GENUINE PROGRESS IN OHIO

Improving measurement and informing policy

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Executive Summary

Genuine progress indicator (GPI) is a metric that has been suggested to replace or supplement gross domestic product (GDP). GPI is designed to take fuller account of the economic activity of a nation, only a part of which pertains to the size of the nation's economy of traded good and services, by incorporating the economic impacts of environmental and social factors which are not measured by GDP. Compared to GDP, GPI more reliably measures economic progress by accounting for the environmental impact and social costs of economic production and consumption that impact health and well-being in ways not captured in measurements that only consider market transactions.

Over the years, researchers at nonprofit organizations and universities have measured the GPI of some states including Ohio. These efforts have incited government action in some of the states, though not in Ohio. Since GPI measures economic activity not measured by GDP, it is a more comprehensive key performance indicator for economic growth than GDP. Ohio state government could be missing out on an opportunity to increase Ohioans' well-being by not considering GPI when crafting state policy.

In order to seize the missed opportunity, this report answers two questions: (1) How can we improve the current GPI, and (2) How can we use the GPI for policymaking in Ohio?

To the first question, we propose adding government expenditures and net exports into GPI calculation for consistency with GDP. In addition, we propose adding health care costs associated with food insecurity to the current the GPI calculation formula because this constitutes an economic cost for Ohioans not currently captured by GPI formulae. To the second question, we suggest that Ohio regularly calculate the GPI and publish the results as a first step. In the long run, the GPI would ideally be incorporated into legislative and executive processes.

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Introduction

The Genuine Progress Indicator (GPI) is an alternative to Gross Domestic Product (GDP) as an indicator of society's development. Historically, GDP has been used by policymakers, media analysts, and economists as the main indicator of economic development. However, GDP is only an indicator of the production of economic goods and services, not an index of well-being or development. It does not include the external environmental, social, or economic costs of producing goods and services. GPI is aimed at reflecting a genuine development of society by accounting more comprehensively for environmental, social, and economic costs associated with both market and non-market activities.

Researchers at nonprofit organizations and universities have conducted studies on GPI and measured the GPI of some states. These efforts have incited government action in some of the states. Although there are a few studies that calculated GPI in Ohio, GPI has not been used for policymaking in Ohio at all. Since GPI is more comprehensively measures well-being than GDP, it is a more comprehensive key performance indicator of economic growth in Ohio. Ohio has the opportunity to increase Ohioans' well-being by considering GPI for policymaking.

In order to take advantage of the opportunity, this report makes proposals related to two questions: (1) How can we improve the current GPI, and (2) How can we use GPI for policymaking in Ohio?

The report is structured in five main sections. First, we explain the development of the GPI and why it matters. Next, we present a typical design of the GPI, which is currently used for calculating the GPI in Ohio. Subsequently, we answer the first question by proposing three main modifications that improve the current design of the GPI. Finally, we answer the second question by presenting a plan that enables Ohio to make use of the GPI for policy-making.

What is the GPI?

Genuine Progress Indicator (GPI) is a metric that has been suggested to replace or supplement Gross Domestic Product (GDP). GPI is designed to take fuller account of the well-being of a nation, only a part of which pertains to the size of the nation's economy of tradable goods and services, by incorporating costs and benefits accrued from external environmental and social factors which are not measured by GDP. For instance, some models of GPI decrease in value when the emission of carbon dioxide increases. The GPI does not naively consider the concept of societal progress as growth in volume of tradable goods alone but also takes external environmental and social costs and benefits into consideration.

GPI grew out of the field of ecological economics, which encompasses "green" economics, sustainability and more inclusive types of economics. The measure factors in environmental and carbon emissions impacts including resource depletion, pollution, and long-term environmental damage. GDP increases twice when pollution is created, since it increases once upon creation (as a side-effect of some valuable process) and again when the pollution is cleaned up; in contrast, the GPI counts the initial pollution as a loss rather than a gain, generally equal to the amount it will cost to clean up later plus the cost of any negative impact the pollution will have in the meantime. With this adjustment, GPI accounts for external costs levied by economic activity.

In addition, GPI factors in a set of activities that contribute to well-being but take place outside the market not measured by GDP. As GDP is based only on market transactions, goods or services not traded in formal markets are excluded from the measure. One of these activities is unpaid work such as housework, personal care work (people with special needs and the elderly), and volunteer work. By factoring in these non-market activities, the GPI is expected to more comprehensively measure well-being.

In summary, the GPI is an attempt to incorporate (a) the environmental impact and social costs of economic production and consumption and (b) non-market activities into a more comprehensive measurement of overall well-being.

Why does GPI matter?

Most economists assess progress in state welfare by comparing gross domestic product over time—that is, by adding up the annual dollar value of all goods and services produced within a country in a given year. However, GDP was not intended to be used for this purpose. The measure does not distinguish between money spent for new production and money spent to repair negative outcomes from previous expenditure. For example, it would treat as equivalent one million dollars spent to build new homes and one million dollars spent in aid relief to those whose homes have been destroyed, despite one category of expenditure being clearly preferable to another. This is relevant for example when considering the true costs of development that destroys wetlands and hence exacerbate flood damages. Simon Kuznets, the inventor of the concept of GDP, noted in his first report to the US Congress in 1934:

> *The welfare of a nation can scarcely be inferred from a measure of national income. If the GDP is up, why is America down? Distinctions must be kept in mind between quantity and quality of growth, between costs and returns, and between the short and long run. Goals for more growth should specify more growth of what and for what.*

To overcome the limitations of GDP, GPI was developed to incorporate environmental, social, and economic costs into a comprehensive economic measure that more accurately estimates the economic development of society. GPI uses household aggregate consumption as a starting point, weighted by inequality (Gini coefficient or Atkinson index). Economic well-being is linked to consumption, not production.[1] This adjustment is built on the assertion that the marginal benefits of GDP growth are different between rich and poor. The marginal utility generated by GDP growth for the poor is greater than for the rich since $100 gained by someone in poverty will increase well-being on average more than it would for a wealthy person.[2]

GPI paints a broader picture of the concept of consumption, incorporating estimates for the economic value of nonmarket transactions and external costs of market transactions.[3] Considering goods and services that are not traded on the market is important because many market activities have nonmarket impacts such as pollution and traffic deaths, which are counted as benefits in GDP but are more accurately external costs imposed by economic activity. Other indicators are incorporated in GPI, such as environmental costs, social costs, defense expenses, and unpaid work. In GPI, the trade-off between costs and benefits of GDP growth is considered, reflecting an aggregate function of well-being based on utility less the "disutility" of economic activities.[4]

The current design of the GPI

The GPI model aggregates its component indicators into a single number, denominated in dollars. Hence, the model must assign monetary units to environmental and social indicators (the economic indicators are mostly already captured in dollars). For example, an acre of farmland is assigned a dollar value to represent what that acre contributes to society. If that acre is lost, the value of that acre is subtracted from the GPI.

Assigning a dollar value to non-market items is challenging, but is necessary to establishing relative worth among resources managed by society.[5] The GPI model uses the best possible estimates from peer-reviewed valuation studies.

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[1] Daly, H. E., Cobb Jr, J. B., & Cobb, J. B. (1994). *For the common good: Redirecting the economy toward community, the environment, and a sustainable future* (No. 73). Beacon Press.
[2] Daly, H. E. (2014). *From uneconomic growth to a steady-state economy*. Edward Elgar Publishing.
[3] Hamilton, C., & Saddler, H. (1997). The Genuine Progress Indicator. *A new index of changes in well-being in Australia*, (14).
[4] Cobb, C., Halstead, T., & Rowe, J. (1995). *The genuine progress indicator: summary of data and methodology* (Vol. 15). San Francisco: Redefining Progress.
[5] Hawaii State Environmental Council (2013). "Towards a Green Economy; Introducing the GPI to Hawaii." Annual Report.

Since GPI is reported as a single number each year, it makes communicating with the public much simpler and can be compared with other metrics more readily. GPI can also be broken down into its components and analyzed in depth. For instance, environmental groups can look at the sub-component environmental indicator which can further be scrutinized down to the forest indicator.

The GPI framework starts with personal consumption expenditures — which can be thought of simply as the amount of goods and services Ohioans themselves buy each year. This is then adjusted for income inequality. With adjusted personal consumption as the baseline, GPI includes the monetary value of activities that increase economic well-being but are not counted in the standard GDP framework. These include household labor, volunteer labor and benefits of higher education. The GPI formula subtracts the monetary cost of the expenditures that we incur to protect the depletion of our natural and social capital. These include cost of auto accidents, costs of crime, lost leisure time, and pollution. It also subtracts the money Ohioans spent on items that must be spent to abate the negative outcomes that result from the way we live and consume. For example, money spent to dispose of personal waste.

The 24 indicators used in standard GPI calculation are detailed in Table 1. They fall into three categories: economic (A-G), environmental (H-P) and social (Q-Z).

Table 1: Components and Methods of Calculation for the Current GPI

Indicator	Impact on Well-Being	Description	Formula
A. Personal Consumption	+ (baseline)	Starting point for GPI	Personal consumption expenditures
B. Income Inequality	+ or -	Marginal value of a dollar means increased inequality leads to less utility drawn from dollars in aggregate	Gini coefficient in year divided by Gini coefficient at baseline low value, 0.3728 in 1970
C. Adjusted Personal Consumption		Becomes the baseline from which other GPI components are added or deducted	Row A divided by Row B.
D. Benefits of Consumer Durables	+	Estimates the services provided by household	20 percent of stock of consumer durables

		equipment, which is a more accurate measure of value that just the money spent on such long-term items	
E. Cost of Consumer Durables	-	The price of durables is subtracted to avoid double counting the value in their services and personal consumption	Personal consumption expenditures for durable goods
F. Cost of Underemployment	-	Involuntary part-time workers, discouraged workers and the chronically unemployed represent people wanting to and unable to find work	Underemployed persons multiplied by unprovided work hours per constrained worker multiplied by average hourly wage
G. Net Capital Investment	+ or -	To avoid consuming its capital as income, a state must increase or at least maintain the supply of capital for each worker to meet the demands of the future labor force	Net stock of private domestic investment
H. Water Pollution	-	Impairment of water systems creates a loss to society in health and recreation costs	Total value of clean waters multiplied by the percentage of streams, rivers, and lakes that are impaired

I. Air Pollution	-	Money spent to repair damage to health, infrastructure and environment from poor air quality	Emissions of particulate matters, Nitrogen Oxide, Sulfur Dioxide and Volatile Organic Chemicals multiplied by their respective costs per ton
J. Noise Pollution	-	The World Health Organization (WHO) produced an estimate for damage caused by noise pollution in U.S.	Ratio of Ohioans living in cities compared to Americans living in cities multiplied by the WHO cost of noise pollution
K. Wetland Change	+ or -	The value of ecosystem services provided by wetlands like flood control, purified water and dust suppression	Acres of lost or gained wetland multiplied by value per acre
L. Farmland Change	+ or -	Trading farmland for urbanization creates costs like reduced local food supply	Acres of lost or gained farmland multiplied by the farmland value per acre
M. Forest Cover Change	+ or -	Losing services like flood control, wildlife habitat and recreation from lost forest land	Acres of forest land lost multiplied by value of forests per acre
N. Carbon Emissions	-	Carbon emissions drive costs from environmental damage associated with climate disruption	Consumption of energy multiplied by the marginal social cost of carbon dioxide emissions associated with each energy source

O. Ozone Depletion	-	GPI captures the economic costs of increased exposure to harmful solar radiation	Chlorofluorocarbon (CFCs) emissions multiplied by cost per ton.
P. Nonrenewable Resource Depletion	-	Depleting nonrenewable resources creates costs for future generations. The GPI tabulates their cost in the year in which they get used	Consumption of coal, natural gas, and petroleum multiplied by the cost to replace that energy with renewable resources
Q. Value of Housework	+	A non-traded economic activity which includes meal preparation, cleaning, repairs, and parenting	Total hours of household work multiplied by the wage one would pay to hire someone else to do that equivalent work
R. Family Breakdown	-	GDP counts the money spent on divorces as positive as well as traditional family bonding activities that are moved to the market economy like babysitting	Costs of divorce on parents and children plus the societal cost of television viewing
S. Crime	-	Harms well-being from medical expenses and damaged property as well as non-monetary mental costs to the victims	Monetary costs of each crime plus the nonmonetary costs to the victims
T. Pollution Abatement	-	Money spent to restore quality back to a baseline	Spending on automotive air filters and catalytic

		doesn't add to well-being so spending on air filters and waste treatment only compensate for externalities created by our economic activity	converters plus the cost of sewage plus the cost of solid waste disposal
U. Volunteer Work	+	Another activity omitted in GDP since no money is exchanged, but nonetheless has economic value since time is traded and value is created	Total hours of volunteer work multiplied by the average hourly value of volunteering
V. Lost Leisure Time	-	GDP counts all work as a positive without accounting for the tradeoff of leisure	People employed multiplied by each year's lost leisure compared to a baseline year (1969, with most leisure) multiplied by the average hourly wage rate
W. Higher Education	+	The GPI captures the indirect personal and societal benefits of an educated population	Bachelor's degree holders multiplied by the social benefits per bachelor's degree holder
X. Services of Highways	+	These services are provided by the government but could be sold. Assumes 25% of miles are driven for pleasure and 10% of net stock is annual value	7.5% of net stock of highways and streets

Y. Commuting	-	Commuting adds costs that don't necessarily add to well-being but must be done	Miles traveled to work multiplied by the cost per mile for vehicle use, added to the hours spent commuting multiplied by a reduced wage rate, added to spending on public transport fares
Z. Car Accidents	-	GDP counts the money spent on property and health damage from car crashes as a positive. GPI corrects for this	Number of fatal accidents, injury accidents and property-damage-only accidents multiplied by their respective costs

Figure 1 shows the Total GPI and its three components for 2010–2019 based on the current design. All figures are inflation adjusted to 2019 U.S. dollars using CPI for all urban consumers in the Midwest region of the U.S.

Total GPI is less than the economic component by approximately $50-70 billion due to the inclusion of the negative environmental component which subtracts for the large environmental degradation, which is partly offset by social component.

Total GPI increased 17.7% between 2010 and 2019. The biggest growth was seen in 2015, a 7.3% increase from 2014.

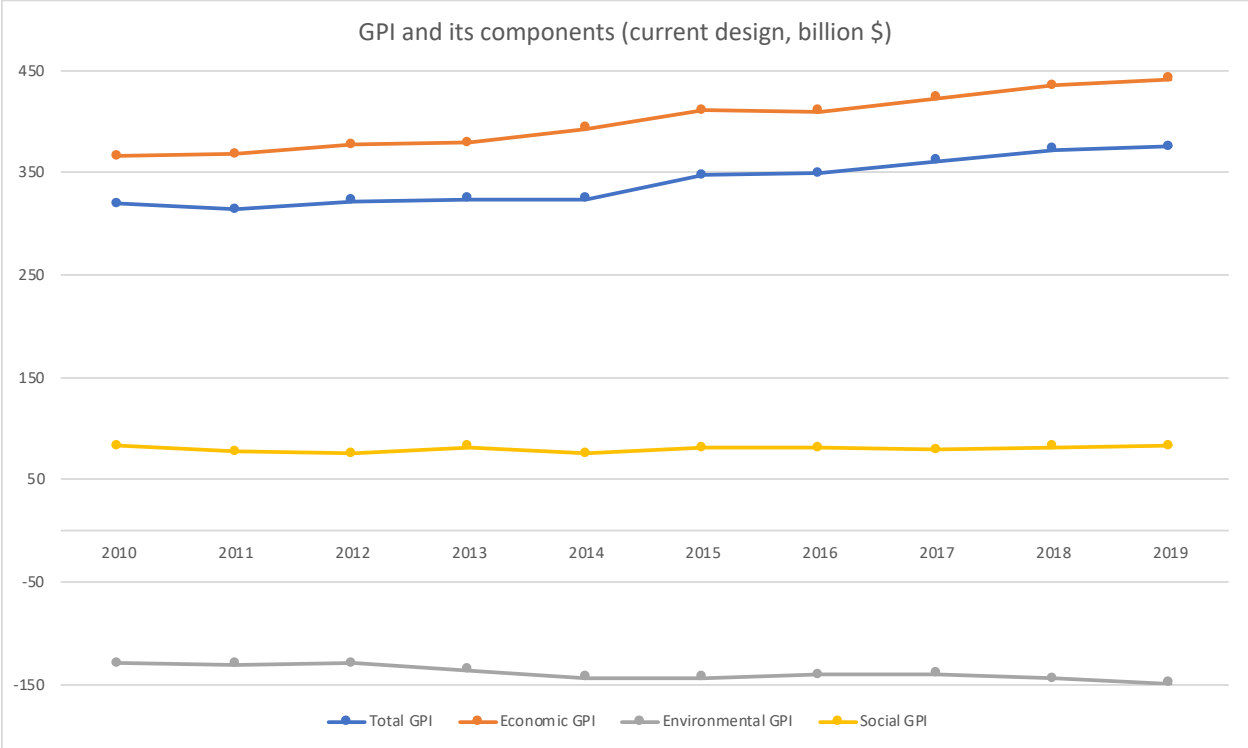

Fig. 1. Total GPI for Ohio and its three components

Modifications to improve the current design

We propose three modifications to the current GPI to improve its measurement of well-being.

As the first and second modifications, researchers should include government expenditures and net exports into the current GPI calculation. These are final good expenditures not currently included in GPI measurement. Government expenditures and net exports are not currently included in GPI but represent economic activity nonetheless.

GDP is defined as the sum of consumption, investment, government spending and net exports. This is based on the expenditure approach, which estimates GDP by calculating the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices.[6]

Although the current GPI design considers consumption and investment with the components A and G in table 1, it currently excludes government spending and net

[6] Market goods that are produced are purchased by someone. In the case where a good is produced and unsold, the standard accounting convention is that the producer has bought the good from themselves. Therefore, measuring the total expenditure used to buy things is a way of measuring production. This is known as the expenditure method of calculating GDP.

exports. Thus, we propose adding state government expenditures and net exports to future GPI calculations. As for net exports, it would be desirable to include not only international trade but also domestic trade (i.e. all trade across the state border). However, due to lack of data availability, we only provide estimates for international trade below. Even so, these modifications would allow us to more accurately measure total state welfare.

Fig. 2 shows the state government expenditures based on the Census data. Although they decreased from 2010 to 2013, they sharply increased from 2013 to 2016 and stabilized from 2016 to 2019. Overall, they increase the GPI by approximately 60-70 billion dollars.

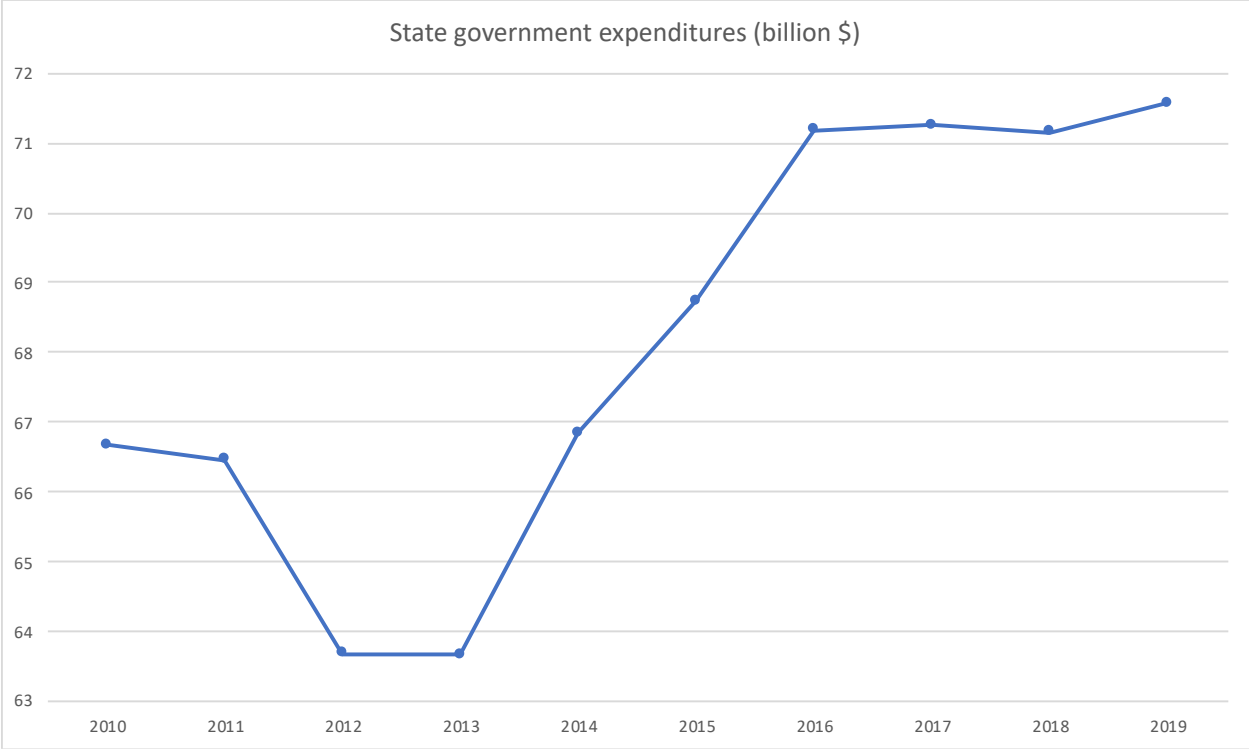

Fig. 2. Ohio state government expenditures

Fig. 3 shows Ohio's exports, imports, and net exports (=exports minus imports) based on the Census data. Throughout the 2010s, imports exceeded exports so that Ohio's net exports were negative, by approximately 10-20 billion dollars.

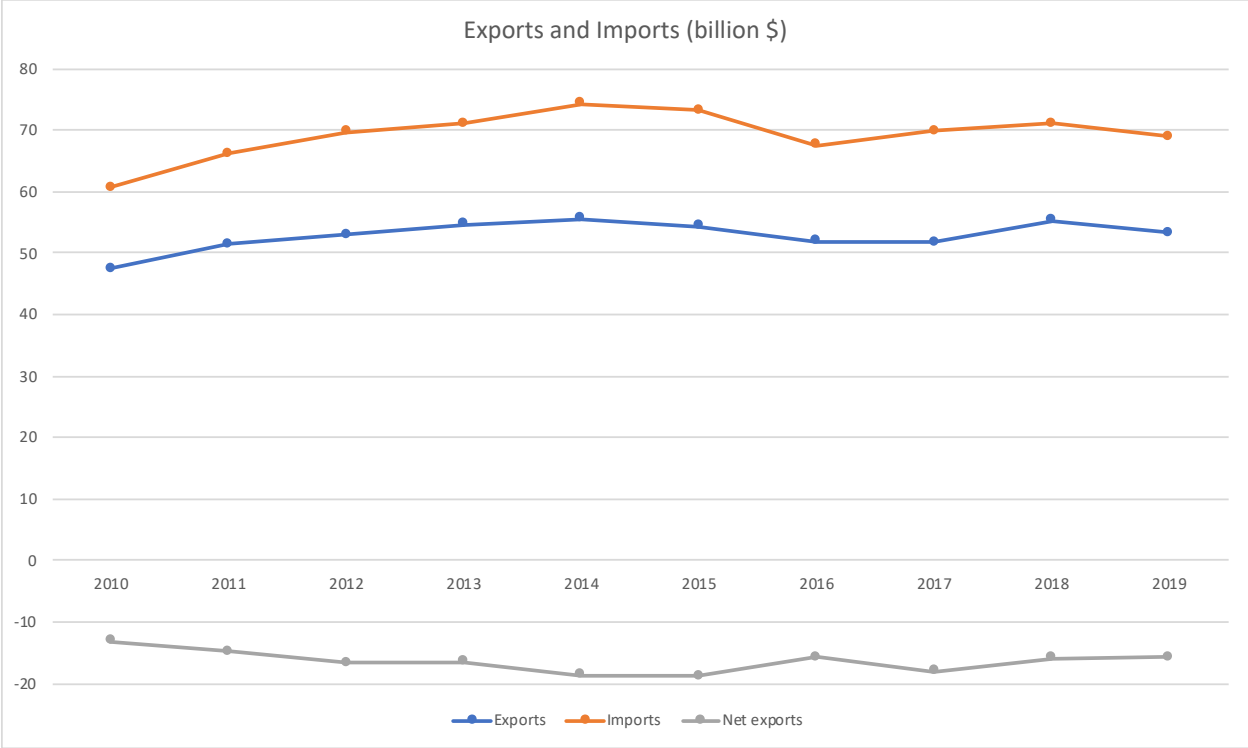

Fig. 3. Exports, Imports, and Net exports in Ohio

Thirdly, we recommend including health care costs associated with food insecurity. When a car crash happens and someone has to pay for car repairs, a new car, or health care expenses, GDP increases. These costs do not lead to higher welfare, though, so the GPI subtracts costs associated with auto crashes. The same logic applies to health care costs associated with food insecurity. Food insecurity is associated with numerous chronic health conditions, including diabetes mellitus, hypertension, coronary heart disease, chronic kidney disease, and depression. It causes substantially higher health care costs among food-insecure individuals than among food-secure individuals.

Since these costs lead to lower well-being, we propose to subtract them from the GPI calculation. A recent study published in *Preventing Chronic Disease* estimates state-level and county-level health care expenditures associated with food insecurity and they estimate the costs in Ohio at $2,239,144,000 in 2016.[7] We propose to use their methodology to estimate health care costs associated with food insecurity and incorporate these into GPI calculation.

[7] Berkowitz, S. A., Basu, S., Gundersen, C., & Seligman, H. K. (2019). Peer Reviewed: State-Level and County-Level Estimates of Health Care Costs Associated with Food Insecurity. *Preventing chronic disease*, *16*.

Fig. 4 shows health care costs associated with food insecurity in Ohio were approximately 2-3 billion dollars over the time period studied and decreased by 19.0% from 2010 to 2019.

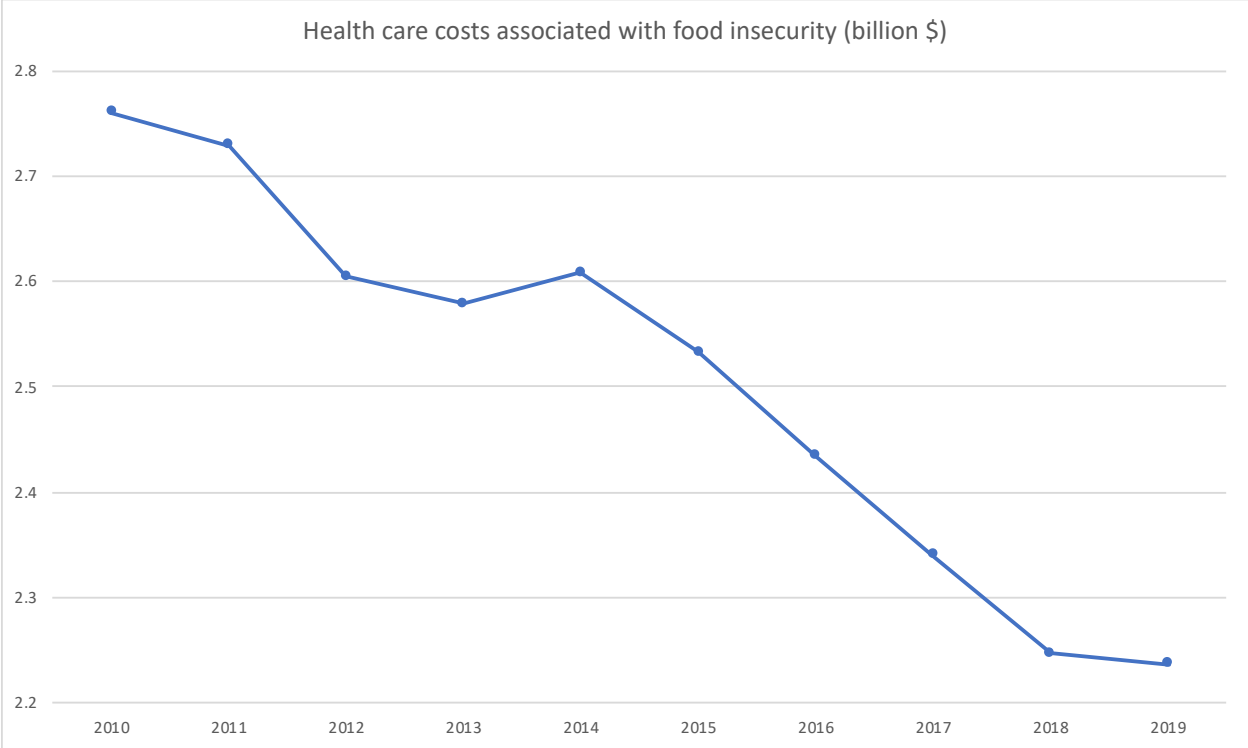

Fig. 3. Health care costs associated with food insecurity in Ohio

Table 2 shows the summary of our proposed modifications to the current GPI design. The calculations for Ohio suggest impact of state government expenditures (approximately 60-70 billion dollars) and net exports (approximately negative 10-20 billion dollars) are bigger than that of health care costs associated with food insecurity (approximately 2-3 billion dollars).

Table 2: New Components and Methods of Calculation for improved GPI design

Indicator	Impact on Well-Being	Description	Formula
State government expenditures	+	Final good spending currently excluded from GPI	Direct expenditures of the state government
Net exports	+ or -	Final good spending currently excluded from GPI	Dollar value of exports minus imports

Health care costs associated with food insecurity	-	Food insecurity generates costs in the form on unwanted health care spending	Number of food insecure persons multiplied by average health care costs associated with food insecurity and by state cost factor

Fig. 4 compares the current design and the improved design of the GPI. Overall, the new design shifts total GPI up by approximately 50 billion dollars, most of which derives from the modification of adding state government expenditures and net exports.

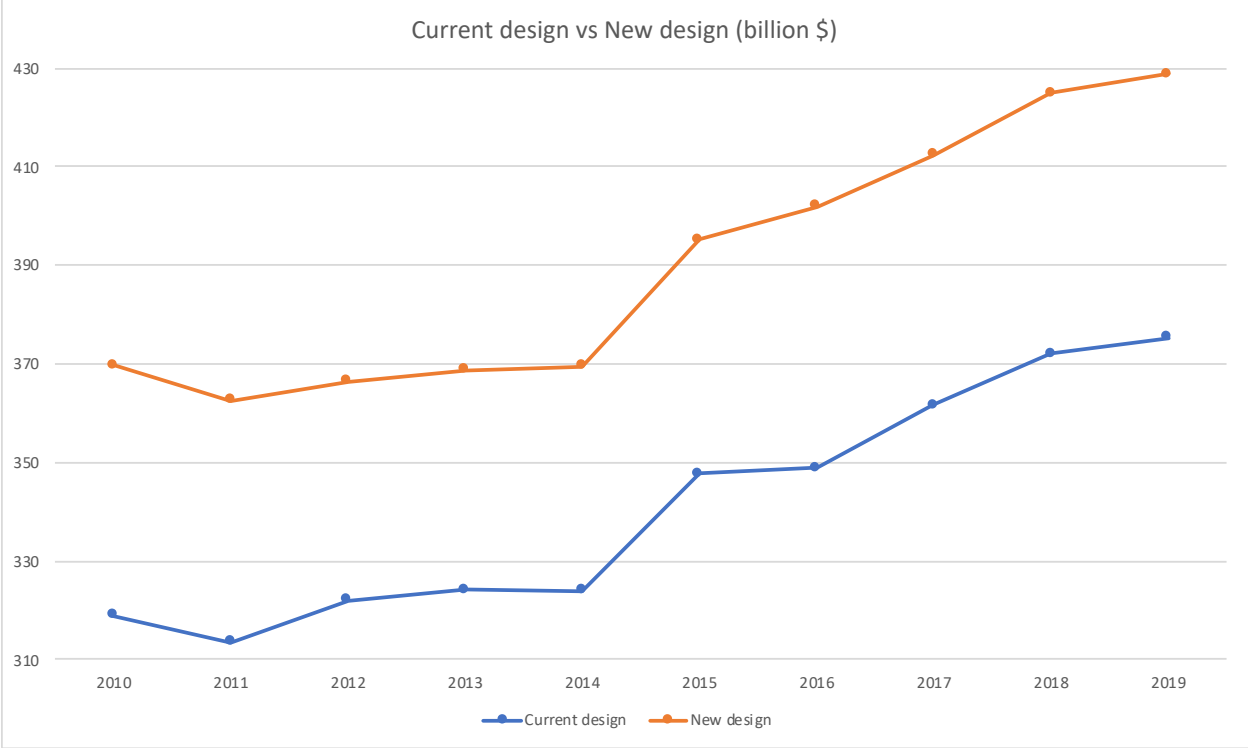

Fig. 4. Comparison of the current design vs proposed design of the GPI

Other Possible Modifications

In addition to the three modifications we propose above, we present three possible modifications that could improve the current design: Refine income inequality calculation, remove cost of ozone depletion, and change the proxies for family breakdown.

Refine income inequality calculation
As a benchmark of income inequality, the current design uses the value of Gini coefficients in 1970, in which the U.S. experienced its lowest level of inequality, then discounts the value of later years depending on how their inequality compares to the benchmark. However, the benchmark might not be ideal for everyone. That is, some people might accept higher level of inequality and others might prefer much less inequality. One possible way to refine the current design is to define a socially acceptable level of inequality—in terms of the Gini coefficient—based on opinion studies instead of using a reference year to adjust consumption by income inequality.[8]

An alternative is to define the socially desirable level of inequality based on opinion surveys, such as the 2005 nationally representative online panel survey of the American public (Norton and Ariely, 2011). This study compared the actual wealth distribution in the US to first, the public's perceptions of wealth distribution and second, to the wealth distribution they would consider to be desirable. Across income groups, political affiliation, and gender, Americans underestimated the amount of inequality in the US and preferred a far more even distribution of wealth than what exists. In fact, when we express the socially desirable level of inequality in terms of the Gini coefficient terms, it corresponds closely to the1970 inequality level in the US. Results from such surveys could provide a more robust estimate of socially desirable income distributions or may strengthen the justification for choosing a particular historical value.

Remove the cost of ozone depletion
The cost of depleting the ozone layer could be removed from the current design, since this problem has been reduced to the point that ozone depletion hardly impacts GPI at all as currently designed, with every state's coming close to zero.[9]

Change the proxies of family breakdown
The current design uses the cost of divorce and time spent watching television in families with children as the proxies for family breakdown. However, these metrics do not correspond to habits in the 2020s. Berik (2020) claims that disagreement has emerged about whether divorce is a cost to social welfare, and perspectives on viewing hours and screen time in general have evolved. These components have been dropped in recent GPI studies, and different proxies could be found for family breakdown/social erosion.[10]

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[8] Garcia, J. R. (2021). Economics of the Genuine Progress Indicator. In *Oxford Research Encyclopedia of Environmental Science*.
[9] Berik, G. (2020). Measuring what matters and guiding policy: An evaluation of the Genuine Progress Indicator. *International Labour Review*, *159*(1), 71-94.
[10] Berik, G. (2020). Measuring what matters and guiding policy: An evaluation of the Genuine Progress Indicator. *International Labour Review*, *159*(1), 71-94.

Evaluation of the improved GPI design compared to the current one

Below, we evaluate our proposed design of the GPI against the current one based on three criteria: accuracy, data availability, and political acceptability.

Accuracy: How accurately does it measure well-being?
Ideally, GPI should comprehensively measure well-being without double counting either costs or benefits. From this viewpoint, adding state government expenditures and net exports improves the GPI accuracy because they contribute to well-being and are not considered in the current design. Moreover, adding health care costs associated with food insecurity also improves the GPI accuracy because they lead to lower well-being. Thus, the improved design of the GPI builds on the benefits of the current one.

Data availability: How easy is it to obtain necessary data for calculation?
Data availability is important for the GPI because it enables the public to calculate the GPI by themselves. Because the GPI should be used to evaluate overall well-being, it is preferable that the public can easily check the validity of the GPI calculation and evaluate their government's performance. In terms of data availability, there is no difference between the improved design of the GPI and the current one because the data for calculation are publicly available in both designs.

Political acceptability: How likely is it to get supported from Ohio decision-makers and be used in the actual policy-making process in Ohio?
Political acceptability is important for the GPI because the GPI should be useful to policymakers trying to improve well-being in the state. In terms of political acceptability, the current design would be politically acceptable because it is one of the established designs on which previous studies calculated the GPI based. However, the improved design may be more likely to get support from Ohio politicians because adding state government expenditures, net exports, and health care costs associated with food insecurity improves the accuracy of the GPI as a metric of overall well-being. Few decision-makers would disagree that the three factors contribute to Ohioans' well-being and should be taken into the calculation.

In summary, the improved design of the GPI either enhances or makes no difference to the current one based on each of the three criteria. For this reason, I believe the Ohio state government would benefit from calculating the improved GPI on a regular basis and providing information on it to policymakers involved with budgeting and regulation.

The GPI in Ohio

There are three previous studies that calculated the GPI in Ohio.

The first GPI study for the state of Ohio was conducted by Kenneth Bagstad and Md Rumi Shammin in 2012.[11] They calculated the GPI for the State of Ohio, the cities of Akron and Cleveland, and 17 Northeast Ohio counties for the years 1990–2005. The researchers estimated temporal and spatial GPI trends, including inter- (Ohio versus other comparable U.S. local GPI studies) and intra-regional (urban–suburban–rural) comparisons. From 1990 to 2005, they found that per capita GPI grew in 11 counties and the State of Ohio (growth ranging from 0.8% to 19.7%) but declined for six counties and the cities of Akron and Cleveland (declines ranging from 0.6% to 22%). Per capita GPI was greatest in suburban counties and lowest in urban areas, and was greater in Maryland and Vermont than Ohio.

The second study was conducted by Gross National Happiness USA and Scioto Analysis.[12] It assesses Ohio's Recovery from the Great Recession by calculating Ohio's genuine progress indicator from 2009 to 2016. The authors conclude that Ohio's economy has rebounded well from the Great Recession, whereas rising inequality has dampened Ohio's recovery, limiting per-capita economic progress over the time period.

The third study was conducted by Scioto Analysis.[13] It measures the GPI in the state of Ohio from 2009 to 2018, building on the second study conducted for the 2009-2016 period. The authors find that Ohio's economy surged from 2016 to 2018 on the back of increased consumption, investment, and employment, benefiting from a stalling inequality trend and in spite of loss of farmland, depletion of non-renewables, and loss of family time in the form of leisure, parenting, and increasing commute times.

Although there are several preceding GPI studies focusing on Ohio, GPI is not currently used in Ohio's actual policy-making process at all.

To gain legitimacy, the GPI must obtain the popular support of citizens and policymakers, as has been the case in Maryland's recent adoption of the GPI as an economic indicator. 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

[11] Bagstad, K. J., & Shammin, M. R. (2012). Can the Genuine Progress Indicator better inform sustainable regional progress?—A case study for Northeast Ohio. Ecological indicators, 18, 330-341.
[12] Moore, Rob, "Ohio's Economy: 2009-2016," Scioto Analysis and Gross National Happiness USA, November 2018.
[13] Moore, Rob, "Ohio's Economy: 2009-2018," Scioto Analysis, May 2020.

number designed to fit the needs – ideological, financial or otherwise – of its creator."[14] Similarly, by involving citizens in identifying indicators important to regional quality of life, indicator programs can gain popular support and broaden dialogue about economic development strategies (Seattle Comprehensive Plan, 2003).[15]

We believe that the GPI has potential to offer opportunities to better engage the public and decision makers in discussions about economic, social, and environmental goals and policies. In this report, we propose a new design of the GPI and suggest that policy analysts in Ohio use it in evaluating positive and negative effects of a policy on the well-being of people in Ohio.

How could we use the improved design of GPI in Ohio's actual policy-making process?

The usefulness of our proposed design of the GPI for Ohio would be greatly enhanced by improving the policy salience of GPI. As an aggregate and comprehensive welfare indicator, GPI has potential for use in assessing the overall impact of specific proposed policies to a region or country. Most GPI research up to this point has focused on accounting for past and current economic welfare, but in order to use the GPI to evaluate specific policies, we need to simulate the impact of policies on the GPI through the impact on specific variables.

First, the Ohio state government should regularly calculate Ohio's GPI and publish the results. We propose that the new GPI calculation should be done by the Ohio Development Services Agency, which is committed to creating jobs and building strong communities, while ensuring accountability and transparency of taxpayer money and exceptional customer service.[16]

Second, the state government should publish the results as a standalone study and in *Ohio Facts*, which is biennially published the Legislative Budget Office of Ohio Legislative Service Commission for providing Ohio legislators, legislative staff, and others with a broad overview of Ohio's economy, public finances, and major government programs.[17]

Then, the GPI also should be used for assessing trade-offs of policy proposals and regulation. As a monetary indicator, the GPI allows us to better assess the trade-offs between socioeconomic decisions and the environmental, social, and economic costs involved. Studies conducted in the United States have examined

[14] Haggart, B. (2000). The gross domestic product and alternative economic and social indicators.
[15] Seattle Comprehensive Plan, 2003. Monitoring our progress: Seattle's comprehensive plan. In: City of Seattle. Department of Design, Construction, and Land Use, Seattle, WA.
[16] The Ohio Development Services Agency, https://development.ohio.gov/
[17] "Ohio Facts", Ohio Legislative Service Commission, https://www.lsc.ohio.gov/

the impact of policy proposals on GPI by simulating or analyzing minimum wage hikes, for example, or the conversion of vacant lots for urban agriculture (Talberth, 2014; Bagstad and Shammin, 2012). In addition, the GPI is also helpful for regulatory processes. For example, since the GPI includes the costs of carbon emissions and loss of farmland, it works as a good barometer to maintain ecosystem services for climate regulation or erosion control.

It is ideal to build the GPI into legislative and executive processes in order to make the most use of the GPI for policy-making in Ohio. One way is to stipulate that the impact on the GPI be calculated and published for bills. This is consistent with that Ohio's current policy that every bill that sees a second hearing has a bill analysis and a fiscal note prepared by the Legislative Service Commission that at the very least say what the bill will do and what it will cost the state.[18] In the legislative and executive processes, policymakers need to know the results of the analysis. It would be done through presentations to the state appropriations committees and the Office of Budget and Management team by the Ohio Development Services Agency or by analysts at the Ohio Legislative Services Commission.

Limitations and Conclusion

GPI is an attempt to overcome the limitations of GDP by adjusting for several negative externalities of the economic process and including nonmarket economic activity not measured by GDP. As a monetary indicator, GPI can be used in simulations and to assess policy trade-offs. However, as Brown and Lazarus (2018) point out, the GPI has three important areas where it cannot be applied: quality of life variables (e.g. human rights, peace, conflict, or political participation), demographic groups, and use of boundary conditions.[19] While GPI improves on GDP, efforts to incorporate equity, capabilities, or subjective well-being into GPI would undermine its theoretical grounding and thus should be understood as separate questions than those posed by GPI.

In this report, we made proposals on how to improve the current design of the GPI and how to use the new design of the GPI for policymaking in Ohio. In order to improve the current design of the GPI, researchers should include in government expenditures, net exports, and health care costs associated with food insecurity. In order to make use of the GPI for policy-making in Ohio, the results of the GPI calculation should be regularly published by the state government. The GPI also should be used for assessing trade-offs of policy proposals and regulation. Ideally, GPI will also be incorporated into legislative and executive processes.

[18] Moore, Rob, "Cost-Benefit Analysis in Ohio," Scioto Analysis, April 2019.
[19] Brown, C., & Lazarus, E. (2018). Genuine Progress Indicator for California: 2010–2014. *Ecological Indicators*, *93*, 1143-1151.

Appendix A: Detailed Methods of the GPI

Adjusted Personal Consumption

The values for personal consumption were obtained from the U.S. Bureau of Economic Analysis Regional Economic Accounts, found here: https://apps.bea.gov/iTable/iTable.cfm?reqid=70&step=1&acrdn=7#reqid=70&step=1&acrdn=7

Research shows that inequality can drag down incomes and that income has decreasing marginal returns to utility.[20] This loss of income can then reduce consumption and along with it reduce economic efficiency in an economy. The GPI corrects for this inefficiency by discounting personal consumption by the amount of inequality each year using an income distribution index. Using 1970 as a base year of inequality following other GPI studies since the U.S. experienced its lowest level of inequality that year and assuming that lower Gini indices lead to higher economic efficiency, the GPI then discounts later years depending on how their inequality compares to the base year, when the value of Gini coefficients was 0.3728.[21] We used the U.S. Census Bureau's Gini figures, found here: https://data.census.gov/cedsci/table?q=ACSDT1Y2019.B19083%20ohio&tid=ACSDT1Y2019.B19083&hidePreview=false

Services of Consumer Durables

The GPI understands the original purchase price of consumer durables as a cost and the services a consumer received from the product over its lifetime as a benefit. Like other GPI studies, the average consumer capital item is assumed to last 8 years which translates into a fixed depreciation rate of 12.5 percent. The Cost of Consumer Durables is used to impute that service of consumer durables. The values were obtained here: https://apps.bea.gov/iTable/iTable.cfm?reqid=70&step=1&acrdn=7#reqid=70&step=1&acrdn=7

Added to the depreciation rate is the average interest rate of 7.5 percent. This is based on the fact that consumers could, instead of purchasing consumer durables, have invested their money at this interest rate. The stock of durables is multiplied by a factor of 20 percent to get each year's services of those durables.

Cost of Consumer Durables

Data on spending on consumer durables is available at the state level from the Bureau of Economic Analysis.

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[20] Thewissen, S., Kenworthy, L., Nolan, B., Roser, M., & Smeeding, T. (2015). *Rising income inequality and living standards in OECD countries: How does the middle fare?* (No. 656). LIS Working Paper Series.

[21] Slottje, D. J. (1990). Change in the US income distribution from 1970 to 1980: assessing state and regional impacts. *The Journal of Human Resources*, *25*(2), 267-274.

Cost of Underemployment
The total cost of underemployment equals the number of underemployed people multiplied by the hours of unprovided work per underemployed worker multiplied by the average real wage rate.

Net Capital Investment
Data of net capital investment is not available at the state level, but is available at the national level from Bureau of Economic Analysis NIPA Table 5.1. The national data was scaled down by population.

Cost of Water Pollution
We used data from the Ohio EPA Integrated Water Quality Monitoring and Assessment Reports from 2010 to 2020, available online:
https://epa.ohio.gov/dsw/tmdl/OhioIntegratedReport
All waterways listed as "impaired" for human health, recreation, and aquatic life purposes were considered "degraded." Since reports are only biannual, off-year degradation rates were estimated using linear interpolation between available data.

We followed Maryland's GPI methodology for calculating the per capita value of clean water. Drawing on a review of a number of valuation studies, a value of $130 dollars per capita in 2000 for clean water was adopted. The cost of water pollution is simply the value of clean water multiplied by the percentage of rivers and lakes that are impaired.

Cost of Air Pollution
Tons of pollution emitted in Ohio was obtained from the National Emissions Inventory Database provided by the Environmental Protection Agency, which provides detailed emissions data for various pollutants at the state level since 1990.
https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data

The cost per ton of pollution was drawn from Muller and Mendelsohn (2007), in which the authors estimated the marginal damage associated with emitting an additional ton of six different pollutants (ammonia, nitrogen dioxide, PM10, PM2.5, sulfur dioxide and volatile organic compounds). Most of the damage associated with air pollution comes from premature mortalities. Overall reductions in health account for 94 percent of the total damages of air pollution. The remaining 6 percent come from visibility loss, reduced agricultural yield, reduced timber yield, accelerated depreciation of man-made material and impaired forest health. The per ton damages of NOX was $273 in 2000 dollars. PM10 damages were $544 per ton. PM2.5 damages were $3462 per ton. SO2 damages were $1261 per ton. VOC was $676 per ton.

Cost of Noise Pollution
National Data was scaled down based on Ohio's urban population, where noise effects are most likely to occur. To calculate the per capita cost of noise pollution in Ohio, Talbert's calculation of the national cost of noise pollution at $14.6 billion in 2000 is used.

Urban population data by decade for every state from 2000-2010 is available here: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2010-urban-rural.html
Liner interpolation was used for the year between the decennial census data.

Cost of Net Wetland Change
Wetland acreage data for the years 1992, 2001 and 2006 were obtained from the National Land Cover Database. Historic wetland cover was retrieved from Mitsch and Gosselink (2007), which contains an estimate of wetland acreage in the mid 1980s and an estimate pre-settlement era circa 1780. Figures were converted from hectares to acres. Colorado had nearly 2 million acres of wetlands in 1780, and by 1985 Colorado was down to roughly 1 million acres. We assumed that wetland acreage did not begin to decline till the 1860s. Averaging 1 million lost wetland acres over the years between 1860 and 1985, meant Colorado lost 7,986 acres a year. This trend was used to estimate wetland acreage for years prior to 1985. Like the lost forest cover indicator, 1960 was set as the base year so lost acreage was calculated from the acreage in 1960. The cost of wetland change is a cumulative cost, so the losses from each year get added to the next year's cost.

The GPI splits wetland loss into two categories: wetland lost before 1950 and wetland lost after 1950. Wetland loss before 1950 is valued at $496 per acre and wetland loss after 1950 is valued at $1,445 per acre following Fox and Erickson (2018).[22] Pre-1950s wetland loss data comes from Fox and Erickson and loss post-1950s is taken from 2017 NRI Summary Report, which was published by the U.S. Department of Agriculture:
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/nri/results/
Since US Department of Agriculture wetland data is only gathered periodically, linear interpolation was used for estimating missing data.

Cost of Net Farmland Change
Farmland acreage is available from the U.S. Department of Agriculture found here:
https://quickstats.nass.usda.gov/
The reports, which are available every five years, list acreage and value of acreage among other items.

[22] Fox, M. J. V., & Erickson, J. D. (2018). Genuine economic progress in the United States: A fifty state study and comparative assessment. *Ecological Economics*, *147*, 29-35.

As the value of farmland lost per acre, I utilized Ohio's "asset value per acre of agricultural land including buildings" from the USDA website.

Cost of Net Forest Cover Change
Forest acreage data was obtained from Annual Inventory Reports, which were published by the U.S. Department of Agriculture:
https://www.nrs.fs.fed.us/fia/data-tools/state-reports/OH/

We used 1950 as the starting point for forest cover:
https://www.fs.fed.us/nrs/pubs/rb/rb_nrs90.pdf
This means that the calculation of the cost of forest land lost sets 1950 as the baseline and calculates loss in acreage from the 1950 figure. The value of lost forest acreage of $318.50 an acre follows the methodology used in Maryland's GPI report.

Cost of Environmental Impact
Total annual tons of carbon dioxide emitted in Ohio were calculated from the amount of carbon dioxide from the consumption of coal, natural gas, petroleum products, and wood and waste available from the Energy Information Administration (EIA). Emissions from petroleum, coal, natural gas and waste are recorded in BTUs. Following Maryland's GPI example, I used the average carbon intensities per British Thermal Unit (BTU) for the four main fuel types to estimate how much carbon dioxide is emitted from each energy source. The following values of pounds of carbon dioxide were used: 160 for petroleum, 120 for natural gas, 215 for coal and 197 for waste. These values were then converted to metric tons. Primary energy consumption was obtained from the Energy Information Association. Records are available from 1960-2018.
https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_use/total/use_tot_OHcb.html&sid=OH
The value for 2019 was estimated with a line of best fit.

Cost of Ozone Depletion
The GPI uses national data on the annual cost of the release of ozone-depleting materials as a baseline then scales down the costs to the state level. Since the national cost of ozone depletion is down to only $14 million a year in 2019 dollars, the Ohio cost is only about half a million dollars total for each year.

Cost of Non-Renewable Energy Resource Depletion
The cost of depleting nonrenewable resources was calculated by the cost it takes to replace those resources with renewables ones. The amount of coal, natural gas and petroleum was broken into two sector categories: electric sector and amount used outside of electric sector. This allows us to pinpoint how much fuel can be

replaced by solar and wind (for electric sector) and how much can be replaced by biofuel (non-electric sector). Electricity that is consumed that can be replaced by solar and wind power is multiplied by 8.75 cents per kilowatt-hour following Costanza et al 2004; Bagstad and Ceroni 2007; Venetoulis and Cobb 2004 which utilize cost estimates from Makhijani 2007. Energy that is consumed that cannot be replaced by solar and wind and must be replaced by other biofuels is multiplied by $116 per barrel. The total BTU's of nonrenewable energy was converted to barrels of oil equivalent. Primary energy consumption was obtained from the Energy Information Association. Records are available from 1960-2018. https://www.eia.gov/state/seds/data.php?incfile=/state/seds/sep_use/tx/use_tx_OH.html&sid=OH
The value for 2019 was estimated with a line of best fit.

Value of Household Work
The value of housework is monetized using a replacement cost method: by calculating how much a family would have to pay to hire someone else to do the equivalent household labor.

Unfortunately, state-level data about time use is not available, so American Time Use Survey data is used to estimate the amount of time Americans spend on housework and caring for others per day.[23] This data is then multiplied by Ohio's age fifteen plus population to estimate the total hours spent on housework and caring for others per day. These hours are then multiplied by wage rates for maids and child care workers to determine what the market value of those hours spent are.

Cost of Family Changes
The GPI estimates the cost of family breakdown by looking at two proxies: divorces and hours watching television. Divorce rates by state are reported by the Centers for Disease Control and Prevention.[24] The state of Ohio does not report how many children are affected by a divorce on average, so data from neighboring Michigan was used.[25] A value of $8,999 per adult and $13,380 per child in 2000 dollars was used, following past GPI studies.[26]

As for television viewing, Ohio does not collect state-level data, so American Time Use Survey data is used to estimate the amount of time Americans spend on

[23] American Time Use Survey, Bureau of Labor Statistics, https://www.bls.gov/tus/
[24] "Divorce Rates by State: 1990, 1995, and 1999-2019," CDC/NCHS, National Vital Statistics System, https://www.cdc.gov/nchs/nvss/marriage-divorce.htm?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fnchs%2Fmardiv.htm
[25] 2018 Michigan Occurrence Divorce Files, Division for Vital Records & Health Statistics, Michigan Department of Health & Human Services; Population Estimate (latest update 7/2019), National Center for Health Statistics, U.S. Census Populations With Bridged Race Categories.
[26] Stiffler, "Colorado's Genuine Progress Indicator."

watching TV per day. The average household size and the number of households with children comes from U.S. Census data. The cost of television viewing is estimated at $0.54 per hour following past GPI.[27]

Cost of Crime

Crime numbers were taken from the Ohio Bureau of Investigation, combined with data from disastercenter.com for earlier years. Both were checked for consistency with annual crime reports. Each crime was then multiplied with the associated costs, both quality of life effects and property losses, from research by the National Institute of Justice at the U.S. Department of Justice into Victim Costs and Consequences.

Crime cost estimates come from the National Institute of Justice's report on victim costs found here https://www.ncjrs.gov/pdffiles/victcost.pdf. Cost were adjusted into 2000 dollars. Both quality of life effects and property value are included in the cost of each crime.

The genuine progress indicator uses FBI Unified Crime Reporting data for Ohio combined with estimates of the cost of crime calculated by the National Institute of Justice to calculate the cost of crime for Ohio for each year.[28] The estimated costs of each crime were $2,276,281 per murder, $97,123 per rape, $7,868 per robbery, $9,326 per aggravated assault, $1,513 per burglary, $321 per larceny, and $4,290 per motor vehicle theft in 2000 dollars, following past GPI studies.[29]

Cost of Personal Pollution Abatement

The cost of household pollution abatement is comprised of automobile emissions abatement, sewage/septic systems and solid waste removal.

Data was used from the Office of Highway Policy Information to find vehicle registration numbers for Ohio.[30] The estimated total number of new vehicles was determined by the differences in vehicles from year to year added to one thirteenth the previous year's registrations, assuming each vehicle has an average life of thirteen years. The number of new cars is then multiplied by the cost of air filters ($8.5 in 2000 dollars) and the cost of catalytic converters ($100 in 2000 dollars) to estimate the total cost of household air pollution abatement.[31]

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[27] Stiffler, "Colorado's Genuine Progress Indicator."
[28] "Ohio Population and Number of Crimes: 1960-2019," http://disastercenter.com/crime/ohcrime.htm
[29] Stiffler, "Colorado's Genuine Progress Indicator."
[30] "State Motor-Vehicle Registrations," Office of Highway Policy Information, Policy and Governmental Affairs, Federal Highway Administration, U.S. Department of Transportation, http://fhwa.dot.gov
[31] Stiffler, "Colorado's Genuine Progress Indicator."

To calculate the costs of waste abatement, the genuine progress indicator uses 1990 data on the breakdown in Ohio between sewer and septic systems, with 78% of Ohio households with sewer systems and 22% with septic systems.[32] Total houses with sewer and septic systems were then estimated using annual data for number of houses from the American Community Survey.

For the sewer costs, the assumption of 250 gallons of sewer flow per day per household was adopted, which is generally used by Maryland's GPI study. This translates to 91,250 gallons per household per year. A rate of $4 per 1,000 gallons in 2000 dollars was adopted which mirrors the Maryland GPI study.

Septic costs were split into septic cleaning costs, which were estimated at $40 per year in 2000 dollars, and new septic costs, which were estimated at about $4,000 per year in 2000 dollars. New septic systems were estimated by subtracting the previous year's estimated number of septic systems from the current year's estimated number of septic systems.

Data on solid waste tonnage (trash sent to landfills) was available from 1960 to 2018 from a report published by EPA:
https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/studies-summary-tables-and-data-related
Value for 2019 was estimated with a line of best fit. Tonnage was then multiplied by $100 in 2000 dollars to estimate the cost.[33]

Value of Volunteer Work

The GPI uses state level data from the Corporation for National and Community Service on statewide volunteer hours in Ohio to estimate the number of hours people volunteer every year.[34] The number of hours in a given year was then multiplied by Independent Sector's historical value of a volunteer hour in Ohio.[35]

Cost of Lost Leisure Time

The GPI measures the cost of lost leisure time using a baseline of hours worked per worker in 1969, which was about 34 hours per week nationally.[36] For recent years, I use trends from the American Time Use Survey (ATUS) of work hours for

[32] "Historical Census of Housing Tables: Sewage Disposal," http://census.gov
[33] Stiffler, "Colorado's Genuine Progress Indicator."
[34] "Ohio," Corporation for National and Community Service, https://data.nationalservice.gov; https://www.nationalservice.gov/serve/via/states/; Data was not available for 2016, 2017 and 2019 so it was estimated with a line of best fit.
[35] "The Value of Volunteer Time / State and Historical Data," Independent Sector, https://independentsector.org/resource/vovt_state_2021/
[36] Leete-Guy, Laura and Juliet B. Schor, "The Great American Time Squeeze: Trends in Work and Leisure, 1969-1989," Briefing Paper, Economic Policy Institute, 1992; Ohio's rate that year is assumed to be the same.

the population 15 and older. Annual hours worked numbers are then multiplied by the number of unconstrained workers (those who have the work hours they want) and then by the hourly wage each year to find the total cost of lost leisure time.[37]

Value of Higher Education

The genuine progress indicator takes American Community Survey data about the number of people in the state with bachelor's degrees or more then multiplies it by $10,500, the value of a bachelor's degree in 2000.[38]

Services and Highways and Streets

The GPI uses Federal Highway Administration data on the miles of highway in the United States and the miles of highway in Ohio to determine a ratio of Ohio highway miles to total highway miles across the country.[39] It then uses Bureau of Economic Analysis data to estimate the federal value of the stock of highways and streets and scales that down to determine Ohio's stock.[40] We assume that the value of Ohio's highways and streets are ten percent of their net stock. Thus, assuming 25% of road use is for commuting, the value of the services of highways and streets comes out to 7.5% of the total stock.

Cost of Commuting

Three components make up the GPI's measure of the cost of commuting: public transit spending, commuting cost of privately-owned vehicles, and lost time spent commuting. Public transit spending data comes from the Federal Transit Administration.[41] Data on mean travel time and types of private commuting come from the American Community Survey and are multiplied by the federal mileage reimbursement, $0.44 per mile in 2000 dollars.[42] Time spent commuting is then multiplied by BLS wage data to determine the opportunity cost of commuting.

Cost of Motor Vehicle Crashes

Data on the number of motor vehicle fatality crashes, injury crashes, and noninjury crashes are taken from the Ohio Traffic Safety Office. Estimates for the cost of fatality, injury, and non-injury crashes are taken from the National Safety Council's "Injury Facts" publication.

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[37] "Occupational Employment and Wage Statistics," Bureau of Labor Statistics, https://www.bls.gov/oes/tables.htm

[38] Stiffler, "Colorado's Genuine Progress Indicator."

[39] "Public Road Length, Miles by Ownership," Office of Highway Policy Information, Policy and Government Affairs, Federal Highway Administration, US Department of Transportation, http://fhwa.dot.gov.

[40] "BEA Current-Cost Net Stock of Government Fixed Assets," National Data: Fixed Assets Accounts Tables, Bureau of Economic Analysis, http://apps.bea.gov.

[41] "Funding Sources," Federal Transit Administration, Department of Transportation, http://transit.dot.gov.

[42] Stiffler, "Colorado's Genuine Progress Indicator."

State Government Expenditures

The U.S. Census Bureau annually provides statistics on revenue, expenditure, debt, and assets (cash and security holdings) for the U.S. governments.[43] We used the amount of direct expenditures of the Ohio state government.

Exports and Imports

Trade data at the state level are provided by the U.S. Census Bureau.[44] We used the total values of exports and imports of Ohio for all commodities.

Health care costs associated with food insecurity

Data on the number of food insecure adults and children from 2010 to 2018 are extracted from the Feeding America *Map the Meal Gap* dataset.[45] The value for 2019 was estimated with a line of best fit. As for the health care costs associated with food insecurity per person and the state cost factor, I used estimates by Berkowitz et al. (2019). They estimate the health care costs associated with food insecurity to be $1,834 per adult and $80 per child in 2016 dollars, and 1.0077 as Ohio's state cost factor.

[43] "State and Local Government Finances Datasets and Tables", U.S. Census Bureau, https://www.census.gov/

[44] "USA Trade Online", U.S. Census Bureau, https://usatrade.census.gov/

[45] Gundersen, C., E. Waxman, E. Engelhard, T. Del Vecchio, & A. Satoh. *Map the Meal Gap 2012: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2010.* Feeding America, 2012.; Gundersen, C., E. Waxman, E. Engelhard, A. Satoh, & N. Chawla. Map the Meal Gap 2013: Food Insecurity Estimates at the County Level. Feeding America, 2013.; Gundersen, C., E. Engelhard, A. Satoh, & E. Waxman. Map the Meal Gap 2014: Food Insecurity and Child Food Insecurity Estimates at the County Level. Feeding America, 2014.; Gundersen, C., E. Engelhard, A. Satoh, & E. Waxman. Map the Meal Gap 2015: Food Insecurity and Child Food Insecurity Estimates at the County Level. Feeding America, 2015.; Gundersen, C., A. Dewey, A. Crumbaugh, M. Kato & E. Engelhard. *Map the Meal Gap 2016: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2014.* Feeding America, 2016.; Gundersen, C., A. Dewey, A. Crumbaugh, M. Kato & E. Engelhard. *Map the Meal Gap 2017: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2015.* Feeding America, 2017.; Gundersen, C., A. Dewey, A. Crumbaugh, M. Kato & E. Engelhard. *Map the Meal Gap 2018: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2016.* Feeding America, 2018.; Gundersen, C., A. Dewey, M. Kato, A. Crumbaugh & M. Strayer. *Map the Meal Gap 2019: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2017.* Feeding America, 2019.; Gundersen, C., A. Dewey, E. Engelhard, M. Strayer & L. Lapinski. *Map the Meal Gap 2020: A Report on County and Congressional District Food Insecurity and County Food Cost in the United States in 2018.* Feeding America, 2020.

Appendix B: Detailed GPI Results (in Billions 2019 USD)

Economic Indicators

Year	Adjusted Personal Consumption	Cost of Consumer Durables	Value of Consumer Durables	Cost of Underemployment	Net Capital Investment	**Total**
2010	344.86	-40.17	69.43	-18.04	9.88	**365.97**
2011	343.45	-41.14	66.78	-15.27	13.76	**367.58**
2012	346.39	-42.30	65.24	-14.04	21.54	**376.83**
2013	346.87	-43.41	64.30	-14.04	25.46	**379.18**
2014	356.39	-44.91	63.60	-11.25	28.67	**392.50**
2015	371.00	-47.16	64.66	-10.68	32.61	**410.44**
2016	375.80	-48.52	65.08	-10.51	27.66	**409.50**
2017	388.32	-50.42	66.01	-10.08	29.00	**422.84**
2018	393.66	-51.36	67.75	-9.17	33.88	**434.75**
2019	400.14	-52.22	69.85	-8.74	32.71	**441.74**

Environmental Indicators

Year	Cost of Water Pollution	Cost of Air Pollution	Cost of Noise Pollution	Cost of Loss of Wetlands	Cost of Loss of Farmland
2010	-2.01	-3.13	-0.65	-4.10	-35.03
2011	-2.01	-2.99	-0.67	-4.10	-36.85
2012	-2.01	-2.81	-0.67	-4.10	-39.28
2013	-2.02	-2.63	-0.68	-4.10	-42.57
2014	-2.02	-2.47	-0.68	-4.10	-46.40
2015	-2.04	-2.09	-0.67	-4.10	-49.05
2016	-2.06	-1.71	-0.67	-4.10	-48.97
2017	2.08	-1.34	-0.68	-4.10	-48.49
2018	-2.11	-1.30	-0.69	-4.10	-49.71
2019	-2.05	-1.25	-0.69	-4.10	-51.58

Year	Value of Net Forest Change	Cost of Carbon Emissions	Cost of Ozone Depletion	Cost of Depletion of Non-Renewables	**Total**
2010	1.01	-10.64	-0.00	-75.45	**-130.01**
2011	1.05	-10.36	-0.00	-74.78	**-130.70**
2012	1.10	-9.71	-0.00	-72.68	**-130.16**
2013	1.12	-10.52	-0.00	-75.25	**-136.65**
2014	1.13	-10.81	-0.00	-78.15	**-143.51**

2015	1.09	-10.17	-0.00	-76.36	**-143.38**
2016	1.07	-10.07	-0.00	-74.74	**-141.24**
2017	1.08	-10.20	-0.00	-74.56	**-140.37**
2018	1.05	-10.49	-0.00	-77.59	**-144.94**
2019	1.04	-10.94	-0.00	-79.69	**-149.26**

Social Indicators

Year	Value of Housework and Parenting	Cost of Family Breakdown	Cost of Crime	Cost of Household Pollution Abatement	Value of Volunteer Work	Loss of Leisure Time
2010	88.24	-3.69	-2.91	-2.81	5.79	-21.72
2011	85.99	-3.63	-2.97	-2.94	5.44	-25.66
2012	83.71	-3.65	-2.89	-2.90	6.34	-26.13
2013	86.21	-3.58	-2.80	-2.96	6.49	-24.12
2014	85.29	-3.52	-2.73	-2.99	6.05	-29.88
2015	88.01	-3.44	-2.93	-2.98	5.95	-26.31
2016	88.69	-3.35	-3.38	-3.00	6.56	-28.04
2017	89.34	-3.32	-3.87	-3.05	6.56	-30.42
2018	88.38	-3.36	-3.38	-3.05	6.79	-28.71
2019	89.42	-3.24	-3.15	-3.03	6.73	-29.26

Year	Value of Higher Education	Value of Highways and Streets	Cost of Commuting	Cost of Auto Accidents	**Total**
2010	28.18	7.51	-10.61	-5.06	**82.93**
2011	28.39	7.71	-10.69	-5.01	**76.64**
2012	29.05	7.86	-10.92	-5.07	**75.39**
2013	30.22	7.89	-11.01	-4.71	**81.62**
2014	31.01	7.70	-11.22	-4.77	**74.93**
2015	31.38	7.81	-11.68	-5.17	**80.63**
2016	32.33	8.02	-11.96	-5.29	**80.59**
2017	33.10	8.18	-12.17	-5.27	**79.07**
2018	34.50	8.38	-12.38	-5.04	**82.13**
2019	34.96	8.48	-12.99	-5.17	**82.75**

New Indicators

Year	State Government Expenditures	Exports	Imports	Health care costs associated with food insecurity	**Total**
2010	66.68	47.44	-60.56	-2.76	**50.79**
2011	66.47	51.44	-66.19	-2.73	**48.98**

2012	63.69	52.98	-69.61	-2.60	**44.46**
2013	63.68	54.63	-71.08	-2.58	**44.65**
2014	66.85	55.53	-74.24	-2.61	**45.53**
2015	68.74	54.36	-73.13	-2.53	**47.43**
2016	71.18	51.87	-67.56	-2.43	**53.07**
2017	71.26	51.79	-69.80	-2.34	**50.91**
2018	71.15	55.20	-71.12	-2.25	**52.99**
2019	71.57	53.23	-68.97	-2.24	**53.59**

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