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SOC 392

The Impact of Climate Change on Healthcare Expenditures: A Cross-Country Analysis

Abstract

Climate change poses major threats to human health and well-being, with its impact on healthcare expenditures becoming an increasingly important area of research. This paper explores the relationship between climate change indicators and healthcare expenditures across 218 countries from 1995 to 2022. Utilizing panel regressions, I examine whether two climate change indicators–the frequency of climate-related disasters and carbon dioxide emissions–increase healthcare spending. Findings suggest that climate change may have a positive association with healthcare expenditures, which is statistically significant when examining fixed effects regressions. These results align with existing literature, indicating the need for further research to address the specific channels through which climate change harms healthcare systems and the health of individuals.

I. Introduction

Climate change has become one of the most pressing concerns in this day and age, threatening the entire global population. Climate change is detrimental to human health and well-being, with the World Health Organization estimating that it will cause 250,000 additional deaths per year between 2030 and 2050. Much literature exists concerning climate change and healthcare, but the intersection is a topic that is less studied. As the impact of climate change on human health has become more visible, this topic is gaining traction. In particular, this paper will focus on climate change's impact on healthcare expenditures, as spending on healthcare is crucial to human health itself as well as to countries' economic outlooks.

II. Literature Review

Existing research on this topic largely uses carbon dioxide emissions and temperature as measurements of climate change. Drawing on data from all 27 European Union countries from

2000-2020, Socol et al. (2023) examine both of these variables, finding that rising temperature and CO2 emissions contribute to higher healthcare costs. Other measurements of climate change include pollution, rainfall, occurrences of extreme weather events, and heat-attributable emergency department visits. Hao (et al. 2018) find that pollution, measured by soot and sulfur dioxide emissions, significantly increased public health spending in 30 Chinese provinces from 1998-2015. The study notes that outdoor air pollution is responsible for over 1.2 million deaths and $1.4 trillion in economic loss annually in China. Hao et al. (2018) postulate that environmental pollution negatively impacts people's health and health and medical expenses are closely linked. Tong et al. (2021) examined 13 hospitals in Perth, Western Australia, concluding that there were 3,697 heat-attributable emergency department visits (ED) during 2012-19, which comprised 4.6% of total ED visits for that period and which generated AU$2.9 million. Azam and Awan (2022) analyze the impact of climate change, measured by temperature, rainfall, and air pollutants, on healthcare expenditures, using panel data from 15 Asian countries from 2000-2017. They find that healthcare expenditure has a positive, long-run relationship with temperature and air pollution and a negative relationship with rainfall. Typical control variables in these studies include income, aging population, and inflation.

Studies agree that the extent of climate change's impact differs between groups. Paavola (2017) claims this is due to differing vulnerability, meaning the differing exposure, sensitivity, and adaptive capacity, of groups and individuals. Studies highlight individuals who are in locations prone to climate shocks, socioeconomically disadvantaged, or experiencing existing health issues as some of these vulnerable individuals. Both Paavola (2017), which examines the United Kingdom, and DeVoe et al. (2023), which studies the United States, concur climate change impacts healthcare to a greater degree for vulnerable groups. DeVoe et. al (2023) also explain how "patients with fewer economic options, and already experiencing a high chronic disease burden, often must live and work in areas most impacted by climate change." Begum and Hamid (2021) study out-of-pocket (OOP) payments for healthcare in Bangladesh, questioning whether the impoverishment impact of OOP payments varied across regions with different levels of risk to climate change. The study concludes that the impoverishment impact of

OOP payments for healthcare is higher for high disaster-prone (HDP) areas than low-disaster-prone (LDP) ones and that the absolute and relative average poverty gaps are larger in HDP areas as well.

One of the main populations experiencing the disproportionate impact that existing research calls attention to is low-income households. Researchers generally agree that climate change hits low-income populations the hardest. Grigoroudis, Kouikoglou, and Phillis (2023) examine resource allocation of national healthcare systems faced with climate change pressures. They formulate a budget constraint that finds "the optimal allocation of healthcare resources that compensate for life expectancy reductions due to climate change." The study finds that the impact of climate change on public health is worse for lower-income countries, which is consistent with the typical view. Their budget constraint supports this conclusion, as they found it "grows nonlinearly with respect to impacts with disproportional demands on lower-income countries." Apergis, Bhattacharya, and Hadhri (2020) inspect data from 178 countries from 1995-2017 to analyze the long-run effects of environmental pollution on healthcare expenditure across four income groups. They found that a 1% increase in CO2 emissions increased health expenditure by 2.5% for all countries and 2.9%, 1.2%, 2.3%, and 2.6% for low, low-middle, upper-middle, and high-income groups, respectively. Interestingly, low-income groups had the highest increase, which contradicts the pattern observed for the other three groups, which is that CO2 emissions increased health spending more the higher the income. Chen et al. (2020) research "the vulnerability of people's health to the impact of climate change on healthcare accessibility in the San Fransico Bay Area," examining data from 98 hospital facilities in the Bay Area. Though this study does not focus on healthcare expenditure, it provides information on how climate change impacts healthcare accessibility across income groups. The study analyzed the impacts across low-income and non-low-income households for two scenarios, baseline and peak water level (PWL) scenarios. PWL meant a 1.4-meter sea level rise and an extreme storm event. Chen et al. (2020) found that, in the baseline scenario, 34.3% of low-income households are within 30 minutes of a hospital, while this number drops to 33.3% in the PWL scenario. For the non-low-income population, these numbers were 35.9% in the baseline scenario and 35.1% in the PWl scenario. This study also found that healthcare reform increased low-income households' capability to reach hospitals. Overall, there is room for more research on how climate change impacts healthcare for different income groups.

Another focal point of existing literature is the bidirectional nature of the relationship between healthcare expenditure and climate change. This paper focuses on the way that climate change impacts healthcare expenditure, but there are mechanisms through which healthcare expenditure can increase climate change as well. Healthcare practices can generate a substantial amount of carbon emissions and other environmental externalities. Akbar et al. (2021) examine the relationship between healthcare spending, CO2 emissions, and human development index (HDI) using a panel dataset of 33 OECD countries from 2006-2016. They find that a bidirectional relationship exists between healthcare expenditure and CO2 emissions, meaning that CO2 emissions increase healthcare spending and healthcare spending increases CO2 emissions (through higher energy consumption). They also witness that healthcare spending increases HDI and that CO2 emissions decrease HDI. Setoguchi et al. (2022) discuss the cycle between climate change, human health, and healthcare systems in which “climate change affects the health of individuals, communities, and populations; in turn, healthcare systems are impacted by the increasing and changing needs; and healthcare systems generate substantial carbon emissions that contribute to the climate crisis.” The study points to restructuring healthcare systems as a potential way to break the cycle. Extending upon the role of healthcare systems, Curtis et al. (2017) agree that adaption to climate change necessitates changes to “institutional and social infrastructure supporting the healthcare system.” Curtis et al. (2017) examine the effect of extreme weather events, namely heatwaves, cold waves, and flooding, on health and social care systems in the United Kingdom, and pinpoint specific ways systems could adapt to such climate events. The study discusses modifying buildings, enhancing risk and emergency response practices, and overall more responsibility in the health system to take precautions against environmental issues.

This paper aims to extend upon existing literature and explore further the impact of climate change on healthcare expenditures, examining the causal relationship of two different climate change indicators on countries’ healthcare expenditures.

III. Hypothesis

My central hypothesis is that climate change is positively associated with healthcare expenditures. Climate change can manifest in many ways, and, as my literature review showed, existing research utilizes a range of indicators to estimate it. For those reasons, I separately analyze two indicators–the frequency of climate-related disasters and carbon emissions–to measure the extent to which climate change impacts a country. Existing literature, including CitatSocol et al. (2023), Setoguchi et al. (2022), and Akbar et al. (2021), postulate this hypothesis and confirm that a positive relationship does exist.

IV. Methodology

I obtained data from two sources, the World Bank and the International Monetary Fund (IMF). My critical independent variables are ClimateDisaster (the frequency of climate-related disasters) and CO2kgperUSD (CO2 emissions measured in kg per 2015 USD of GDP). Data for ClimateDisaster comes from the IMF's Climate Change Dashboard, which compiles data from the Emergency Events Database (EM-DAT). The EM-DAT records disasters that caused at least 10 fatalities, affected at least 100 people, caused a declaration of a state of emergency, and/or caused a call for international assistance. ClimateDiaster encompasses wildfires, storms, landslides, floods, extreme temperatures, drought, fog, wave actions, and glacial lake outbursts that are climate-related disasters. The minimum frequency of climate-related disasters is 1 and the maximum is 43. My dependent variable is HealthExpPercent (current health expenditure as a percent of GDP). HealthExpPercent has a minimum of 1.264% and a maximum of 24.231%. I control for HospitalBeds (number of hospital beds per 1,000 people), AgingPop (the population ages 65 and above as a percent of the total population), and GDPpc (GDP per capita in constant 2015 USD). The HopsitalBeds variable includes "inpatient beds available in public, private, general, and specialized hospitals and rehabilitation centers" and "beds for both acute and chronic care" (World Bank Group 2024). The minimum for HospitalBeds is 0.1 and the maximum is 19.57. AgingPopulation is based on the population that "counts all residents regardless of legal status or citizenship" (World Bank Group 2024). The minimum for AgingPop is 0.172% and the maximum is 35.97%. The minimum GDP per capita is 210.542 and the maximum is 228667.9 in constant 2015 USD.

Economic conditions may influence that country's healthcare spending and ability to adapt to climate change; thus, controlling for GDP wil help control for these effects. A larger population size may have a higher demand for healthcare services, as may an aging population. Hence, I will ppopulation ages 65 as a percent of a country's total population. The availability of healthcare infrastructure may affect healthcare expenditures. One way I can control for this is by including the number of hospital beds per 1,000 people as a control variable. My sample contains 218 countries from 1995-2022. The unit of observation is country-year. Table 1 summarizes the descriptive statistics for my dataset, including the mean, standard deviation, and number of observations for each variable.

Table 1: Descriptive Statistics

	HealthExpPercent	ClimateDisaster	CO2kgperUSD	HospitalBeds	AgingPop	GDPpc
Mean	6.207	2.934	0.522	3.949	7.886	14629.6
Standard Deviation	2.794	3.825	0.516	2.827	5.649	21763.94
Minimum	1.264	1	0	0.100	0.172	210.542
Maximum	24.231	43	5.175	19.570	35.970	228667.9
Number of Obs	3939	3023	4778	2471	6076	5623
Units	Percent of GDP	Number of disasters	Kilograms per 2015 USD of GDP	Number of beds per 1,000 people	Percent of total population	Constant 2015 USD

To analyze the impact of climate change on health expenditures, I estimated multiple panel regressions, as my dataset contains panel data. For the first and second regressions, I estimated HealthExpPercent as a function of the climate indicator ClimateDisaster and the control variables HospitalBeds, AgingPop, and GDPpc. For the second regression, I incorporated country and year-fixed effects to account for factors that do not change much over time but vary across countries and for factors that do not vary much across countries but change over time. This controls for such unobservable variables that may have been omitted from the regression. The third and fourth regressions switch to

CO2kgperUSD as the indicator for climate change instead of ClimateDisaster and include the same set of control variables. The fourth regression incorporates country and year-fixed effects.

V. Findings

Table 2 displays the results of my four regression analyses. In the first regression, HospitalBeds has a negative impact on HealthExpPercent that is statistically significant at the 1% level. AgingPop has a positive and statistically significant effect at the 1% level. GDPpc is statistically significant at the 5% level and has a small, positive impact. The main predictor, ClimateDisaster, has a low positive impact on HeatlhExPercent, though not statistically significant. The regression's R^2 is 0.2026.

In the second regression that includes fixed effects, HospitalBeds has a negative effect on HealthExpPercent that is not statistically significant. AgingPop has a positive effect, significant at the 10% level. GDP has a very low positive effect that is significant at the 5% level. The main predictor, ClimateDisaster, has a positive impact on HealthExpPercent that is significant at the 10% level. The regression has an R^2 value of 0.286.

For the third regression, HospitalBeds has a negative impact at a 1% level of significance. AgingPop has a positive impact at the 1% level. GDP per capita has a low, negative impact at the 5% level. The main climate change predictor variable, CO2kgperUSD, has a positive but insignificant effect on HealthExpPercent. The regression's R^2 value is 0.1433.

In the fourth regression, which includes country and year-fixed effects, HospitalBeds has an insignificant, negative effect, AgingPop has a positive effect significant at the 1% level, and GDPpc has a low negative impact significant at the 5% level. The critical climate change indicator, CO2kgperUSD, has a positive effect on HeatlhExpPercent at the 5% level of significance. The fourth regression has a R^2 of 0.2023.

Table 2: Panel Regression of Current Health Expenditure (% of GDP)

	Dependent Variable: HealthExpPercent			
	(1)	(2)	(3)	(4)
Fixed Effects	None	Country and year-fixed effects	None	Country and year-fixed effects
ClimateDisaster	.0094356 (.0107582)	.0206369* (.0119187)		
CO2kgperUSD			.1324035 (.1189148)	.5033815** (.2116384)
HospitalBeds	-.1248234*** (.0307685)	-.0248443 (0.0885351)	-.0850415*** (.0278881)	-.0207943 (.0733174)
AgingPop	.2715982*** (.0195708)	.1530734* (.0916468)	.3063118*** (.0182855)	.1991567*** (.0633957)
GDPpc	.0000206** (8.28e-06)	.0000198** (8.19e-06)	-.0000168** (7.19e-06)	-.0000372** (.0000161)
Constant				
R^2	0.2026	0.2860	0.1433	0.2023
Observations	1,177	1,177	2,045	2,045

*p<0.1, **p<0.05, ***p<0.01

VI. Discussion

I found some evidence for my hypothesis. The regressions indicate that climate change may be positively associated with healthcare expenditures for a country, though the significance of this effect is subject to some uncertainty. Climate indicators have a positive and significant association with health expenditures in the two regressions with fixed effects. They do not have a significant impact in the two regressions without fixed effects. The R^2 values were comparatively higher for the regressions with fixed effects than regressions without, which suggests that the fixed effects models are better fits and have a higher explanatory power. The regressions that are better fits according to R^2 values yield significant, positive effects of the frequency of climate-related disasters and carbon dioxide emissions on healthcare expenditures. My findings that support for hypothesis that climate changes increases healthcare spending agree with the results from previous literature. My control variables are significant in most regressions, which is what the literature predicts.

VII. Conclusion

This research paper contributes to the growing body of literature on the association between climate change and healthcare expenditures. I analyze data from 218 countries from 1995-2022, providing insights into how climate change indicators, such as the frequency of climate-related disasters and carbon emissions, impact healthcare spending. These findings suggest that climate change may indeed result in increased healthcare expenditures, particularly in regression analyses that incorporate fixed effects. These results indicate that climate change has an adverse effect on healthcare systems, increasing costs globally, and underscore the importance of mitigating climate change impacts. Further research is warranted to unpack the mechanisms through which climate change impacts healthcare systems under different circumstances.

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