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How Digitalization and Financial Advancement Contribute to the Green Energy Transition: The Malaysian Experience

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Objective & Motivation

- One of the most important strategies for reducing CO_2 emissions and addressing climate change is the development of renewable energy.
- Digitalization is viewed from this perspective as a means of achieving an energy transition
- Digital technologies currently have a significant capacity to achieve the goal of energy sustainability.

- However, there is a lack of empirical data confirming the significance of digitalization in driving the transition to green energy.

- To answer this question, this study aimed to empirically measure the impact of digitalization and financial development in Malaysia on the green energy transition from 2000 to 2021.

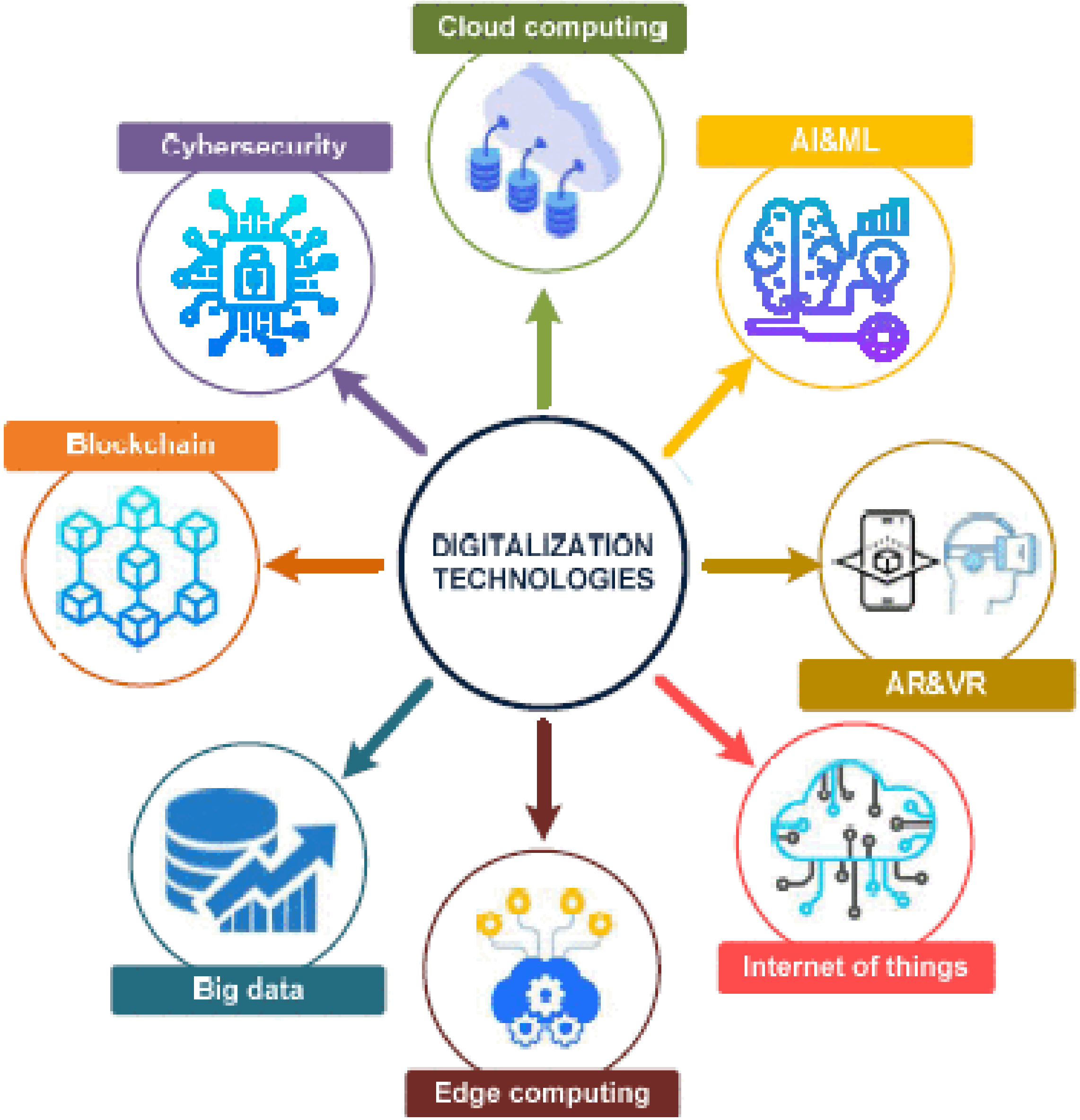
Contributions

- This research will provide a variety of contributions to the literature.
  1. First, to our knowledge, this is the first econometric analysis to use the most recent data from 2000 to 2021 to examine how digitalization has affected Malaysia's shift to green energy.
  2. Second, this study provides new perspectives on the function of digitization in the switch to green energy. The connection between digitization and the switch to green energy has not been empirically studied.

- RE has grown rapidly since the beginning of the 21st century, but still only contributes to a small portion of a nation's overall worldwide energy system, as integration, energy security, and supply issues must be addressed.

- Digital technology offers a new approach to address this issue. Digital technology has long been used in the energy sector

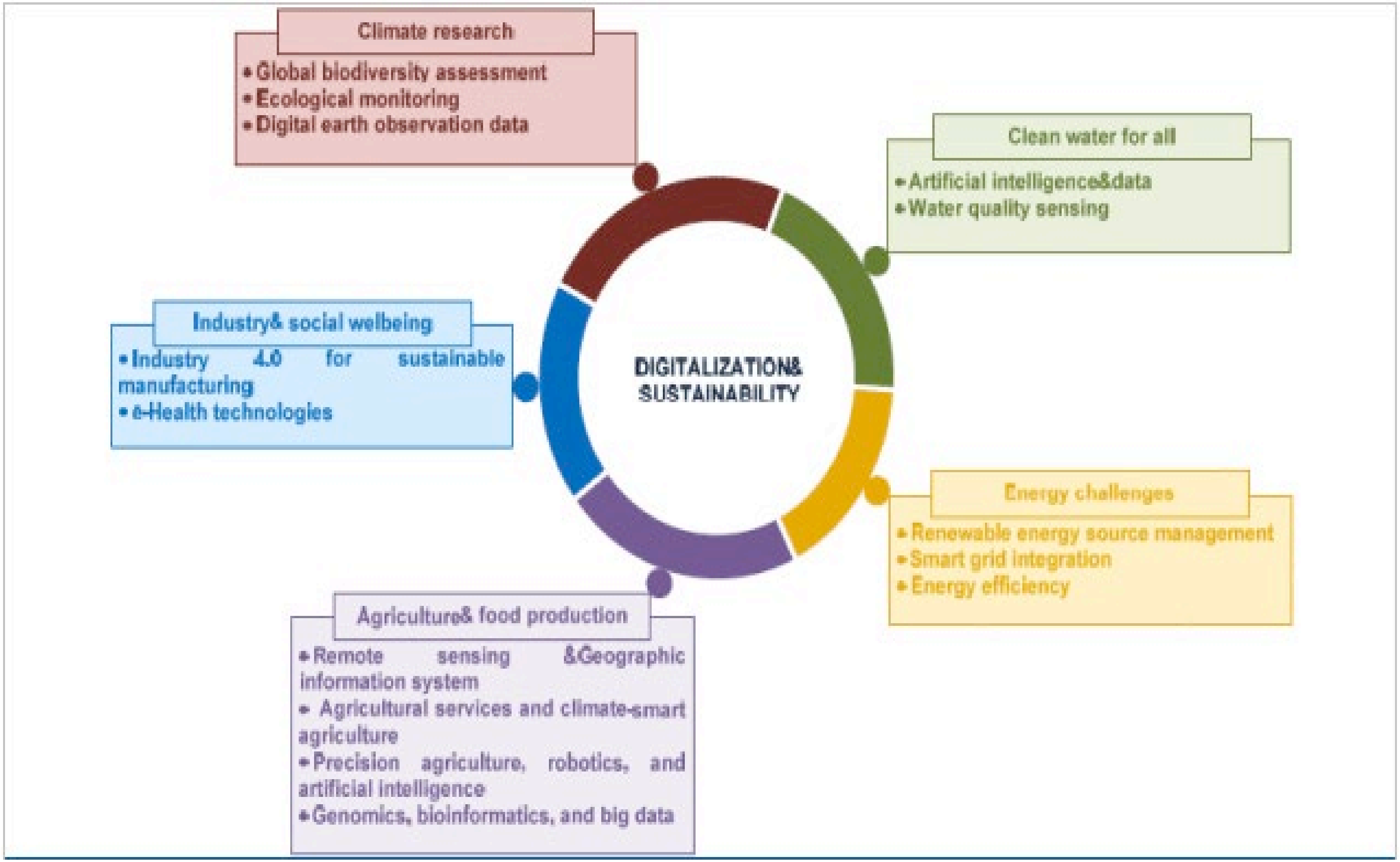
Background of Digitalization



Digitalization & Energy

- Lange et al. (2020) claims that digitalization has four effects on energy consumption.
  - Direct effect
  - Efficiency and rebound effects
  - Economic growth
  - Sectoral change

The Different Effects of Digitalization on Green Energy Growth



Opportunities of Digitalization in the Energy Sector

- – Billing
- – Marketing and sales
- – Automation
- – Applications for the smart grid and data transfer
- – Grid management
- – Identity management and security
- – Resource sharing
- – Competition
- – Transparency

Why Malaysia?

- The financial industry is one of the primary industries contributing significantly to a country's green economy expansion.
- Strong digital infrastructure spanning the broadband Internet and 5G networks.
- Malaysia approval of five digital banks in April 2022, the introduction of robot advisors, and the use of blockchain technology to improve security and efficiency.

- Also, ***Digital Economy and Cooperation in Green Economy agreement*** signed between Malaysia and Singapore on January 30, 2023, which is the first green economy agreement Malaysia has ever had.

Some digitalization statistics from Malaysia

- At the beginning of 2023, when Internet penetration reached 96.8%, there were 33.03 million Internet users in Malaysia.

- Early in 2023, there were 44.05 million active mobile phone subscriptions in Malaysia, which represents 129.1% of the country's population.

- Between 2022 and 2023, Malaysia recorded a 1.2 million (+2.9%) growth in the number of mobile subscriptions

Some clean energy statistics from Malaysia

- Malaysia's shift to a green energy policy between 2012 and 2018 decreased CO_2 emissions by up to 0.16%.

- Malaysia's energy demand grows faster than supply growth

Data

Table 1. Information about Data

Variables	Definition	Unit of measurement
Dependent Variable		
RE	Renewable energy	% Equivalent primary energy
Digitalization Variables		
IU	Internet users	% of population
MCS	Mobile cellular subscriptions	Per 100 people
FBS	Fixed broadband subscriptions	Per 100 people
Green Energy Transition Variables		
CO_2	Carbon emission	Metric tons per capita
EE	Energy Efficiency	Primary energy consumption per capita, kWh/person
FFEC	Fossil fuel energy consumption	Fossil fuels per capita (kWh)
Macroeconomic/Control Variables		
GDP	Economic growth	GDP per capita (current US$)
FD	Financial Development Index	%
FDI	Foreign Direct Investment	Balance of payment (BoP), current US$

Methods

- This study empirically explains how digitalization, green energy transition, and macroeconomic factors affect the clean energy transition and analyzes how these factors contribute to the energy transition. The model is defined as follows.

- $RE_t = \alpha_t + \beta_1 Digital_t + \beta_2 GreenEnergyTrans_t + \beta_3 ControlV_t + \varepsilon_t$

Bayesian auto-regressive distributed lags (BARDL)

- The BARDL method is generally selected over the conventional ARDL models.
  - First, while this BARDL test allows for a heterogeneous order of integration in variables, it is not overly complex in terms of the cointegration features of model variables.
  - BARDL method solves the issues of inconclusive cases by creating more critical values, which makes it more appropriate for the dynamic time-series model than the conventional ARDL model.

The mathematical model specification

$$RE_t = \sum_{i=1}^{p} \alpha_t RE_{1-i} + \sum_{j=0}^{q} \beta_j \, Digital_{1-j} + \sum_{k=0}^{r} \gamma_k \; GreenEnergyTrans_{1-k} + \sum_{m=1}^{s} \tau_m \, ControlV_{1-m} + u_t \qquad \textbf{(4)}$$

where t denotes the number of years and I, j, k, and m are the lags that change from p, q, r, and s, respectively. However, u_t represents the error correction value with zero mean and constant variance, thus, the following equation can be expressed using the BARDL method:

$$RE_t = \varphi RE_{t-1} + \gamma Digital_{t-1} + \theta GreenEnergyTrans_{t-1} + \vartheta ControlV_{t-1} + \sum_{i=1}^{p-1} \lambda_t RE_{1-i} + \sum_{j=0}^{q-1} \delta_j \, Digital_{1-j} + \sum_{k=0}^{r-1} \pi_k \, GreenEnergyTrans_{1-k} + \sum_{m=1}^{s-1} \vartheta_m \, ControlV_{1-m} + u_t \qquad \textbf{(5)}$$

The terms used in this context to indicate the associated functions are $\lambda, \delta, \pi, and\ \vartheta$. However, after being transformed into an error-correction form, the equation can be expressed as follows, along with an autoregressive vector for level. The unconditional model is created using a constant term (c) as follows:

$$RE_t = \tilde{c} + \tilde{\varphi} RE_{t-1} + \tilde{\gamma} Digital_{t-1} + \tilde{\theta} GreenEnergyTrans_{t-1} + \tilde{\vartheta} ControlV_{t-1} + \sum_{i=1}^{p-1} \tilde{\lambda}_t RE_{1-i} + \sum_{j=0}^{q-1} \tilde{\delta}_j \, Digital_{1-j} + \sum_{k=0}^{r-1} \widetilde{\pi_k} \, GreenEnergyTrans_{1-k} + \sum_{m=1}^{s-1} \widetilde{\vartheta_m} \, ControlV_{1-m} + \widetilde{u_t} \qquad \textbf{(6)}$$

Empirical Findings

Table 5: Short and Long-Term BARDL Results

Dependent Variable: RE sources				
Variables	**Long Term**	**Short Term**	**Coefficient**	**T-statistics**
IU	0.091**	0.592	0.091**	0.592
MCS	-0.337	-1.569	-0.337	-1.569
FBS	0.089	0.720	0.361***	3.429
CO_2	0.747**	2.794	0.747**	2.794
EE	20.059***	9.564	20.059***	9.564
FFEC	-20.473***	-10.853	12.936**	2.337
GDP	0.138	0.798	0.138	0.798
FD	-0.538**	-2.469	-0.638**	-3.469
FDI	-0.000	-0.037	0.016	1.880

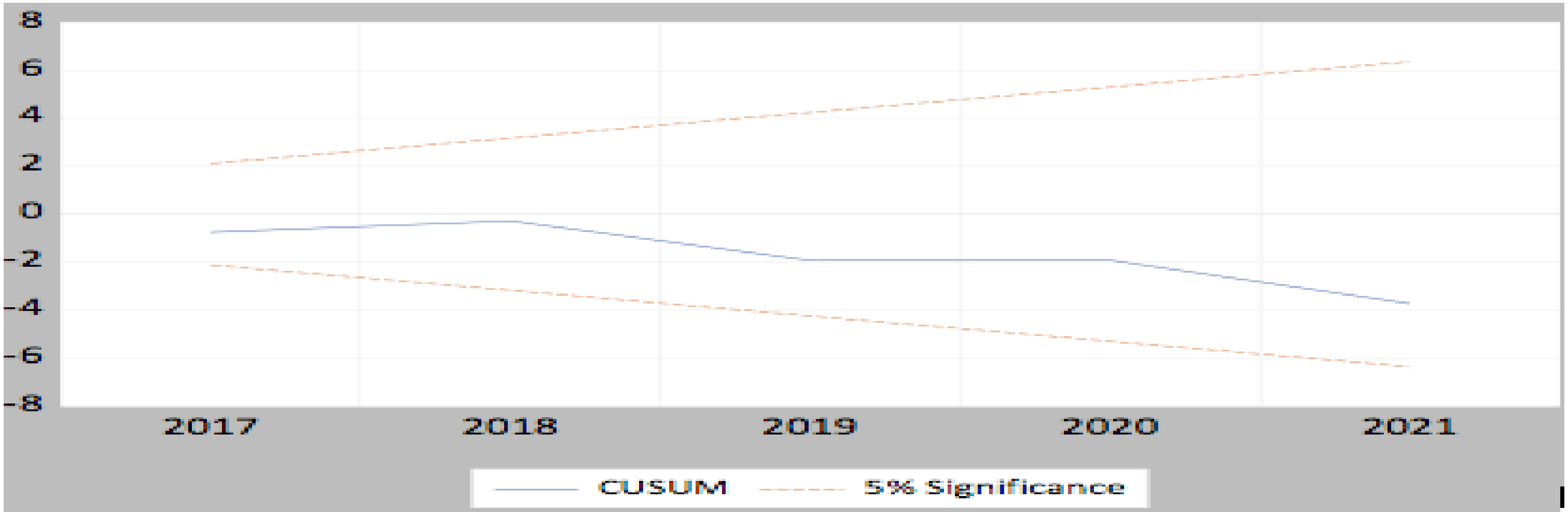
Long-Term Stability Test		
Test	**F Statistics**	**P Value**
X^2_{NORMAL}	1.561	0.542
X^2_{SERIAL}	1.423	0.585
X^2_{ARCH}	1.197	0.652
X^2_{HETERO}	1.874	0.425
X^2_{RESET}	1.170	0.306

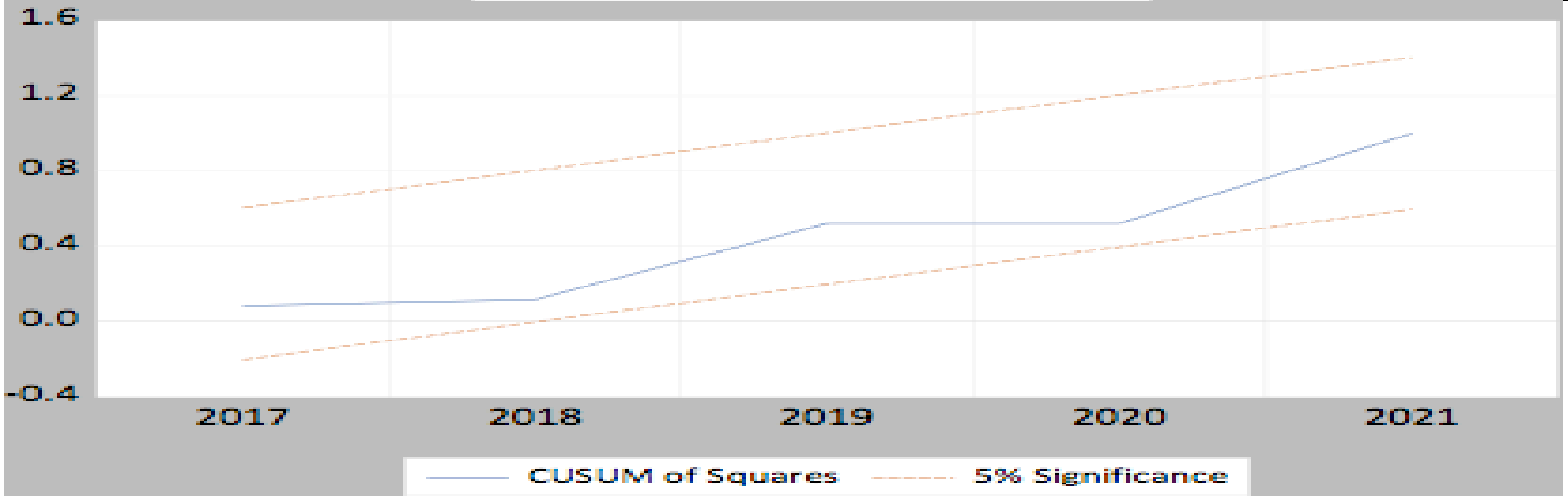
*Notes: The symbols *, **, and *** represent the 1%, 5%, and 10% significance levels, respectively.*

- Table 5 demonstrates that the digitalization sector (Internet users and fixed broadband subscriptions) greatly accelerates the switch to green energy by 0.09% and 0.36%, respectively.

- Moreover, CO_2, energy efficiency, and the use of fossil fuels all contribute 0.74%, 20%, and 12%, respectively, to the green energy transition.

The CUSUM and CUSUMQ graphs





Conclusion

- According to empirical findings;
  - The digitalization industry is the major force behind the switch to green energy.
  - The impact of CO_2 and energy efficiency, among other factors, accelerates the energy transition.
  - Additionally, the transition to green energy is negatively affected by the use of fossil fuels and financial growth.

Policy Recommendation

- **First,** the energy sector's move to digitalization provides technical support for the growth of variable RE, which can significantly increase renewable integration.
- **Second,** the favorable impact of renewable integration is affected by digitization at a threshold.
- **Third,** the integrated development of decarbonization and energy system digitization should receive more priority in emerging economies

Thank you for listening!

For collaboration and further questions:

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