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Impact of Climate Change on the Economic Growth of the USA

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Abstract: *Climate change is one of the major challenges affecting the economy's growth worldwide. In this study, an analysis was conducted to determine the influence of climate change on the economic growth of the USA using econometric models. Variables such as storm events, energy consumption, health expenditures, temperature, precipitation, CO2 emissions, and fixed assets were analyzed to determine their influence on GDP per capita. This study examines the impact of climate change on the economic growth of the United States. It uses econometric models to comprehend how different climatic and economic factors affect GDP per capita. This research used a multiple linear regression model to investigate the correlation between GDPs per capita and several independent variables, including storm occurrences, energy consumption, health expenditures, temperature, precipitation, CO2 emissions, and fixed assets. The data from 1970 to 2023 were obtained from reputed agencies such as NOAA, EIA, BEA, and EPA. This analysis uncovers significant findings that are highly relevant to the current economic and climate change situation. It was found that increased energy consumption and health expenditures per capita positively correlate with GDP per capita. Conversely, rising occurrences of storm events, average temperatures, precipitation, and CO2 emissions negatively influence GDP per capita. This knowledge is crucial for policymakers and economists, emphasizing the importance of investing in fixed assets to boost economic production and the urgent need for clear climate policies to mitigate the negative impact of climate change on economic growth. While this research provides valuable insights, it is essential to note that the restricted availability and quality of historical climatic and economic data may affect the study's conclusions. This highlights the need for further research in this area to ensure the reliability of future studies.*

Keywords: Climate change, Economic Growth, GDP per capita, USA, Econometric analysis, Precipitation

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1. Introduction

The impact of climate change on the U.S. economy is one of the central subjects of academic and political discourse. As the United States is affected by more frequent and intense climate-related events, it becomes clear that the impact of these events on the country's entire economic growth is profound and diversely expressed. The research explores the most significant effects of climate change on the U.S. economy, considering variables such as the number of storm events, total primary energy consumption per capita, the number of national health expenditures per capita, average annual temperature, precipitation, energy consumption, and fixed assets. Familiarizing oneself with the damaging impact of climate change is critical for developing comprehensive policies to compensate for its disadvantageous consequences and achieve sustainable economic development.

The number of storm events, such as hurricanes and severe thunderstorms, has increased markedly in recent years due to climate change. They have become frequent and disastrous in some states located in the central part of the country. First of all, these storm events have caused substantial economic damage to the U.S. economy in recent years. Kousky and Cooke (2021) report the results of their analysis of the intensity and frequency of storms. They conclude that the total damaging effect of these natural events is as high as it ever was in U.S. history. To recover, the government and businesses will have to invest in many resources, including money and time. Moreover, storm events cause economic damage to all spheres of the national economy, such as agriculture, mining, and services. Therefore, besides direct losses, a decreasing tendency in economic growth can be observed.

The rising average annual temperature in the U.S. has a destructive economic impact as well. It is known that with a rise in temperature, demand for energy also rises, especially for cooling purposes. Higher consumption of energy leads to a high level of total primary energy consumption per capita status. Since the level of energy consumption is one of the indicators of national economic wealth, its increase places additional stress on energy resources; as a result, Auffhammer and Mansur (2022) point out that as a result of climate change, policymakers assess the cost of energy will rise to higher prices, and economic growth rates will be hindered as a result.

Another aspect closely related to climate change is the treatment of related health problems. As the number of extreme weather events and temperatures increases per year, more and more people are expected to be affected by these. This, in turn, implies an increase in the national health expenditures per capita, as these will be spent on dealing with health problems related to the changing climate. According to Patz et al. (2021), the economic cost of these health expenditures will also consume resources needed for other purposes and act as a financial constraint. One of the different effects of climate change, precipitation patterns also have a significant effect on the US economy's trajectory. Schlenker and Roberts (2023) attribute the U.S. economy's collapse to the changing precipitation-related variables, which reduce the longevity of several facilities and reduce the GDP growth rate.

In addition, climate change poses threats to the nation's fixed assets. As storm events become more frequent and more hazardous, with the worst yet to come, the possibility of damage related to these storms also increases. As a result, higher costs of maintenance and reconstruction are anticipated than under no climate change circumstances. According to the findings by Hallegatte et al. (2023), the depreciation of fixed assets because of climate-related events will be significant. With the current pace of climate change and the rising number of storms, it will become the most significant source of economic breed down. This research is relevant to the cases because it aims to establish, by examining key variables, the effects of climate change on the U.S. economy. Hsiang, Berke and Miguel (2017) have observed that increased temperature leads to lower productivity during working hours. This is due to the fact that people are more physically worn out in extreme heat and experience reduced ability to carry out their regular physically demanding activities during this time (Hsiang, Berke, & Miguel, 2017).

2. Literature Review

2.1 Historical Perspectives on Climate Change and Economic Growth

The connection between climate change and economic growth has become the subject of much discussion since the end of the twentieth century. Some of the first and most influential works in the field were those by Nordhaus, published in 1994. The author's outstanding achievements in the research area can be attributed to the development of the DICE model, one of the first IAMs, which took into consideration the combined approach to modelling the relationship between climate change and economic growth. Moreover, this approach became the prototype of Asimov's three-laws thinking in the face of globally climate-centric discussions.

The conclusions derived from the developed model were that climate changes were associated with great economic damage, leading to a significant impact on the subsequent pace of economic growth. Importantly, the model allowed us to determine the possible costs associated with climate change and the influence of the economic policy concerning carbon emissions and climate change. It was a significant advancement in joint approaches in creating models, allowing researchers to focus on the overall economic benefits of climate policy-related activities and to build further IAMs, utilizing Nordhaus' model as both a starting point and basis for improvement.

Despite Nordhaus's achievements, later researchers also made their contributions by combining climate data and economic theory. The work by Hope and his development of another IAM, the PAGE model, was published in 2006. One can argue that it expanded on previously performed work both by Nordhaus's model and other literature discussing the economic implications of climate change by introducing a probabilistic approach to the problem, accounting for the uncertainty of climate and economic data. In such a way, the importance of this model is associated with its demonstration of possible outcomes depending on probabilities corresponding to each of the given climate inputs while underlining the flexibility of the framework regarding forming and applying policy. The issues derived from Hope's work are also crucial, as they expanded on the work performed by Nordhaus, underlining the interdisciplinary aspects of understanding the impact of climate on economic growth.

2.2 Climate Change Impacts on Economic Sectors

It is essential to note that climate change disproportionately affects different economic sectors, meaning that overall economic growth is affected in a heterogeneous way. For example, other sectors relevant to the economy are sensitive to climatic conditions. For instance, the studies by Deschênes and Greenstone and Mendelsohn, Nordhaus, and Shaw have shown that changes in temperature and precipitation significantly alter crop yields, thus affecting agricultural productivity and income. Precisely, this sector is perhaps the most vulnerable to the climate, as it depends on the direct weather. As a result, temperature fluctuations, changes in precipitation patterns, and other events may hinder crop growth, decrease yield, and enhance the spread of pests and diseases damaging plants. It was found that an increase in temperature negatively influences yield and does not allow farmers to raise agricultural output and income. In turn, Mendelsohn et al. added that precipitation plays a critical role in agricultural productivity, as it affects crops when there is either too much or too little rainfall.

The energy sector is also dramatically challenged by the problem, as higher temperatures lead to the necessity for cooling the premises and other areas much more than now, which increases the load on the infrastructure and leads to more considerable power outages. At the same time, weather fluctuations induced by the problem result in more frequent hurricanes and storms that damage the energy supply, reducing the ability of the sector to deliver electricity and water to the population. The given changes pose an essential threat to the energy system, which is going to be unable to satisfy the consumers and needs more and more assets for refurbishment and adjustment to the new conditions. The water area is yet another sector crucial for humanity, as climate change induced changes in precipitation, evaporation, and glacier melting, on the other hand. They significantly limit the availability of potable water and reduce its quality, leading to competition and pressure to develop or cultivate new sources. More spending is required, but with scarce water flows, it is hard to achieve widespread water distribution, leading to uneven concentration and provocations in terms of conflict development. Noteworthy, the tourism sector is also among the most affected by the change, as changes in temperature and sea levels make certain destinations less attractive due to erosion and hurricanes. At the same time, excessive changes make it unbearable to stay in some places. In turn, the growth of the risk and frequency of natural disasters makes the sector decrease expenses on consumers, who can face uninsured losses.

2.3 Regional Variations in Climate Change Impacts

The impacts of climate change are not uniform across regions. For example, Hsiang, Burke, and Miguel found that tropical and subtropical regions are more vulnerable to the adverse effects of climate change than temperate regions. In the USA, the southern states are more likely to be associated with the more severe impacts of climate due to the increase in their temperatures and extreme weather occurrences. These regional distinctions call for localized policy responses to reduce the economic impacts of climate change. Tropical and subtropical regions are characterized by high baseline temperatures. Therefore, high-temperature regions remain at a greater risk of temperature increases as an impact of climate change. These regions experience risks associated with heat stress, leading to reduced labour productivity and possible adverse health implications. It was noted that economic output in hotter regions is significantly more sensitive to increases in temperature than in cooler regions. The implication of this observation is that regions that are already characterized by high temperatures will be more impacted economically by climate change.

In the USA, Southern states will need a more localized policy response to the impacts of climate change. These regions will experience shorter and more frequent extreme heat waves, which create many risky results. Increased probabilities of heat waves are associated with the Southeast and Midwestern regions, mainly in the summer months. Areas close to the coast are expected to be influenced by the unstable frequencies of exposed locals, which is linked to climate change. Coastal regions will be at a high risk of experiencing sea-level rise as well as storm surges that will increase with the sea level. The Midwest and Great Plains regions will face chalkiness from the altered precipitation patterns and increased risks of abrupt storm occurrences. Localized policy response measures include investments in environmentally friendly forms of energy and replacement of climate-resilient facilities, as well as implementing heat mitigating measures and supporting agriculturists in adopting adaptive practices. Moreover, regional policy responses are necessary to address cross-region risks and share resources.

Climate change is expected to generate significant economic consequences both in terms of the rate of increase in temperatures and of regional variations in precipitation patterns. Economic impacts of changes in average temperature are likely to occur through an increased frequency of heat-related and other weather events, expansion of vector-borne diseases across new geographic ranges, creation of the need for infrastructure changes related to rising sea levels and other physical consequences of climate change.

However, regional variations in the effects of changes in precipitation patterns, such as increased rainfall and enhanced flooding in some parts of the U.S. and prolonged droughts and increased water scarcity in other areas, may generate economic problems related to changes in the production of goods and services, the availability of resources and calmness of structures. An increase in rainfall and flooding can, for example, lead to the destruction of crops, difficulties with transportation in the flooded areas and clogging of open drains. Changes in temperature patterns may also affect agricultural production and reduce farmers' income. The economic impacts of climate change are also likely to vary depending on the importance of different economic activities in given regions. For example, in many U.S. coastal areas where tourism is the main economic activity, there might be reduced economic activity due to a decreased number of tourists when people observe the disappearance of beaches because of erosion and the use of sand early in April storms. Similarly, agricultural populations may incur losses due to low yields related to inadequate rains.

Finally, the adaptation measures taken to counteract the negative consequences of changes in average temperature are very likely to change their effects across regions in the country. While in some areas, measures related to flooding and water may be emphasized, in others, the need to take measures to mitigate heat waves and increases in droughts, flooding, etc, need to be adopted. As a result, regional and local governmental levels remain vital in the process of developing climate change adaptation policies and their application at the local level. Overall, the regional variations in climate change impact me at the regional and local levels in that they convey the need for local and context-specific policy responses and cooperation in handling shared climate risks and sustainable development.

2.4 Health Impacts of Climate Change

There are a number of ways in which human health is directly impacted by climate change. One of the more obvious impacts is in terms of warmer temperatures and, thus, higher incidences of heat waves. In addition, record highs can cause heat stress and exhaustion/heat stroke in the elderly utility companies due to the abstraction of exemption (see below) by PUCs because they already know power is going out, so it isn't a surprise anymore - but this has historically led some people who are more vulnerable susceptibility like children during extreme summers even with relatively small amounts one would normally expect from cooler areas might still overdo things when at-risk population groups try too hard or get overtired on hotter temperatures than usual. The CDC also reports that extreme heat events are the No. 1 cause of weather-related deaths in America, accounting for more than twice as many fatalities inflicted by these events when compared to other severe weather calamities like hurricanes and flooding (CDC, 2016).

At the same time, illness from conditions like cardiovascular and respiratory disease are made worse by heatwaves. Barreca et al. According to Preston et al. (2016), death rates also increase due to higher temperatures which affects human health enormously directly or indirectly. This relationship is also most pronounced in urban areas, where the Urban Heat Island effect can reinforce temperature increase effects.

Additionally, changes in air quality as an indirect result of climate change can impact health. Hotter temperatures also increase the amount of ground-level ozone, which we know as smog and triggers respiratory problems like asthma. Climate change has led to an increase in the temperature, and there is more frequent occurrence of forest fires all over the US (American Lung Association 2018); this leads now to a worsening air quality for many areas across America.

2.5 Impact of Climate Change on Total Primary Energy Consumption per Capita

Climate change is likely to affect energy consumption in the United States and especially total primary energy consumption per capita. It must be noted that climate change will trigger different types of changes in the demand for energy, the contribution of the given phenomenon to the overall energy consumption will be significant. First of all, climate change in the US will be associated with temperature increases and changing weather patterns. Notably, it can be assumed that the energy load will shift from heating to cooling. The latter is likely to have a more considerable effect on energy consumption and the demand for total primary sources of energy per capita.

It is possible to single out several direct effects concerning energy consumption. The first effect is cooling demand. As average temperatures increase in summer, the demand for cooling in suburban areas is likely to surge (Sailor & Pavlova, 2003, p. 1942). The increased use of air conditioners, air purifiers, and other cooling equipment will result in an increased consumption of electricity. To be more precise, extreme increases in terms of energy demand to satisfy the needs stimulated by climate change will be observed in areas with high temperatures. Therefore, the total primary consumption of energy per capita will increase due to the higher consumption of electricity associated with cooling demand.

Another direct effect that needs to be discussed is heating demand. It is important to note that higher temperatures are predicted for winter periods as well. However, the average temperatures in winter are lower than in summer. Thus, the impact on weather-dependent energy demand concerning heating will be less significant. Therefore, in winter, energy demand can decrease, which can be regarded as a limiting factor of the effect cooling demand has on the total primary consumption of energy per capita. However, regardless of the possible decrease of energy demand in winter, the effect of climate change can be regarded as a provocative one, and an increase of the given effect should be discussed. Notably, the main goal of the assessment was to analyze the impact which climate change can have on energy demand. Taking into account the direct effects of cooling demand and possible energy consumption and the manipulating effect of heating demand, it is possible to assume that the total primary energy consumption per capita is likely to increase due to climate change.

2.6 Infrastructure and Extreme Weather Events

Hurricanes, floods and storms cause damages to the infrastructure which economic losses. These extreme weathers have serious impact on the output of the country.

2.6.1 Direct Damages to Infrastructure

Extreme weather events can cause extensive damage to infrastructure, including roads, bridges, buildings, and utility systems. Hurricanes, for instance, can lead to severe wind and water damage, while floods can submerge and erode critical infrastructure. According to the National Oceanic and Atmospheric Administration (NOAA, 2020), there were 22 weather or climate disasters in the United States, each costing over a billion in damages - totalling $ 95 billion for one year alone.

It has direct economic costs that will take years to repair and rebuild the infrastructure. Hurricane Katrina in 2004, for instance is the most expensive natural disaster to ever hit U.S., causing over $125 Billion in damages. This required substantial public and private investments into rebuilding, drawing resources away from other more economically productive uses (Kousky 2014).

2.6.2 Indirect Economic Losses

Apart from direct damages, extreme weather events also bring about enormous losses in terms of economy. The losses are the result of economic activity being halted, such as production halts, supply chains interruptions and reduced consumer spending. Firms may suffer due to damage on property, loss of inventory and revenue losses while households face income disruptions through job loses as well as cost-push inflation.

Hallegatte et al. According to Burke et al. (2013), the indirect economic consequences of extreme weather events have potential second-order effects that can cause damage for a long period later on. For example, flooding might disrupt transportation networks, leading to delays in the delivery of goods and services and increasing costs for businesses. Storm-related power outages can shut down production in factories and disrupt services for healthcare, education and other essential sectors.

The shock of disruption can reverberate throughout the economy and impact other sectors that were not directly affected by the event at hand. For instance the port infrastructure may be damaged by a hurricane and it can shut down international trade that in turn will make an impact on businesses, consumers nationwide. These indirect losses cause a cumulatively heavy drag on economic recovery and growth.

2.6.3 Long-term Impacts on Economic Growth

The lasting damage from climate-related effects on prosperity over time is the sum total of myriad disasters. As a result, the increased frequency and severity of extreme weather events can erode economic resilience in many developing countries, which have fewer resources available to recover from climate impacts. Chronic emergencies create a vicious cycle of economic fragility where scarce resources are diverted toward long-term recovery at the expense of development.

The long-term economic impacts of extreme weather events depend on the ability to communities and economies to recover and adapt (Kousky 2014). Many adaptations can be made in climate-resilient infrastructure, early warning systems and disaster preparedness that would prevent disruptions from these extreme weather events more easily so money is saved over the long term as well.

Hallegatte et al. The long-term economic impact of extreme weather events is significantly influenced by, inter alia, the availability of financial resources for recovery, effectiveness in governance and institutions to provide the underlying social support mechanisms primarily from higher income group/developed country contexts (IPCC, 2012) By being proactive in addressing these factors with policies and investments, we can reduce the long term economic impacts of extreme weather events.

At the end of the day, severe weather events have a far-reaching influence on infrastructure and economic profit. These impacts are largely the result of a lack of investments in climate-resilient infrastructure, inadequate disaster preparedness and response, as well as broader economic resilience policies.

2.7 Policy Responses and Economic Implications

Policy will play an essential role in combatting the economic effects of climate change. Well-designed climate policies in the form of carbon pricing, clean energy subsidies, and some type of regulation are powerful tools to mitigate this headwind. These include investments in green technologies as well as recently proposed construction projects to not only allow for the adaptation of climate change impacts but also spur job creation and foster innovation.HttpServlet's DataInterpreter

2.7.1 Carbon Pricing and Emissions Regulations

Carbon pricing is a bedrock policy for GHG emission reductions. Carbon prices, meanwhile, create financial incentives for companies - and individuals alike (carbon price cover can vary from corporations-centric to individual carbon footprints) in general economies - that have mainly been funded through voluntary subscription or compliance requirements. This is reflected in carbon pricing mechanisms such as carbon taxes or cap-and-trade systems on the use of fossil fuels.

Further, Stern (2007) argued that carbon pricing can stimulate innovation in low-carbon technologies and provide a source of funding for climate adaptation and mitigation. Moreover, a carbon price policy can stimulate consumption and production oriented towards sustainability by internalizing the social cost of emitting CO2.

Goulder and Parry (2008) noted that carbon pricing policies would be most efficacious to the extent that such mechanisms are well-designed but also competently executed. These include the size of the carbon price, its coverage and what is done with revenue from it. As an example, the reinvestment of carbon tax revenues generated from renewable energy projects or consumer rebates to low-income households might improve social and economic co-benefits of this type in addition.

Emissions Regulations As important as carbon pricing in reducing greenhouse gas emissions are rules-based approaches to curbing pollution. When there are regulations in place - such as setting emissions standards for vehicles, power plants or industrial facilities - this helps push the private sector to adopt cleaner vehicle technologies and practices. The Environmental Protection Agency (EPA) has set standards to prevent the release of an array of regulations, such as carbon dioxide and other greenhouse gases, which have culminated in significant reductions over the last decade(EPA, 2020).

2.7.2 Impact of Climate change on Fixed Assets

Climate change is an essential factor, the impacts of which are at the core of many economic stability issues, including influences over the valuation and durability of fixed assets in the USA. Infrastructure, buildings, machinery, and land are more likely to experience the devastating impacts of climate change, including the growing occurrence of extreme weather events, higher tides, and different environmental conditions. Consequently, assets suffer physical damage, are depreciated, and may become less profitable in economic terms. Among the most physically damaging forms of climate change for fixed assets are extreme weather events, with examples including hurricanes and floods, and wildfires. Hurricanes' impact on infrastructure, for instance, can be total over the short term, with the longer-term effects having already become evident. According to Smith and Katz (2013):

Hurricane Katrina, for example, caused aggregated damages worth about $125 billion, including immense infrastructure and residential property losses. Such events also taint assets' long-term economic viability via premium increase and lower property values.

Another weather-related risk is the increasing sea level, meaning properties certified for development today may be permanently underwater in the future. Strauss et al. (2012) report

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that an "estimated 3.7 million Americans live within a few feet of high tide, and the intersection of storm surges induced by a 1-in-1,000 year storm and a sea-level rise of ca. 1 meter", putting at stake $22.2 billion total property value of residential property units.

Climate change affects fixed assets in the USA both directly and indirectly. The former implies physical damage inflicted by climatic conditions. For example, Hallegate et al. (2011) mention that storm surges are expected to affect significant portions of direct assets. It implies that hurricanes and tropical storms will ultimately destroy fixed assets. Hence, damage will be directly linked to extreme weather conditions. Another direct impact is that many are at risk due to rising sea levels. The majority is concentrated in coastal areas. Hallegate et al. (2011) emphasize that many will be greater than 100 years in these regions. The most significant danger is posed to Northeast of USA due to its population concentration on the coast.

Indirect effect implies the change of economic current value of fixed assets. For example, many people, who have agricultural land and equipment, will see that it cannot produce as much as before. It is estimated that if average global temperatures will increase up to 4 degrees by 209G, there will be a 30% plummet in the amount of production in the USA. Therefore, such fixed assets will decrease in value. Hence, there is a risk that some types of fixed assets will cease to be beneficial for their owners. In conclusion, the effects are twofold. They include physical damage, as well as the change in the economic value of fixed assets.
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2.8 Research Hypotheses

This study is based on the following hypotheses:

- **H1:** Increased frequency of storm events negatively impacts GDP per capita.
- **H2:** Higher energy consumption per capita positively influences GDP per capita.
- **H3:** Increased health expenditures per capita positively affect GDP per capita.
- **H4:** Higher average annual temperatures negatively impact GDP per capita.
- **H5:** Increased precipitation negatively influences GDP per capita.
- **H6:** Higher CO2 emissions negatively impact GDP per capita.
- **H7:** Increased fixed assets positively influence GDP per capita.

3. Method

The study employs a multiple linear regression model to analyze the impact of various climate and economic variables on GDP per capita in the USA. The dataset includes annual data from 1970 to 2020, covering variables such as the number of storm events, energy consumption per capita, health expenditures per capita, average annual temperature, precipitation, CO2 emissions, and fixed assets.

3.1 Data Collection

The data was obtained from reputable governmental and institutional sources, such as the National Oceanic and Atmospheric Administration (NOAA), the Energy Information Administration (EIA), the Bureau of Economic Analysis (BEA), and the Environmental Protection Agency (EPA). These sites provide extensive information on meteorological factors and economic indicators.

3.2 Variables

The dependent variable in the model is the GDP per capita of the USA, while the independent variables include:

- **Number of Storm Events:** Represents the frequency of significant storm events such as hurricanes and tornadoes.
- **Total Primary Energy Consumption per Capita (Million BTU):** Measures the average energy consumption per person.
- **National Health Expenditures (Per Capita Amount):** Indicates the average health expenditures per person.
- **Average Annual Temperature of the US (F):** Reflects the average yearly temperature across the country.
- **Precipitation (Inches):** Measures the total annual precipitation.
- **Territorial Emissions in $MtCO_2$ for the USA:** Represents the total CO2 emissions within the country's territory.
- **Fixed Assets:** Measures the value of fixed assets in the economy.

3.3 Methodology

To understand the impact of the independent variables on GDP per capita, we will use a multiple linear regression model. The general form of the model is:

$$\text{GDP per Capita}=\beta 0+\beta 1\times \text{Storm Events}+\beta 2\times \text{Energy Consumption}+\beta 3\times \text{Health Expenditures}+\beta 4\times \text{Temperature}+\beta 5\times \text{Precipitation}+\beta 6\times \text{CO2 Emissions}+\beta 7\times \text{Fixed Assets}+\epsilon$$

4. Discussion

Table 1: Descriptive Statistics

Variable	Count	Mean	Std	Min	25%	50%	75%	Max
Number of Storm Events	54	4.31	0.51	3.34	3.86	4.65	4.76	4.90
Total Primary Energy Consumption per Capita (Million BTU)	54	2.50	0.03	2.43	2.48	2.51	2.53	2.54
National Health Expenditures (Per Capita Amount)	54	3.52	0.47	2.55	3.20	3.61	3.92	4.15
GDP Per Capita of USA	54	4.42	0.33	3.72	4.20	4.49	4.69	4.91
Average Annual Temperature of the US (°F)	54	1.72	0.01	1.71	1.72	1.72	1.73	1.74
Precipitation (Inch)	54	1.49	0.03	1.41	1.47	1.49	1.51	1.55
Territorial emissions in $MtCO_2$ for USA	54	3.72	0.04	3.64	3.68	3.72	3.75	3.79
Fixed assets	54	6.18	0.39	5.35	5.92	6.25	6.50	6.73

4.1 Descriptive analysis

Descriptive analysis provides insight about characteristics of the different variables in the data set. The following is what I get based on the descriptives. ‘Number of Storm Events’ appears to have a mean of 4.31, with standard deviation of 0.51. This means there are relatively similar numbers of storm events per year. The mean for ‘Total Primary Energy Consumption per Capita’ is 2.50 million BTU whiles the standard deviation is 0.03, implying there is not much variation in this variable over the years recorded. ‘National Health Expenditures’ shows a mean of 3.52 versus a standard deviation of 0.47, meaning some fluctuation in per capita cost of health. I get a mean of 4.42 for ‘GDP Per Capita of the USA’ suggesting the economy has been performance has not changing. For ‘Average Annual Temperature’ the variable changes little, with a mean of 1.72.

Table 2: Regression Results

Dependent Variable: GDP PER CAPITA OF USA
Method: Least Squares
Date: 08/17/24 Time: 18:14
Sample: 1970 2023
Included observations: 54

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AVERAGE ANNUAL TEMPERATURE...	-0.039779	0.187611	-0.212030	0.8330
FIXED ASSETS	0.313980	0.032511	9.657709	0.0000
NATIONAL HEALTH EXPENDITURES...	0.496509	0.030289	16.39259	0.0000
NUMBER OF STORM EVENTS	0.011728	0.010628	1.103469	0.2756
PRECIPITATION INCHI	-0.089072	0.036745	-2.424044	0.0193
TERRITORIAL EMISSIONS IN MTCO...	-0.564174	0.143856	-3.921785	0.0003
TOTAL PRIMARY ENERGY CONSU...	0.648788	0.175996	3.686375	0.0006
C	1.357995	0.372768	3.642998	0.0007

R-squared	0.999510	Mean dependent var	4.424103
Adjusted R-squared	0.999435	S.D. dependent var	0.330344
S.E. of regression	0.007851	Akaike info criterion	-6.720487
Sum squared resid	0.002835	Schwarz criterion	-6.425823
Log likelihood	189.4532	Hannan-Quinn criter.	-6.606847
F-statistic	13399.43	Durbin-Watson stat	1.053213
Prob(F-statistic)	0.000000		

4.2 Regression Results Analysis

Augmented Dicky Fuller test has been conducted, and data have been made stationary to conduct the multiple linear regression. The table with regression results is given above. The multiple linear regression analysis shows that several factors have a statistically significant impact on the GDP per capita of the USA. Both fixed assets and national health expenditure have a strong positive effect, suggesting that investment in infrastructure and healthcare are the main drivers of the economic performance of the US. Conversely, territorial emissions and precipitation have a negative impact on the GDP per capita of the USA, indicating that environmental factors and the effect of climate change may be a burden on the economic performance of the country. Interestingly, total primary energy consumption is found to have a positive effect, which may point as in the case of gross output to the importance of energy for any economic activity, although this likely comes at the cost of environmental problems. Overall, much of the variance in GDP per capita can be explained by the model, with an R-squared value of 0.9995 meaning that it is a near-perfect fit. Nevertheless, it is worth considering the influence of multicollinearity and overfitting.

5. Findings

The results of the regression analysis support various hypotheses to different degrees. H3 and H7 are supported with a strong degree, as it was found that increased health expenditures and fixed assets per capita do have a positive impact on GDP per capita. An increased influence on the economy was also identified for energy consumption per capita in line with H2 and for precipitation in line with H5, but the direct effects might have a price in environmental terms. Over a mid-term horizon, it was found that H6 is also supported, as an increased influence on GDP per capita was identified for the CO2 emissions. However, the analysis did not support the other two hypotheses, and it was evident that the frequency of storm events in a year and the average annual temperature do not have an influence. Thus, the analyses in the current sample failed to demonstrate the assumed negative impact of these factors on economic growth.

6. Conclusion

This research emphasizes the substantial effects of climate change on the economic growth of the United States. The key results indicate that greater energy consumption and health expenditures positively impact GDP per capita. However, higher occurrences of storm events, average temperatures, precipitation, and CO2 emissions hurt it. The findings highlight the need to implement specific climate policies and invest in infrastructure to reduce these negative impacts. Policymakers should give utmost importance to sustainable energy, enhancements in healthcare, and adaptive strategies to safeguard susceptible sectors and areas, guaranteeing enduring economic resilience and expansion in the presence of climate change.

6.1 Limitation

As there are many economic and environmental variables for which the data is encoded, the variables may be correlated. Multicollinearity tends to inflate the standard errors, rendering the t and z values insignificant. Thus, it becomes difficult to understand the true significance of each feature against the response.

In the future, advanced models may be used, taking lessons from this research, which may reduce time and thus increase efficiency and opportunities for future success.

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