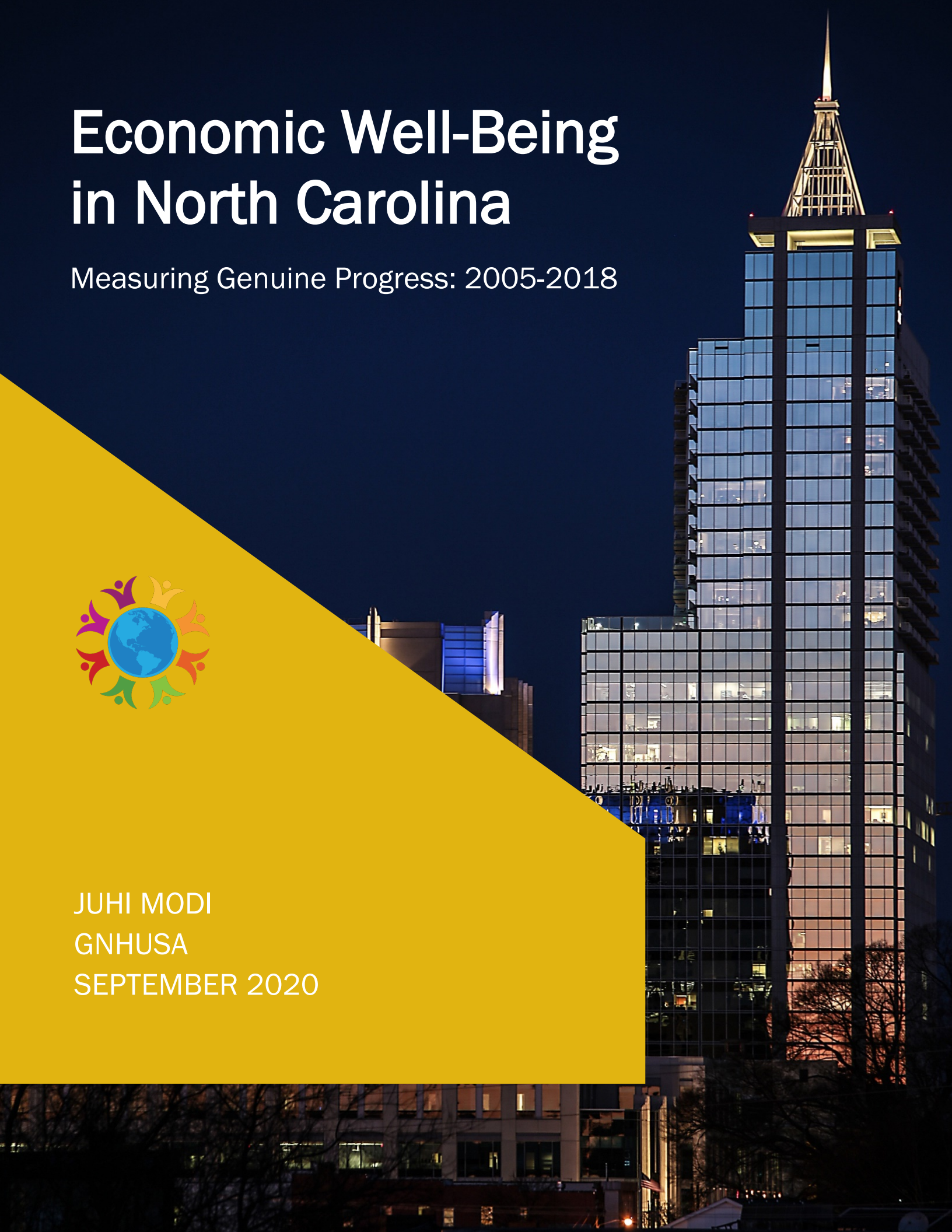
Economic Well-Being in North Carolina

Measuring Genuine Progress: 2005-2018



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This study evaluates the economic well-being of North Carolina from 2005 to 2018 using a metric known as the Genuine Progress Indicator (GPI). The Gross Domestic Product (GDP) has commonly been taken at face value as a representation of an area's economic prosperity and well-being, even though it was never intended as such. The GPI was designed as a more comprehensive measure of economic welfare, as it takes into account economic, environmental, and social indicators that are omitted from GDP. Using the GPI, we examine North Carolina's economy before, during, and after the Great Recession.

Personal consumption expenditures is the largest component and benefit of North Carolina's GPI, followed by the value of housework and parenting, the value of consumer durables, and benefits of higher education. The largest costs and drags on North Carolina's economy are the costs of income inequality, farmland loss, non-renewable energy resource depletion, followed by the cost of consumer durables and loss of leisure time.

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INTRODUCTION

The Gross Domestic Product (GDP) measures the market value of all final goods and services exchanged in an economy in a given period of time.[1] This metric is widely used to measure economic performance, but GDP is also often treated as an all-encompassing indicator of well-being and success. Simon Kuznets, who developed the concept of GDP, has stated that "GDP should never be confused with well-being."[2] While it does serve its purpose of measuring an economy's output, it has limitations that hinder it not only from indicating the social well-being of an area but also the full economic landscape.

GDP omits important indicators of economic, environmental, and social well-being. Volunteering and housework/parenting are just two examples of non-market activities that are not counted in GDP simply because no money changes hands, even though they are valuable areas of work that contribute to economic and social well-being.[3] Another shortcoming of GDP is that it does not differentiate between monetary exchanges that do and do not indicate higher well-being. For instance, the purchase of security systems as a result of higher crime rates increases GDP, contributing to a false indication of progress.[4] Furthermore, GDP does not accurately reflect economic and social inequality or sustainability as it omits costs such as income inequality and environmental degradation that deplete well-being.

The Genuine Progress Indicator (GPI) was designed to address the shortcomings of GDP and measure sustainable economic welfare rather than economic activity alone.[5] The GPI, like the GDP, first accounts for personal consumption, but then it corrects for income inequality, costs of environmental damage, and non-market social benefits and costs, such as the loss of leisure time and the value of higher education. As seen in Table 1, the GPI's 26 indicators fall into three categories: economic, environmental and social. With these indicators, the GPI serves to provide a more comprehensive view of an area's well-being.

1 Callen, Tim. "Gross Domestic Product: An Economy's All." International Monetary Fund, 24 February 2020.
2 Pilling, David. "Why the GDP Is a Terrible Measure of Success and Wealth." Time, 25 January 2018.
3 Goldsmith, Courtney. "Why GDP Is No Longer the Most Effective Measure of Economic Success." World Finance, 25 July 2019.
4 Stiffler, Chris, "Colorado's Genuine Progress Indicator (GPI): A Comprehensive Metric of Economic Well-Being in Colorado from 1960-2011," Colorado Fiscal Institute, January 7, 2014.
5 "Maryland's Genuine Progress Indicator." Maryland Department of Natural Resources.

Table 1: Components of GPI[4]

+/-	**Indicator**	Explanation
Economic		
+	Personal Consumption Expenditures	The bulk of GDP as well, consumption informs the baseline from which the rest of the indicators will be added or subtracted.
÷	Income Inequality	Using the Gini index and the Income Distribution Index (IDI), its relative change over time.
(PCE/IDI) *100	Adjusted Personal Consumption	Formula = (Personal consumption/IDI) x 100. Forms the base number from which the remaining indicators are added or subtracted.
-	Cost of Consumer Durables	Calculated as a cost to avoid double counting the value provided by the durables themselves.
+	Value of Consumer Durables	Estimates the services provided by household equipment, which is a more accurate measure of value that just the money spent on such long-term items.
-	Cost of Underemployment	Encompasses the chronically unemployed, discouraged workers, involuntary part-time workers and others with work-life restraints (lack of childcare or transportation).

+/-	Net Capital Investment	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.
Environmental		
-	Cost of Water Pollution	Damage to water quality from things such as chemicals or nutrients, and the costs of erosion/sedimentation in waterways.
-	Cost of Air Pollution	Includes damage to vegetation, degradation of materials, cost of clean-up from soot or acid rain, and resulting reduced property values, wage differentials and aesthetics.
-	Cost of Noise Pollution	Noise from traffic and factories can cause hearing loss and sleep deprivation. The World Health Organization (WHO) produced an estimate for damaged caused by noise pollution in U.S.
+/-	Wetland Change	Valuates the services given up when wetlands are lost to development i.e. buffering of weather, habitat, water purification. + if increase in wetland area; - if loss of wetlands.
+/-	Farmland Change	Due to urbanization, soil erosion and compaction. This indicator is measured cumulatively to account for all years of production lost as it compromises self-

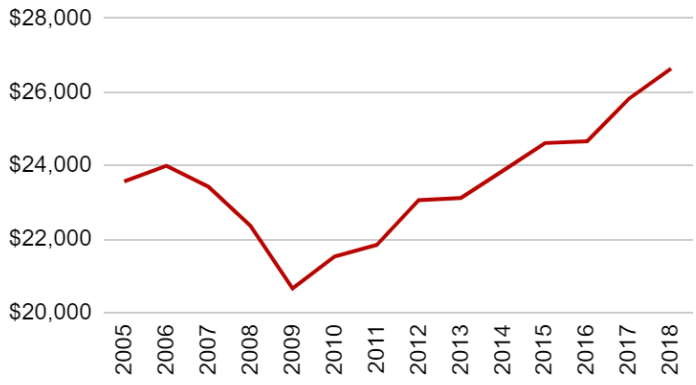
		sufficient food supply. + if increase in farmland area; - if loss of farmlands.
+/-	Forest Cover Change	Loss of biodiversity, soil quality, water purification, carbon sequestration, recreation etc. Cumulative affect year over year. + if increase in forest area; - if loss of forest cover.
-	CO_2 Emissions	Increases in severe weather is causing billions in damages. GPI tries to quantify the costs from environmental damage associated with climate disruption. A value per ton of CO2 emitted is based on a meta-analysis study by Richard Tol (2005).
-	Cost of Ozone Depletion	Captures the economic costs of increased exposure to harmful solar radiation from ozone depletion. Depletion can lead to increased cases of cancer, cataracts and plant decline.
-	Depletion of Non-Renewables	These cannot be renewed in a lifetime and their depletion creates costs for future generations. Depletion is measured against cost of implementing and substituting with renewable resources.
Social		
+	Value of Housework and Parenting	An important economic activity that is omitted from GDP, which includes parenting, meal preparation, cleaning, and

		repairs. Valued at the amount a household would have to pay for those services.
-	Cost of Family Changes	Costs of divorce, the decrease of traditional family bonding activities, and moving family activities to the market.
-	Cost of Crime	Medical expenses, property damages, psychological care and security measures to prevent crime are all included in this indicator.
-	Cost of Household Pollution Abatement	Cost to residents to clean the air and water in their own household (i.e. air and water filters) to compensate for externalities created by our economic activity.
+	Value of Volunteer Work	Valued as a contribution to social welfare. Neighborhoods and communities can find an informal safety net through their peers and volunteer work.
-	Loss of Leisure Time	Compared to 1969 hours of leisure. Recognizes that increased output of goods and services can lead to loss of valuable leisure time.
+	Value of Higher Education	Accounts for the indirect personal and societal benefits of an educated population, such as knowledge, productivity, civic engagement, savings, and better health outcomes.

+	Value of Highways and Streets	Annual value of services contributed from the use of streets & highways. Valued at 7.5% of net stock of local, state and federal highways.
-	Cost of Commuting	Money spent to pay for the transportation and time lost in transit as opposed to other more enjoyable activities.
-	Cost of Auto Accidents	Property damage and health costs as a result of traffic accidents. Increased traffic densities are a direct result of industrialization and wealth accumulation.

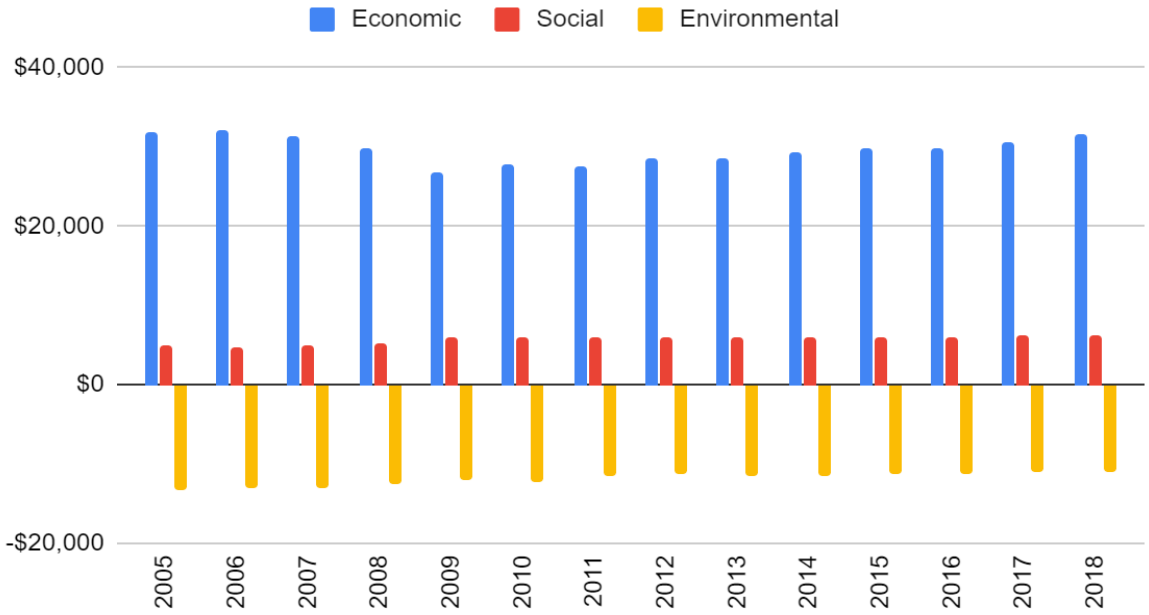
OVERVIEW: NORTH CAROLINA'S ECONOMIC PROGRESS

Figure 1: NC GPI Per Capita (2018 $)



North Carolina's GPI per capita decreased by 14% from 2006 to 2009 due to the economic fallout from the Great Recession. From 2009 to 2018, the GPI per capita increased by 29%, signaling a strong recovery from the recession. While household consumption steadily increased from 2009 to 2018, driving the recovery, income inequality worsened during that period, which weighed down recovery from the recession.

Figure 2: Per Capita Benefits and Costs of Major GPI Sections (2018 $)



As seen in Figure 2, the economic indicators have the largest impact on North Carolina's GPI. The social indicators provide additional benefits to the economy that are otherwise ignored in GDP, while the environmental indicators have a severely negative impact on overall economic welfare.

Figure 3: Per Capita Values and Costs of NC GPI in 2018

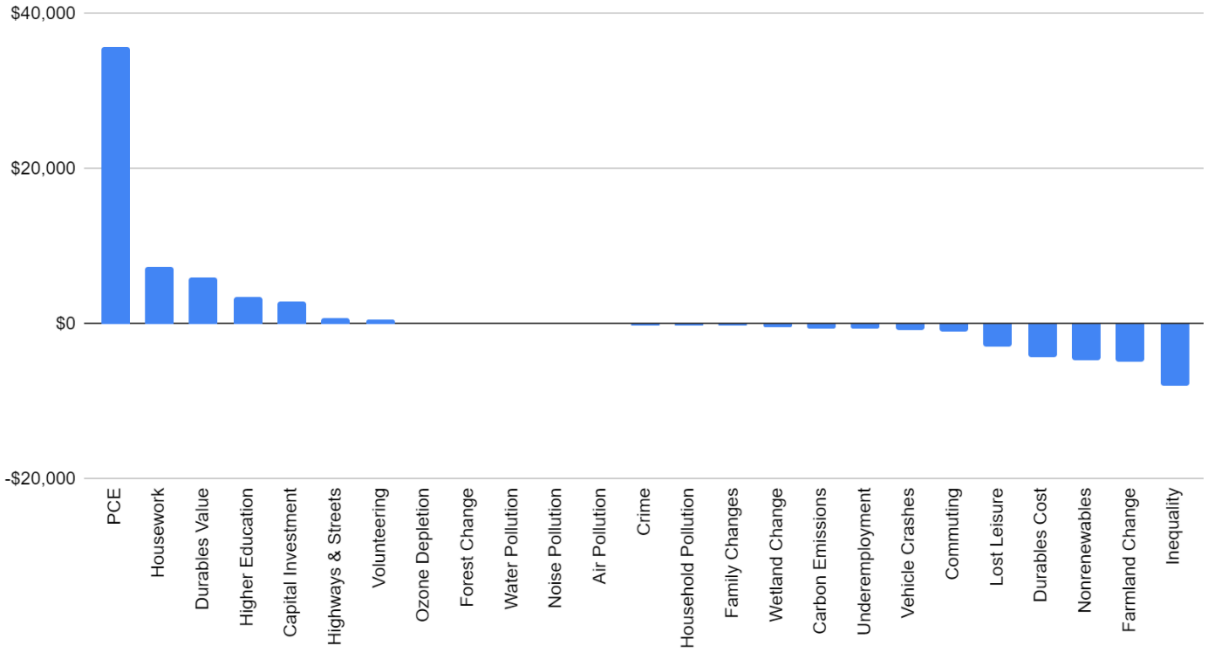
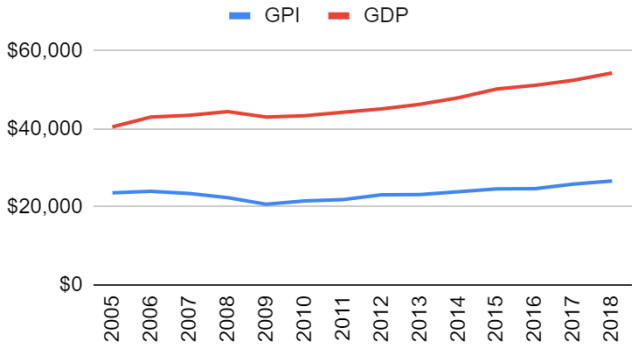


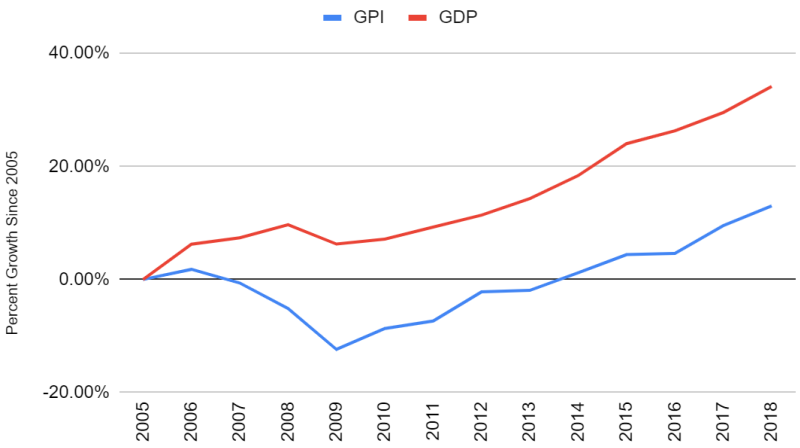
Figure 3 illustrates the weight that each indicator has on the overall GPI calculations for North Carolina in 2018. Personal consumption expenditures is the largest component of the GPI, making up 63% of the total benefits in 2018. The value of housework constitutes 13% of gross benefits, and the cumulative value of consumer durables and higher education makes up 17% of total benefits. The cost of inequality is the largest burden on NC's economy, making up 27% of total costs in 2018. The costs of farmland loss and non-renewable energy resource depletion each make up about 16-17% of the cumulative cost.

Figure 4: NC GDP Per Capita vs. GPI Per Capita



Figures 4 and 5 compare per capita GPI to per capita GDP and their growth rates. The large difference between per capita GPI and GDP is primarily driven by the costs of environmental damage and income inequality accounted for in the GPI. The trends of the two measures are generally similar, showing a decline in economic activity and welfare during the recession and the growth of the economy since then, signaling a recovery.

Figure 5: NC Cumulative GDP Per Capita Growth vs. Per Capita GPI Growth

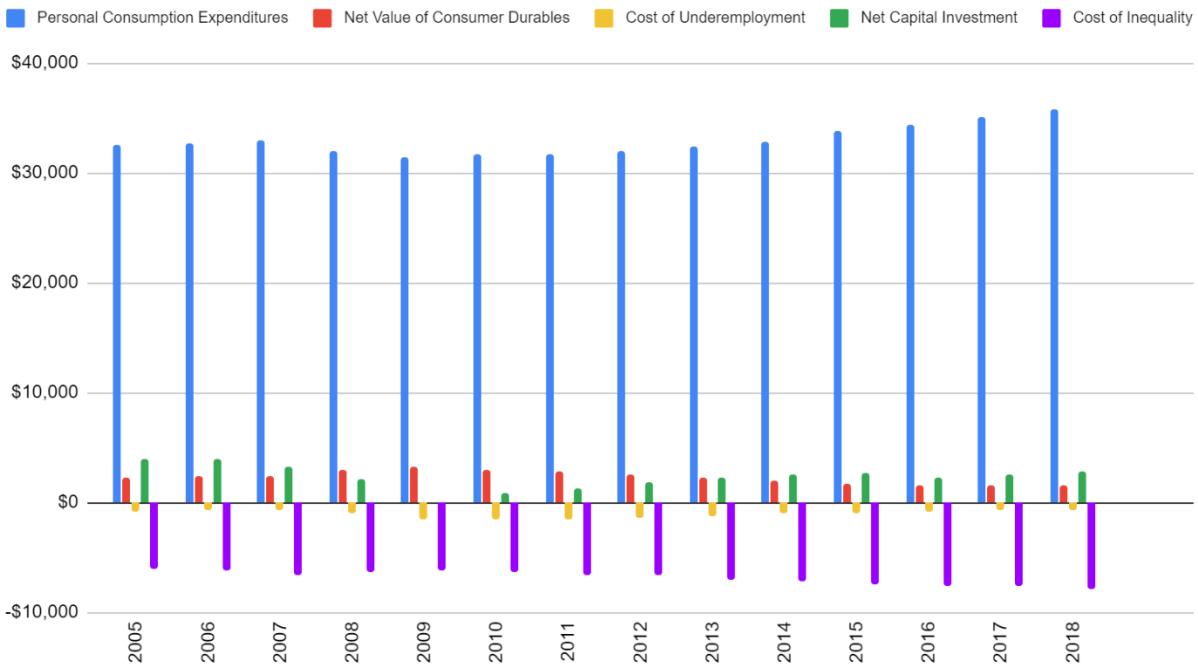


A stark difference between the GPI and GDP per capita is the rate at which they decline during the recession and increase afterwards. From 2007 to 2013, the GPI per capita markedly declines (relative to 2005), while the GDP per capita itself does not decrease and simply grows at a slower rate. The rate at which the GPI recovers from 2009 to 2018 is much slower and less steady than the that of the GDP. By 2018, the GDP per capita increased by 34% while the GPI by 13% since 2005.

ECONOMIC INDICATORS

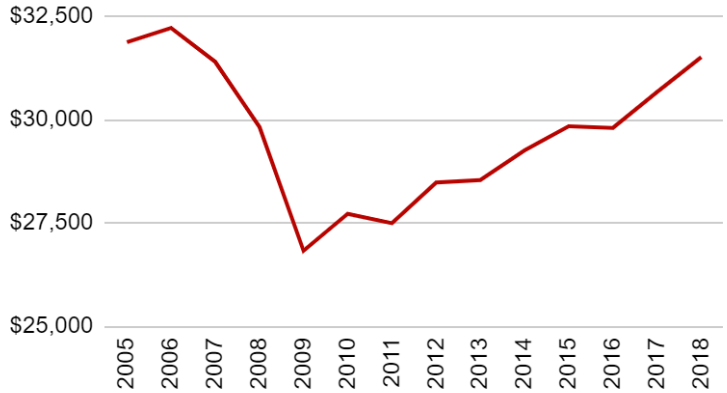
The foundation of the GPI is five economic indicators from which other indicators are added or subtracted: personal consumption expenditures, income inequality, the value of consumer durables, the cost of underemployment, and net capital investment.

Figure 6: Per Capita Benefits and Costs of Economic Indicators (2018 $)



As seen in Figure 6, personal consumption makes up a significant portion of the economic indicators. Personal consumption has been increasing steadily since the recession, reaching its highest amount yet in 2018. At the same time, though, income inequality has also been rising, which has hindered the growth of per capita economic welfare.

Figure 7: Per Capita Net Economic Welfare (2018 $)



Per capita net economic welfare dropped nearly 17% ($5,390) from 2006 to 2009 due to a significant decrease in net capital investment and a large increase in the cost of underemployment - From 2008 to 2009, the cost of underemployment increased by 60%. The per capita net economic welfare has gradually increased since the recession, although the value in 2018 was 1.1% less than the value in 2005. While personal consumption was nearly 10% higher in 2018 than in 2005, net economic welfare did not fully recover from the recession by 2018 due to the 31% increase in the cost of income inequality.

PERSONAL CONSUMPTION EXPENDITURES

Personal consumption is the "base" of the GPI from which all other indicators are added or subtracted.[4] By beginning with this measure, the GPI is comparable to the GDP as it allows us to calculate the generation of value in terms of consumer goods and services.[6] Everything that households spend money on, from groceries to transportation to healthcare, is included in personal consumption.

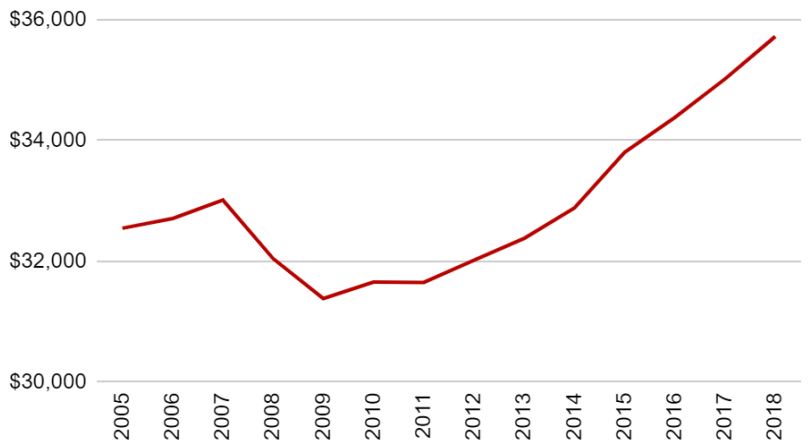
As seen previously in Figures 2 and 6, personal consumption is the largest component of the economic indicators and the GPI as a whole. As personal consumption constitutes almost seventy percent of GDP and is a larger driver of economic output, it is important to incorporate that as an indicator of economic growth in the GPI.[7]

The Bureau of Economic Analysis (BEA) measures personal consumption expenditures and population estimates at the state level. Using this data, we can estimate the personal consumption per capita for North Carolina.

[6] Zencey, Eric. "The 2018 Vermont Genuine Progress Indicator." University of Vermont. March 2018.
[7] U.S. Bureau of Economic Analysis, Shares of gross domestic product: Personal consumption expenditures, retrieved from FRED, Federal Reserve Bank of St. Louis

From 2005 to 2018, personal consumption increased by 10%, with an average increase of 0.7% per year. Expenditures decreased 3% from 2007 to 2008 due to the economic fallout of the Great Recession.

Figure 8: Personal Consumption Expenditures Per Capita (2018 $)

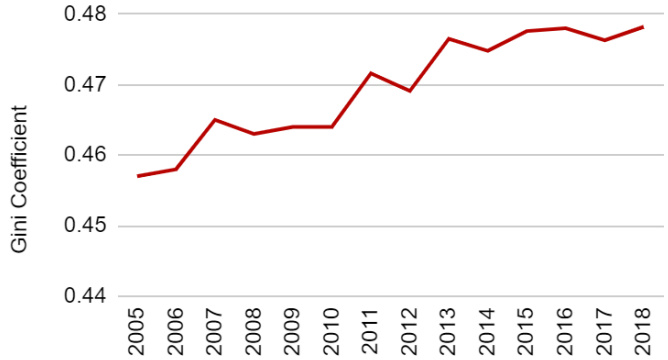


INCOME INEQUALITY

Income inequality in the U.S. has risen for the past several decades.[8] As seen in Figure 9 below, the trend in North Carolina is no different.

To measure income inequality, we use the standard measure of the Gini Coefficient. It measures the difference between the existing income distribution and a perfectly equal distribution of incomes.[4] Values lay on a spectrum of zero to one, with a Gini of zero signifying perfect equality and one representing perfect inequality.

Figure 9: Income Inequality in NC



From 2005 to 2018, NC's Gini rose approximately 5%, from 0.46 to 0.48, peaking in the years 2007, 2011, and 2013.

Personal consumption expenditures are adjusted to account for income inequality. While a large amount of spending may indicate high incomes and economic prosperity, in a country such as the U.S. with high levels of income inequality it is important to factor in inequality to more genuinely capture economic well-being for all. Income inequality is a social cost that directly relates to a degradation of economic welfare and social cohesion.[4]

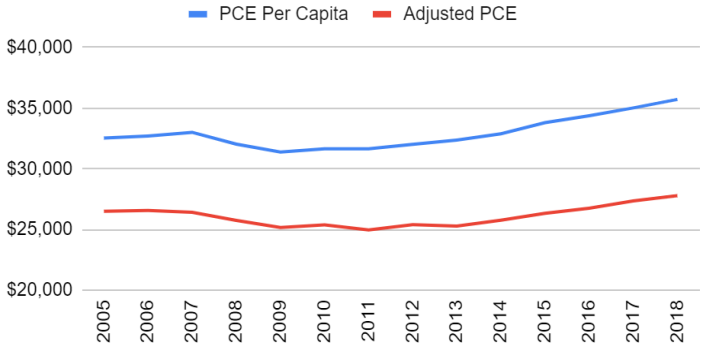
[8] McGuire, Sean, et al. "Measuring Prosperity: Maryland's Genuine Progress Indicator." The Solutions Journal, March 2012.

Another reason to account for income inequality is that is leads to economic inefficiencies. There is a large amount of research that demonstrates that income inequality hurts the economy by suppressing economic growth and increasing vulnerability to economic crises.[9, 10, 11,12] Inequality in the U.S. has slowed the growth of aggregate demand (spending by households, businesses and governments) and contributed to secular stagnation, which in turn has negatively affected U.S. GDP.[13, 14] With reduced consumption comes reduced economic efficiency. The adjusted personal consumption expenditures is a way to correct for that inefficiency. Furthermore, due to the marginal value of money, lower-income groups profit more from the same increase in income than wealthier groups.[4] As such, it is important to adjust for inequality since the benefits of increased income and consumption vary for people of different socioeconomic statuses.[4]

Personal consumption expenditures are adjusted using an income distribution index calculated by dividing current-year Gini by a base year Gini.[4] Previous GPI studies have used 1970 as the base year; Due to a lack of data currently available on the state level, we used 1969 as the base year.

Figure 10 demonstrates the impact of income inequality as measured by GPI in the difference between the adjusted and non-adjusted personal consumption expenditures per capita. On average, there is a $6,845, or 21%, difference between adjusted and non-adjusted expenditures from 2005 to 2018.

Figure 10: Per Capita PCE and PCE Adjusted with Income Inequality



[9] Stiglitz, Joseph. "Inequality and Economic Growth." Columbia Business School.
[10] Wisman, Jon. "Wage stagnation, rising inequality, and the financial crisis of 2008." Cambridge Journal of Economics, 19 February 2013.
[11] Georgopoulos, Demosthenes, et al. "Factors related to the depth of the latest crisis for EU-27 countries: The key role of relative inequality/poverty" Economic Letters, 17 March 2012.
[12] Boushey, Heather and Park, Somin. "Fighting inequality is key to preparing for the next recession." Economic Policy Institute, 15 May 2019.
[13] Bivens, Josh. "Inequality is slowing US economic growth." Economic Policy Institute. 12 December 2017.
[14] Thewissen, Stefan, et al, "Rising Income Inequality and Living Standards in OECD Countries: How Does the Middle Fare?" Journal of Income Distribution, Volume 26, No. 2, 2018

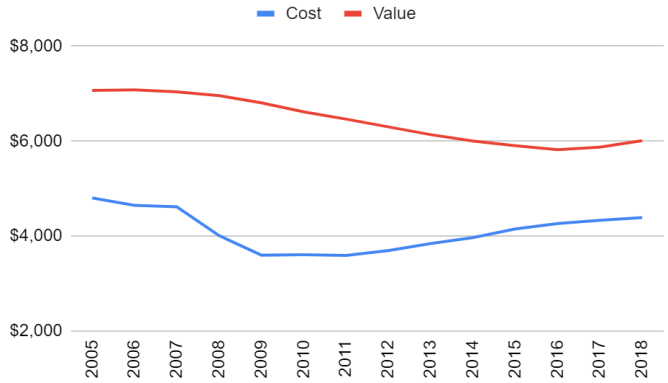
NET VALUE OF CONSUMER DURABLES

Included in personal consumption expenditures are durable goods that have at least three (often more) years of life, such as cars, furniture, appliances, and mattresses. As these products last over a long period of time, they are not meant to be purchased often. One criticism of GDP is that durables are only counted in the year that they are purchased, and the benefits that accrue over their long lives are ignored.[4] Additionally, due to the way durables are counted, GDP increases from repeated consumption but not from reusing goods (the latter of which benefits households). For instance, take a household that purchases a car that breaks down, requires repairs, and may even need to be replaced entirely. These frequent purchases are counted as increases in GDP, while the value a household receives from buying one sturdy car that lasts for ten years would not be counted in GDP.

To correct for this issue, the GPI considers expenditures on durable goods as a cost and the long-term use as a benefit.[6] The Bureau of Economic Analysis provides estimates of annual expenditures on durable goods.[15] Then, to calculate the value of these goods, we define the annual services derived from durables as the sum of the depreciation rate and interest rate.[16] The GPI assumes that consumer durables last an average of eight years and that depreciation is fixed and linear.[17] Given this, a 12.5 percent depreciation rate is adopted. An interest rate of 7.5 percent is used to consider the interest consumers could have received if they had alternatively invested the money.[4] With the 12.5 depreciation rate and 7.5 interest rate, the annual value of durable goods' services is calculated as 20 percent of the total stock of durables in North Carolina.[4]

[15] "Total Personal Consumption Expenditures (PCE) By State." Regional Data: GDP and Personal Income, Bureau of Economic Analysis.
[16] Talbert, et al. "The Genuine Progress Indicator 2006: A Tool for Sustainable Development." Redefining Progress, February 2007.
[17] Moore, Rob. "Ohio's Economy: 2009-2016: Assessing Ohio's Recovery from the Great Recession." Gross National Happiness USA, Scioto Analysis, November 2018.

Figure 11: Per Capita Cost and Value of Consumer Durables (2018 $)



As seen in Figure 11, the cost of durables sharply dropped in 2009, as consumer spending tightened due to the recession, and gradually increased from 2010 to 2018 as consumers resumed purchasing durable goods. The value of consumer durables remained fairly stable from 2005 to 2007 and saw a gradual decrease from 2008 to 2016.

Figure 12: Per Capita Net Value of Consumer Durables (2018 $)

From 2009 to 2016 we see a 51% decrease in the per capita net value of consumer durables (from about $3,200 to $1,555) and begin to see an increase from 2017-2018. The net value peaks in 2009 due to the fact that through recessions, consumers still experience the long term benefits of durable goods while they reduce their consumption of such new goods.[17] As such, the net value of consumer durables is expected to be higher during recessions and lower when the economy is in a better condition.[17]

COST OF UNDEREMPLOYMENT

"Underemployment" refers to those who are unemployed, marginally attached, and working part time for economic reasons but would prefer to work full time.[18] When there are workers who are unable to work as much as they would like to, full economic potential is not met.[4] Underemployment is a cost that is deducted in GPI to account for the unmet economic benefits and declines in economic output as a result of the workforce not being fully used.[4]

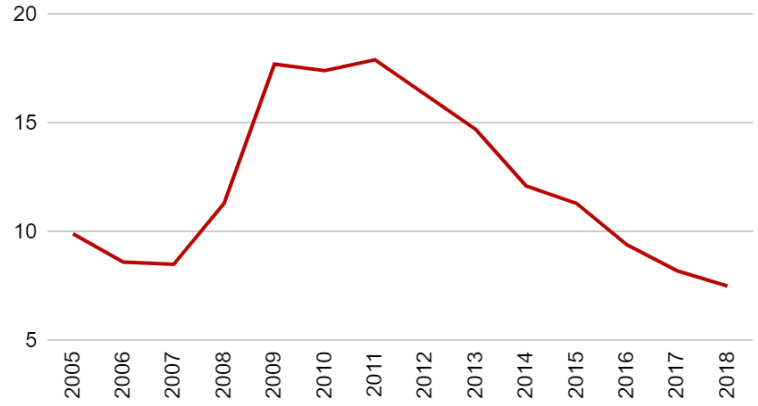
In addition to economic costs, there are social and personal costs of underemployment. Workers who are unable to work as much as they desire may experience adverse mental

[18] "Alternative Measures of Labor Underutilization for States." Local Area Unemployment Statistics, Bureau of Labor Statistics, 2020.

health outcomes and a deterioration of skills and motivation.[4] Additionally, persistent unemployment can decay social values and community cohesion.[4]

To calculate the total cost of underemployment, we multiply the number of hours of unprovided work per underemployed worker by the average real wage rate, both of which are estimated by the Bureau of Labor Statistics.

Figure 13: NC Underemployment Rate (Percent)



Downturns in the economy at large are the largest driver of underemployment, as seen in Figure 13. The underemployment rate decreased significantly since the recovery from the recession, with a rate of 18% in 2009 and only 8% in 2018.

From 2005 to 2018, the underemployment rate decreased by 24% and the cost of underemployment by 22%. From 2009 to 2018, the underemployment rate decreased by 58% and the cost of underemployment by 57%.

Figure 14: Per Capita Cost of Underemployment (2018 $)

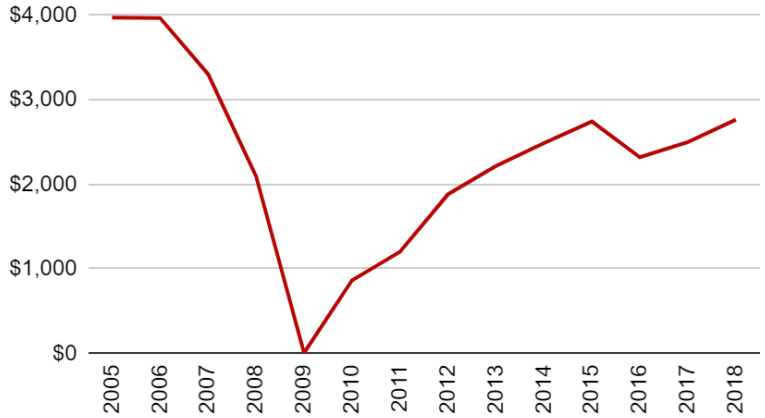
NET CAPITAL INVESTMENT

For an economy to be sustainable over time, it must maintain or increase its supply of capital (infrastructure, buildings, machinery) as the population increases.[4] As workers use capital to increase productivity and efficiency, capital must be replaced and invested in to lead to sustained or greater output and efficiency of resource use.[6]

If an economy suddenly shifted the amount spent on capital to consumer goods, it would lead to a less sustainable economy.[17] GDP would not capture this, though, as those expenditures would still be spent on goods and as such, still be counted as increases in GDP.[4] To correct for this, the GPI tracks net capital investment.

As data on net capital investment is not available at the state level, we used national estimates and scaled them down to estimate the amount of capital for North Carolina.

Figure 15: Per Capita Net Capital Investment (2018 $)

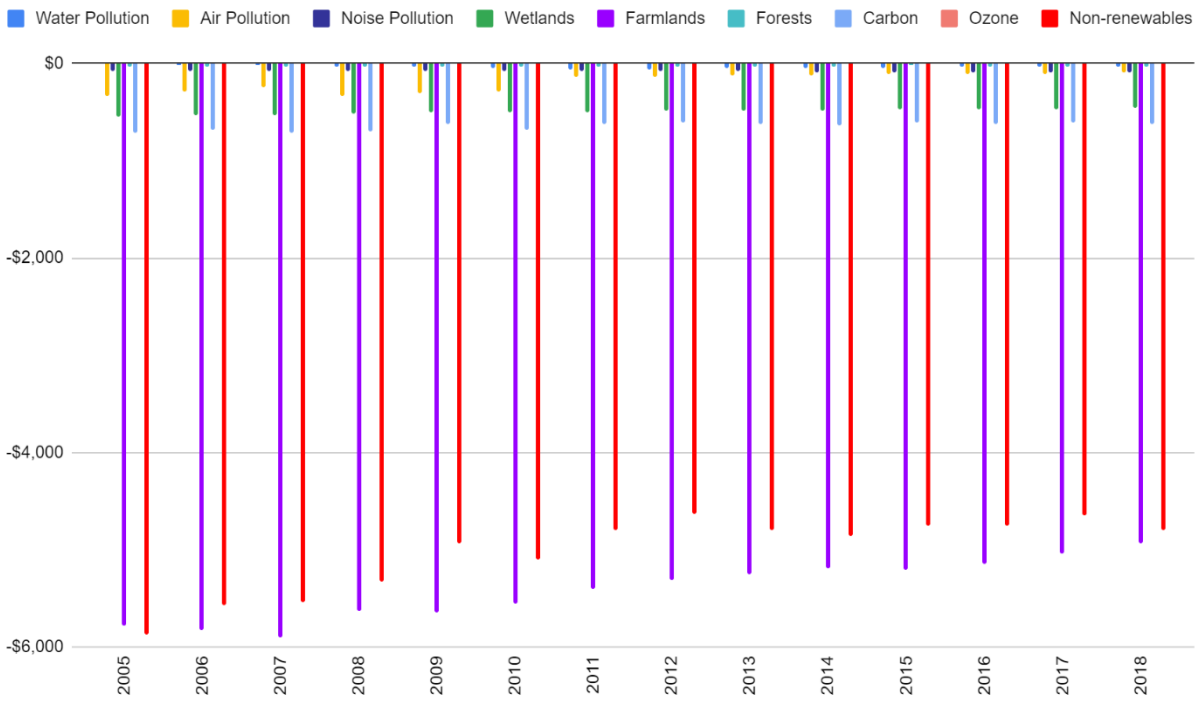


In 2005, per capita net capital investment was nearly $4000, and in 2009 it dropped 99.9% to a mere $4. Since then, as seen in Figure 15, it increased until 2016, when per capita net capital investment saw a 15% decrease. It then steadily increased from 2017 to 2018.

ENVIRONMENTAL INDICATORS

A drawback of GDP is that it does not account for environmental indicators that are known to have economic effects. The GPI calculates nine environmental components: the cost of water, air, and noise pollution, change in wetland, farmland, and forest area, carbon emissions, ozone depletion, and the depletion of non-renewable energy resources.

Figure 16: Per Capita Benefits and Costs of Environmental Indicators (2018 $)



The cost of farmland loss and non-renewable resource depletion have similarly significant impacts on the per capita cost of all environmental indicators. On average across the years, the two make up 87% of the total per capita cost. Each of these environmental indicators are costs to NC's economy for all years from 2005 to 2018.

From 2005 to 2018, the per capita cost of environmental damage decreased by 17%. This decrease was driven primarily by the drop in the cost of air pollution, which fell 70% from 2005 to 2018. Additional decreases in the costs of wetland loss, forest cover, ozone depletion, non-renewable resource depletion, farmland acreage, and carbon emissions contributed to the overall decrease in per capita economic costs of environmental damages.

Figure 17: Per Capita Cost of Environmental Damage (2018 $)

COST OF WATER POLLUTION

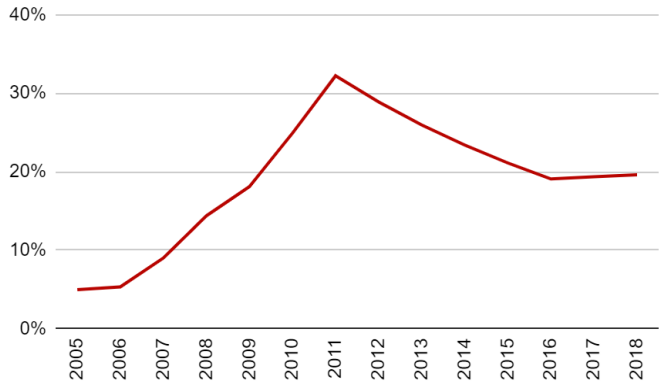
The many costs of water pollution have widespread effects on humans, animals, and the environment. In 2015, water pollution caused 1.8 million deaths worldwide.[19] It causes illness for about 1 billion people around the world and disproportionately harms low-income communities, as they tend to be closest to polluting industries.[20] Contaminants of chemicals and heavy metals in the water not only cause health issues for humans but are toxic to aquatic life. Additionally, water pollution causes algal blooms which reduces oxygen levels of the water and suffocates plants and animals.[20] Given these harmful impacts, GPI accounts for the cost of water pollution.

The GPI multiplies the percentage of impaired water bodies by the per capita value of perfectly clean water by the state population to calculate the cost of water pollution. We used a per capita value of $190.75 in 2018 dollars, drawing on a review of several valuation studies.[4] The area of water impaired and assessed was retrieved from the NC Department of Environmental Quality's Water Quality Assessment Data.[21] The Department publishes these reports on water quality every two years. Data for years in between were linearly interpolated, as well as for 2012 and 2014, due to a lack of

[19] "The Lancet Commission on pollution and health." The Lancet, 19 October
[20] Denchak, Melissa. "Water Pollution." NRDC, 14 May 2018.
[21] "Water Quality Data Assessment: Integrated Report Files." North Carolina Department of Environmental Quality.

retrievable data. Data for 2011 was taken from the fifty-state GPI study by Fox and Erickson.[22]

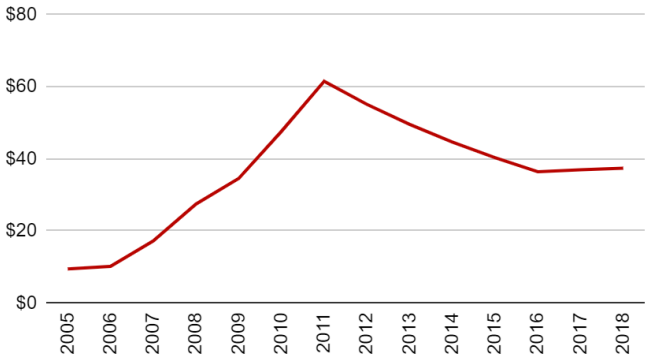
Figure 18: Percentage of NC Waterways Degraded



The percentage of impaired waterways in NC peaked in 2011 at 32%. 5% of water bodies were degraded in 2005 and by 2018, 20% were degraded.

The trend for the per capita cost of water pollution reflects that of the percentage of degraded water bodies. From 2005 to 2011, the per capita cost increased from $9.50 to $61.50. From 2011 to 2018 the per capita cost decreased by $24.

Figure 19: Per Capita Cost of Water Pollution (2018 $)



COST OF AIR POLLUTION

In the U.S., about 111 million Americans (35% of the population) live in counties with unhealthy air.[23] The most dangerous consequence of air pollution is premature death.[24] Poor air quality is linked to long-term damage to the respiratory and cardiovascular systems (such as asthma and increased risk of heart attacks), cancer, and death.[25,26] In 2018, an estimated 4.5 million people worldwide died due to exposure to air pollution from fossil fuels.[27] Additionally, as a result of fine particulate matter (PM2.5) pollution

[22] Fox, Mairi-Jane and Erickson, Jon. "Genuine Economic Progress in the United States: A Fifty State Study and Comparative Assessment.

[23] "Air Quality – National Summary." US Environmental Protection Agency. 2019.

[24] "The economic consequences of outdoor air pollution." OECD Policy Highlights, OECD, June 2016.

[25] "Environmental Health." Office of Disease Prevention and Health Promotion, 2020.

[26] Muller, N.Z. & Mendelsohn, R. (2007). Measuring the damages of air pollution in the United States. Journal of Environmental Economics and Management, 54, 1 – 14.

[27] Myllyvirta, Lauri. "Quantifying the Economic Costs of Air Pollution from Fossil Fuels." Centre for Research on Energy and Clean Air, February 2020.

there were 4 million new cases of child asthma and 2 million premature births worldwide.[27]

Air pollution also exacts non-health economic costs. For one, it reduces work productivity.[28] The health effects of air pollution lead to a lower labor force participation rate and a reduced ability to work.[27] PM2.5 pollution was responsible for 1.8 billion days of absence from work in 2018.[27] Children with asthma may miss school days, affecting their education, and their guardians may have to take time off of work. A study by Greenpeace and the Centre for Research on Energy and Clear Air shows that air pollution in the U.S. costs $600 billion per year.[27]

Furthermore, air pollution affects the earth's climate and ecosystems. It negatively impacts all components of the environment, including the air, soil, and groundwater.[29] In turn, it reduces agricultural crop yields, which then has an impact on the ability of families to get access to food and farmers to make a living.[24]

Air pollution also has psychological costs. Research shows that air pollution causes decreases in happiness and increases in instances of depression.[28] It is also associated with elevated anxiety and may be a risk factor for substance abuse, self-harm, and suicide. Cognitively, air pollution impairs decision-making and heightens the risk for disorders such as dementia and attention deficit hyperactivity disorder.[28]

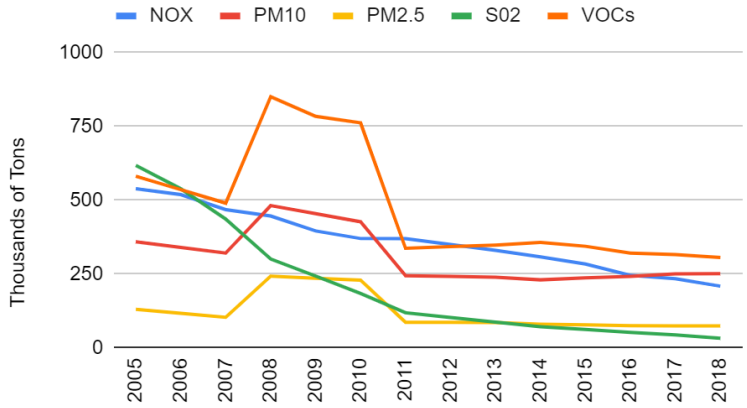
GPI accounts for five standard air pollutants in calculating the cost of air pollution. Fine (PM2.5) and large (PM10) particulate matter, Nitrogen Oxides (NOx), Sulfur Oxides (SOx), and Volatile Organic Compounds (VOCs). PM2.5 and PM10 can easily enter lung tissue via the nose and throat and cause serious health issues.[30] NOx and SOx are components of motor vehicle emissions and byproducts of industrial processes.[30] VOCs are emitted from products such as paints, pesticides, and glue.[30] Additionally, gasoline and natural gas are large sources of VOCs, which are released during combustion.[30]

GPI calculates the cost of air pollution by multiplying the estimated emissions for each pollutant by the per-ton cost for each stated in the 2007 report by Muller and

[28] Lu, Jackson. "Air pollution" A systematic review of its psychological, economic, and social effects." Current Opinion in Psychology, April 2020.
[29] Manisalidis, Ioannis, et al. "Environmental and Health Impacts of Air Pollution: A Review." Frontiers in Public Health, 20 February 2020.
[30] "Air Pollution and Your Health." National Institute of Environmental Health Sciences, 27 August 2020.

Mendelsohn.[31] Respectively, the costs per ton in 2018 dollars for PM2.5, PM10, NOx, SOx, and VOCs are $5048, $793, $398, $1839, and $986. Estimates of yearly emissions were gathered from the Environmental Protection Agency (EPA)'s National Emissions Inventory (NEI) dataset on state annual emissions trends.[32]

Figure 20: Air Pollution in NC



The amount of air pollution and per capita cost of air pollution peaked in 2008 for all five pollutants. From 2008 to 2018, the per capita cost of air pollution decreased by 71%.

As seen in Figures 20 and 21, the trends in emissions for VOCs, PM2.5, and PM10 are generally comparable. From 2011 to 2018, the overall decline in emissions of each air pollutant led to a steady reduction in the per capita cost of air pollution.

Figure 21: Per Capita Cost of Air Pollution (2018 $)

[31] Muller, Nicholas and Mendelsohn, Robert. "Measuring the damages of air pollution in the United States." Journal of Environmental Economics and Management, July 2007.

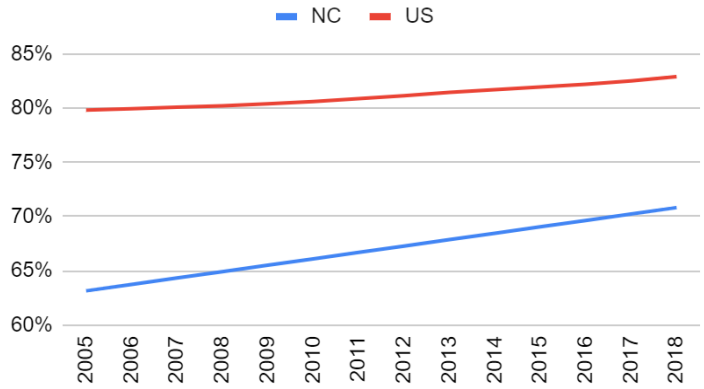
[32] "Air Pollutant Emissions Trends Data." United States Environmental Protection Agency.

COST OF NOISE POLLUTION

Noise pollution has many more negative effects on humans than most are aware of. Not only does it disrupt recreation and sleep, but it leads to adverse health effects such as hearing loss, cardiovascular disease, and increases in stress, blood pressure, anxiety, and depression.[33,34,35,36]

Data on noise pollution is not available at the state level. As such, we estimate NC's cost of noise pollution by scaling down estimates of national costs to the state level. The GPI does this by using the percentage of urban residents in NC, as most noise pollution occurs in urban areas.[4] The urban population is estimated with 2000 and 2010 census data and using linear interpolation for the years in between.

Figure 22: Percentage of Residents Living in Urban Areas



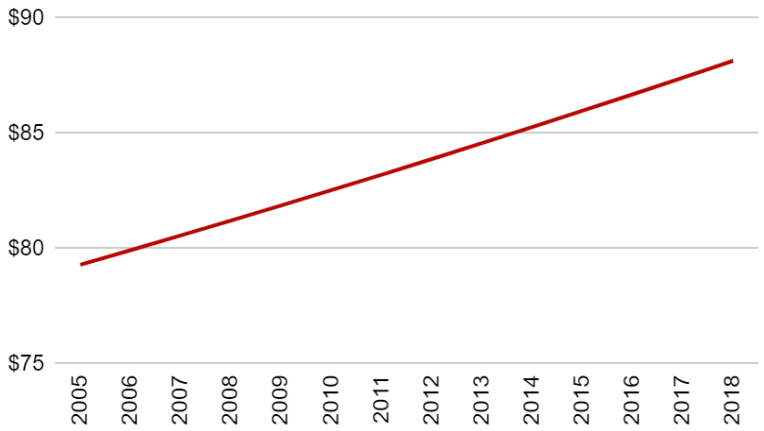
In 2005, NC had about 17 percentage points fewer residents living in urban areas compared to the U.S. as a whole. The percentage of the NC urban population has been steadily increasing since 2005, though, leading to a 12-percentage point difference in NC and the country's urban population in 2018.

Following other GPI studies, the national cost of noise pollution is retrieved from a World Health Organization study that estimated national damages in 1972 at $4 billion.[4] This estimate is extrapolated for years following 1972 based on the mitigation of noise pollution.[4] GPI assumes that this national cost of noise pollution increases by one percent each year due to noise abatement regulations in the years following 1972.[4] The annual national costs are then standardized to 2018 dollars and scaled down to the state level based on North Carolina's share of the U.S. urban population.

[33] Neitzel, Rick. "Chronic health effects and injury associated with environmental noise pollution." Centers for Disease Control and Prevention, 17 May 2018.
[34] "Health Effects of Environmental Noise Pollution." Australian Academy of Science.
[35] "Burden of disease from environmental noise." World Health Organization Europe, 2011.
[36] "Noise Pollution." Tox Town – National Institutes of Health, 31 May 2017.

Due to the GPI methodology that is adopted as a result of a lack of statewide data, the per capita cost of noise pollution in NC is a fairly linear increase, with an 11% increase from 2005 to 2018. This increase in the per capita cost largely is because of the increase in NC's urban population.

Figure 23: Per Capita Cost of Noise Pollution (2018 $)



Collection of state-level data on noise pollution would give a more precise estimate on the per capita cost.

COST OF NET WETLAND CHANGE

Wetlands are one of the most productive ecosystems in the world.[37] They host a diverse variety of species, and more than one-third of the U.S.' threatened and endangered species live in wetlands.[37] Additionally, they provide many services that play large roles in the ecology of the watershed.[37] Some of those services are water quality improvement, shoreline erosion control, flood protection, and nutrient cycling.[4,37] In 1780, NC had more than 11 million acres of wetlands.[38] In 2020, having lost about 62% of wetland area since 1780, there are about 4.2 million acres of wetlands left.[39]

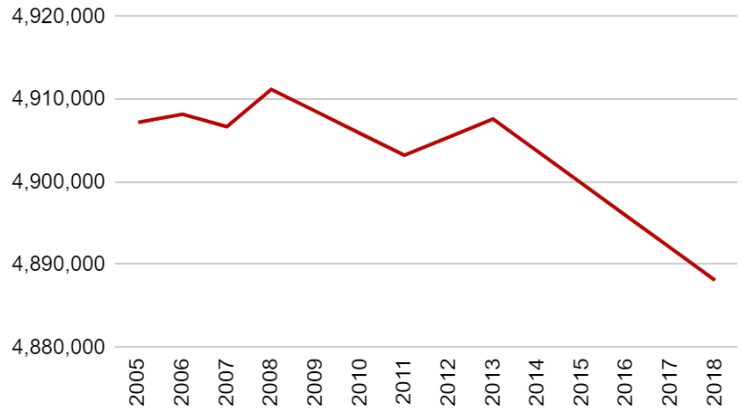
This indicator accounts for the loss of wetland acreage since precolonial times, following previous GPI studies. The cost is calculated by multiplying the area of lost wetlands (in acres) by the value per acre. The value of wetland loss is different for years before and after 1950. For the precolonial era to 1950, each acre of wetland is valued at $577.46, and for years after 1950 at $1339.91 (both in 2018 dollars). These values and the methodology follow Fox and Erickson's study.[22]

Wetland acreage from precolonial times and 1950 come from a U.S. Department of Interior Fish and Wildlife Service (FWS) report from 1990.[38] Values for wetland acreage

[37] "Why are Wetlands Important?" US Environmental Protection Agency.
[38] Dahl, Thomas. "Wetlands Losses in the United States: 1780s to 1980s." US Fish & Wildlife Service, US Department of Interior, 1990.
[39] "State of the Wetlands." Carolina Wetlands Association.

in NC for 1990 and 2010 were respectively obtained from a (different) FWS state summary report and the Fox and Erickson study.[22,40]Additionally, for every two or three years from 2001-2016, acreage data were obtained from a National Land Cover Database (NLCD) report from 2016.[41] All other years were estimated using linear interpolation.

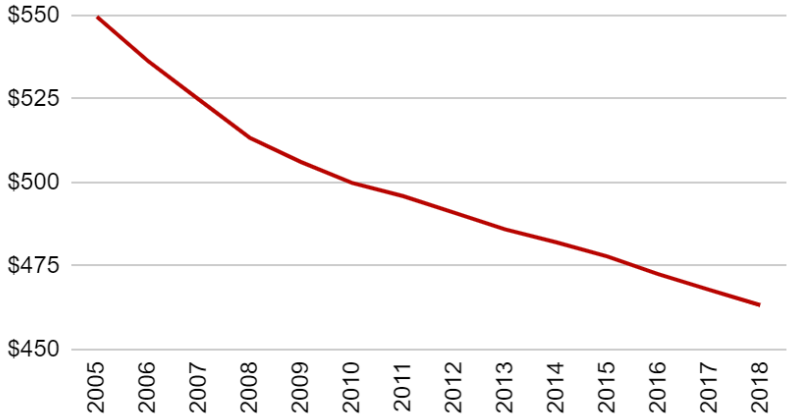
Figure 24: Wetland Acreage in NC



As seen in Figure 24, the amount of wetland area in NC slightly fluctuated until 2013, when there began a steady yet small decrease in the acreage of state wetlands. From 2013 to 2018, there was just a 0.4% decrease in wetland area.

The per capita cost of wetland loss decreased almost 16% from around $550 in 2005 to $463 in 2018. This decrease is primarily driven by increases in the state population, as the total cost of wetland change without factoring in the population was 0.5% higher in 2018 than in 2005.

Figure 25: Per Capita Cost of Net Wetland Change (2018 $)



COST OF NET FARMLAND CHANGE

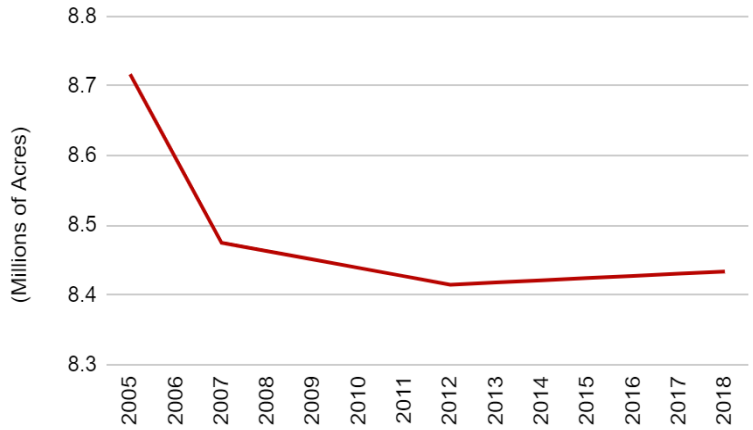
Farmland is important for wildlife preservation, producing sustainable food, and preventing floods. Farmland losses are gauged in the genuine progress indicator with a baseline of 1950 farmland acreage. The lost acreage is multiplied by the market value per farmland acre, which estimates how much the lost farmland cost.[17]

[40] Bales, Jerad and Newcomb, Douglas. "North Carolina Wetland Resources." National Water Summary, US Fish & Wildlife Service.

[41] "National Land Cover Database 2016." Multi-Resolution Land Characteristics Consortium.

Farmland acreage and the value per acre are both retrieved from the United States Department of Agriculture's Census of Agriculture.[42] As the Census is conducted every five years, years in between those for which data was available were linearly interpolated.

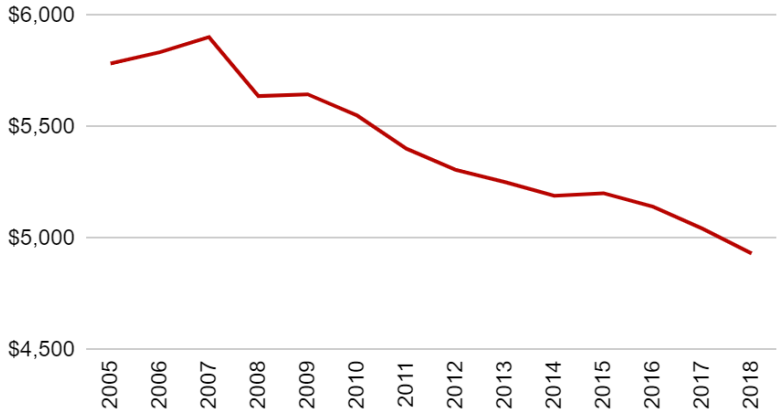
Figure 26: Farmland Acreage in North Carolina



North Carolina lost about 10.9 million acres of farmland from 1950 to 2018, almost half of the state's total farmland. As seen in Figure 26, from 2005 to 2018 the state lost an estimated 280,000 acres of farmland, a 3% decrease.

From 2005 to 2018, the per capita cost of the loss of farmland decreased in that lost farmland cost $850 less in 2018 than it did in 2005, signifying a 15% decrease. This decrease is largely driven by increases in population, as the cost without factoring in population was actually 2% higher in 2018 than in 2005.

Figure 27: Per Capita Cost of Net Farmland Change (2018 $)



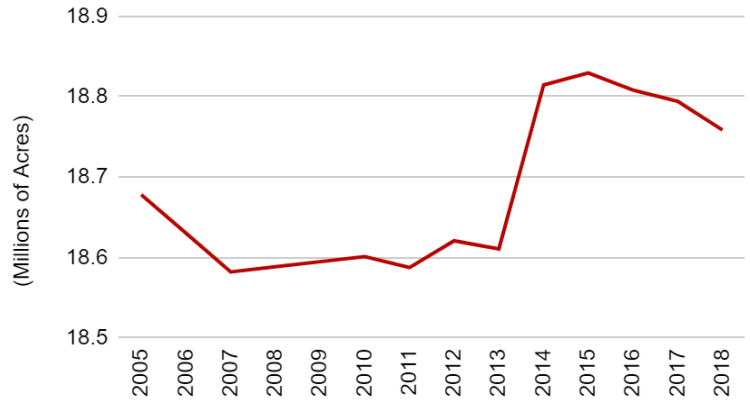
COST OF NET FOREST COVER CHANGE

Forests are crucial for yielding trees for timber, controlling floods, serving as areas for recreation, camping, and hunting, and providing habitats for animals.[4] Lost forest cover is accounted for in the GPI by multiplying each lost acre by $464.45 (in 2018 dollars). This value is adopted from the Maryland GPI study, following suit of other GPI studies.[4]

[42] "Data and Statistics." National Agricultural Statistics Service, US Department of Agriculture.

The amount of NC forest area in 1950 was interpolated using values from studies by Knight and McClure (1966) and Brown (1993).[43,44] Values for forest area for years 2007 and 2010-2018 were obtained from the U.S. Department of Agriculture Forest Service's Forest Inventory and Analysis program.[45] Data for other years were linearly interpolated.

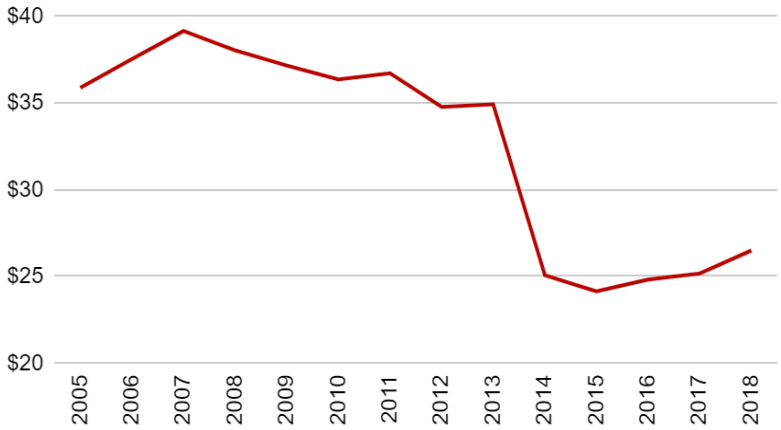
Figure 28: Forest Acreage in North Carolina



From 1950 to 2018, forest acreage in North Carolina decreased by nearly 600,000 acres. As shown in Figure 28, forest acreage in North Carolina dramatically increased from 2013 to 2014, but has slightly declined since. From 2005 to 2018, there was only a 0.4% increase in forest acreage, with various fluctuations in between.

The forest acreage increased from 2013 to 2014 corresponds to a relatively sharp decline of 28% in the per capita cost of net forest coverage in that year. From 2005 to 2018, there was a 26% decrease in the per capita cost of net forest coverage.

Figure 29: Per Capita Cost of Net Forest Cover Change (2018 $)

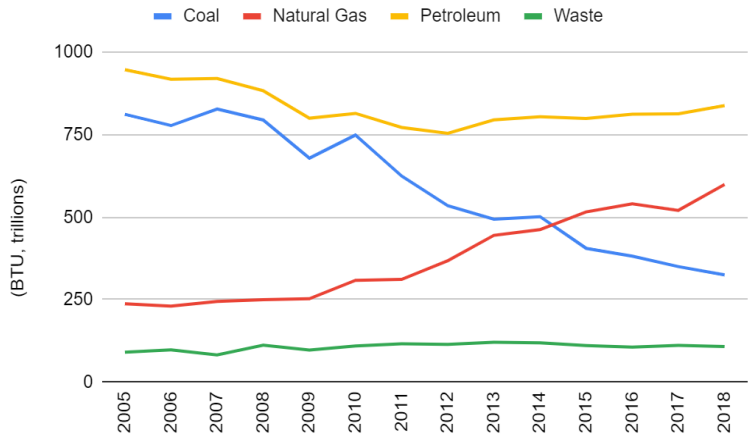


[43] Knight, Hebert and McClure, Joe. "North Carolina's Timber 1964." Resource Bulletin SE-5. Southeastern Forest Experiment Station, US Department of Agriculture Forest Service, 1966.
[44] Brown, Mark. "North Carolina's Forests, 1990." Resource Bulletin SE-142. Southeastern Forest Experiment Station, US Department of Agriculture Forest Service, 1993.
[45] "State Inventory Data Status: North Carolina." Forest Inventory and Analysis – Southern Research Station, US Department of Agriculture Forest Service.

COST OF CARBON EMISSIONS

The effects of climate change, such as reduced agricultural yields and severe weather events (e.g. hurricanes, floods) are severe and tend to disproportionately affect marginalized communities.[46] The cost of carbon emissions is estimated by using data from the U.S. Energy Information Administration on the consumption of coal, natural gas, petroleum, and wood and waste. We then use that data to estimate the amount of carbon dioxide created through consumption of these resources.[17]

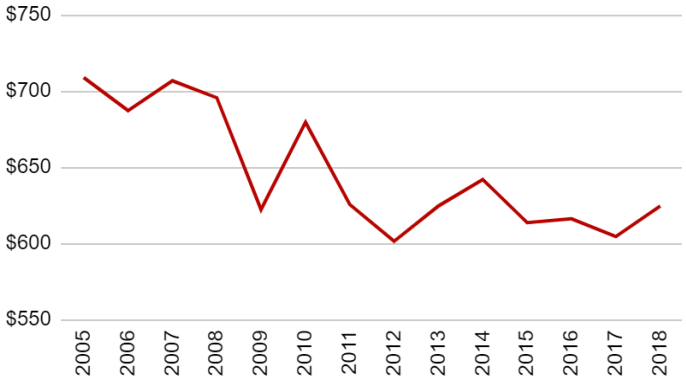
Figure 30: Carbon-Emitting Energy Consumption in North Carolina



The total amount of carbon emitted from these four sources in North Carolina decreased by 10% from 2005 to 2018. Since 2005, the amount of coal consumption decreased in North Carolina (by -60%), while the amount of natural gas consumption greatly increased (by 152%). Petroleum consumption also decreased over this time period by 12%.

The per capita cost of carbon emissions was on a downward trend from 2005 to 2018, though the cost was volatile over the years. The per capita cost decreased 12% from $709 in 2005 to $624 in 2018. This decline was driven by the decrease in coal consumption and the switch to natural gas beginning around 2010/2011, since natural gas produces around 50% less carbon than coal.[47]

Figure 31: Per Capita Cost of Carbon Emissions (2018 $)



[46] Islam, S.N., and Winkel, John. "Climate Change and Social Inequality." UN Department of Economic and Social Affairs, October 2017.

[47] Kim, InYoung and He Yu-Ying. "Ultraviolet radiation-induced non-melanoma skin cancer: Regulation of DNA damage repair and inflammation." Genes and Diseases. December 2014.

COST OF OZONE DEPLETION

Ozone layer depletion leads to an increased amount of UVB radiation that reaches the Earth's surface. Studies have shown that UVB causes non-melanoma skin cancer and can lead to malignant melanoma development.[47] In addition to the health impacts, UVB has agricultural impacts as it harms plants.[48] Emissions of ozone-depleting chemicals has decreased dramatically since the Montreal Protocol of 1989.[17] As such, there have been discussions to remove this measure from GPI calculations.[49]

Since there is very little data available on the release of ozone-depleting substances at the state level, we estimate the annual national costs of ozone depletion and scale those down to estimate state-level costs, following other GPI studies.

The annual national cost of ozone depletion is only about $14.5 million in 2018 dollars. As such, the cost scaled down for NC is less than half a million dollars, which costs four to five cents per capita each year from 2005 to 2018. Evidently, the cost of ozone depletion has a very small impact on the GPI for NC.

COST OF NON-RENEWABLE ENERGY RESOURCE DEPLETION

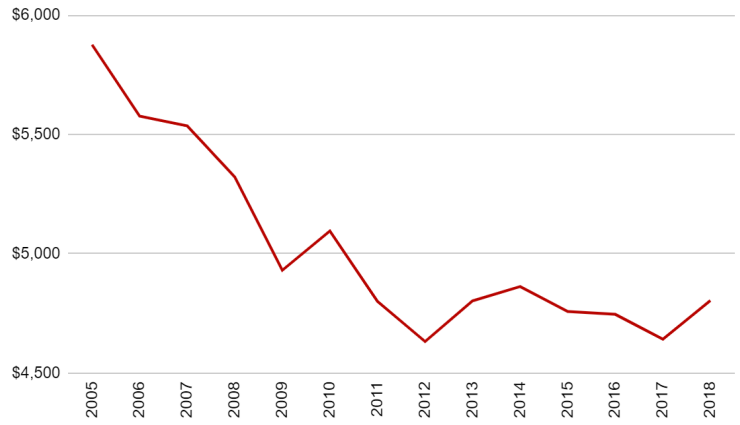
While non-renewable resources may aid local economies in the short-term, they cannot be sustained as sources of income in the long-term.[4] As such, the depletion of non-renewable resources such as coal, petroleum, and natural gas, causes a net loss of wealth for North Carolinians.[4] To account for the sustainability of income and temporary value of non-renewable resources, the GPI calculates what it would take to replace non-renewable resources with renewable sources of energy. This method ties the cost of using non-renewable resources to the year in which they are consumed.[4]

The U.S. Energy Information Association provides annual state-level data on the consumption of coal, petroleum, and natural gas. Data is divided into electric and non-electric energy consumption to calculate how much fuel can replaced by solar and wind for the electric sector and biofuel for the non-electric.[4] Total non-renewable electric consumption is multiplied by $12.78 (2018 dollars) per kilowatt hour, and total non-electric is multiplied by $169.15 (2018 dollars) per barrel equivalent, following Costanza

[48] "Health and Environmental Effects of Ozone Layer Depletion." US Environmental Protection Agency.
[49] Bagstad, Kenneth J., Günseli Berik, and Erica J. Brown Gaddis. "Methodological developments in US state-level genuine progress indicators: toward GPI 2.0." Ecological Indicators 45, 2014.

et al.; Bagstad and Ceroni; and Venetoulis and Cobb who draw these cost estimates from Makhijani.[4]

Figure 32: Per Capita Cost of Non-Renewable Energy Resource Depletion (2018 $)

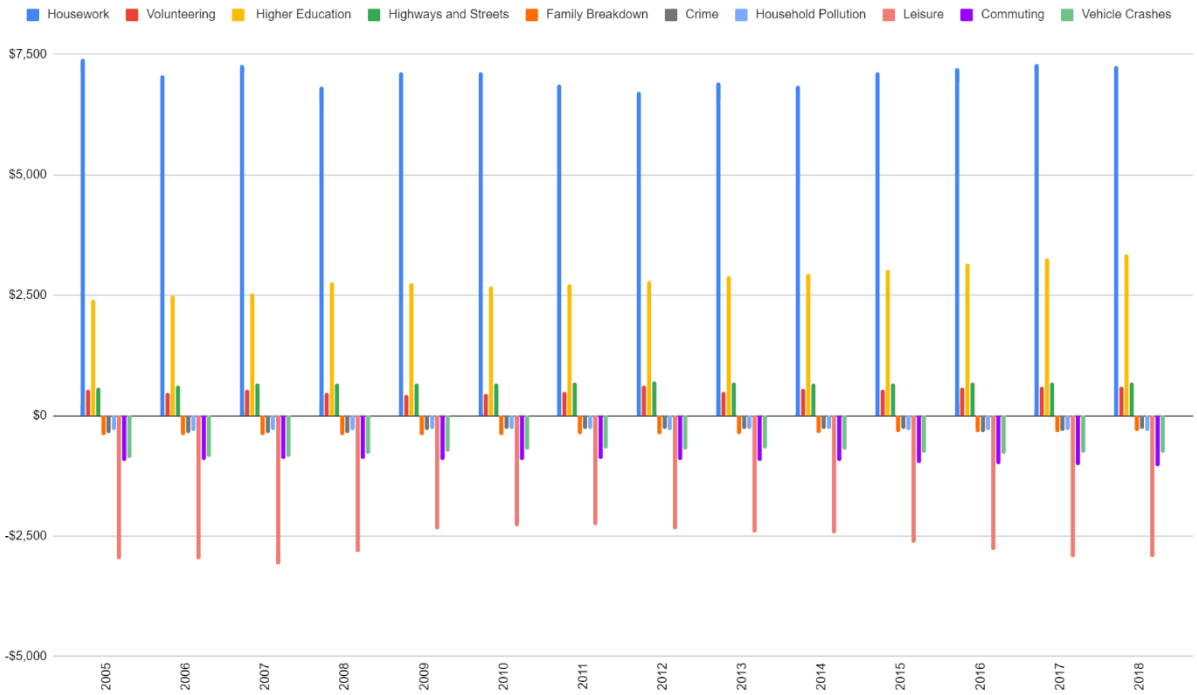


The per capita cost of non-renewable energy resource depletion has overall decreased since 2005, as the cost was 18% lower in 2018 than in 2005. 2010, 2014, and 2018 saw fairly small spikes in the per capita cost, with a 3% increase from 2009 to 2010, a 5% increase from 2012 to 2014, and a 3% increase from 2017 to 2018.

SOCIAL INDICATORS

After accounting for economic and environmental indicators, the GPI measures social indicators that impact the economy and well-being. The ten social indicators included are: value of housework and parenting, cost of family breakdown, cost of crime, cost of household pollution abatement, value of volunteer work, cost of lost leisure time, value of higher education, value of highways and streets, cost of commuting, and the cost of motor vehicle crashes.

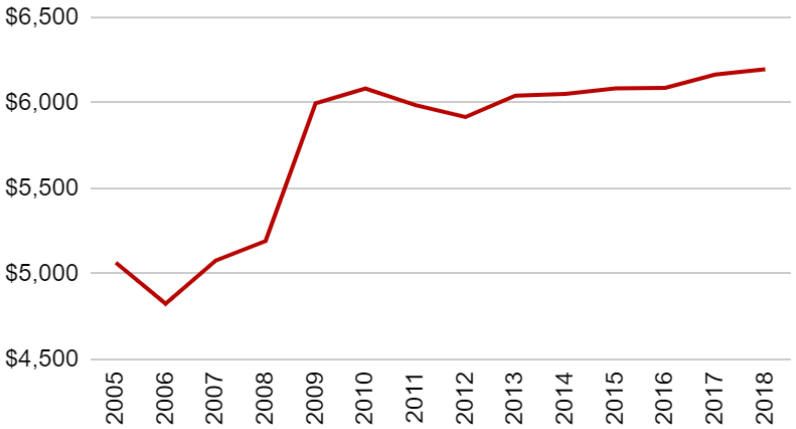
Figure 33: Per Capita Benefits and Costs of Social Indicators (2018 $)



As seen in Figure 33, the value of housework and parenting is the largest component of the social indicators, making up 64% of the total benefits on average from 2005 to 2018. The cost of lost leisure time has the second largest impact on net social welfare, as it constitutes an average of 50% of the total costs. The value of higher education has almost the same impact as the loss of leisure on the per capita net social welfare, with lost leisure costing just $178 more (in absolute terms) than the value of the benefit of higher education on average across 2005 to 2018. While the cost of lost leisure in 2018 was nearly the same as in 2005, the benefit of higher education increased by was 38% higher in 2018 than in 2005 and was even 13% higher than the 2018 cost of lost leisure time.

As seen in Figure 34, the per capita net social welfare increases from 2006 to 2010 by 26%, peaking at a little over $6,000. Net social welfare decreases about 3% from 2010 to 2012 and then proceeds to increase to its highest point in 2018 at nearly $6,200 per person.

Figure 34: Per Capita Net Social Welfare (2018 $)

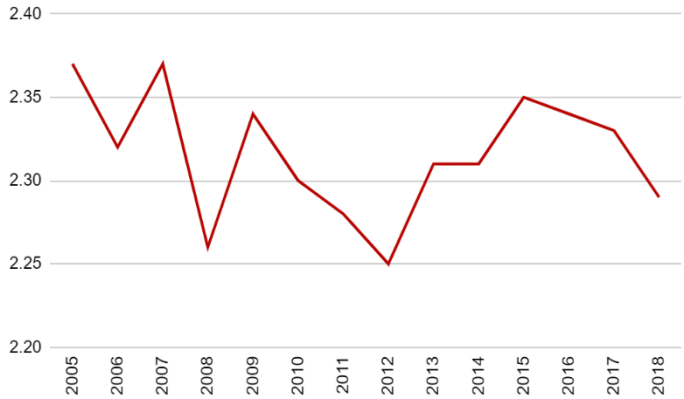


VALUE OF HOUSEWORK AND PARENTING

A major hole in GDP is the exclusion of the value of parenting and household work. If a household hires a child care worker or a housekeeping cleaner, all the dollars paid are included in GDP. Yet, if someone cares for their own child or cleans their own house, the time and value of that work is not counted in GDP. Including the value of parenting and household work allows us to capture the value of family labor and avoid the illusion that the economy is growing more than it is.[17]

GPI calculates the value of parenting and household work by multiplying the hours spent doing such work by the amount it would cost to pay someone else for that work. State-level time use data is not available, so we use data from the American Time Use Survey that estimates the hours per day that Americans age fifteen and over spend on housework and caring for others. We then multiply that data by the NC age fifteen and over population to estimate the hours spent on parenting and housework. Those state-level hours are then multiplied by mean average wages for child care workers and maids to attach a market value.[17]

Figure 35: U.S. Hours of Housework and Caretaking Per Capita Per Day



From 2005 to 2018, the hours spent on housework and caretaking at the national level fluctuated between 2.37 (seen in 2005 and 2007) and 2.25, the lowest point, which was in 2012. In 2018, the amount of time spent on these activities per day was 4.8 minutes lesser than that of 2005.

As seen in the Figures above, the per capita value of housework and parenting follows a generally similar trend to that of the national hours of housework and caretaking per capita per day. In the span of just one year, from 2007 to 2008, the per capita value fell 6%, or $455. Then, after increasing from 2008 to 2009, the value again decreased by 5.8 percent, or $417.2,1 from 2009 to 2012.

Figure 36: Per Capita Value of Housework and Parenting (2018 $)

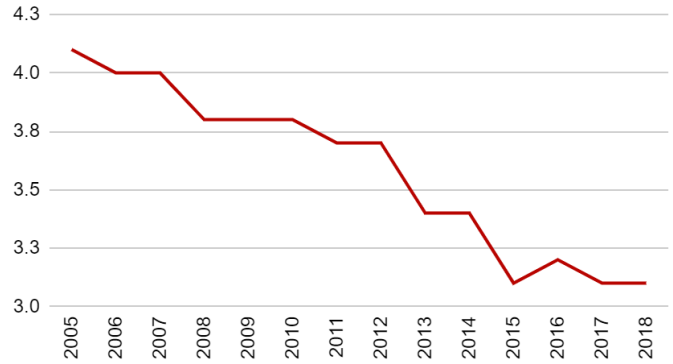
COST OF FAMILY BREAKDOWN

As families break down, GDP generally grows. This is because an increase in divorce rates means more people are paying legal fees, buying separate houses, and incurring other divorce expenses, and thus more dollars are trading hands. As families spend less time together and cook less together, GDP rises from the transfer of such activities into the market, such as paying for TV subscriptions and eating at restaurants, although many families do not experience greater welfare from moving these activities into the market.[17]

The GPI calculates family breakdown by examining divorce costs on adults and children involved and the cost of watching television.

State-level divorce rates are retrieved from the Centers for Disease Control and Prevention.[50] Since NC does not report data on the number of children affected by a divorce, we drew that data from Michigan, following another GPI study. The direct cost per divorce for adults is $13,123.20 (2018 dollars), based on legal fees, counseling, and living separately, following Anieski and Rowe.[4] The cost per child affected by divorce, also taken from Anielski and Rowe, is $19,512.74, which monetarily approximates difficulties at school/work, hardships in personal relationships, and lifetime damage incurred.[4]

Figure 37: NC Divorces per 1000 People

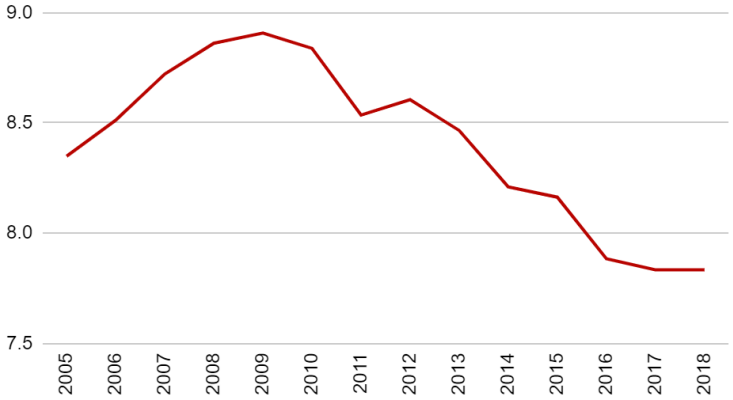


The divorce rate in NC decreased by 24% from 2005 to 2018, from 4.1 to 3.1 per 1000 people. From 2007 to 2008, the rate decreased by 5% and remained at 3.8 through the recession and until 2010.

The GPI calculates the cost of television watching as a means to measure decreased time of personal family interactions. As NC does not report state-level data, hours spent watching television were taken from national data reported by Nielsen in The Atlantic. These hours were then scaled down to the state-level using data on the number of households with children in NC. The cost per hour of television watched is $0.79, also taken from Anielski and Rowe, following previous GPI studies.

Nationally, time spent watching television decreased starting in 2012, as the average household watched 0.77 fewer hours of television in 2018 than in 2012 (a 9% decline). It is likely that the decrease in television watching is due to an increase in the use of other technological media such as phones, computers, tablets,

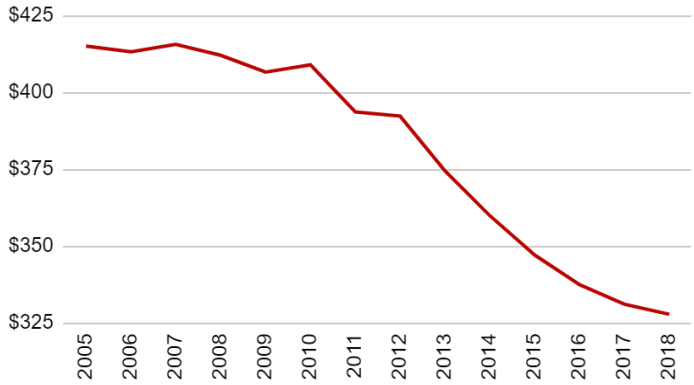
Figure 38: National Television Viewing Hours per Household per Day



[50] "Divorce rates by state: 1990, 1995, and 1999-2018." National Vital Statistics System, Centers for Disease Control and Prevention, 2018.

which also may indicate family breakdown. Due to these technological advancements, this portion of the indicator would likely benefit from an update.

Figure 39: Per Capita Cost of Family Breakdown (2018 $)



The decrease of both proxies for family breakdown discussed above account for the overall decrease in the per capita cost of family breakdown for NC. From 2005 to 2018, the per capita cost decreased by 21%, about $87, though some of this is no doubt due to changes in technology and not trends in family breakdown.

COST OF CRIME

Crime harms society in a multitude of ways, but GDP does not account for the social costs it incurs. Instead, money spent as a result of crime, whether on security systems, corrections systems, or funeral expenses, increases GDP and counts these costs as contributions to economic welfare.

In calculating the cost of crime, we used NC State Bureau of Investigation data from the annual crime reports to gather incidence rates of murder, rape, robbery, assault, burglary, larceny, and motor vehicle theft. Estimates of the cost of each crime are retrieved from a report by the National Institute of Justice of the U.S. Department of Justice, following previous GPI studies. These estimates capture physical damages as well as the devastation to victims' quality of life and well-being. For each murder, rape, robbery, assault, burglary, larceny, and motor vehicle theft, the costs in 2018 dollars are respectively: $3,319,339.12, $141,627.82, $11,473.99, $13,599.75, $2,206.96, $469.20, and $6,255.95.

Due to the high cost attributed with murder, it is a large driver of the overall cost of crime. As such, Figures 40 and 41 demonstrate that the general trend of the per capita cost of crime resembles that of the annual murders in North Carolina. Although cases of murder only make up an average of 0.16% of the total incidence of crime statewide across the years, the cost of murder for each year is greater than the costs of all other crimes combined.

Figure 40: Annual Murders in NC

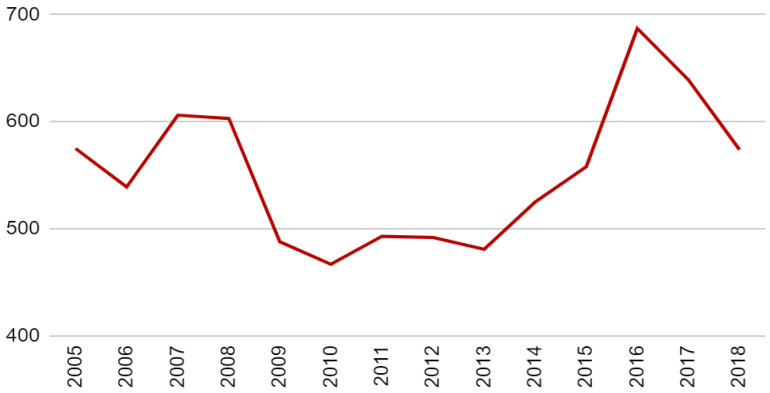
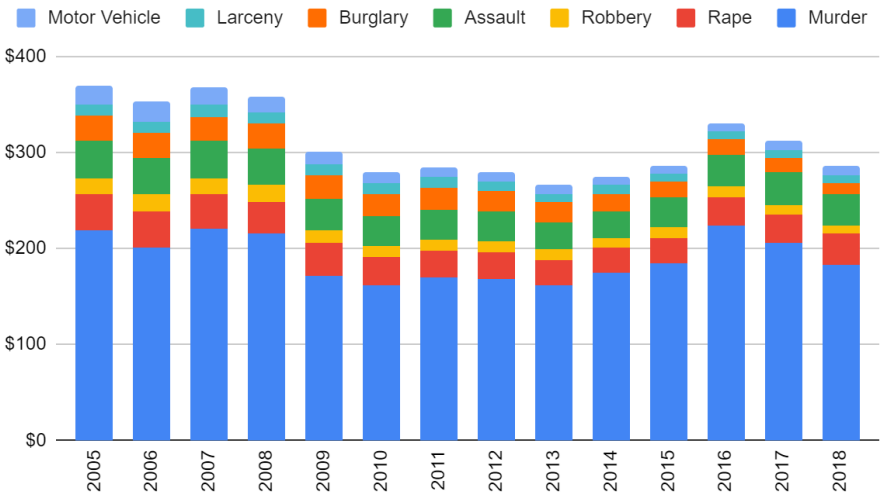


Figure 41: Per Capita Cost of Crime (2018 $)



The per capita cost of crime was 23% lower in 2018 than in 2005. The per capita cost experienced similarly sudden changes in both 2009 and 2016, as the cost decreased by 16% from 2008 to 2009 and then increased 16% from 2015 to 2016.

COST OF HOUSEHOLD POLLUTION ABATEMENT

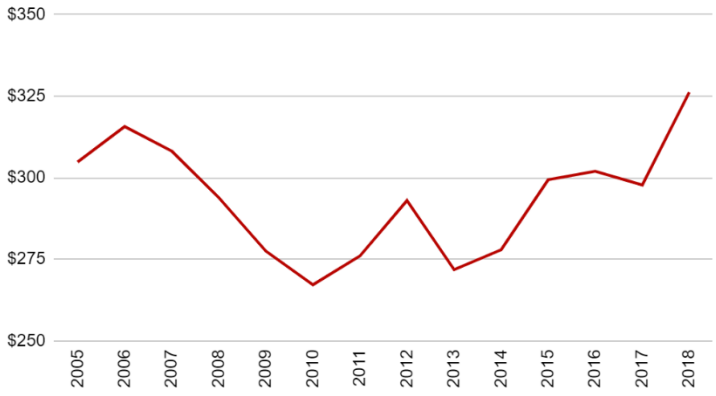
GDP increases not only from the direct financial costs from pollution itself, but from consumer spending on household pollution abatement, such as air filters and catalytic converters in automobiles and household sewer and septic systems.[17] The GPI subtracts such defensive spending that does not improve the well-being of households but is made necessary as a result of harmful activities, such as pollution in this instance.[4] Households spend to reduce or dispose of their pollution in three ways: automobile emissions abatement, wastewater treatment, and solid waste disposal.

To calculate vehicle emissions abatement, we calculate the amount spent on catalytic converters and air filters for all new vehicles in each year (given that these are new vehicle purchases and a part of regular maintenance).[4] Following previous GPI studies that go back to Bagstad and Ceroni, the cost of a catalytic converter in 2018 dollars is $124.59 and an air filter is $10.59.
We retrieve data from the Office of Highway Policy Information on the number of automobiles registered in NC for each year. Then, the number of new vehicles per year is estimated by taking the difference in the amount of vehicles between years and adding it to one-thirteenth of the previous year's automobile registrations, given the assumption by the Department of Transportation that the average lifespan of a car is 13 years.[17] This number of new vehicles per year is then multiplied by the costs for both catalytic converters and air filters.

To calculate wastewater treatment, the GPI uses census data from 1990 on the proportion of households with sewer and septic systems and annual data from the American Community Survey on the number of housing units in North Carolina.[51] The number of households with each type of system are multiplied by respective costs for sewer and septic systems. Using estimates on the amount of sewer flow, the sewer cost per household per year in 2018 dollars is estimated at $532.25. The septic cleaning cost is $58.33, and the cost per new septic system is valued at $5,832.92.

Data on solid waste was taken from the NC Department of Environmental Quality's Solid Waste Management Annual Reports. The amount of waste disposed was multiplied by the cost per ton of solid waste, which was estimated as $145.82 in 2018 dollars.

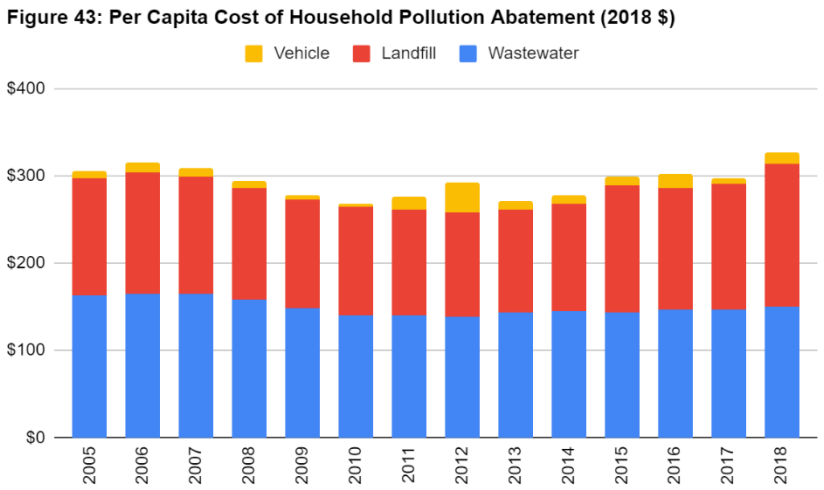
Figure 42: Per Capita Cost of Household Pollution Abatement (2018 $)



The per capita cost saw a relatively large decline from 2007 to 2010 of 15%. The cost then peaked in 2012, with an increase of nearly 10% from 2010 and then an immediate decrease of 7% in one year from 2012 to 2013. From 2013 to 2018, the per capita cost rose by 20% or $54.

[51] "Historical Census of Housing Tables: Sewage Disposal." US Census Bureau.

Figure 43 allows us to take a closer look at the makeup of the per capita cost. Wastewater abatement and solid waste disposal respectively make up 51% and 45% of the total per capita cost on average, with vehicle emissions constituting a small portion of the whole.



The per capita cost of household pollution abatement for NC is higher than that of other states' GPIs. This is driven by higher wastewater abatement and solid waste disposal costs. As of 1990, North Carolina had the fourth highest proportion of households that use septic systems in the country. As a result, due to the high cost for new septic systems, NC's wastewater abatement cost is larger than states that have lower proportions of households with septic systems. Additionally, we used available state data on annual solid waste instead of scaling down national data to the state level (the method used in most other GPI studies due to lack of data availability), and therefore our solid waste tonnage is higher than the amount reported in other studies.

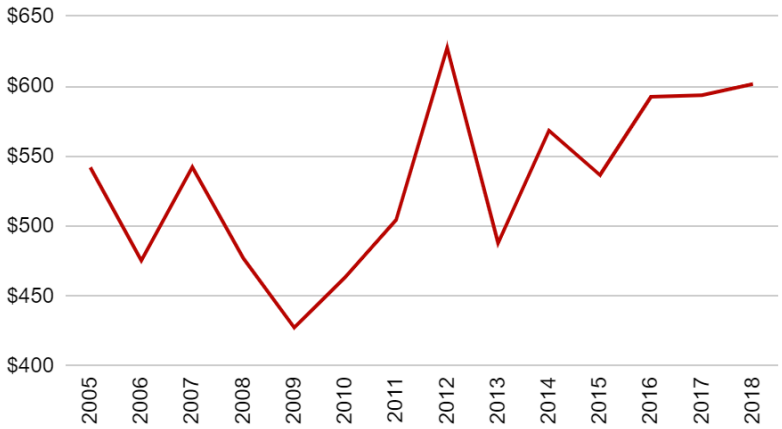
VALUE OF VOLUNTEER WORK

GDP does not count volunteer work, as it is unpaid, but in turn it ignores the great social and economic benefits of volunteering. A 2013 report by economists at Columbia University showed that for every dollar invested in national service, almost four dollars are returned to society in increased output, higher earnings, and other community-wide benefits.[52] Additionally, a study by a team from the Harvard School of Public Health reports that those older than 50 who volunteered about two hours a week had a substantially reduced risk of death, improved sense of well-being, and higher levels of physical activity.[53] Volunteering strengthens communities and enriches individual lives.

[52] Belfield, Clive. "The Economic Value of National Service." The Franklin Project at the Aspen Institute and Voices for National Service and Civic Enterprises, September 2013.
[53] Kim, Eric, et al. "Volunteering and Subsequent Health and Well-Being in Older Adults: An Outcome-Wide Longitudinal Approach." American Journal of Preventative Medicine 59, no.2, August 2020.

The GPI calculates the value of volunteering by multiplying the number of volunteer hours per year in NC and the per-year value of a volunteer hour. The number of hours statewide was drawn from the Corporation for National and Community Service. Data for years 2016-2018 were not available and therefore extrapolated using a line of best fit technique. The value of a volunteer hour was retrieved from the Independent Sector's state dataset.

Figure 44: Per Capita Value of Volunteer Work (2018 $)



As seen in Figure 44, the per capita value of volunteer work peaked in 2005, 2007, and 2012. The per capita value dropped 21% from 2007 to 2009 due to the Great Recession. From 2009 to 2012, it increased by 47%, almost $200.

LOSS OF LEISURE TIME

Since GDP considers increased market labor as a benefit, GDP grows as more people work for longer hours. GDP does not account for the loss of leisure time that results from working more hours and thus ignores the value that free time adds to our well-being. There is much research on how overwork leads to underperformance and less productivity. Additionally, several studies show that overwork and the resulting stress can lead to a variety of health issues, including depression, heavy drinking, diabetes, and heart disease.[54,55,56]

The GPI measures the cost of the loss of leisure time by subtracting the number of hours worked annually (retrieved from the American Community Survey) to a baseline of the hours worked in 1969. Those hours are then multiplied by the number of unconstrained workers (those working as much as they want) to calculate the total hours of leisure time

[54] Virtanen, Marianna, et al. "Overtime work and incident coronary heart disease." European Heart Journal, vol. 31, 14 July 2010.
[55] Virtanen, Marianna, et al. "Long working hours and alcohol use." BMJ, 13 January 2015.
[56] Carmichael, Sarah G. "Working long hours makes us drink more." Harvard Business Review, 10 April 2015.

lost. Those total hours are multiplied by the annual mean hourly wage to calculate the cost of the loss of those leisure hours.

On average, a laborer in NC was working 30 minutes more per week in 2007 than in 2018. Since the large drop in hours worked in 2010 due to the recession, the average amount increased by 42 minutes, or 2%, by 2018.

Figure 45: Average Hours Worked Per NC Worker Per Week

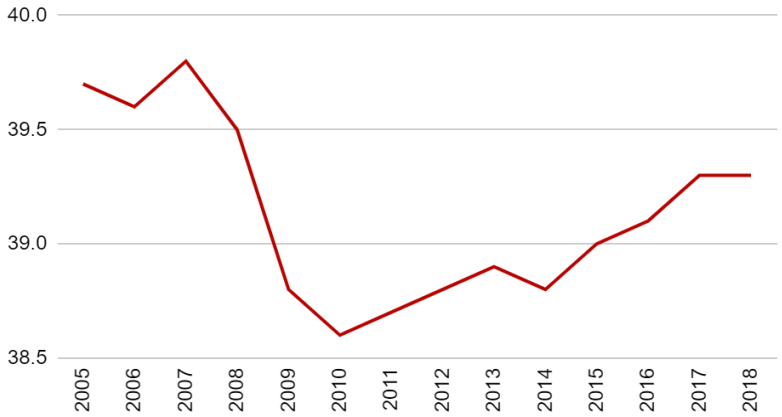
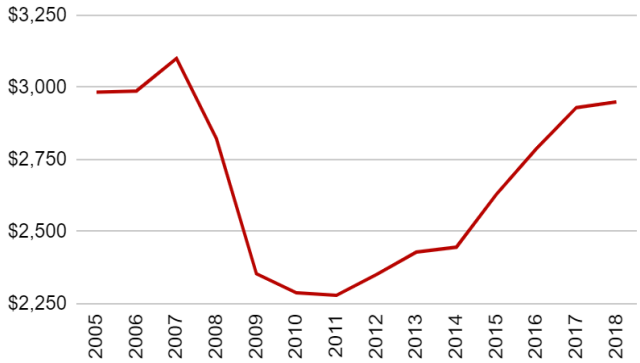


Figure 46: Per Capita Cost of Lost Leisure Time (2018 $)



The trend for the per capita cost of lost leisure time resembles that of the average hours worked per worker per week. As seen in Figure 46, lost leisure time is a substantial cost to North Carolina. In 2007, lost leisure time cost each NC resident, on average, $3100. In 2011, the per capita cost was about $2,280 and at its lowest. From 2011 to 2018 it increased by 29% to $2,950.

VALUE OF HIGHER EDUCATION

Many benefits come with higher education attainment, including higher earnings, more job benefits, greater civic engagement, and healthier lifestyles, to name a few.[57]

The GPI calculates the value of higher education by multiplying the number of people in the state with a bachelor's degree or higher by $15,312.26 (2018 dollars) - the value used by several previous GPI studies from a report by McMahon that quantified private and societal benefits of higher education. Some other studies use $16,000 in 2000 dollars (or $23,331 in 2018 dollars) from a different report, but we think this double counts some of

[57] "The Benefits of Higher Education." Cleveland State University.

the higher education benefits, such as income impacts that are already accounted for in personal consumption expenditures.

The percentage of NC residents age 25 and older with a bachelor's degree or higher steadily increased from 2005 to 2018. The percentage in 2018 was 26% higher than in 2005. In 2013 and 2016, the rate of increase was twice the average rate of about 2% per year.

Figure 47: NC Residents Age 25 and Older With a Bachelor's Degree or Higher

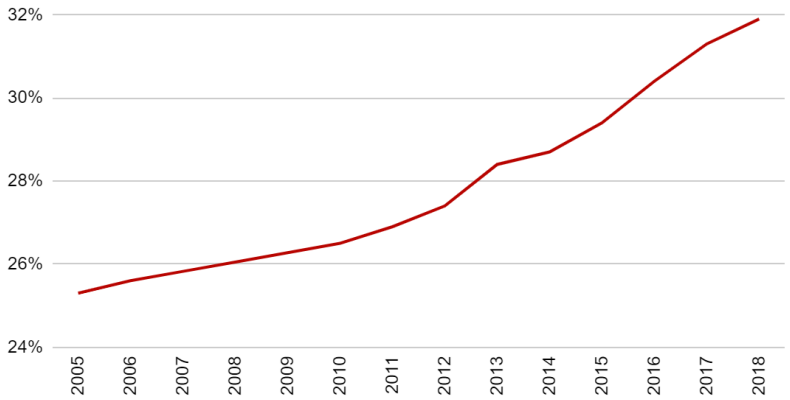
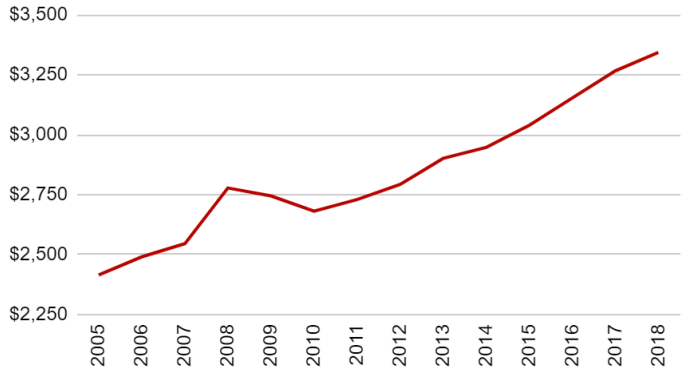


Figure 48: Per Capita Value of Higher Education (2018 $)



The per capita value of higher education greatly mirrors the trend of the previous figure. The per capita value decreased by 4% from 2008 to 2010. The value in 2018 was 38% higher than in 2005, a difference of $928.

VALUE OF HIGHWAYS AND STREETS

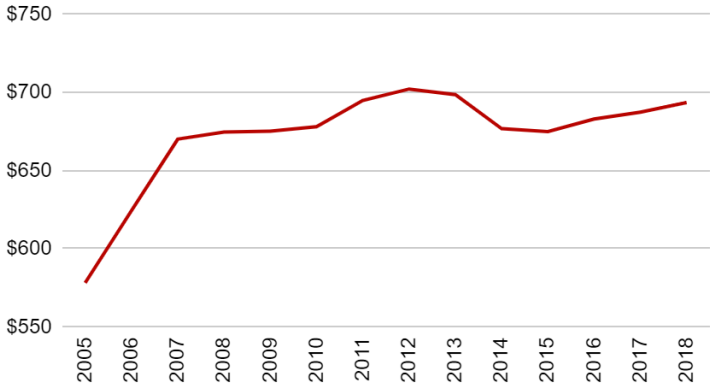
Highways and streets are made available to benefit consumers and businesses. Since they are public goods and not paid by drivers, their value is not accounted for in GDP.[17]

The GPI retrieves the miles of highway in NC and the U.S. from the Federal Highway Administration and then calculates the ratio of highway mileage in NC to the total in the U.S. We use this ratio because state-level data on the value of highways and streets is not available. To determine that value, we first use data from the Bureau of Economic Analysis to estimate the federal stock of highways and streets and scale that down to calculate NC's stock (using the aforementioned ratio). The annual value of highways and streets is estimated as 7.5% of the net stock value, given that 10% of the net stock equals

the annual value and 25% of miles traveled are for commuting, leaving 75% as net benefits. Therefore, we take 10% of 75% to get 7.5%.

The per capita value of highways and streets has, for the most part, been increasing over the time period of 2005 to 2018. It increased by 16% in two years from 2005 to 2007. From 2005 to 2018, the per capita value rose by almost 20%, from $578 to $693.

Figure 49: Per Capita Value of Highways and Streets (2018 $)



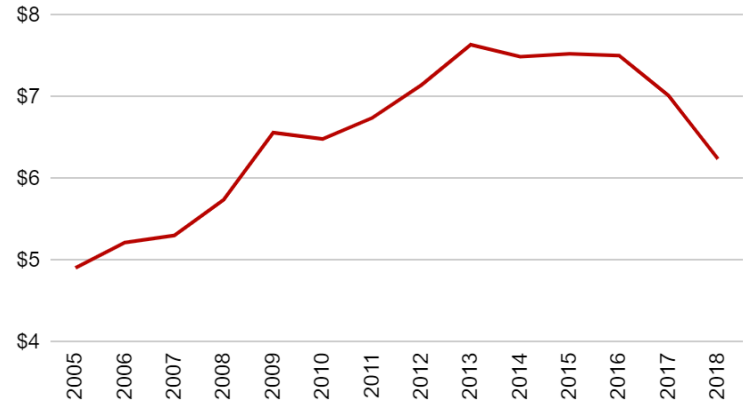
COST OF COMMUTING

Commuting exacts both direct and indirect costs, such as the purchase, operation, and maintenance costs of vehicles, money spent on public transportation, and the lost time spent commuting or in traffic. These costs increase GDP. The more that people commute and the longer they commute for, the more GDP increases from the accumulation of those costs.

The GPI looks at three different components to calculate the cost of commuting: spending on public transportation fares, the commuting cost of personal vehicles, and time lost from commuting.[4]

Spending on fares for public transit is drawn from the Federal Transit Administration. To calculate the commuting cost, we use data from the American Community Survey on mean travel time and commuting characteristics to calculate the average miles driven per car and the number of commuting cars driven. Due to a lack of availability of ACS data prior to 2010, these values from 2005 to 2009 are linearly interpolated using 2000 census data and 2010 data from the table available online. We then multiply the miles driven by the federal mileage reimbursement, $0.64 in 2018 dollars. To calculate the cost of lost time, we multiply the hours spent commuting by the mean hourly wage from the Bureau of Labor Statistics data.

Figure 50: Per Capita Spending on Public Transit



Per capita spending on public transit increased by nearly 34% ($1.66) in four years from 2005 to 2009. After a slight decline from 2009 to 2010, it again rose by 18% from 2010 to 2013. Per capita spending in 2018 was 18% lower than in 2013 but 27% higher than that of 2005.

The average commute time in NC has experienced periods of relatively slight decrease and increase, one after another. Since values for 2005 to 2009 were linearly interpolated, those years do not see much variation. From 2011 to 2018, the commute time rose 6%, by nearly 1.5 minutes.

Figure 51: Average NC Commute Time (minutes)

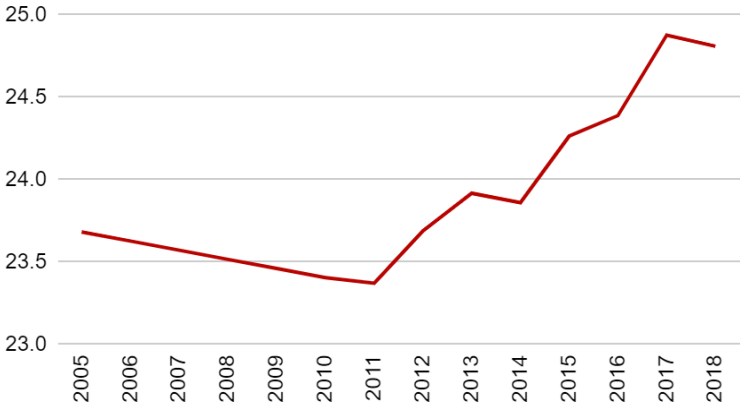
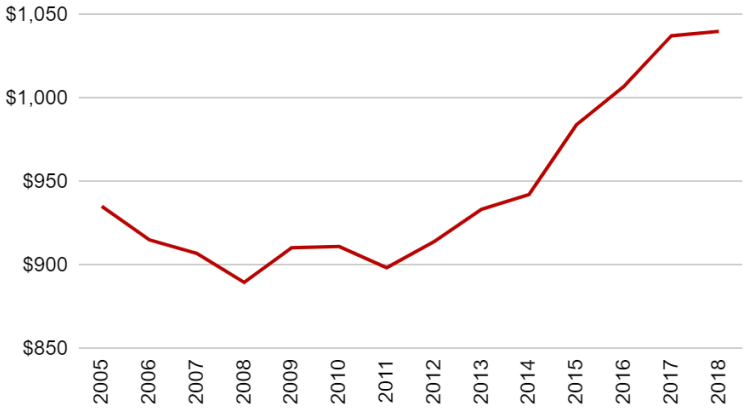


Figure 52: Per Capita Cost of Commuting (2018 $)



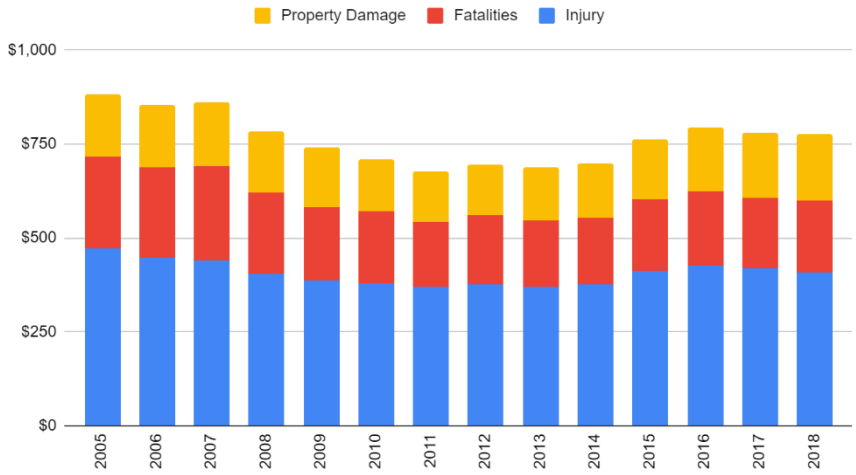
Both the increases in commute times and wages are likely to explain the increase in the per capita cost from 2011 to 2018. The cost increased from about $900 to $1,040, or about 16%. As seen in Figure 52, the per capita cost dropped in both 2008 and 2011.

COST OF MOTOR VEHICLE CRASHES

GDP increases from the costs incurred by vehicle crashes, such as car repairs, the need for a new vehicle, healthcare expenses, and the indirect costs of damaged well-being and lost life due to the consequences of injury and death.

Data on the incidence of motor vehicle property damage, injury, and fatality crashes are retrieved from annual traffic crash reports from the NC Division of Motor Vehicles. The estimated costs for each type of accident are drawn from the National Safety Council's Injury Facts statistics. Each property damage, injury, and fatality crash respectively costs about $9,300, $52,500, and $1.49 million.

Figure 53: Per Capita Cost of Motor Vehicle Crashes (2018 $)



Although the cost of fatal crashes is about 28 times higher than that of injury accidents, the incidence of injury accidents was on average 58 times higher than that of fatal crashes throughout these years. Such is why the cost of injury crashes is the largest portion of the total per capita cost of motor vehicle crashes. The per capita cost dipped in 2011 when it was 23% ($200) lower than the cost in 2005. In 2018, the per capita cost was 15% higher than in 2011.