commuting (average -\$214), and unemployment and underemployment (average -\$106). Slight declines were also seen in the value of volunteer work, while increases were seen in the cost of household pollution abatement, noise pollution, and wetland and farmland loss, though the magnitude of these changes was not large relative to the overall GPI (Figure 4, Table 4).

Some positive contributions to GPI grew from 1990-2005. These included an increase in net capital investment (average +\$834, derived solely from national data), services of household capital (average +\$384) and highways and streets (average +\$128), and a decline in the costs of vehicle crashes (average +$206). Slight reductions were also seen in the costs of crime, family breakdown, water and air pollution, and ozone depletion. Forest re-growth added value to some Northeast Ohio counties but forest loss deducted value in others. These added values, however, were not enough to overcome the increasing costs components. Average per capita GPI for Ohio, the 17 counties, and cities of Akron and Cleveland declined by $504 between 1990 and 2005.

Examining the 1990-2000 and 2000-2005 time periods separately, we found generally greater per capita growth from 2000-2005. From 1990-2000, per capita GPI rose in 3 counties, the cities of Akron and Cleveland, and State of Ohio, and fell in 14 counties. From 2000-2005, per capita GPI rose in 14 counties and declined in 3 counties, the cities of Akron and Cleveland, and State of Ohio. These trends were similarly influenced by the relative growth of inequality-adjusted personal consumption versus other environmental and social costs. In geographies that had relatively high personal consumption growth without rising inequality, per capita GPI generally grew. Geographies with slowly rising personal consumption or greatly expanding inequality saw declines in per capita GPI.

3.2 Spatial trends: intra-regional comparisons

As expected, GPI and its component costs and benefits vary greatly across the region. Per capita GPI was highest in suburban regions and lowest in urban areas, with rural regions intermediate (Figure 5). Wealthier suburban areas generally had the greatest personal consumption, an important driver of GPI trends. Urban areas had higher income inequality and costs of unemployment and underemployment, leading to lower GPI. Suburban areas had higher per capita costs for some environmental and social components, such as farmland loss and commuting, owing to high rates of land conversion and automotive dependence.

An examination of all GPI components shows why GPI values diverge in different geographies (Figure 6). Geauga County, the wealthiest in the study area, saw the greatest percent growth in per capita GPI from 1990-2005 (Table 3). Geauga County did have high costs associated with suburbanization, including higher per capita costs of commuting, wetland and farmland loss, climate change, and nonrenewable resource depletion. However, these costs were more than offset by greater personal consumption, a consequence of larger per capita income. Cleveland, meanwhile, has low personal consumption, greater income inequality, and greater costs of crime and unemployment and underemployment. Huron and Lake counties saw the largest declines in per capita GPI from 1990-2005. Rising income inequality over this period was largely responsible for this decline, as inequality-adjusted personal consumption declined in these counties over the 15-year period. Huron and Lake counties were the only places to witness declines in inequality-adjusted consumption during this period.

3.3 Spatial trends: inter-regional comparisons

Per capita GPI is lower in Ohio than in corresponding Vermont geographies (i.e., for Ohio versus Vermont, rural Northeast Ohio versus rural Northern Vermont, and suburban Northeast Ohio versus Chittenden County, Vermont, Figure 7). Ohio and rural Northeast

Ohio start with greater per capita personal consumption than Vermont or rural Northern Vermont. The primary contributors to Vermont's larger GPI are the smaller costs of climate change and nonrenewable resource depletion, and greater value of forest gain. Vermont geographies generally also had lower cost of vehicle crashes, consumer durables, commuting, and household pollution abatement, and greater value of volunteer labor and services of streets and highways. Ohio generally had greater value from services of household capital and less leisure time loss. However, these items totaled only 7% of the total adjustments to the GPI, and were thus small relative to the larger costs such as personal consumption (41%), income inequality (9%), household labor (14%), and nonrenewable resource depletion (9%).

Chittenden County, Vermont and Geauga County, Ohio illustrate two different paths to similarly high per capita GPI. These counties have the highest per capita GPI of their respective study areas. While Geauga County has greater per capita personal consumption and services of household capital, Chittenden County has lower income inequality, more value from household labor, and smaller costs of climate change and nonrenewable resource depletion (Figure 8).

Per capita GPI in Ohio is similar to that in the U.S., with both U.S. and Ohio values below those of Vermont. However, since the national GPI was calculated using different methods (Talberth et al. 2007), state and national values are not strictly comparable.

3.4 Sensitivity analysis: Non-local data and non-conservative assumptions

Our baseline results presented above used local data wherever possible with generally conservative assumptions to measure and value economic, social, and environmental costs and benefits. Since the data and methods differ from past U.S. GPI studies, we next compare the effects of these changes on our results. Absolute and relative changes should be addressed when data and methods are changed – first, how much do GPI values change and second, are the temporal and spatial trends between geographies preserved?

When local data were omitted, GPI values for all geographies changed, but not always equally. Without local data, GPI results were overestimated at the local level by as much as 22% and underestimated by as much as 23% in different geographies. GPI was overestimated in all years for Ashtabula, Cuyahoga, Erie, and Mahoning counties and the City of Cleveland, generally less wealthy geographies. GPI was underestimated in all years for Geauga, Huron, Lorain, Medina, Portage, Stark, and Wayne counties, generally wealthier geographies.

The omission of local data did not change spatial GPI rankings for most geographies. However the omission of local data did lead to relatively lower rankings for Ashland, Lorain, and Portage counties and relatively higher rankings for Cuyahoga, Erie, and Mahoning counties. Local data most responsible for absolute and relative changes in GPI trends included personal consumption, services of household capital/cost of consumer durables, the cost of underemployment and unemployment, and the cost of climate change. To be as accurate as possible, it is particularly important that future GPI studies obtain local data for these components.

Our “nonconservative assumptions” included:

1. Adding a social cost of murder along with the cost of property crime to the overall cost of crime (which has not been done in past GPI studies). Adding murder to the cost of crime reduces per capita GPI in different geographies a maximum of 5%, but an average of less than 1%.
2. Using presettlement wetland cover as a baseline (as has been done in past GPI studies) rather than extrapolated wetland cover in 1940. Using a presettelement baseline for wetland loss reduces per capita GPI in different geographies up to 33%, with an average reduction of 5%.
3. Using replacement costs for biofuel for all nonrenewables depletion cost (as has been done in past GPI studies) rather than using solar and wind as replacements for electricity generation. The less realistic assumption that biofuels be substituted for all nonrenewable energy sources reduces per capita GPI in different geographies as much as 41% and an average of 13%.
4. Using greenhouse gas emissions data based on emissions from each sector (as has been done in past GPI studies) rather than based on greenhouse gas intensities of various consumer expenditure categories. The choice of which climate change cost measure to apply can lead to a change of up to 7% in GPI in different geographies, though the average change is near zero. Using consumer expenditures as a basis for calculating carbon emissions leads to higher costs in counties like Medina and Geauga, which had the greatest levels of personal consumption.
5. Accumulating the cost of ozone depletion over time (as has been done in past GPI studies). Accumulating the costs of ozone depleting chemicals reduces per capita GPI in different geographies by an average of 7% and a maximum of 17%.
6. Using presettlement forest cover as a baseline (as has been done in past GPI studies) rather than 1940 forest cover. Using a presettelement baseline for forest loss reduces per capita GPI in different geographies up to 6%, with an average reduction of 2%.

Combining these non-conservative assumptions, GPI is reduced an average of 27%, a maximum of 66%, and a minimum of 10% for different geographies in different years.

4. Discussion

4.1 Temporal and spatial trends

The declines in per capita GPI for parts of Northeast Ohio from 1990-2005 are not unique, as authors of GPI studies have often documented stable or declining per capita GPI in recent years (Jackson and Stymne 1996, Lawn and Clarke 2008). However, per capita GPI grew in eight of 17 counties from 1990-2005. Aside from the fact that all urban regions declined in per capita GPI over this period, there is no clear spatial pattern to GPI’s rise or decline. In the rural and suburban parts of Northeast Ohio, some rural and suburban counties’ per capita GPI grew while others declined. Per capita GPI declined for most geographies from 1990-2000 while growing from 2000-2005.

The largest contributors to changing GPI were personal consumption, income inequality, household labor, leisure time loss, climate change and nonrenewable resource depletion, and net capital investment (Table 4). Changes to the cost of consumer durables and services of household capital were important but are closely related to levels of personal consumption expenditures. Where personal consumption grows faster than the various negative social, economic, and environmental costs, GPI grew. For example, Geauga, Erie, and Portage counties saw per capita personal consumption grow over 30% from 1990 to 2005. These counties all saw per capita GPI rise during this period. By contrast, Huron and Trumbull counties had the smallest growth in personal consumption, only 11%. These counties both had declines in per capita GPI from 1990-2005, particularly in Huron County, where income inequality also increased over this period. Places where personal consumption starts at a low level may also be unable to overcome growing social, economic, and environmental costs through growth in consumption. Despite 22% growth in per capita personal consumption and a decline in inequality, Cleveland, which started with the region's lowest personal consumption, witnessed a 7% decline in per capita GPI from 1990-2005.

As with intra-regional comparisons, the discrepancy between personal consumption and other environmental, social, and economic costs and benefits can explain differences in per capita GPI between Northeast Ohio and Northern Vermont. Ohio had greater per capita personal consumption than Vermont, as did rural Northeast Ohio versus rural Northern Vermont. However, the lower income inequality, greater value of forest re-growth, and smaller cost of climate change and nonrenewable resource depletion in Vermont typically led to greater per capita GPI than corresponding Ohio geographies. This pattern was also seen in Chittenden County, Vermont, which had similar environmental and socioeconomic performance as the rest of Vermont, combined with high levels of personal consumption. As such Chittenden County had per capita GPI nearly equal to that of Geauga County, Ohio, which had the highest GPI of any geography in Northern Vermont or Northeast Ohio.

Although Ohio's per capita GPI was smaller than Vermont's, such differences should be expected due to their radically different socioeconomic and environmental settings. Politically and economically, observers have considered Ohio to be reflective of the U.S. as a whole, a microcosm of national-scale political, socioeconomic, and environmental trends (Cleveland Plain Dealer 2004). Vermont, however, has a much different economic and demographic profile than much of the rest of the U.S., owing largely to its overwhelmingly rural geography. One key difference between these states is the source of electricity, which impacts climate change and nonrenewable resource depletion costs. In Ohio, where nearly 90% of electricity is generated using coal, these costs are greater than Vermont, which obtains 75-80% of its electricity from hydroelectric and nuclear power. Just because Vermont has higher GPI than Ohio does not mean that both states could not improve certain GPI component indicators. It also does not necessarily mean that it would be feasible or desirable for Ohio to adopt policies to improve well-being based on those in place in Vermont.

Due to changes in how the U.S. Bureau of Economic Analysis computes subnational GDP, it is difficult to construct recent time series of state-level per capita GDP. BEA (2003) provides a time series of state-level GDP from 1977-2001. These data show that Ohio's per capita GDP was typically greater than Vermont's from 1977-2001. However, Ohio's per capita GPI was consistently lower than Vermont's. When per capita GDP and GPI are indexed to 1980, Vermont's per capita GDP is found to have grown 51% from 1980-2001, while Ohio's grew 33%. However, Vermont's per capita GPI grew only 15% from 1980-2000, while Ohio's grew by 8% from 1980-2000 and 4% from 1980-2005 (Figure 9). These trends suggest that not all economic growth is created equally, and that the growth occurring in Ohio in recent decades has not supported well-being as measured by the GPI.

4.2 Sensitivity analysis

Local data is clearly important to improving the accuracy of GPI estimates at the state, county, or city level. When state or national data are scaled down, absolute and relative trends may be compromised. Local GPI studies in the U.S. have used progressively higher quality local data, with this study using the most yet (Minnesota Planning Environmental Quality Board 2000, Costanza et al. 2004, Venetoulis and Cobb 2004, Bagstad and Ceroni 2007). Our choice to abandon serious attempts at analysis prior to 1990 was an important compromise on data quality. GPI estimates for these early years are of poor quality and depend on increasingly unreliable extrapolation for earlier decades. Going forward, having more high-quality GPI analyses that use good quality data to facilitate regional comparisons can help provide motivation for new jurisdictions to follow with their own studies.

Despite these gains, there is still room for improvement in local estimates. In particular, GPI components measuring time use rely on state-level data, with local estimates frequently not existing. Time use data influence estimates of household and volunteer labor, leisure time loss, and the cost of unemployment and underemployment. Improved local data for these categories would further benefit local GPI estimates.

With the exception of adding the cost of murder, which more comprehensively treats the cost of violent crime, we generally prefer to use conservative approaches to valuing economic, social, and environmental costs and benefits in the GPI. We felt it was important to use realistic and policy-relevant baselines for the cost of wetland and forest loss, since a return to presettlement land cover conditions is neither a realistic nor desirable public policy goal. Similarly we did not accumulate the cost of greenhouse gases and ozone depleting chemicals, attributing costs in a given year only to release in that year. There are certainly social legacy costs to past production and release of these substances. But for ozone depletion, we felt that the phase-out of CFC production by the Montreal Protocol means that current and future social welfare measurements should not be burdened by the costs of past actions. Finally, we use more realistic costs to account for the replacement of nonrenewable energy sources by renewable energy and to account for the carbon intensity of consumer spending rather than direct energy consumption. These methods improve local estimates while addressing the import-export problems of the GPI, at least for greenhouse gas emissions of imported goods or energy (Clarke 2007).

The large reductions in per capita GPI, as high as 66%, when using non-conservative assumptions are a potential source of much of the criticism behind use of the GPI to pinpoint when economic growth becomes "uneconomic" (Neumayer 1999, 2000). Since the author of a given GPI study effectively defines its system boundaries, critics of the GPI have argued that researchers are ideologically biased in the search for a measure that supports the threshold hypothesis. We feel that by including conservative but comprehensive assumptions and valuation methods, such ideological pitfalls can be better avoided.

4.3 Strong sustainability and the costs of urban decline and suburbanization

Neumayer (1999) notes that GPI is not a measure of strong sustainability. It is entirely possible to deplete natural or social capital while expanding income and consumption to produce rising per capita GPI. This trend is observed in the wealthier suburbanizing counties in Northeast Ohio. Many of the externalities associated with suburban development, such as rising commute times, air and water pollution, and open space loss are monetized as part of the GPI. However, these external costs are often offset by increased wealth and consumption in these communities, which can lead to greater per capita GPI. By extending our treatment of the costs of climate change to include personal consumption expenditures, we do incorporate some of the social costs of increasing consumption. Similar to our results, Venetoulis and Cobb (2004) found that counties in the San Francisco Bay Area with the highest personal consumption per capita, Marin and San Mateo counties, also had the greatest GPI per capita. Alameda and Solano counties had the lowest per capita personal consumption levels and also the lowest per capita GPI.

Conversely, GPI seems to better capture the costs of urban decline. Cleveland and Akron both registered low per capita GPI due in part to low income, high inequality, and high costs of crime, unemployment, and underemployment. As such, GPI serves as a sometimes-imperfect measure of social well-being in the regional context. While critics have pointed out the strong sustainability problem with the GPI in theory, this study is the first to show how it operates in practice, by enabling comparisons of multiple geographies using the same methods.

Unfortunately, we were unable to reliably capture the long-term GPI trends during the period of suburbanization and urban decline that took place in the last half of the twentieth century. Local data from the 1950s-1980s were generally of poor quality, requiring extrapolation of present-day trends. Such extrapolation assumes that present-day socioeconomic and environmental trends held true in earlier decades. This assumption is likely invalid for the areas that have undergone the most change –urban centers, which have suffered population and employment loss, and suburban counties, many of which have grown from rural towns to today's suburbia.

4.4 Implications for future local GPI studies

Discussions on green accounting in the U.S. at the federal level have been frozen for the last 15 years (Cobb et al. 1995). Thus community-level engagement with local and state decision makers based on the GPI may be a useful way to move this debate forward. Additional local and regional studies can also facilitate more interregional comparisons, as demonstrated in this paper for Ohio and Vermont. To enable comparisons, new studies should use comparable data sources and methods. In this study we have endeavored to develop and document methods that will enable accurate, policy-relevant measurements of the GPI for states, counties, and large cities. This can enable a better understanding of how the costs and benefits of economic growth are distributed within a nation. As described in the next section, local GPI estimates can also be used to engage local groups in discussions about regional sustainability and economic development.

5. The policy process

5.1 Well-being in Northeast Ohio

As residents of a region that has seen widespread loss of its industrial employment base, Northeast Ohioans have long been concerned with the state of the regional economy, particularly on maintaining employment opportunities. At the same time, interest has grown in building a region that takes more sustainable approaches to issues like land use, energy, and food systems. Organizations like Green City Blue Lake (GCBL, http://www.gcbl.org) have promoted both causes. Yet conventional economic measures like the region's "Dashboard of Economic Indicators" (http://www.futurefundneo.org/page10474.cfm) focus on economic indicators, along with a few social metrics. The Dashboard ranks Northeast Ohio's performance on indicators of economic growth against other urban areas, with the underlying assumption that further economic growth will provide more jobs, a primary social concern in the region. Yet if the region focuses solely on quantitative economic and employment growth, it may see declines in other aspects of regional well-being. For instance, the construction boom of the 1990s and early 2000s provided employment opportunities, but at the cost of open space loss, increasing traffic and automotive dependence, and loss of vitality in the region's urban centers. Northeast Ohio has recently witnessed controversy over payday lending and casino gambling, both potential employment sources with accompanying social costs. Job growth that provides external economic, social, and environmental benefits is more likely to improve the region's well-being than growth in sectors that erode social and natural capital.

Measures that are designed to account for economic, social, and environmental performance, like the GPI, offer one way to bridge the gap between these two views of the regional economy. The GPI to date has been primarily an academic exercise conducted to show both the benefits and costs of economic growth. However, members of the local academic and nonprofit communities are developing and implementing an outreach program based on the GPI. We hope this program can serve as a model for other communities interested in focusing on the broader impacts social impacts of economic decisions.

5.2 Moving beyond academia

To move beyond an academic exercise, GPI must obtain the popular support of policymakers and their technical staff. 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." As such, GCBL and Oberlin College are collaborating on a series of workshops to build support for GPI-based indicators in Northeast Ohio. As a local nonprofit institution, GCBL's goals include making results and methods more accessible to the public and local decision makers. By collaborating with academic institutions, nonprofits like GCBL can provide publicity, host workshops and training events, and provide a "home" for periodic updates of the region's GPI estimates.

5.3 Framing the issues

GPI trends for much of Northeast Ohio are quite similar to national trends, with some areas gaining and some losing but the region as a whole remaining flat or declining slightly. From a policy perspective, it is important not to frame these trends as a cause for hopelessness, but as a set of indicators that can be improved upon at the local and regional level. Local governments have little control over monetary and fiscal policy, or national and global business cycles. However, they can make strategic choices about education, infrastructure, land use, energy, and other types of investment. GPI could also promote regionalism by demonstrating that gains in certain areas brought about by intra-regional migration register as losses in other areas, while the entire region's well-being remains flat. Adoption of a qualitative economic development mentality, versus a quantitative growth mentality is typically politically difficult. However, Northeast Ohio presents an interesting opportunity for examining alternative regional development strategies, for two reasons. First, due to the job loss of recent decades, a blind rush toward economic globalization has not been universally accepted as desirable. Second, many leaders realize that in order to attract a creative, skilled work force, it is increasingly necessary to protect and enhance "quality of life" amenities in the region. If the GPI can be measured regularly and be indicative of changes brought about by these policies, it has the potential to serve as a highly useful local indicator in guiding policy.

Acknowledgements

Data collection, preparation, and calculations for many of the GPI components were completed by Greta Bradford, Colin Miller, Carl Schubert, and the students of the spring 2008 ENVS 220 course at Oberlin College. Partial support for this project was provided by Oberlin College and the University of Vermont. Brent Bleys, Steve Posner, and John Talberth, provided helpful suggestions on methods. David Beach, Brad Chase, and Laura Christie at Green City Blue Lake assisted in developing and implementing the GPI outreach program for Northeast Ohio.

References

Anielski, M. 2001. The Alberta GPI Blueprint: The Genuine Progress Indicator (GPI)

sustainable well-being accounting system. The Pembina Institute: Drayton Valley, Alberta.
Bagstad, K.J. and Ceroni, M. 2007. Opportunities and challenges in applying the Genuine Progress Indicator/Index of Sustainable Economic Welfare at local scales. International Journal of Environment, Workplace, and Employment 3 (2): 132-153.
Clarke, M. 2007. Is the GPI really genuine? Considering well-being impacts of exports and imports. International Journal of Environment, Workplace, and Employment 3 (2): 91-102.
Clarke, M. and P. Lawn. 2008. Is measuring genuine progress at the sub-national level useful? Ecological Indicators 8: 573-581.
Cleveland Plain Dealer. 2004. Five Ohios. Retrieved January 27, 2009 from http://www.cleveland.com/fiveohios/wide/index.ssf?/fiveohios/charts/0704a.html.
Cobb, C., T. Halstead, and J. Rowe. 1995. If GDP is Up, Why is America Down? Atlantic Monthly, October 1995: 59-78.
Costanza, R., J. Erickson, K. Fligger, A. Adams, C. Adams, B. Altschuler, S. Balter, B. Fisher, J. Hike, J. Kelly, T. Kerr, M. McCauley, K. Montone, M. Rauch, K. Schmiedeskamp, D. Saxton, L. Sparacino, W. Tusinski, and L. Williams. 2004. Estimates of the Genuine Progress Indicator (GPI) for Vermont, Chittenden County, and Burlington, from 1950 to 2000. Ecological Economics 51: 139-155.
Daly, H.E. and J.B. Cobb, Jr. 1989. For the Common Good: Redirecting the Economy toward Community, the Environment, and a Sustainable Future. Beacon Press: Boston, MA.
Diener, E., Suh, E.M., Lucas, R.E., and Smith, H.L. 1999. Subjective well-being: Three decades of progress. Psychological Bulletin 125 (2): 276-302.
Easterlin, R.A. 2005. Feeding the illusion of growth and happiness: A reply to Hagerty and Veenhoven. Social Indicators Research 74 (3): 429-443.
Eckersley, R. 2000. The state and fate of nations: Implications of subjective measures of personal and social quality of life. Social Indicators Research 52: 3-27.
EIO-LCA. 2006. Economic Input-Output Life Cycle Assessment. Carnegie Mellon Green Design Institute. Retrieved January 27, 2009 from http://www.eiolca.net.
ESRI. 2008. 2008 methodology statement: ESRI data – consumer spending. ESRI: Redlands, CA.
Frey, B. and A. Stutzer. 2002. What can economists learn from happiness research? Journal of Economic Literature 40 (2): 402-435.
Haggart, B., 2000. The gross domestic product and alternative economic and social indicators. *in*. Economics Division, Government of Canada. http://dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/BP/prb0022-e.htm#(13)txt
Haggerty, M.R., R.A. Cummins, A.L. Ferriss, K. Land, A.C. Michalos, M. Peterson, A. Sharpe, J. Sirgy, and J. Vogel. 2001. Quality of Life Indexes for National Policy: Review and Agenda for Research. Social Indicators Research 55: 1-96.
Hanley, N., I. Moffatt, R. Faichney, and M. Wilson. 1999. Measuring sustainability: A series of alternative indicators for Scotland. Ecological Economics 28: 55-73.
Harris, M. 2007. On income, sustainability, and the 'microfoundations' of the Genuine Progress Indicator. International Journal of Environment, Workplace, and Employment 3 (2): 119-131.

Jackson, T. and S. Stymne. 1996. Sustainable Economic Welfare in Sweden – A Pilot Index 1950 – 1992. London: Stockholm Environment Institute, The New Economics Foundation.

Jackson, T., N. McBride, and N. Marks. 2006. An index of sustainable economic well-being: A report for Yorkshire Futures. New Economics Foundation: London.

Kahneman, D., A.B. Krueger, D. Schkade, N. Schwarz, and A. Stone. 2004. Toward national well-being accounts. The American Economic Review 94 (2): 429-434.

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

Lawn, P.A. and M. Clarke. 2006. Comparing Victoria's genuine progress with that of the rest-of-Australia. Journal of Economic and Social Policy 10 (2): 115-138.

Lawn, P.A. and M. Clarke. 2008. Sustainable welfare in the Asia-Pacific: Studies using the Genuine Progress Indicator. Edward Elgar: London.

Matthews, J., M. Munday, A. Roberts, A. Williams, M. Christie, and P. Midmore. 2003. An index of sustainable economic welfare for Wales: 1990-2000. Report for the Countryside Council for Wales. Cardiff Business School: Cardiff.

Makhijani, A. 2007. Carbon-free and nuclear-free: A roadmap for U.S. energy policy. IEER Press and RDR Books: Takoma Park, MD and Muskegon, MI.

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

Minnesota Planning Environmental Quality Board. 2000. Smart signals: An assessment of progress indicators. Minnesota Planning Environmental Quality Board: St. Paul, MN.

Moffatt, I. and M. Wilson. 1994. An index of sustainable economic welfare for Scotland, 1980-1991. International Journal of Sustainable Development and World Ecology 1: 264-291.

Neumayer, E. 1999. The ISEW – Not an index of sustainable economic welfare. Social Indicators Research 48: 77-101.

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

Nordhaus, W. and J. Tobin. 1972. Is Growth Obsolete? Economic Growth, National Bureau of Economic Research General Series vol. 96E. New York: Columbia University Press.

Pulselli, F.M., F. Ciampalini, E. Tiezzi, and C. Zappia. 2006. The Index of Sustainable Economic Welfare (ISEW) for a local authority: A case study in Italy. Ecological Economics 60 (1): 271-281.

Pulselli, F.M., S. Bastianoni, N. Marchettini, and E. Tiezzi. 2008. The road to sustainability: GDP and future generations. WIT Press: Southampton, UK.

Shammin, M. and C. Bullard. In review. Impact of cap-and-trade policies for reducing greenhouse gas emissions on US Households. Submitted to: Ecological Economics.

Shammin, M., R. Herendeen, M. Hanson, and E. Wilson. In press. A multivariate analysis of the energy intensity of sprawl versus compact living in the US for 2003. Accepted for publication in Ecological Economics.

Sustainable Measures. 2006. Communities working on sustainability. Retrieved November 18, 2008 from http://sustainablemeasures.com/Resources/SustainableCommunities.php.
Talberth, J., C. Cobb, and N. Slattery. 2007. The Genuine Progress Indicator 2006: A tool for sustainable development. Oakland, CA: Redefining Progress.
U.S. Bureau of Economic Analysis (BEA). 2003. Regional accounts archive for May 22, 2003. Retrieved January 12, 2009 from http://www.bea.gov/histdata/RMyearAPFfiles.asp?docDir=/2001/GSP/state/initial_May-22-2003.
Venetoulis, J. and C. Cobb. 2004. The Genuine Progress Indicator 1950-2002 (2004 Update). Redefining Progress: Oakland, CA.
Wen, Z., K. Zhang, B. Du, Y. Li, and W. Li. 2007. Case study on the use of genuine progress indicator to measure urban economic welfare in China. Ecological Economics 63 (2-3): 463-475.
Ziegler, R. 2007. Political perception and ensemble of macro objectives and measures: The paradox of the Index of Sustainable Economic Welfare. Environmental Values 16: 43-60.

Figures

Figure 1. Study area map

Figure 2. Urban, suburban, and rural counties

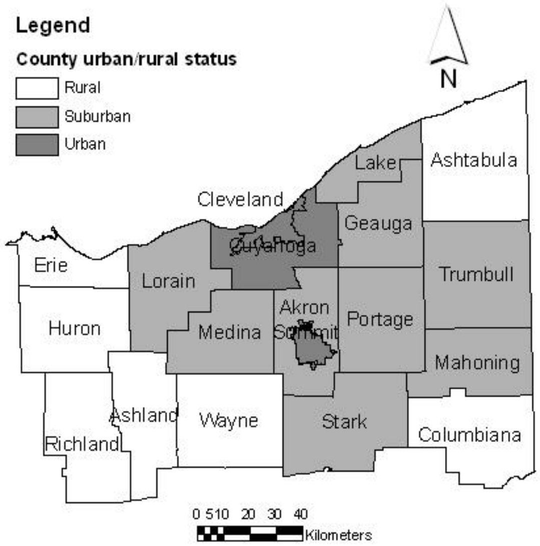


Figure 3. Northeast Ohio GPI trends from 1950-2005

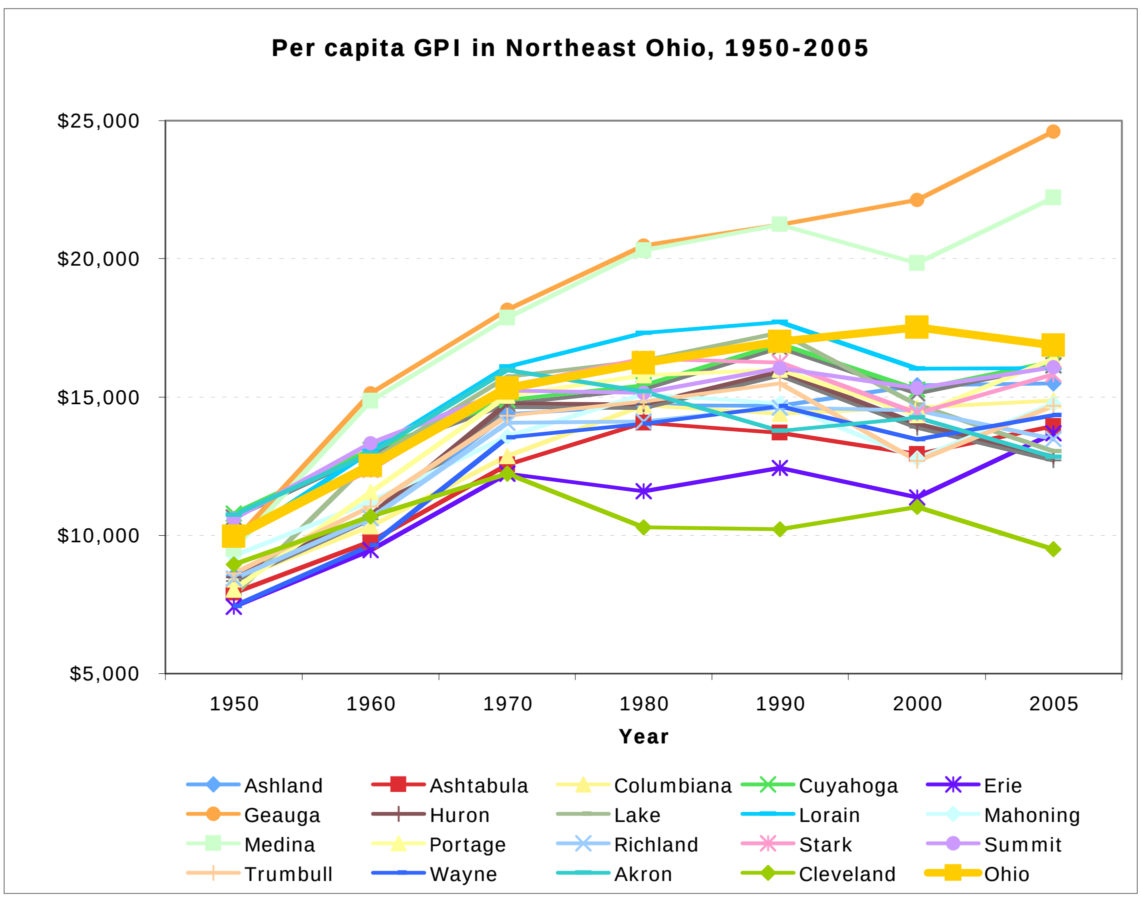


Figure 4. Change in GPI components from 1990-2005 for Ohio

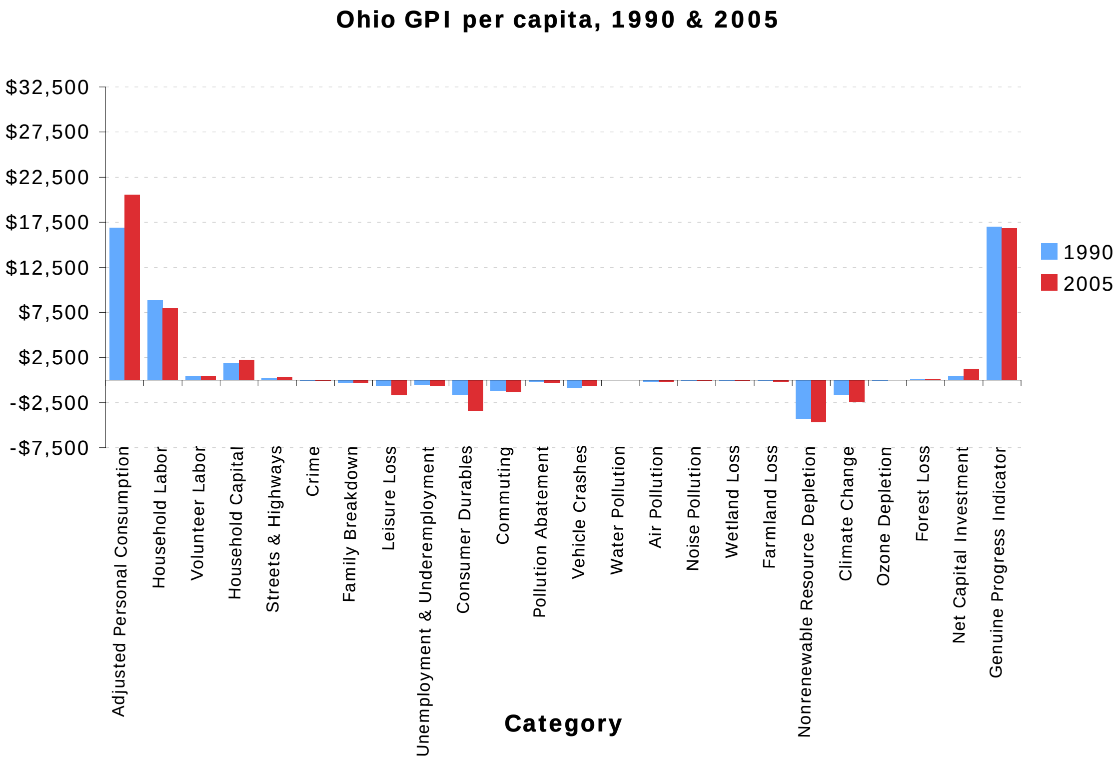

Ohio GPI per capita, 1990 & 2005
$32,500
$27,500
$22,500
$17,500
$12,500
$7,500
$2,500
-$2,500
-$7,500
1990
2005
Adjusted Personal Consumption
Household Labor
Volunteer Labor
Household Capital
Streets & Highways
Crime
Family Breakdown
Leisure Loss
Unemployment & Underemployment
Consumer Durables
Commuting
Pollution Abatement
Vehicle Crashes
Water Pollution
Air Pollution
Noise Pollution
Wetland Loss
Farmland Loss
Nonrenewable Resource Depletion
Climate Change
Ozone Depletion
Forest Loss
Net Capital Investment
Genuine Progress Indicator
Category

Figure 5. Differences in per capita GPI, personal consumption, income inequality, costs of unemployment and underemployment, and farmland loss across Northeast Ohio

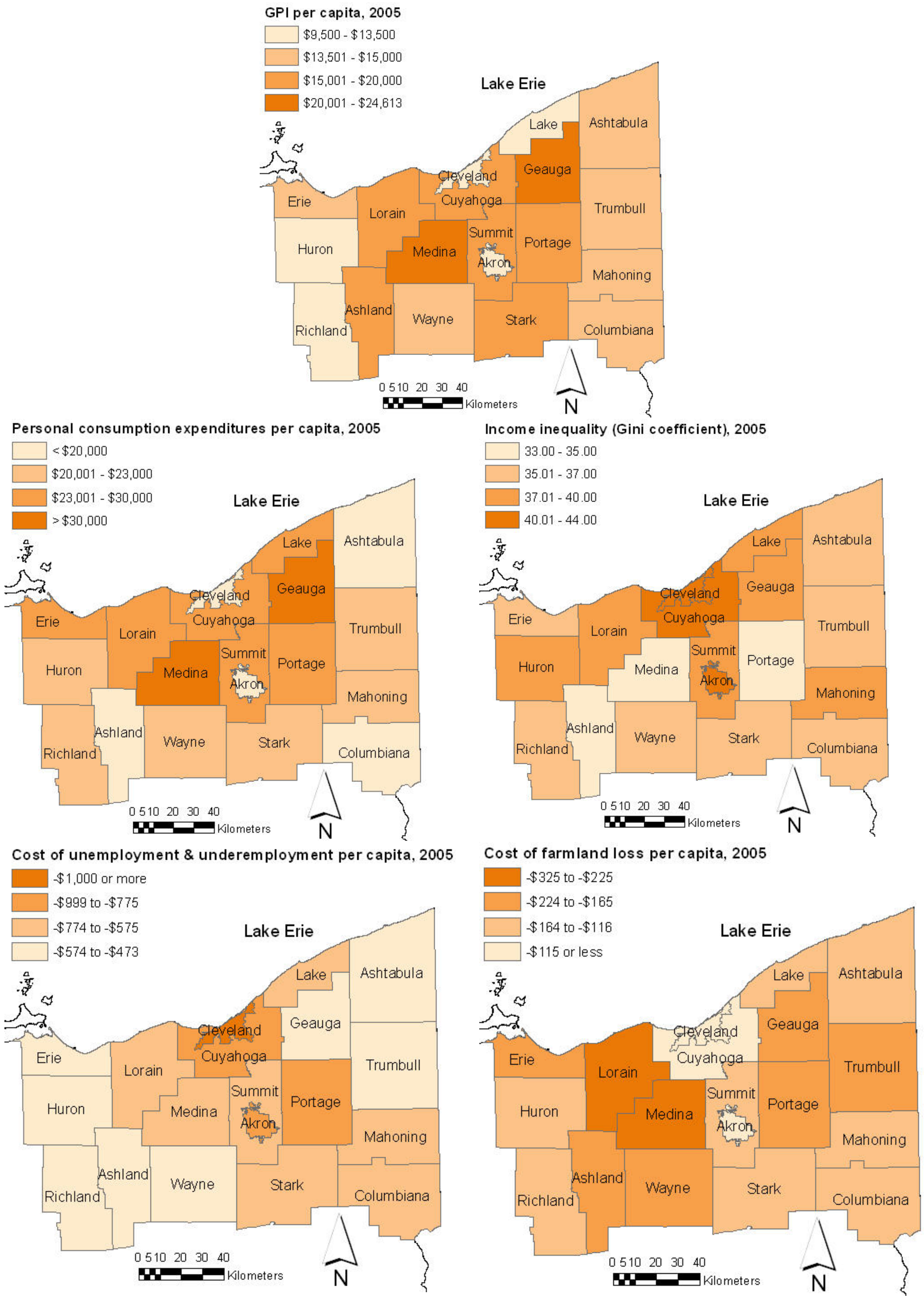
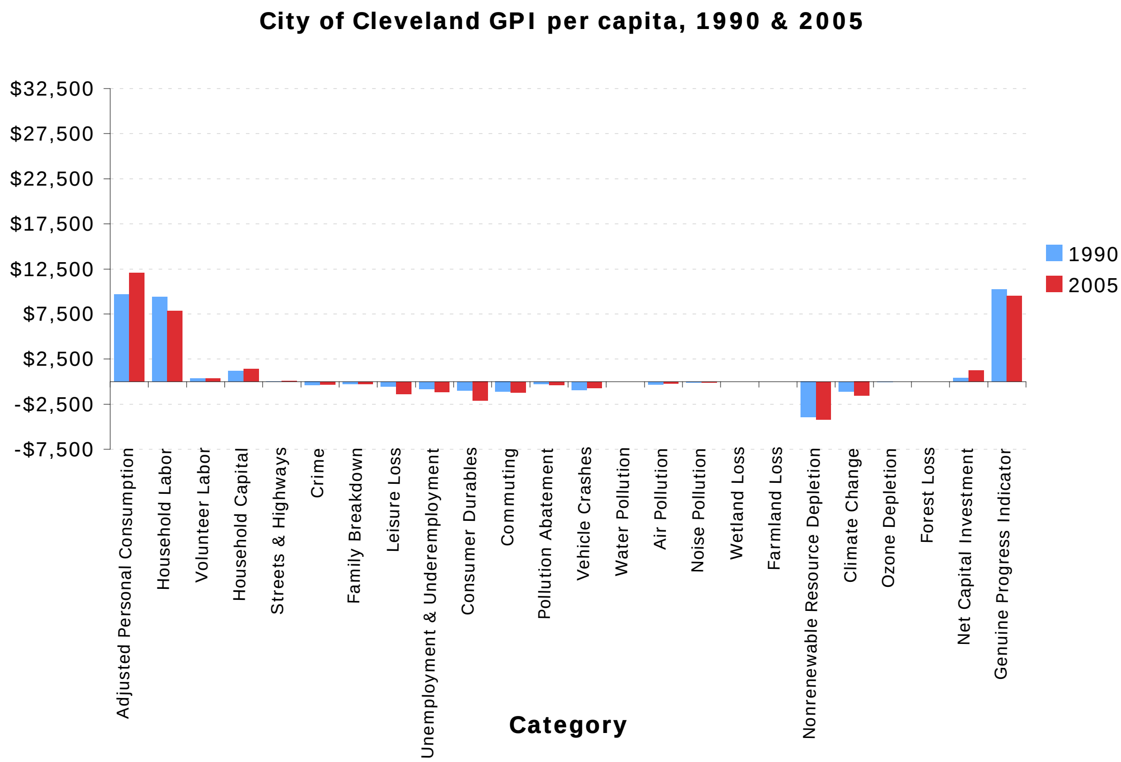


Figure 6. Change in GPI components from 1990-2005 for the City of Cleveland (top) and Geauga County (bottom)



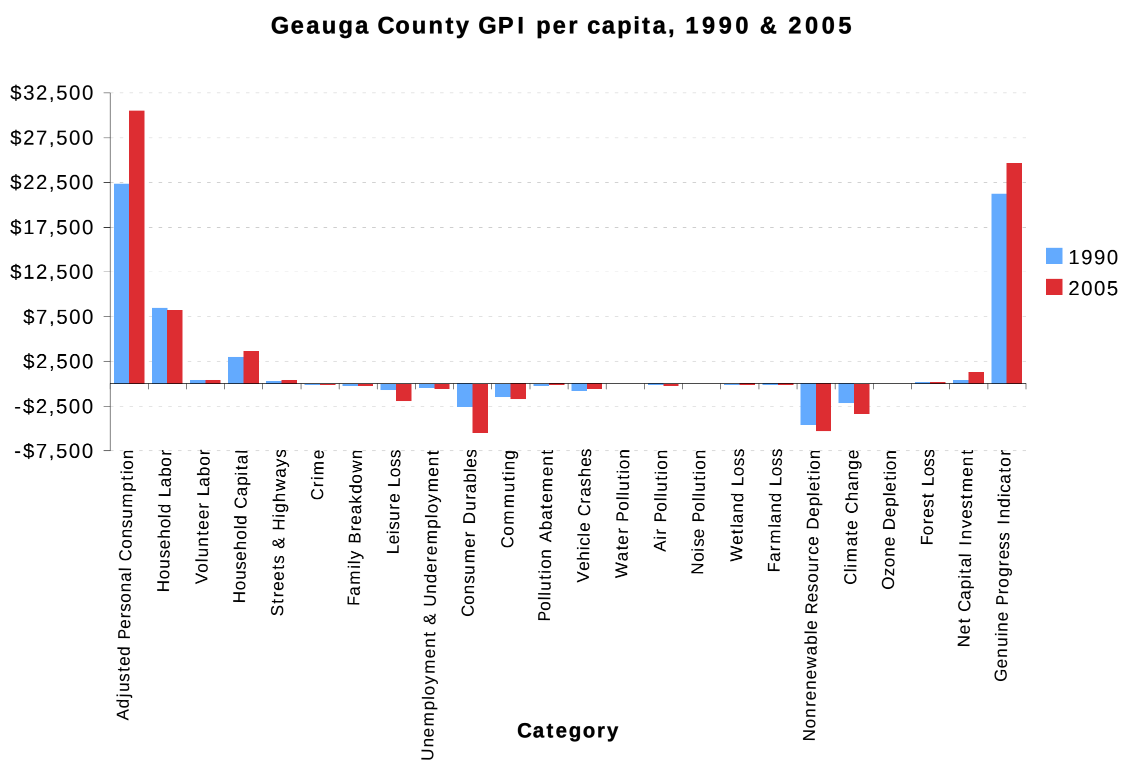


Figure 7. Per capita GPI for corresponding Ohio and Vermont geographies, 1990-2005

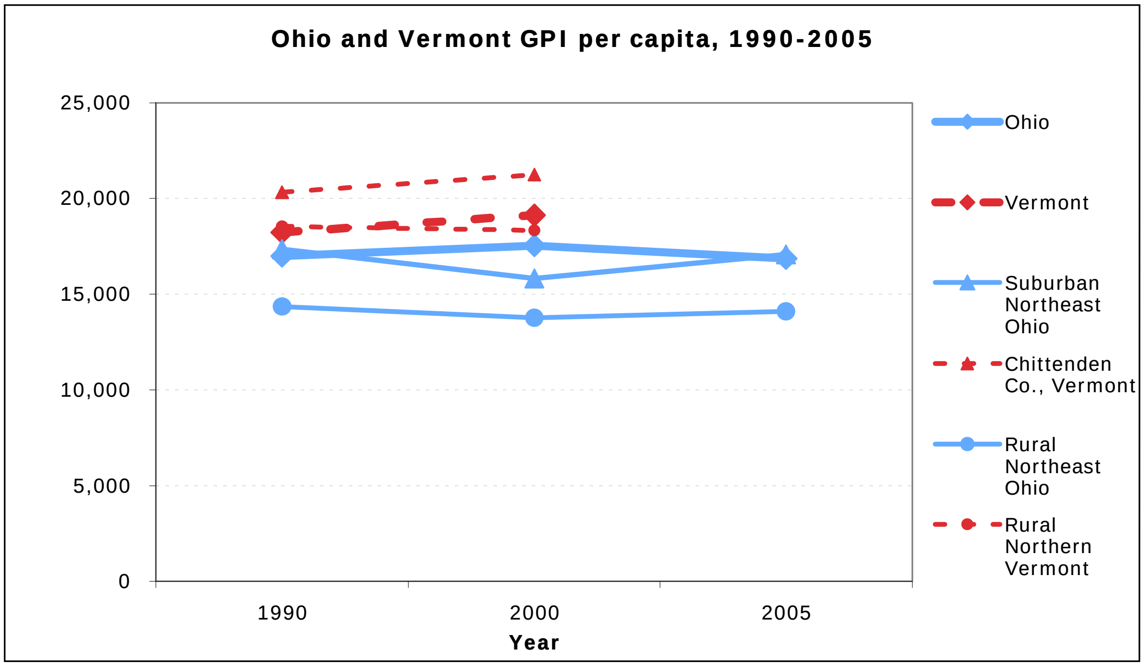


Figure 8. Per capita GPI for Geauga County, Ohio and Chittenden County, Vermont for 2000.

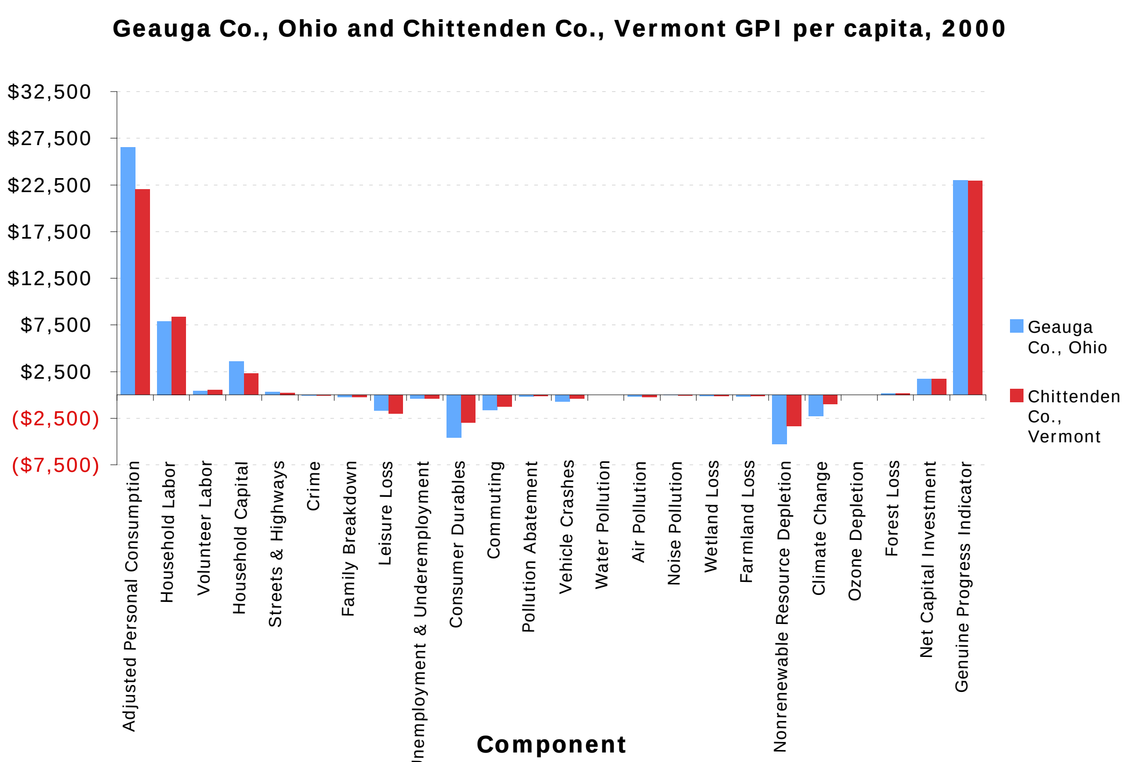


Figure 9. Indexed GDP and GPI per capita, Ohio and Vermont

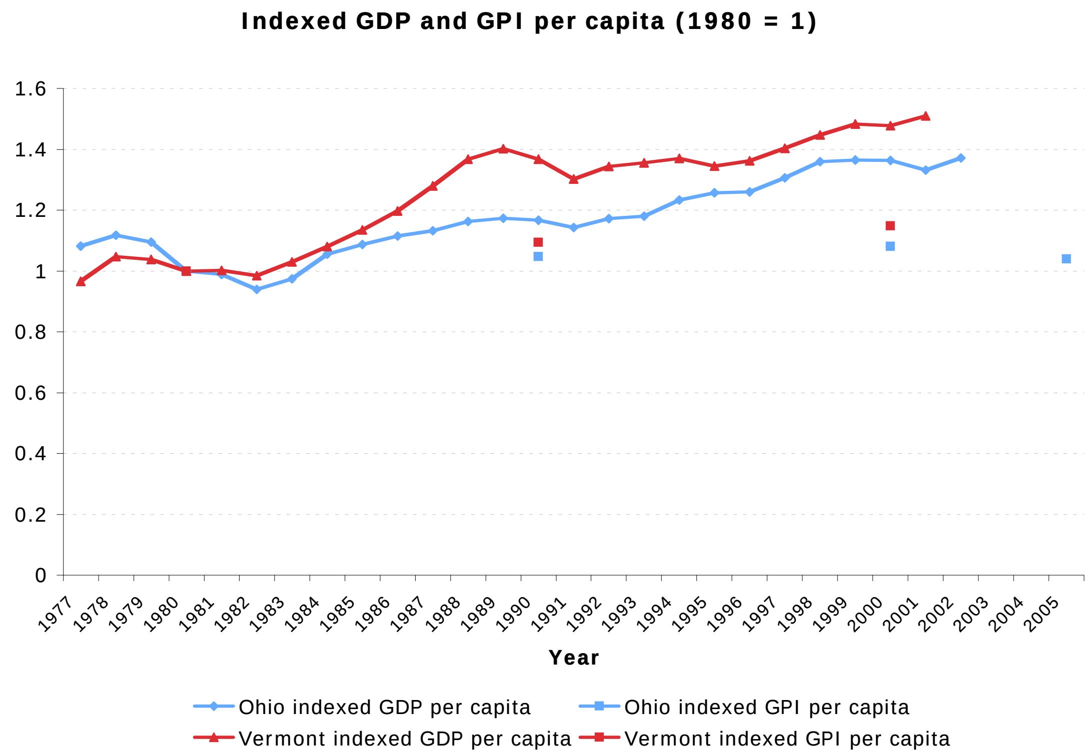


Table 1. Methods, local data, and assumptions used for GPI components

GPI component	Methods followed	Additional local data used	Assumptions for conservative estimates
A Personal consumption	Bagstad and Ceroni (2007)	Local consumer spending data	
B Income inequality	Bagstad and Ceroni (2007)		
D Household labor	Bagstad and Ceroni (2007)	Local time use and wage rate data	
E Volunteer work	Bagstad and Ceroni (2007), with refined state-level estimates for value of volunteer hours and number of hours worked		
F & L Services of household capital, costs of consumer durables	Talberth et al. (2007)	Local consumer spending data on consumer durables	
G Streets & highways	Bagstad and Ceroni (2007)		
H Crime	Costanza et al. (2004)	Local consumer spending data on security systems	Costs of murder not estimated (vs. estimated using costs used for traffic fatalities)
I Family breakdown	Bagstad and Ceroni (2007)	State time use data on TV watching	
J Leisure time loss	Bagstad and Ceroni (2007)	Local wage rates and time use for work hours	
K Unemployment & underemployment	Costanza et al. (2004)	Local wage rates	
M Commuting	Costanza et al. (2004)	Local wage rate for commute time	
N Household pollution abatement	Costanza et al. (2004)		
O Vehicle crashes	Bagstad and Ceroni (2007)		
P Water pollution	Bagstad and Ceroni (2007)		
Q Air pollution	Bagstad and Ceroni (2007)		
R Noise pollution	Costanza et al. (2004)		
S Wetland loss	Bagstad and Ceroni (2007)		Only wetland losses since 1950 valued
T Farmland loss	Bagstad and Ceroni (2007)		
U Nonrenewable resource depletion	Bagstad and Ceroni (2007), Makhijani (2007)		Renewable energy sources correctly substituted: wind and solar for electricity, biofuels for liquid fuels
V Climate change	Talberth et al. (2007), Shammin and Bullard (in review)	Local consumer spending data on energy	Local data on the size of manufacturing, commercial sectors,

			household expenditures on energy
W Ozone depletion	Talberth et al. (2007)		Costs not accumulated
X Forest loss	Costanza et al. (2004), forest valued at $481/ac-yr		Only forest losses since 1950 valued
Y Net capital investment	Costanza et al. (2004)		
Z Net foreign lending/borrowing	Costanza et al. (2004)		

Table 2. Energy and carbon intensities for aggregated personal consumption categories for Northeast Ohio (2005)

Personal consumption categories	Energy intensity (btu/$)*	Carbon intensity (lbs/$)**
Food at Home	6,155	0.25
Food Away From Home	4,753	0.20
Alcoholic Beverages	4,556	0.18
Household Operations: Personal services	2,522	0.10
Household operations: All other	3,998	0.15
Owned Dwelling – Mortgage interest	1,852	0.08
Owned Dwelling – Mortgage principle	7,203	0.32
Owned Dwelling - Property tax	0	0.00
Rented dwelling	3,450	0.14
Other lodging	4,651	0.19
Natural Gas	114,710	2.80
Electricity	151,750	4.70
Fuel Oil	111,300	3.66
Bottled Gas	111,300	3.66
Coal/Wood/Other	111,300	3.66
Phone	2,356	0.09
Water/Sewer	8,031	0.32
Housekeeping Supplies	4,589	0.18
Household Furnishings & Equipment	4,688	0.19
Apparel & Services	5,926	0.24
New cars, trucks, vans	5,984	0.24
Used cars, trucks, vans	6,470	0.26
Other vehicles	8,769	0.34
Gasoline	94,299	3.20
Diesel	94,299	3.20
Motor Oil	94,299	3.20
Other vehicle expenses	2,219	0.09
Public trans	18,128	0.71
Air	18,128	0.71
Health care	1,799	0.73
Entertainment-Reading	3,554	0.14
Personal care	3,500	0.14
Education	2,689	0.11
Tobacco	1,604	0.07
Cash Cont	3,346	0.14
Life/other insurance	1,424	0.06
Miscellaneous expenses	3,809	0.15

* Authors' calculations based on Shammin et al. (accepted with revisions)
** Authors' calculations based on Shammin and Bullard (in review)

Table 3. GPI per capita, 1990-2005

Geography	Per capita GPI, 1990	Per capita GPI, 2000	Per capita GPI, 2005	% change, 1990-2000	% change, 2000-2005	% change, 1990-2005
Ashland	$14,680	$15,421	$15,484	5%	0%	5%
Ashtabula	$13,700	$12,923	$13,942	-6%	8%	2%
Columbiana	$14,383	$14,622	$14,874	2%	2%	3%
Cuyahoga	$16,917	$15,272	$16,274	-10%	7%	-4%
Erie	$12,426	$11,372	$13,689	-8%	20%	10%
Geauga	$21,244	$22,136	$24,613	4%	11%	16%
Huron	$15,915	$14,034	$12,853	-12%	-8%	-19%
Lake	$17,327	$14,708	$13,041	-15%	-11%	-25%
Lorain	$17,709	$16,013	$16,037	-10%	0%	-9%
Mahoning	$14,767	$12,785	$14,748	-13%	15%	0%
Medina	$21,238	$19,840	$22,213	-7%	12%	5%
Portage	$15,985	$14,346	$16,387	-10%	14%	3%
Richland	$14,621	$14,512	$13,489	-1%	-7%	-8%
Stark	$16,245	$14,410	$15,818	-11%	10%	-3%
Summit	$16,036	$15,316	$16,081	-4%	5%	0%
Trumbull	$15,495	$12,687	$14,682	-18%	16%	-5%
Wayne	$14,664	$13,469	$14,335	-8%	6%	-2%
Akron	$13,781	$14,254	$12,826	3%	-10%	-7%
Cleveland	$10,213	$11,034	$9,500	8%	-14%	-7%
Ohio	$16,993	$17,523	$16,855	3%	-4%	-1%
U.S.	$14,978	$15,198	$15,262	1%	0%	2%
Urban avg.	$13,637	$13,520	$12,867	-1%	-5%	-6%
Suburban avg.	$17,338	$15,805	$17,069	-9%	8%	-2%
Rural avg.	$14,341	$13,765	$14,095	-4%	2%	-2%

Table 4. Components of GPI change from 1990-2005 (average of 17 Northeast Ohio counties)

GPI component	Average county change, 1990-2005	Absolute value of change	Percent of total change
Personal Consumption Expenditures	$4,504	$4,504	35.6%
Adjustment for Income Inequality	-$1,324	$1,324	10.5%
Household Labor	-$673	$673	5.3%
Volunteer Labor	-$3	$3	0.0%
Household Capital	$384	$384	3.0%
Streets & Highways	$128	$128	1.0%
Crime	$7	$7	0.1%
Family Breakdown	$34	$34	0.3%
Leisure Loss	-$973	$973	7.7%
Unemployment & Underemployment	-$106	$106	0.8%
Consumer Durables	-$1,794	$1,794	14.2%
Commuting	-$214	$214	1.7%
Pollution Abatement	-$34	$34	0.3%
Vehicle Crashes	$206	$206	1.6%
Water Pollution	$2	$2	0.0%
Air Pollution	$38	$38	0.3%
Noise Pollution	-$1	$1	0.0%
Wetland Loss	-$8	$8	0.1%
Farmland Loss	-$34	$34	0.3%
Nonrenewable Resource Depletion	-$516	$516	4.1%
Climate Change	-$777	$777	6.1%
Ozone Depletion	$43	$43	0.3%
Forest Loss	$0	$0	0.0%
Net Capital Investment	$834	$834	6.6%
Genuine Progress Indicator	-$282	$12,641	