

Climate Risk Management in Insurance: Exploring the Relationship between Global Greenhouse Gas Emissions and Premium Pricing

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Submitted: 04/05/2024 Revised: 17/06/2024 Accepted: 24/06/2024

Abstract: Climate change continues to pose enormous risks to global ecosystems and economies. Understanding the impact of climate change on the insurance business is critical for efficient risk management and mitigation of effort. This study looks into the relationship between global greenhouse gas (GHG) emissions and premium pricing in the insurance industry, with an emphasis on the implications for climate risk mitigation. A regression analysis is performed using historical premium data from Organisation for Economic Co-operation and Development (OECD) countries and globally GHG emissions data to investigate the relationship between these variables. The findings show a substantial positive association between GHG emissions and insurance premiums, implying that rising levels of GHG emissions are associated with higher premium prices. This study points out the significance of including environmental issues into insurance risk assessment and pricing models in order to properly account for climate-related hazards. These findings have implications for climate risk management in the insurance business, highlighting the need for proactive actions to meet the mounting difficulties posed by climate change.

Keywords: Insurance, Risk management, GHG emissions, OECD, Pricing

1. Introduction

Climate change, mainly driven by anthropogenic activity, has emerged as one of the most important concerns of the twenty-first century, with profound implications for ecosystems, economies, and civilizations around the world. Among the numerous sectors affected by climate change, the insurance industry is at the forefront, dealing with increasing hazards and uncertainties associated with extreme weather events.[7] Celine Herweijer et.al. (2009) revealed that Climate change will have a short-term impact on underwriting processes by mandating risk quantification methodologies. In the long run, inadequate adaptation in regions of increased risk may jeopardise the idea of insurability by restricting the availability and affordability of private insurance coverage.[3] Andrew Dlugolecki (2014) expressed that the Climate change is a major concern for the insurance sector due to both direct and indirect implications, including strategies to decrease emissions and avoid damage. The consequences in Europe are already becoming severe. By 2040, the worldwide economic cost of weather damage could exceed one trillion dollars each year. As a result, the

consequences will be more severe in underdeveloped countries. [14] Jung Hee Noh (2023) ensured that Climate change, driven by an increase in carbon dioxide and greenhouse gases (GHGs) from anthropogenic activities, has emerged as a significant national and social concern over time. Numerous studies have shown that climate change has a negative influence on ecosystems, including decreased water availability, agricultural output, and increased extreme weather events, all of which affect human health and well-being.[17] Long Hua (2023) stated that climate change poses a significant danger to economic stability since it exposes the economy to physical and climate threats. Physical dangers arise from the direct effects of climate change, such as more frequent and severe natural disasters. Climate hazards stem from the changes an economy may make as it transitions to a future with lower carbon emissions.

As insurers attempt to define and manage climate risks, there is a growing recognition of the significance of incorporating environmental considerations into risk assessment and pricing models. The study of the relationship between global greenhouse gas (GHG) emissions and insurance premiums is critical to this effort, as these gases are a major contributor to climate change. The aim of this research paper is to investigate the intricate interplay between global GHG emissions and premium pricing in the insurance sector, with a particular focus on climate risk management. By elucidating the relationship between GHG emissions and insurance premiums, this study seeks to provide valuable

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insights into the mechanisms through which climate change impacts the insurance industry and to inform evidence-based strategies for enhancing climate resilience and sustainability.

India is one of the many non-member economies with which the OECD works in addition to its member countries, hence it participates in OECD general operations. India has been invited to serve as an observer on the OECD's Committee on Fiscal Affairs, which helps to set worldwide tax standards, notably in areas such as tax treaty and transfer pricing.

1.1 Context and Significance

The importance of understanding the relationship between GHG emissions and premiums cannot be overstated, given the escalating frequency and severity of climate-related disasters such as hurricanes, wildfires, and floods. These events not only pose significant financial risks to insurers but also have profound socio-economic implications for communities and businesses. Against this backdrop, insurers are faced with the daunting task of accurately pricing climate-related risks while ensuring the affordability and availability of insurance coverage for policyholders. Failure to adequately account for the impact of GHG emissions on insurance premiums could result in under-pricing of risk, leading to adverse selection, moral hazard, and potential solvency risks for insurers.

Moreover, the integration of environmental considerations into insurance risk assessment and pricing models has broader implications for climate policy, economic development, and societal resilience. By aligning insurance incentives with climate mitigation and adaptation objectives, insurers can incentivize investments in low-carbon technologies, sustainable infrastructure, and resilient communities, thereby contributing to global efforts to mitigate and adapt to climate change.

1.2 Limitations

1. The study focuses on a sample of OECD countries and may not be generalizable to other regions with different socioeconomic and environmental characteristics. Future research could examine the relationship between GHG emissions and insurance premiums in diverse global contexts to assess the robustness of the findings.

2. The regression analysis conducted in this study assumes that all other factors influencing insurance premiums remain constant, which not hold may true in

real-world scenarios (by *Ceteris Paribus*). Other factors such as market conditions, regulatory changes, and technological advancements could also influence premium pricing and may confound the observed relationship between GHG emissions and insurance premiums.

3. The regression model used in this study represents a simplified representation of the complex interactions between GHG emissions, insurance premiums, and other relevant variables.

4. While the regression analysis identifies a significant association between GHG emissions and insurance premiums, caution should be exercised in interpreting causality. The observed relationship may be influenced by complex causal pathways and feedback loops, requiring additional causal inference techniques to establish causal relationships definitively.

2. Methodology

The research employs a quantitative research design to analyse the relationship between global greenhouse gas (GHG) emissions and insurance premiums. This design allows for the systematic examination of numerical data to identify patterns and correlations between variables. The primary data sources include historical premium data from OECD countries and Global Greenhouse gas emissions data.

The units of measurement for premium data and greenhouse gas emission are in US dollars and metric tons of carbon dioxide equivalent (CO₂). The inferential statistics are used to run regression analysis between Gross premium of OECD countries and Global Greenhouse gas emissions. A 95% Confidence interval was chosen so that a p-value of less than 0.05 can reject the null hypothesis.

3. Development of the model

Data on gross premiums (in million USD) for countries in the OECD from 1990 to 2022 was collected from oecd.org, while GHG emissions (in metric tonnes) were collected from www.climatewatchdata.org.

A linear regression equation is written as:-

$$Y = a + bx + e$$

Y = Insurance Premium

x = GHG Emissions

a = the intercept (the value of y when x=0)

b = the slope of the line

e = error term

4. Result and Inference

Regression Statistics	
Multiple R	0.9863
R Square	0.9728
Adjusted R Square	0.9718
Standard Error Percentage	6.703%

Table 1: Regression Statistics Output

	Coefficients	Standard Error	t Stat
Intercept	-5919844.443	295754.6725	-20.01606396
GHG Emissions	232.2281758	7.211823868	32.20103265

Table 2: Summary Output

The results of the regression analysis provide strong empirical evidence of a significant and highly predictive relationship between global GHG emissions and insurance premiums. The Multiple R value of approximately 0.9863 indicates a strong positive correlation between GHG emissions and insurance premiums, suggesting that variations in GHG emissions explain a substantial proportion of the variability in insurance premiums. The coefficient estimate for GHG

emissions implies that for every unit increase in GHG emissions, insurance premiums increase by approximately \$232,228, holding other factors constant. This coefficient is statistically significant, suggesting that GHG emissions have a significant positive effect on insurance premiums.

The relationship between global greenhouse gas emission and Insurance premium can be formulated into,

$$\text{Insurance Premium} = 232.228 * (\text{GHG Emissions}) - 5919844.443 + e$$

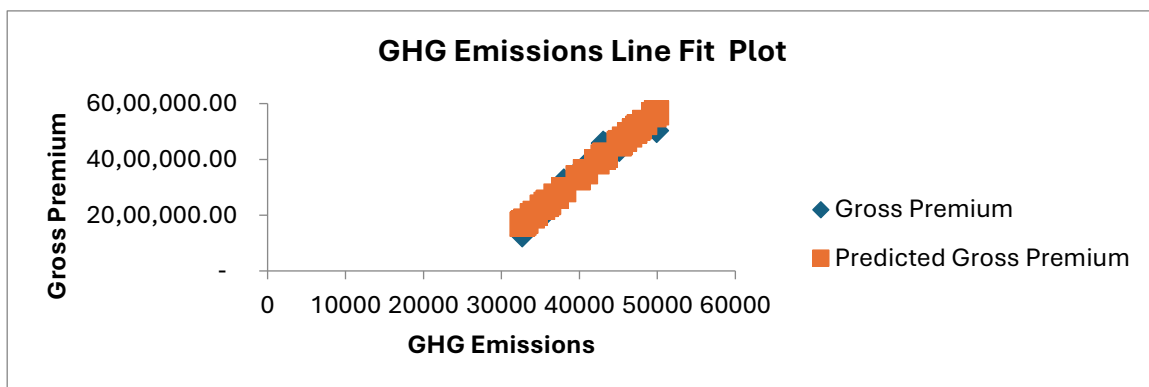


Fig 1: GHG Emissions vs. Predicted Gross Premium

5. Conclusion

This study provides empirical evidence of a significant and positive relationship between global greenhouse gas (GHG) emissions and insurance premiums. By quantifying the impact of GHG emissions on insurance premiums, insurers can better assess and price climate-related risks, thereby enhancing their resilience to the adverse effects of climate change. Moreover, these findings underscore the need for insurers to incorporate environmental considerations into their risk assessment and pricing models, aligning insurance incentives with climate mitigation and adaptation objectives. However, it is essential to acknowledge the limitations of this study. Despite these limitations, the results of this study contribute to our understanding of the complex interactions between climate change, insurance markets,

and societal resilience. By identifying the linkages between GHG emissions and insurance premiums, this research provides valuable insights for policymakers, insurers, and stakeholders seeking to mitigate climate risks and build sustainable, resilient communities in the face of a changing climate. Future research should focus on refining the methodology, addressing data limitations, and exploring causal mechanisms underlying the observed relationship between GHG emissions and insurance premiums. By advancing our understanding of these issues, we can develop evidence-based strategies to promote climate resilience and sustainability in the insurance industry and beyond.

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