THE BUILDING BLOCKS OF SUCCESSFUL CLEAN ENERGY POLICIES: AN ECONOMETRIC ANALYSIS OF SOCIOECONOMIC FACTORS THAT IMPACT REGULATORY AND POLICY SUPPORT FOR CLEAN ENERGY

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INTRODUCTION

Clean energy policy has become an increasingly relied upon climate change mitigation strategy globally. As the climate change crisis becomes more pressing, countries are being encouraged to implement domestic clean energy policies, ranging from carbon pricing to renewable energy subsidies. However, not every country has the same economic or social environments to implement successful policies.

The purpose of this paper is to inquire on which social and economic problems need to be addressed and resolved as building blocks to create a socioeconomic environment that can support clean energy policies.

VARIABLES & LITERATURE REVIEW

Regulatory Indicators for Sustainable Energy (RISE) Scores
- An average between the UN's scoring of countries' renewable energy and energy efficiency
- Literature identifies a positive relationship between GDP and clean energy (Cai et al., 2018; Chien & Hu, 2008). GDP is also a stimulant for technological innovation and economic development (Adewale Alola et al., 2021). As GDP grows, it spurs sustainable development (Adewale Alola et al., 2021).

Independent

GDP Per Capita
- Calculated through dividing gross domestic product by the country's mid-year population; current US$.

Population Growth
- Determined as an annual exponential rate of growth where population includes all residents, irrespective of legal status; annual %.
- Increasing populations have adverse impacts on environmental quality, including increased resource use, pollution, and CO2 emissions (Lin et al., 2016). However, there are opportunities for population to drive decreasing GHG emissions (Sanoh et al., 2014).

Unemployment Rate
- Represents the proportion of the labour force currently without work but seeking it; % of total labor force, modeled ILO estimate.
- Clean energy provides greater opportunities for green jobs and jobs in technological advancements, which reduces unemployment (Naqvi et al., 2021). However, the inverse relationship is less thoroughly researched: how does unemployment impact clean energy?

Access to Electricity
- Determined through industry, surveys, and international sources; % of population.
- While it would be theorized that an increase in access to electricity would increase support for clean energy policy as to sustain access, complex policy environments can actually impede further entry to clean technologies (Alstone et al., 2015). Therefore, the relationship is more complex than it appears and is insufficiently researched in existing literature.

Democracy Index
- Compiled by the Economist Intelligence Unit that scores countries from 0 to 10; 0 being considered an authoritarian regime and 10 being considered a full democracy
- When moving from an autocratic regime to a democratic regime, this liberalization of the public sector is associated with an overall decreased harm to the environment (Bjørnskov, 2018). An increased social capital associated with more democratic governments has a positive relationship with a government's willingness to implement environmental, or clean energy, policies (Satrovic et al., 2021).

Income Level
- Dummy variable categorized as high income, middle income, or low income by the World Bank
- Clean energy policies have implications on income equality themselves, where traditional policies, such as carbon pricing, are designed in such a way that low-income households are more disadvantaged than high-income households (Perry et al., 2013). High-income households are more likely to switch to clean energy sources because of their stronger ability to pay and a greater expectation for quality of life (Yan et al., 2020).

METHODOLOGY

Clean energy policy and regulatory support is quantified using portions of the UN's Regulatory Indictors for Sustainable Energy (RISE) and the explanatory variables include GDP per capita, population growth rate, access to electricity, the democracy index, unemployment rate, and income level. An econometric analysis is applied using a random-effects model on panel data for 137 countries over the years 2010-2019., using the random-effects formula below.

$$Y_{it} = \beta_0 + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + u + e$$

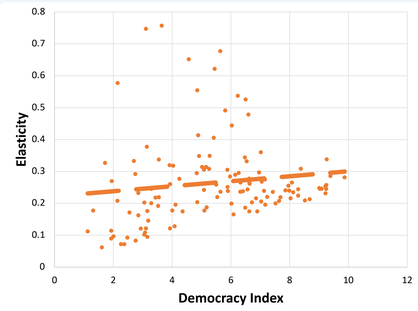
Elasticities of each variable is also calculated to determine which socioeconomic factors have the greatest influence on regulatory and policy support for clean energy. The equation below was used to determine these values.

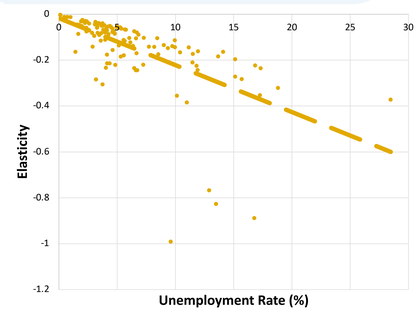
$$E = \frac{\%\Delta Y}{\%\Delta X} = \frac{\frac{Y_2 - Y_1}{(Y_2 + Y_1)/2}}{\frac{X_2 - X_1}{(X_2 + X_1)/2}}$$

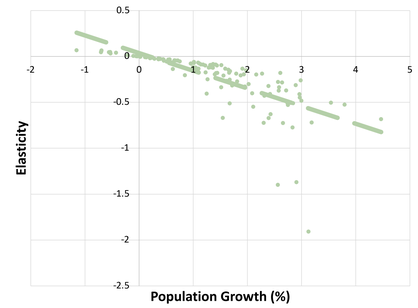
RESULTS: REGRESSION & ELASTICITIES

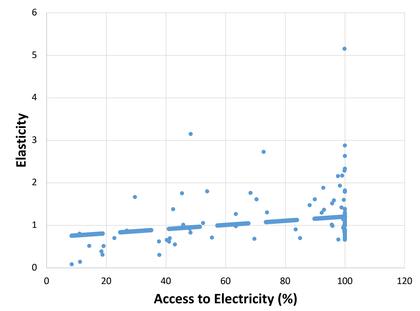
The table below displays the results of the regression. All results are significant, except for GDP. Additionally, the relationship with Y is the opposite sign as predicted for the variables GDP per capita and population growth. While the results from the regression yield intriguing insights given the nature/direction of the relationship of each variable on policy and regulatory support to clean energy, the results are difficult to compare to each other given their differing units. Thus, elasticities were also determined and display which independent variables have relatively greater or smaller impacts on RISE scores. Access to electricity is the most elastic value at the mean point, having the greatest impact on RISE scores. Further, the starting point of a country in relation to these socioeconomic variables determines how elastic a change in the value would have on RISE scores. These relationships are displayed in the scatter plots below: democracy index and access to electricity increase in elasticity as the value increases, while unemployment rate and population growth decrease in elasticity as the value increases.

Dependent variable	**Regression**		**Elasticities**	
RISE score	Coefficient	Standard Error	Value	Relationship with Y
Intercept	11.79**	4.24		
Demographic Variables				
GDP per capita	-0.0000026	0.000050	0.00	-
Population growth	-5.18***	0.55	0.20	-
Unemployment	-0.98***	0.16	0.18	-
Energy Variable				
Access to electricity	0.62***	0.050	1.30	+
Political Variable				
Democracy index	2.28***	0.58	0.33	+
Dummy Variables				
High income	-13.31*	5.59		-
Middle income	-22.77***	4.24		-









DISCUSSION & CONCLUSION

All variables, except for GDP per capita, had significant relationships with RISE scores. While previous literature often focuses on the impact of clean energy or clean energy policy on socioeconomic factors, this model showed that there is an inverse impact. As such, population growth, unemployment, access to electricity, form of government (e.g., democracy), and income level all influence the support for clean energy policy and regulations.

Each statistically significant independent variable also had the expected direction relationship on RISE scores, with the exception of population growth. This is helpful in the academic field to clarify some of the conflicting speculative research on population growth and clean energy in the past. The insignificant result of GDP per capita additionally is helpful to the academic field. As analyzed from the results, the nature of the relationship of GDP with clean energy policy and regulatory support is discrete and thus realized in the discrete impact of income level. Further research is necessary to determine the causation and implications of this finding.

Access to electricity produced the highest elasticity value signifying that its change has the greatest impact on RISE scores compared to the other independent variables. This has implications for stakeholders to provide greatest focus on increasing the scope of electricity grid access. Countries which have lower rates of access to electricity should receive greater focus on that aspect in order to instigate greater regulatory and policy support for clean energy. These countries include Chad, Liberia, and Burundi.

This research is important for stakeholders including policymakers, sustainability, environmental, or energy organizations, environmental advocacy groups, sustainable development NGOs, and voters. Continued research on the socioeconomic building blocks of clean energy policy will remain an important area for future research.

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