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The Impact of Economic Openness and Globalization on the Production of Renewable Energies: Empirical Evidence from OECD Countries

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ABSTRACT

The study aims to measure the impact of economic openness and globalization on the production of renewable energies in the Organization for Economic Cooperation and Development from 1995 to 2020. We measured the impact of economic openness, globalization, carbon emissions, and economic growth on the total production of renewable energies. We relied on econometric models using dynamic approaches estimated through the difference generalized moments method (GMM difference). The study concluded that economic openness, globalization, and carbon emissions lead to an increase in renewable energy production. Thus, a policy of economic freedom would support the energy transition process. Economic growth has a negative relationship with renewable energy production.

Keywords: Renewable Energy, Economic Openness, Globalization, Carbon Emissions.

Introduction :

The contemporary epoch of globalization, along with the increasing inclination toward economic liberalization, has eradicated conventional boundaries that have traditionally obstructed commercial transactions. Furthermore, the tangible dimensions of collaboration and dependency have intensified, resulting in elevated degrees of integration and connectedness across economies. Economic activities have embraced the structure of worldwide production networks, with phases integrated within global value chains. The unyielding quest for economic liberalization and heightened globalization has led to a reconfiguration of the principles governing production, commerce, international specialization, and division of labor. These economic phenomena have significantly impacted many economic sectors, particularly the diverse components and domains of the energy sector, with the renewable energy industry being particularly affected.

The advancement of renewable energy generation, the shift in its sources, and energy dependence represent a prominent characteristic of the contemporary global economic environment, thereby affirming the complex interplay between global economic policies and the transition to more sustainable energy sources. The renewable energy sector has become a focal point as economic and environmental impacts navigate the intricacies of international trade, investment, and the reciprocal influences of trade agreements and feedback loops, mirroring broader trends towards environmental sustainability and energy security. The pursuit of a sustainable and secure energy future has gradually evolved into a worldwide initiative, requiring a clear comprehension of the economic processes and global trends propelling the shift toward renewable energy.

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This essay seeks to examine the complex effects of economic openness and globalization on renewable energy generation and the overall context of the energy transition. This study examines the interplay between national and international economic policies, such as trade liberalization, monetary freedom, financial deregulation, labor mobility, and investment freedom, to clarify how these mechanisms affect the adoption and integration of renewable energy technologies. It also explores how the economic environment at national, regional, and global levels can significantly influence the future of energy production and consumption.
The connection between economic openness, globalization, and renewable energy is an important area of study because countries are trying to make energy transitions while staying environmentally friendly as economies become more dependent on each other and global integration speeds up through globalization processes. This research seeks to analyze the correlation between economic openness and globalization and their effects on renewable energy generation. Consequently, this research aims to investigate the following question: How much can economic openness and globalization facilitate the enhancement of renewable energy generation and the attainment of the energy transition?

The study seeks to elucidate the significance of economic openness and globalization in facilitating the energy transition by assessing their effects on renewable energy generation and exploring pathways of influence. It aims to provide policies that maximize advantages from more liberalized approaches in accordance with the circumstances and goals of sustainable development. The research strategically examines a subset of OECD nations and chronologically spans from 1995 to 2020.

1. relationship between economic openness, globalization, and renewable energy from the perspective of previous empirical literature:

Several empirical studies have investigated the correlation between economic openness and the generation and use of renewable energy in both developed and developing nations. Researchers have examined this link using a composite variable of economic openness, which includes sub-indicators such as trade freedom, financial freedom, monetary flexibility, company freedom, tax burden, and other ancillary factors. A series of research studies has determined that particular dimensions of economic freedom, including trade freedom, monetary freedom, financial freedom, and business freedom, positively influence renewable energy. Research demonstrates that economic and trade liberalization often fosters the use of renewable energy and contributes to a reduction in carbon emissions, especially in the long term and within industrialized nations. Nevertheless, research indicates that the effects may vary by geography and level of development, with potential adverse environmental consequences in underdeveloped nations.

Amoah (2020) determined that economic openness in Africa initially enhances the proportion of renewable energy sources in overall energy consumption; however, this impact subsequently reverses at a certain threshold. Concerning sub-indicators, trade freedom and business freedom have a beneficial influence on renewable energy usage, whereas property rights and tax burdens have an adverse effect. Özçelik and Önder (2023) indicated that economic freedoms pertaining to labor and monetary policy correlate with an increase in the proportion of renewable energy within total energy consumption, whereas investment and finance freedoms exert a contrary impact. Conversely, Jacqmin (2023) determined that, over time, trade liberalization favorably influences the generation of energy from renewable sources. Alam and Murad (2023) support this conclusion by highlighting that economic growth, trade liberalization, and technological innovation significantly influence the long-term utilization of renewable energy in OECD nations, while short-term dynamics vary based on differing degrees of trade openness and technological development.

Empirical studies demonstrate a substantial positive correlation between financial openness and investments in renewable energy. Matheus et al. (2020) discovered that financial independence facilitates investments in renewable energy by lowering financing costs, which is particularly crucial for capital-intensive energy sources that depend more on external finance. Koengkan et al. (2019) corroborate this finding by determining that financial openness positively impacts investments in renewable energy in Latin American nations, with both short-term economic growth and long-term financial openness enhancing the capacity for renewable energy. In BRICS nations, economic openness and financial stability enhance renewable energy usage, but financial growth and technical advancements also contribute significantly. In Asian nations, financial openness positively influences renewable energy use over the long term, with enhanced financial openness fostering renewable energy usage in all areas except Western Asia.

Although economic openness often stimulates renewable energy, several research studies suggest a contrary impact. The findings of the research by Qiang et al. (2023) indicate a unidirectional causal link from trade openness to renewable energy use. Furthermore, Xuhua et al. (2021) indicate that trade liberalization may result in heightened fossil fuel use, underscoring the need for enhanced investment in renewable energy sources and the advancement of sustainable trade practices. The discussions indicate that economic openness, which includes trade openness, financial openness, business freedom, and monetary freedom, typically exerts a beneficial influence on the advancement of renewable energy, aids in alleviating environmental degradation, and promotes green economic growth. However, different aspects of economic freedom, such as the tax burden, can lead to complex and sometimes negative consequences. These effects vary between developed and developing countries, as well as across different regions, highlighting the need for tailored policies that take into account local economic and technological conditions.

Furthermore, globalization impacts the production and use of renewable energy. Research suggests that several aspects of globalization often facilitate the advancement of renewable energy and may result in decreased carbon emissions and environmental impacts, since globalization is crucial in influencing the adoption of renewable energy. Ziroat et al. (2023) assert that economic globalization favorably influences the adoption of renewable energy across various income levels, particularly in high-income and middle-income nations. The research by Abraham et al. (2023) demonstrates a favorable correlation with renewable energy, underscoring the need to prioritize environmental sustainability and advance globalization for the proliferation of clean energy. The research by Zhe et al. (2023) also shows that increased economic, social, and political globalization is linked to more renewable energy use. This means that trade policies should work with national efforts to make these countries better at producing and using renewable energy.

Salman et al. (2023) demonstrated that the diverse manifestations of globalization (economic, social, and political) affect the adoption of renewable energy among countries categorized by income levels, with economic globalization notably enhancing renewable energy utilization. Gozgor et al. (2020) and Padhan et al. (2020) determined that economic globalization positively influences renewable energy consumption in OECD countries, with increased globalization levels promoting renewable energy utilization and potentially alleviating climate change effects. Zhang et al. (2022) discovered that the progression of the digital economy undermines and reduces the correlation between globalization and renewable energy. Globalization has a more significant impact on renewable energy development in contexts where the digital economy is underdeveloped.

In contrast, Matheus et al. (2021) contend that trade liberalization in Latin American and Caribbean nations is inadequate for attracting heightened investments that promote research and development in energy efficiency technologies and equipment aimed at diminishing energy consumption from non-renewable sources by households and enterprises. Empirical evidence ultimately suggests that globalization primarily benefits the production and use of renewable energy across diverse economies. These parameters may fluctuate based on the characteristics of the economic structure, degrees of economic complexity, the digital economy, and the form of globalization. The results indicate that embracing globalization may function as a strategic method to augment the use of renewable energy and promote environmental sustainability. The impact of globalization on renewable energy advancement and environmental footprints is intricate and may vary based on a country's economic setting, income level, and development status.

2. Data and Variables:

We have assessed the influence of economic openness and globalization on the production of renewable energy, using both greenhouse gas emissions and GDP growth as complementary explanatory variables for the examined economic phenomena. The following table encapsulates the study's variables and specifies the data sources used.

Indicator	Definition	Source
Total renewable energy	The International Renewable Energy Agency's definition of renewable energy explicitly incorporates the concept of sustainability: "Renewable energy includes all forms of energy generated from renewable sources in a sustainable manner, including biomass, geothermal energy, hydropower, ocean energy, solar	https://pxweb.irena.org/pxweb/en/IRENASTAT/

	energy, and wind energy." However, in practice, existing statistical databases account for all energy production from renewable sources, regardless of sustainability, as "renewable energy."	
Economic freedom	The Economic Freedom Index, an annual report published by the Heritage Foundation in Washington, covers 12 freedoms, ranging from property rights to financial freedom. The index serves as an excellent objective tool for analyzing 184 economies worldwide, with each country's page serving as a source for in-depth analysis of political and economic developments in any country, facilitating an understanding of the fundamentals of economic growth and prosperity.	https://www.heritage.org/index
Globalisation Index (**KOFI**)	The KOF Globalization Index measures the economic, social, and political dimensions of globalization. Globalization in these fields has been on the rise since the 1970s, receiving a particular boost following the end of the Cold War.	https://kof.ethz.ch/en/data/
CO2 emissions	Carbon dioxide emissions arise from the combustion of fossil fuels and the production of cement. They encompass carbon dioxide generated during the consumption of solid, liquid, and gaseous fuels as well as gas combustion.	https://databank.worldbank.org/
GDP growth	The annual growth rate of Gross Domestic Product (GDP) at market prices based on constant local currency. The aggregates are based on constant prices for the year 2015, expressed in U.S. dollars. Gross Domestic Product is the sum of the total value added by all resident producers in the economy plus any taxes on products, minus any subsidies not included in the value of products. It is calculated without making deductions for the depreciation of manufactured assets or for the depletion and degradation of natural resources.	https://databank.worldbank.org/

Statistical Approaches Used :

We propose to estimate a dynamic model using Arellano & Bond's (1991) Generalized Method of Moments (GMM) difference estimator to investigate the effects of trade liberalization and economic globalization on the total renewable energy production. This method employs the second-order lagged values (t-2) as instrumental variables, and the estimation process is based on the differences for all variables. This approach tackles the bias issue that arises from the endogeneity of the independent variables used to measure the dependent variable. Due to the independent variable's expression as a function of the dependent variable, such circumstances may lead to a correlation between the independent variables and the error term. Additionally, the correlation between the error term and one of the independent variables, specifically the lagged value of the dependent variable, may cause bias issues.

We apply the Sargan test and Hansen test to verify the correctness of the instrumental variables used in the estimation process and examine the autocorrelation of the residuals to ensure the validity of the results obtained through this method.

3. Results and Discussion

The results in Table 2 show that the instrumental variables were valid using Hansen's tests after the study model was estimated using the Generalized Method of Moments (GMM) difference approach. Additionally, the Arellano-Bond test confirmed the presence of first-order autocorrelation in the residuals, while also indicating the absence of this autocorrelation in the errors at the second order. This confirms the assumptions of the aforementioned method, which is characterized by first-order autocorrelation in the residuals. These tests affirm the statistical robustness of the estimated models.

Variable	Coefficient	Std.error	Z-Statistic	P-Value
Lag variable	0.937738	0.0065572	143.01	0.000***
Economic freedom	0.1931019	0.0740114	2.61	0.009***
Globalization Index	0.1995128	0.0459662	4.34	0.000***
CO2 emissions	0.0316496	0.0051489	6.15	0.000***
GDP growth	-0.0016749	0.0005948	-2.82	0.005***
_cons	-1.418909	0.2315383	-6.13	0.000***
Arellano-Bond test for AR(1) in first differences			z = -3.34	P-value = 0.001
Arellano-Bond test for AR(2) in first differences			z = -0.83	P-value = 0.404
Sargan test of overid. Restrictions			$\chi^2(249) = 568.24$	P-value =0.000
Hansen test of overid. Restrictions			χ^2 (249) = 27.58	P-value =1.000
Difference-in-Hansen tests of exogeneity of instrument subsets: GMM instruments for levels				
Hansen test excluding group			χ^2 (229) =27.58	P-value =1.000
Difference			χ^2 (20) =0.00	P-value =1.000
Difference-in-Hansen tests of exogeneity of instrument subsets: instruments variables				
Hansen test excluding group			χ^2 (245) =30.43	P-value =1.000
Difference			χ^2 (4) =2.85	P-value = 0.6152

The estimation outputs shown in the above table lead to the following conclusions:

- The estimation outputs demonstrate a positive impact of economic openness on renewable energy production, with the effect being statistically significant at the 1 percent level.
- Globalization enhances the production of renewable energy, with the impact being statistically significant at the 1 percent level.
- An increase in carbon dioxide emissions leads to a rise in renewable energy production, indicating a trend toward a transition to alternative energy sources.
- Regarding the impact of economic growth, the estimation results reveal an inverse effect, suggesting that as economic growth increases, renewable energy production decreases in the countries under study.

The favorable relationship between economic openness, globalization, and renewable energy output demonstrates how liberal economic policies may foster an atmosphere that promotes the expansion of renewable energy industries. Higher degrees of globalization and trade liberalization, characterized by the elimination of tariff and non-tariff barriers and different trade restrictions, enhance the import and export of renewable energy technology. This, in turn, reduces

expenses and encourages a wider variety of renewable energy sources. Policies designed to reduce tariffs and non-tariff barriers on green technology foster innovation and enhance international adoption.

Also, the freedom to move money freely across borders and its flexible allocation is a part of economic globalization and openness. This makes it easier to get money and lowers the cost of getting it because there is competition from many different financial markets and instruments. Monetary independence, characterized by low inflation rates, minimal government intervention in the market, and the ease of financial transactions, contributes to this benefit. These elements promote investments in renewable energy. This climate attracts money and fosters innovation and competitiveness in the renewable energy industry. This underscores that monetary autonomy, capital liberty, and associated changes may operate as crucial elements in expediting the shift to sustainable energy sources.

Business freedom, labor freedom, and investment freedom are crucial elements that act as pivotal entry points. Their combined effects converge and synergize to facilitate the transition to renewable energy by optimizing output in this sector. The consequences of optimizing the initiation and operation of enterprises within the renewable energy sector—minimizing barriers, fostering competition, and incentivizing entrepreneurs and investors—may transcend local investment enhancement to encompass the attraction of foreign direct investment in renewable energy. A stable and transparent regulatory framework, along with unrestricted capital flow mechanisms, are crucial factors for such investment. Also, flexible job markets can quickly match up local and international workers with the changing needs of the renewable energy sector. This encourages global cooperation in training programs, skill development, and getting workers ready for work in this field, which makes sure that workers' freedom helps the sector grow.

The study's results indicate that the tax burden and government size are crucial to attaining energy transition goals and enhancing the development of sustainable energy sources. The amalgamation of expenditure policies, designated regions for subsidies and transfers, funding sources, and income accomplishes this. Targeted government interventions in renewable energy sectors, including subsidies and financial awards, influence the direction of economic activity toward sustainable energy practices. Moreover, tax incentives for renewable energy initiatives stimulate investment and production in this domain, thereby enhancing profitability. Tax exemptions, discounts, and accelerated depreciation for renewable energy investments promote industry expansion. On the other hand, an increased tax burden makes it easier to generate the necessary funds for government expenditures, with a portion going towards energy transition initiatives.

Rising carbon emissions highlight the need for an energy transition, elucidating the intricate dynamics within the energy sector and the interrelationships between carbon emissions and heightened fossil fuel usage. This link generates stress related to environmental issues, leading to a surge in awareness and concern about the rising carbon emissions. These concerns lead to modifications in governmental legislation, commercial sector practices, and family habits. As a consequence, investments in renewable energy arise from both public and commercial sectors, with technical advancements stemming from their partnerships and collaborations, promoting a social shift towards clean energy sources. These activities and behaviors may enhance the efficiency and reduce the cost of renewable energy sources, facilitating their acceptance and proliferation. Increased carbon emissions are inherently harmful to the environment, but they may indirectly promote the development of renewable energy technology, highlighting the intricate relationship between environmental issues and innovative solutions that may emerge. The data ultimately demonstrate that heightened economic expansion has a detrimental impact on renewable energy output. The data illustrate the complex interplay between economic growth and sustainability, which includes energy transition. The found result fits with the Environmental Kuznets Curve (EKC) hypothesis, which says that environmental damage gets worse as the economy grows, but it gets better after a certain income level as people become more aware of the problem and invest in clean technologies. This analysis indicates that a time of economic expansion that exceeds the adoption of renewable energy technology results in heightened reliance on more polluting conventional energy sources. This outcome highlights the consequences of prioritizing growth ambitions above sustainability strategies, requiring an increased reliance on conventional energy sources. This pattern highlights the need for focused policies and investments to facilitate sustainable energy transitions throughout economic growth.

4. Concution:

This study aimed to analyze the impact of economic openness and globalization on the production of renewable energy. Through the analysis and interpretation of the effects of economic openness and globalization, we seek to better

understand the pathways through which liberal and more liberated economic, financial, and trade policies can contribute to the energy transition. The study concluded that globalization and the state of economic openness could contribute to an increase in renewable energy production and enhance the energy transition process in OECD countries. Therefore, the formulation and implementation of policies that support economic freedom and promote globalization can expedite the shift toward renewable energy, a fundamental step in combating climate change and enhancing global environmental sustainability.

In light of the findings, it is essential for policies to aim to create an open economic environment supportive of renewable energy. This includes not only direct support for renewable energy projects but also broader economic reforms that enhance freedom, reduce barriers, and stimulate both domestic and foreign investment. Policymakers should focus on integrating sustainability into the fabric of economic policy, ensuring that they harness the static and dynamic effects of economic openness and globalization to maximize the energy transition and achieve sustainability. The following are some recommendations:

-There is a necessity to invest in infrastructure that supports the production and distribution of renewable energy to maximize the benefits of economic openness. This includes physical infrastructure, such as smart grids, and regulatory infrastructure, such as policies that facilitate the integration of renewable energy into the national grid.

-There is a need to adopt targeted incentives for investment in renewable energy, where policies can focus on encouraging local and foreign investment in renewable energy through tax incentives, subsidies, or reducing entry barriers. We should give special attention to technologies with high initial costs, as they are essential for achieving long-term sustainability.

-To ensure that the expansion in renewable energy production positively contributes to attaining sustainable development goals, policies must include environmental safeguards against potential negative impacts of increased economic activity. Furthermore, social policies may also be necessary to ensure equitable access to the benefits of growth in the renewable energy sector.

Given the global nature of both economic openness and globalization, as well as the challenges of climate change, international cooperation is essential. Agreements that reduce tariffs on renewable energy technologies and promote technology transfer could accelerate progress toward renewable energy goals.

- To mitigate the negative impact resulting from increasing economic growth on renewable energy production, a multi-faceted approach focusing on policies, regulatory frameworks, incentives, and technological innovation is required. This entails the implementation of green taxes and financial policies, which include progressive taxation on carbon emissions and tax incentives for investors and consumers in renewable energy sources, thereby enhancing the attractiveness of investment and consumption in renewable energy. Renewable Purchase Obligations (RPOs), which require a certain percentage of a supplier's energy portfolio to come from renewable sources, also make sure there is a market for renewable energy and keep an eye on the energy market's makeup, its effects, and how it helps the economy grow.

5. Referance:

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