ECON 676: Research Project

National Decarbonization Policy in Costa Rica: Capacity Building for Global Climate Change - Cassia Rodrigues (UID:119129180)

**Abstract**

This research delves into an examination of the efficacy of Costa Rica's climate mitigation endeavors, with a specific focus on the National Decarbonization Plan instated in 2019. The primary objective is to investigate the potential causal relationship between carbon dioxide (CO2) levels and Gross Domestic Product (GDP). The findings of this analysis aim to contribute valuable insights to facilitate the active engagement of other developing nations in climate negotiations, enhance their access to climate finance, and foster the effective implementation of climate policies, drawing inspiration from the exemplary climate actions undertaken by Costa Rica.

**Introduction**

Costa Rica is a small Central American nation and is celebrated for its rich biodiversity, stunning landscapes, and commitment to environmental conservation. Nestled between Nicaragua to the north and Panama to the south, Costa Rica is bordered by the Pacific Ocean to the west and the Caribbean Sea to the east. The country is renowned for its lush rainforests, diverse ecosystems, and an abundance of wildlife, making it a haven for nature enthusiasts and ecotourists.

Costa Rica is unique not only for its natural beauty but also for its progressive stance on environmental sustainability. It has set itself apart by aiming to become one of the world's first carbon-neutral nations.

Costa Rica’s Vision for the Future:

* President Alvarado has a clear vision of the city of the future. “I imagine a city where mobility is based on clean energy; a city that bets on technology but prioritizes people’s well-being, freedom, and right to privacy; a city where you breathe clean air; a city that manages waste sustainably and a city where you are in contact with nature to find peace of mind,” he said.
* Implementing the National Decarbonization Plan is expected to bring USD 41 billion in net benefits to the Costa Rican economy between 2020 and 2050.

The National Decarbonization Plan:

* The NDP published in 2019 by the government of Costa Rica sets the goal of becoming carbon-neutral by 2050, with Costa Rica’s local emissions being offset by the local absorption provided by forests and other carbon sinks.[[1]](#footnote-1)
* The NDP proposes a set of actions organized around ten “lines” (see appendix A) representing Costa Rica’s main economic and infrastructure sectors.
* The NDP entails bold mid- and long-term targets to reform transport, energy, waste, and land use, were launched in February of 2019.
* The aim is to achieve net zero emissions by 2050, meaning the country will produce no more emissions than it can offset through actions such as maintaining and expanding its forests. They anticipate that the net emissions will drop below zero in certain CO2-emitting industries (see appendix B for graph). Reaching net-zero CO2 emissions means both reducing sources of emissions, such as the combustion of fossil fuels, and increasing carbon sinks, by, for example, expanding forests, since trees capture carbon from the atmosphere as they grow. The salient message of climate research is that as long as the global economy releases more CO2 into the atmosphere than it removes through carbon sinks, the climate will continue to warm.
* Costa Rica’s most important climate policy is its National Decarbonization Plan, and the latest update report shows that almost all the original planned actions are on track, despite the negative effects of the pandemic.
* Funded by the Inter-American Development Bank’s (IDB)- French Climate Fund (RG-T3193) and Sustainable Energy and Climate Change Initiative (RG-T2713).

Capacity building for climate change refers to the process of enhancing the abilities, skills, knowledge, and resources of individuals, organizations, and communities to effectively understand, mitigate, adapt to, and address the challenges posed by climate change. It involves empowering individuals and institutions to develop the capacity to assess, plan, implement, and monitor climate change-related initiatives. It is an investment in the effectiveness and future sustainability of the society. This research aspires to uncover favorable outcomes stemming from the National Decarbonization Policy, with the aim of identifying replicable successes that can be translated and applied in other developing nations. This study offers ideas and models that are valuable for other countries interested in decarbonization, and that can inspire development partners globally.

**Literature Review**

The literature review section of this research project encompasses a comprehensive exploration of climate policy studies conducted in various countries, providing a foundational understanding of the integration of Structural Equation Modeling (SEM) models into the current study. Noteworthy contributions from existing research include:

1. ‘Sharing the burden for climate change mitigation in the Canadian Federation’ study delves into the intricate challenges of distributing the responsibility for greenhouse gas abatement among provinces in Canada. Utilizing a computable general equilibrium model, the authors compare various strategies for allocating the burden of emission reductions across Canadian provinces.
2. ‘Climate Justice, the Global South, and Policy Preferences of Kenyan Environmental NGOs’- Focuses on the dynamics between the heavily industrialized Global North and the developing Global South, this research addresses the negotiations for a global agreement to address climate change. It sheds light on the policy preferences of Kenyan Environmental NGOs within the context of climate justice.
3. ‘The Benefits and Costs of Decarbonizing Costa Rica's Economy: Informing the Implementation of Costa Rica's National Decarbonization Plan Under Uncertainty’ - Employing an innovative methodology for planning under deep uncertainty, this study evaluates the economic viability of Costa Rica's National Decarbonization Plan (NDP). Beyond meeting international commitments, the research aims to determine whether the benefits of NDP implementation surpass the associated costs, thereby justifying collective action.

These seminal works collectively contribute to the contextual understanding of climate policies globally and lay the groundwork for the integration of SEM models in the current research endeavor.

Objective of the study:

* The idea is to measure how effective the National Decarbonization policy has been in Costa Rica in building a sense of global climate justice equity.
* In this study, the success of Costa Rica’s climate actions can enable other developing countries to effectively participate in climate negotiations, access climate finance, and implement climate policies.
* To explain the causal relationship between CO2 emissions and GDP. Whether a decrease in CO2 emissions will lead to an increase in GDP in Costa Rica.

**Data:**

The data for this research project is sourced from the World Bank's World Development Indicators database. Specifically, the Climate and Development Report (CCDR) within the Sustainable Development Indicators section provides a rich repository of time series data spanning the period from 1990 to 2050.

The chosen variables include:

1. CO2 emissions across various sectors, offering a nuanced understanding of the environmental impact.
2. "CO2 per dollar of manufacture" refers to the amount of carbon dioxide (CO2) emissions produced per unit of economic output or manufacturing activity. This metric is a measure of the environmental efficiency of a manufacturing process, indicating the level of carbon emissions associated with each dollar of goods or services produced.

The formula for calculating CO2 per dollar of manufacture is: CO2 per dollar of manufacture = CO2 emissions/Manufacturing output (in dollars)

In essence, it quantifies the environmental impact of manufacturing by expressing the amount of carbon dioxide emitted for every unit of economic value generated.

Lower values of CO2 per dollar of manufacture indicate a more environmentally efficient manufacturing process, suggesting that less carbon dioxide is emitted relative to the economic output. Conversely, higher values suggest a less environmentally efficient process, with more carbon emissions associated with each dollar of manufacturing.

Reducing CO2 emissions per unit of economic output is a key goal for sustainable and environmentally friendly manufacturing practices. It reflects efforts to decouple economic growth from environmental impact, emphasizing resource efficiency and a shift towards cleaner and more sustainable production methods.

1. I chose GDP per capita (constant) as this reflects the nominal GDP. "GDP per capita (constant)" refers to Gross Domestic Product (GDP) per capita adjusted for inflation or changes in the price level over time. The term "constant" in this context means that the values are expressed in terms of a constant or base period's purchasing power. In other words, the GDP per capita values are adjusted to reflect the real, inflation-adjusted standard of living or economic output.

The formula for calculating GDP per capita (constant) involves adjusting the nominal GDP per capita using a price index, typically the Consumer Price Index (CPI) or the GDP deflator. The adjustment aims to remove the impact of inflation or deflation, providing a more accurate representation of the real value of economic output per person.

1. The time dimension is captured through the inclusion of the variable 'Year,' ensuring a comprehensive examination of trends and patterns over the specified timeframe.

This robust dataset forms the foundation for the empirical analysis, enabling a thorough exploration of the interplay between climate-related factors and economic indicators.

**Descriptive statistics:**

A graph with a line going up

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Fig.1. GDP per Capita Over the years

The graph Fig.1 above shows an increase in GDP over the years, a dip in 2019-2020 possibly due to the impact of COVID-19.

A graph with a line

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Fig.1.1. Estimated Population Growth over the years

The graph Fig.1.1 above shows that Population growth will see a steady increase until 2050, plateau around 2020-2040 according to estimates.

A graph of carbon dioxide emissions

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Fig.1.2. CO2 emissions amongst different sectors

The graph Fig.1.2 above shows the biggest CO2 emitters namely- Building, Energy, Electricity, Manufacturing, Fuel combustion, and Other sources. Amongst the industry CO2 emitters, Energy is the highest and building the lowest on average. This gives insight into the specific policy recommendations that can be made based on the industry.

**Methodology:**

For this research project, I will be employing SEM techniques on the National Decarbonization Policy implemented. Structural Equation Modeling (SEM) is a statistical technique used in research to analyze complex relationships among variables. SEM allows researchers to simultaneously examine multiple dependent and independent variables within a single model, providing a framework to assess both direct and indirect relationships. Through this statistical technique, I will ascertain whether this policy has been effective so far. Investigating the causal relationship between the CO2 emission per dollar of manufacture and the Year variable with the GDP per capita(constant). Conducting the SEM on Stata yields the Fig.2 below:

A diagram of a graph

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**Fig. 2. SEM model**

**Results:**

As we can see from the SEM results table in Fig.2.1, an additional year causes CO2 emissions per dollar to decrease by 0.002pp. This means that as the years go by Costa Rica does lower their carbon emissions. An increase in CO2 emissions per dollar causes a decrease in GDP by $55,199.49. Thereby supporting my research objective, that there is a causal relationship between CO2 emissions and GDP per capita. Since the P-values are lower than 0.05, we can say that the results are statistically significant.

**A screenshot of a calculator

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**Fig 2.1. Table showing SEM estimation**

**Conclusion**

Lowering the carbon levels does in fact lead to an increase in the GDP per capita this provides an incentive to other developing countries to pursue a Decarbonization policy like Costa Rica, and my analysis proves this. We can see that over the years Costa Rica has successfully lowered its carbon emissions despite the negative effects of the pandemic.

In conclusion, the empirical evidence presented in this study underscores a positive correlation between the reduction of carbon levels and an increase in GDP per capita, thereby offering a compelling incentive for other developing countries to consider and emulate a decarbonization policy akin to that of Costa Rica. The comprehensive analysis conducted substantiates this assertion, highlighting Costa Rica's commendable success in curbing carbon emissions over the years, even in the face of the adverse impacts of the global pandemic. Nevertheless, it is crucial to acknowledge the limitations of this research, including the exclusion of additional indicators—such as the influence of renewable energy sources, innovation, and technology adoption—which could potentially yield more robust outcomes. The oversimplification of the model, focusing solely on the causal link between CO2 emissions and GDP, overlooks the multitude of other variables that intricately shape GDP trends.

Despite these limitations, the findings hold significant implications for Costa Rica's decarbonization endeavors. Firstly, they contribute to garnering support for the implementation of the National Decarbonization Policy (NDP). Furthermore, the insights gleaned offer valuable guidance for the ongoing execution of the NDP. Importantly, the tools and methodologies developed in this study are actively shaping Costa Rica's updated decarbonization commitment on the international stage. Beyond the national context, this research aligns with a broader research and policy agenda, playing a pivotal role in informing decarbonization initiatives throughout Latin America. As such, this study not only adds to the body of knowledge surrounding the interplay between carbon reduction and economic growth but also contributes meaningfully to the broader discourse on sustainable development and climate action in the region.

**References**

1. Data: [https://databank.worldbank.org/source/world-development-indicators#](https://databank.worldbank.org/source/world-development-indicators).
2. Böhringer, C., Rivers, N., Rutherford, T., & Wigle, R. (2015). Sharing the burden for climate change mitigation in the Canadian federation. The Canadian Journal of Economics / Revue Canadienne d’Economique, 48(4), 1350–1380.
3. Beer, C. T. (2014). Climate Justice, the Global South, and Policy Preferences of Kenyan Environmental NGOs. The Global South, 8(2), 84–100. <https://doi.org/10.2979/globalsouth.8.2.84>
4. Groves, David G., James Syme, Edmundo Molina-Perez, Carlos Calvo Hernandez, Luis F. Víctor-Gallardo, Guido Godinez-Zamora, Jairo Quirós-Tortós, Felipe De León Denegri, Andrea Meza Murillo, Valentina Saavedra Gómez, and Adrien Vogt-Schilb, The Benefits and Costs of Decarbonizing Costa Rica's Economy: Informing the Implementation of Costa Rica's National Decarbonization Plan Under Uncertainty. Santa Monica, CA: RAND Corporation, 2020.
5. https://www.clientearth.org/latest/latest-updates/stories/what-is-a-carbon-sink/

**Appendices (if necessary)**

A diagram of energy efficiency

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Appendix A

A graph of different colored bars

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Appendix B

1. A carbon sink is anything that absorbs more carbon from the atmosphere than it releases – for example, plants, the ocean and soil. [↑](#footnote-ref-1)