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DETERMINANTS OF RENEWABLE ENERGY CONSUMPTION IN ASIA: THE ROLE OF INSTITUTIONAL QUALITY AND EVIDENCE FROM THE LINEAR AND NON-LINEAR ANALYSES

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This study examines the impact of economic growth, CO2 emissions, trade openness, and financial development on renewable energy consumption from 1998 to 2020 in 30 Asian countries, divided into two groups of low institutional quality and high institutional quality. The research methods include two-step Generalized Method of Moments, Panel-Corrected Standard Errors, and Feasible Generalized Least Square estimation methods for linear empirical investigation and the dynamic panel threshold model for non-linear investigation. The results show that there is a positive relationship between economic growth and institutional quality with renewable energy consumption. Specifically, countries with high economic growth, financial development, and institutional quality will have higher renewable energy consumption. In contrast, countries with low institutional quality that increase CO2 emissions tend to hinder renewable energy consumption. Meanwhile, trade openness has no significant impact on renewable energy consumption regardless of the institutional quality of the country.

Keywords: *Carbon emissions, financial development, non-linear effect, sustainable growth, threshold.*

1. INTRODUCTION

Climate change, especially global warming, has caused a series of severe natural disasters, causing many serious consequences. Therefore, this is an issue that has received much attention from countries and organizations around the world. One of the urgent topics is to find measures to improve the situation, notably reducing the use of fossil fuels, promoting the consumption of renewable energy in economic activities (COP28), aiming to limit global warming to 1.5 degrees Celsius by 2030 [1]. In fact, the consumption of renewable energy in economic activities tends to increase globally [2]. There are many factors that affect this process such as GDP [3], [4], trade openness [5], [6], financial development [7], [8], CO2 emissions [9], [10]. In addition, the institutional quality of a country also plays an important role in promoting renewable energy [11], [12], [13]. Institutional quality not only directly affects renewable energy consumption [10], [14], [15] but also indirectly through its impact on other determinants of renewable energy consumption. Specifically, Corruption, a component of institutional quality, increases carbon emissions in Chinese provinces [16]. The relationship between institutional quality and financial development in developing and emerging countries is reexamined in [17]. Their results show that different components of institutional quality have different impacts on financial development. Institutional quality has a significant positive impact on economic growth in 29 emerging countries [18]. Therefore, the impact of the determinants of renewable energy consumption is expected to vary based on the level of institutional quality.

Although the push for green energy is a global trend, even in regions less vulnerable to climate change such as Asia. However, the transition in this region is slow, and countries here still consume more than 70% of coal and oil gas in their economic activities [19]. Therefore, it is necessary to study in depth the factors affecting renewable energy consumption, thereby finding solutions to promote this process. In fact, some studies have mentioned Asia but not comprehensively, only focusing on some sub-regions such as South Asia [20], ASEAN [21], [22], [23], ASEAN + 3 [24]. In addition, studies often divide the country sample into different categories such as development (advanced, emerging and developing countries [25]); income group (high-income, upper-middle and lower-middle income countries [26], [27]). Thus, the novelty of this study is to focus comprehensively on 30 Asian countries, and divide them based on high or low institutional quality during the period from 1998 to 2020. The study also uses the dynamic panel threshold model method proposed by [28], implemented by [29] which allows for endogeneity in both regressors and the threshold variable, unlike other threshold models [30], [31]. Thus, this study can clarify the potential nonlinear relationship between renewable energy consumption and its determinants with a comprehensive index of institutional quality used as the threshold variable.

2. LITERATURE REVIEW

Renewable energy is energy that comes from natural sources or natural processes that are continuously replenished such as biomass, solar, hydropower, geothermal and wind [32]. Thus, renewable energy consumption (REC) means energy consumption from all the energy sources listed above. There are many methods used to measure REC, however, in the scope of this study, REC is measured as a percentage of total final energy because this is a widely used and easily collected data. Final energy consumption is a bottom-up approach, summing all passive energy in different consumption sectors (industry, transportation, households, services and other sectors). This index is measured by the actual energy consumed by the end user (after conversion from primary energy form to final use form). It should be noted that electricity is counted as a separate fuel alongside other fuels.

The use of non-renewable energy in industries in countries, especially under developed countries, promotes the process of destroying nature and the environment [33]. Therefore, the transition and provision of the use of renewable energy in economic activities is very urgent. Some countries even apply sanctions to push forward this process. Additionally, using RECs in economic activities could make changes in economic growth [34]. For those reasons, this is a very important issue and the factors affecting the process of renewable energy consumption need to be carefully considered. In general, the impacts of most factors on renewable energy consumption are still contradictory. Specifically, there is a relationship between economic growth (in terms of GDP or GDP per capita) and renewable energy consumption that exists in some empirical evidences. This relationship could described as an inverted U function [35]. In the early stages, as per capita income increases (or the economy grows), environmental pollution also increase. However, in the later stages, after a certain income level, the trend reverses, indicating a positive effect of economic growth on environmental quality due to higher energy consumption, including all renewable energy sources [26], [36]. However, in some contexts such as India, the United States, Ukraine, or some other European countries, renewable energy consumption has a negative impact on the economy [37], [38], because these countries possess abundant non-renewable resources, and this delays the transition to renewable energy use [39]. In addition, some other evidence proves that economic growth is not related to renewable energy consumption [40], [41].

Another factor that affects renewable energy consumption is CO2 emissions. Countries are encouraged to use more renewable energy in economic activities to reduce CO2 emissions, thereby slowing down global climate change. In general, the impact of CO2 emissions on renewable energy consumption remains is a controversial issue. Many opinions argue that increasing CO2 emissions will promote the use of renewable energy sources in different countries, as well as in developed and developing countries [9], [10], [42]. In ASEAN and African countries, the relationship between CO2 emissions and renewable energy consumption is not consistently positive. Empirical evidence suggests that environmental degradation may even hinder renewable energy adoption [24], and the dynamics vary depending on regional economic structures and institutional conditions [12].

Renewable energy consumption could also be affected by trade openness [43]. The impact of trade openness varies primarily depending on country-specific characteristics, such as physical and human capital or environmental regulations [14]. As in newly industrialized countries, trade openness provides countries with access to new, more energy-efficient technology sources [6]. Conversely, in some developed countries, increased international trade negatively affects renewable energy consumption. The impact of trade openness could also vary with mixed effects on renewable energy consumption if countries have different levels of democracy. If a country has low democracy, high trade openness, and few strict environmental regulations, its environmental pollution rate as well as its renewable energy exploitation and consumption will be low [12].

Regarding the impact of financial development on renewable energy consumption, many studies show that financial development is the main source of investment for renewable energy exploitation and thus, promotes the use of this greener energy source [11], [44], [45]. However, some other studies [3], [24] suggested that financial development reduces renewable energy consumption in regions such as the G-7 or ASEAN+3. On the other hand, global financial development did not significantly affect the transition to renewable energy in the long term [46].

Additionally, this study focuses on 30 Asian countries which are divided into groups of high or low institutional quality. This is a previously overlooked research gap in this region. In general, renewable energy consumption benefits from general political stability, strong legal solutions, effective management and secure property rights [47]. A political commitment, together with a solid and transparent institutional process and solutions, is crucial to ensure continued support for the private sector and renewable energy project developers [15], [48]. This study groups countries based on six institutional quality indicators as Voice and Accountability (VA), Political Stability and Absence of Violence/Terrorism (PV), Government Effectiveness (GE), Regulatory Quality (RQ), Rule of Law (RL) and Control of Corruption (CC), not focusing on some aspects such as greed, government effectiveness or corruption as in some previous studies by [49], [50].

Thus, the empirical evidence shows that the ability of countries to consume renewable energy is influenced by many factors. Specifically, this study refers to valuable factors including economic growth, CO2 emissions, trade openness and financial development. This relationship will be examined on groups of Asian countries with different regimes of institutional quality.

3. METHOD

Following previous studies such as [12], [51], [52] to build a dynamic model for estimating the impact of economic growth, CO2 emissions, trade openness and financial development on renewable energy consumption, our empirical model equation (1) can be written as:

$$lnREC_{i,t} = \alpha \ln REC_{i,t-1} + \beta^T X_{i,t} + \mu_i + e_{i,t} \quad (1)$$

In which, REC is renewable energy consumption which is calculated as a percentage of total primary energy consumption; GDP is the indicator of economic growth calculated by GDP (constant 2015 US$); CO2 is CO2 emissions (metric tons per capita); TRADE is share of trade to GDP (% of GDP).

The subscripts $i = 1, \ldots, N$ represents the country, $t = 1, \ldots, T$ indexes the time, $X_{i,t} = [\ln GDP_{i,t}, \ln CO2_{i,t}, \ln TRADE_{i,t}, \ln FD_{i,t}]^T$, μ_i is the country fixed effects, and $e_{i,t}$ is the idiosyncratic error term.

The database of REC, GDP, CO2,

TRADE, IQ of 30 Asian countries from 1998 to 2020 is from World Bank (WDI and WGI) and of FD is from IMF (FDID).

To further contribute to the literature, this study examines the potential nonlinear impact of the set of explanatory variables on renewable energy consumption, equation (1) can be extended to a sample split form, where the group is determined by the value of a threshold variable. The dynamic panel threshold regression model (DPTRM) following the method of [28] can be expressed as follows:

$$lnREC_{i,t} = \alpha_1 \ln REC_{i,t-1} + \beta_1^T X_{i,t} + \mu_i + e_{i,t},\ q_{i,t} \leq \gamma_0 \quad (2)$$

$$lnREC_{i,t} = \alpha_2 \ln REC_{i,t-1} + \beta_2^T X_{i,t} + \mu_i + e_{i,t},\ q_{i,t} > \gamma_0 \quad (3)$$

Where $q_{i,t}$ is the threshold variable, which is the institutional quality in this study, and γ_0 is the threshold level.

The compact form of the DPTRM is given as follows:

$$lnREC_{i,t} = \beta^T \Omega_{i,t} + \delta^T \Omega_{i,t} I(q_{i,t} \leq \gamma_0) + \mu_i + e_{i,t} \quad (4)$$

Where $\Omega_{i,t} = [\ln RE_{i,t-1}, X_{i,t}^T]^T$, $I(.\ )$ is the indicator function and $\delta = \beta_1 - \beta_2$ measures the level of the threshold effect. Note that, if $\delta = 0$, DPTRM reduces to DPRM.

The data analysis process commences with descriptive statistics, followed by the construction of a correlation matrix, tests for multicollinearity, and cross-sectional dependence. Subsequently, stationarity and panel cointegration tests are conducted. Tests for heteroscedasticity and autocorrelation are also performed to inform the selection of appropriate regression techniques. Following this, the two-step system GMM (2SGMM) regression method will be employed to investigate the linear relationship between renewable energy consumption and its determinants. For robustness checks of the linear findings, Feasible Generalized Least Square (FGLS) and Panel Corrected Standard Errors (PCSE) will be utilized, drawing upon the methodologies employed by [51] and [20]. Subsequently, a linearity test will be performed to ascertain evidence of non-linearity and determine the appropriate number of thresholds. Then, the dynamic panel threshold regression model developed by [28] will be applied to examine the varying effects of the determinants across different levels of institutional quality. Finally, it is still necessary to supplement the analysis with short-term and long-term effects to provide a more comprehensive picture of the relationships between variables in the model by PMG (Pooled Mean Group) and DFE (Dynamic Fixed Effects) regressions.

4. EMPIRICAL RESULTS AND DISCUSSION

The evidence shows that the cross-sectional dependence in the data set is not present because the null hypothesis of no CSD is not rejected through the Pesaran CD test and Friedman's test (Appendix A2).

In addition, through the Wald test and the Wooldridge [53] test, groupwise heteroskedasticity and autocorrelation exist (Appendix A3). Therefore, the 2GSMM model will be used to test the effects of GDP, CO2 emissions per capita, trade openness and financial development on renewable energy consumption. In addition, the PCSE and the FGLS are also employed to check the robustness of the 2SGMM results.

Through Table 1, all 3 models show that CO2 emissions and financial development are the drivers for renewable energy consumption. On the contrary, there are 2 factors that do not promote renewable energy economy, which are GDP and trade openness. Therefore, the potential nonlinearity in the model is tested according to [54]. This methodology involves iteratively estimating the model with an incrementally increasing number of switch points until the null hypothesis of 'no switch points' can no longer be rejected. The implementation of this procedure is facilitated by the 'threshold' command in STATA, as operationalized by [55]. This command utilizes the bootstrap methodology developed by [56] to generate asymptotic critical values or p-values. The threshold variable considered within the model is institutional quality. Employing a bootstrap resampling procedure with 1000 iterations, the estimated threshold for the single-threshold model is 4.2619, accompanied by a 95% confidence interval of [4.25, 4.2785]. The F-statistic obtained is highly significant at the 1% level ($p<0.01$), leading to the rejection of the linear model in favor of a threshold specification. Consequently, a double-threshold model is subsequently estimated. However, a test for the presence of a second threshold, with the alternative hypothesis (H1) postulating 'two switch points', yields a p-value exceeds 0.10. This result fails to reject the null hypothesis (H0) of 'one switch point'. Therefore, the sequential estimation procedure is terminated, providing evidence for the existence of only one significantly significant in threshold institutional quality within the model (Table 2).

The literature on dynamic econometric models has extensively examined the implications arising from the presence of nonlinear asymmetric dynamics. Various model specifications have been developed to capture these features, notably the Panel Smooth Transition Regression (PSTR) model, the Threshold Autoregression (TAR) model, and the Static Panel Threshold Model (SPTM) introduced by [57]. However, these established approaches are inherently static and typically assume the exogeneity of both the regressors and the threshold variable. Building upon the methodologies proposed by [57], [58] and [30], [28] have advanced a dynamic panel threshold regression model capable of accommodating nonlinear asymmetric dynamics, unobserved individual heterogeneity, and endogeneity in both the threshold variable and the regressors. This Dynamic Panel Threshold Regression Model (DPTRM) leverages the First-Differenced Generalized Method of Moments (FD-GMM) estimator to address the limitations of static approaches, which may compromise the applicability of threshold regression models in a wider context. Given the established evidence of nonlinearity from the preceding analysis, the DPTRM are employed to investigate the heterogeneous effects of the determinants of REC across varying levels of institutional quality. The estimated results from this analysis are presented in Table 3.

Table 1. Linear Estimation with 2SGMM, PCSE and FGLS Method

Variables	2SGMM	PCSE	FGLS
L1.LN_REC	0.8266*** (0.1053)		
LN_GDP	0.0022 (0.0053)	0.0022 (0.0051)	-0.0012 (0.0026)
LN_CO2	-0.5077* (0.2878)	-0.9618*** (0.053)	-0.8314*** (0.0339)
LN_TRADE	0.0735 (0.0616)	0.0880 (0.064)	0.0097 (0.0318)
LN_FD	0.4326** (0.2139)	0.1504** (0.0654)	0.0821** (0.0378)
_cons	0.9846 (0.6067)	2.6369*** (0.3259)	3.1286*** (0.1613)

*, **, *** denote significance levels of 10%, 5% and 1% respectively.
Corrected standard errors are in parentheses.
The lag use is lag (2,7).
Source: Compiled results from STATA software

Table 2. Linear Threshold Effect Test in the Single-Threshold and Double-Threshold Fixed Effect Model

Model	Threshold	Lower	Upper	P-value
Single	4.2619	4.2500	4.2785	0.0040
Double	4.2619	4.2500	4.2785	0.0040
	1.1093	.	.	0.1780

Source: Compiled results from STATA software

Table 3. Hausman Test Table

Variable	pmg (b)	dfe (B)	Difference (b-B)	Std. err.
ln_gdp	0.082362	0.027432	0.054929	0.307065
ln_co2l	-1.543785	-0.21087	-1.332915	3.762955
ln_trade	2.308466	-0.00291	2.311375	7.494906
ln_fd	-0.781558	-0.351782	-0.429775	6.371868
Chi2			0.18	
Prob > chi2			0.9963	

Table 4. Dynamic Panel Threshold Regression Model

Threshold Variable	**LN_IQ**	
Regimes	**Low**	**High**
L1.LN_REC	0.1898 (0.1599)	0.2379** (0.1043)
LN_GDP	-0.0370** (0.0204)	0.1124*** (0.0218)
LN_CO2	-0.5973*** (0.2160)	0.6005 (0.3743)
LN_TRADE	-0.0505 (0.1631)	-0.1575 (0.2476)
LN_FD	0.2214** (0.1122)	-0.0950 (0.1074)

*, **, *** denote significance levels of 10%, 5% and 1% respectively.
The number of threshold is one.

Source: Compiled results from STATA software

Table 5. Estimation Results of PMG and DFE Models

	(1)	**(2)**	**(3)**	**(4)**
VARIABLES	**pmg**	**pmg**	**Dfe**	**dfe**
ec		-0.0310 (0.0216)		-0.1209** (0.0582)
D.ln_gdp		-0.0093* (0.0049)		-0.0041 (0.0053)
D.ln_co21		-0.9562*** (0.1381)		-0.6949*** (0.1486)
D.ln_trade		-0.0584 (0.0686)		0.0660 (0.0827)
D.ln_fd		0.0172 (0.1274)		-0.0302 (0.0547)
ln_gdp	0.0824*** (0.0162)		0.0274 (0.0338)	
ln_co21	-1.5438*** (0.1982)		-0.2109 (0.2664)	
ln_trade	2.3085*** (0.3940)		-0.0029 (0.2924)	
ln_fd	-0.7816** (0.3352)		-0.3518 (0.3468)	
Constant		-0.2662 (0.2179)		0.1342 (0.2132)
Observations	660	660	.	.

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In terms of data, since the data series are cointegrated, the use of the original series in the xthenreg model is suitable for short-run and long-run analysis because it takes advantage of the long-run equilibrium relationship between the variables. Using the original series avoids losing the inherent trend or long-run relationship between the variables, which would be lost if the difference is taken [59]. In addition, the model also shows how the variables respond to short-run shocks, as well as how the variables adjust to their long-run equilibrium through institutional thresholds (IQ thresholds).

PMG (Pooled Mean Group) and DFE (Dynamic Fixed Effects) models are used to analyze the short-run and long-run effects (Table 5). Hausman test is performed to check which model is more suitable. The p-value result > 0.05 shows that the difference between the long-run coefficients of the two models is not statistically significant. Thus, the PMG model is more suitable due to its flexibility in allowing for differences in long-run coefficients across countries, while specifying the Error Correction Term (EC). In other words, the PMG model takes into account differences in economic characteristics and institutional quality across countries, enhancing the accuracy and validity of the conclusions.

CO2 emissions have a significant negative impact on renewable energy consumption in countries with lower levels of institutional quality. In addition, CO2 emissions have a negative impact on renewable energy consumption in both the short and long run. Specifically, in the short run, the coefficients in both models are statistically significant ($p < 0.01$) with lnco21 = -0.9562 (PMG) and -0.6949 (DFE). In the long run, this impact is even stronger with lnco21 = -1.5438 ($p < 0.01$) in the PMG model. However, this coefficient in the DFE model is not statistically significant in the long run. Thus, PMG better reflects the negative impact of CO2 on renewable energy consumption in different countries. This result is consistent with the conclusions of many previous studies on the negative impact of CO2 emissions on renewable energy consumption such as [20], [22], [52], [60]. However, in the group of countries with better institutional quality, this negative impact is insignificant because environmental regulations could be more stringent. In addition, people also desire better environmental quality. Therefore, in these countries, the negative impact of CO2 is reduced. Therefore, institutional quality, especially through the policy channel, can have an important impact on changing the impact of CO2 on RECs.

Economic growth only promotes renewable energy consumption in countries with relatively good institutional quality. For other groups of countries, the relationship between economic growth and renewable energy consumption is negative. In addition, in the short run, the level of economic growth shows a negative effect on renewable energy consumption in the PMG model, although the effect is not significant (-0.0093, $p < 0.1$). Since the initial investment in renewable energy is expensive compared to non-renewable sources and any additional costs are passed on to consumers [61], countries have little incentive to switch to greener energy sources to boost income growth. Institutional quality plays an important role in promoting the transition to a more sustainable economy. With high institutional quality, environmental policies are more concerned [62]. In addition, the stringency of these policies is also enhanced [15]. Higher levels of institutional quality allow citizens to freely express their environmental demands, which can put pressure on the government, thereby improving environmental quality [63].

Thus, with pressure for a better environment from the government and citizens, production programs may rely more on renewable energy sources despite the relatively higher required costs. However, in the long run, economic growth promotes the region to increase its renewable energy consumption (0.0824, $p < 0.01$). The DFE model does not show statistically significant results across periods, as the DFE imposes a homogenous coefficient assumption across countries, ignoring differences in how economies develop renewable energy.

Trade openness has a negligible effect on renewable energy consumption in both high and low institutional quality groups, supporting the results in some previous studies by [10], [49], [64] as there is a strong nonlinear relationship between trade openness and renewable energy consumption depending on the level of trade. The effects first follow a decreasing trend, then turn to an increasing trend when involving 35 OECD countries. In addition, the nonlinear effect of trade on RECs is determined over time. Specifically, trade openness has a positive effect until 2000, an insignificant effect until 2011, and a positive and significant effect thereafter until 2016 [52]. This result is completely consistent with the findings in this study because the PMG model shows that the trade openness factor has a strong impact on the long-term renewable energy consumption.

Financial development can promote higher growth in renewable energy consumption in countries with lower institutional quality, but this relationship is insignificant in countries with higher institutional quality. Results from the PMG model also show that financial development has a negative impact on renewable energy consumption in countries in this region in the long run. Some studies show that institutions can weaken the impact of financial development on RECs, especially after institutional quality archives a certain threshold level. Specifically, the inverted U-shaped relationship between institutional quality and renewable energy capital flows suggests that institutional quality only has a positive impact on flows at an early stage but turns negative after a certain threshold [65]. In other words, the impact of financial development on per capita energy use is positive in a weak institutional environment but negative in a well-developed one [66]. This is because a tightly regulated investment environment can create barriers for investors, especially foreign investors, to invest in greener energy sources [67].

5. CONCLUSION AND POLICY IMPLICATIONS

Over the last decade, there has been much investigation to comprehend the determinants of renewable energy consumption. After a thorough literature search, there is a dearth of studies in the case of Asia, which acts as a major motivation for this study. Therefore, this study provides a theoretical discussion on how renewable energy consumption determinants effects could vary under different regimes of institutional quality. The authors utilise data from 30 Asian economies between 1998 and 2020 and the dynamic panel threshold model to estimate the impact of economic growth, CO2 emissions, trade openness and financial development on renewable energy consumption based on the institutional quality threshold. The research results highlight the non-linear and indirect effects of institutional quality in accelerating the transition towards a renewable energy economy through different effects on renewable energy consumption determinants.

By taking together the above analysis, we find that (i) Except for trade openness, other factors namely economic growth, CO2 emissions, and financial development have changing effects on renewable energy consumption depending on the levels of institutional quality; (ii) Economic growth leads to higher growth of renewable energy consumption growth in countries with higher levels of institutional quality, but it is negatively impacts renewable energy in lower levels of institutional quality; (iii) CO2 emissions negatively impact renewable energy consumption in lower regimes of institutional quality but this impact becomes statistically insignificant in higher regimes of institutional quality; (iv) Change in financial development is positively associated with the growth of renewable energy consumption in countries with less institutional quality but the relationship is insignificant in countries with better institutional quality; (v) Trade openness does not significantly impacts renewable energy consumption in both levels of institutional quality.

Previous literature highlights the important role of institutional quality in pushing the transition to greener sources of energy. Therefore, policymakers in Asia should leverage institutional strengths to accelerate renewable energy consumption. Firstly, actions should be taken to combat corruption and strengthen policy implementations. This can involve strengthening transparency, fostering public participation in policy formulation, and holding officials accountable. Also, a well-functioning bureaucracy staffed with competent and autonomous officials is crucial for efficient policy implementation. Secondly, Asian policymakers should consider fostering government transparency and public participation. Transparent and accountable governance with clear and consistent regulations and predictable long-term policy frameworks will foster trust among investors and encourage them to support renewable energy projects. Strengthening environmental democracy in Asia can lead to increased public pressure for renewable energy adoption. This can be achieved through measures like promoting access to environmental data and encouraging public participation in environmental decision-making processes. Finally, collaboration between Asian nations is crucial for knowledge sharing and accelerating technological advancements in renewable energy. Regional initiatives and partnerships with developed countries with strong renewable energy sectors can provide valuable knowledge transfer and facilitate technology acquisition to accelerate the pace of clean energy adoption across Asia.

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APPENDIX

Table A1. List of Asian Countries Included in the Analysis

No	Nation	No	Nation	No	Nation
1	Armenia	11	Iran, Islamic Rep.	21	Philippines
2	Azerbaijan	12	Israel	22	Saudi Arabia
3	Bangladesh	13	Japan	23	Singapore
4	Bhutan	14	Kazakhstan	24	Syrian Arab Republic
5	Cambodia	15	Korea, Rep.	25	Tajikistan
6	China	16	Lebanon	26	Thailand
7	Cyprus	17	Malaysia	27	Turkiye
8	Georgia	18	Mongolia	28	Turkmenistan
9	India	19	Nepal	29	Viet Nam
10	Indonesia	20	Pakistan	30	Uzbekistan

Table A2. Cross-sectional Dependence Test of Variables in the Model

Test	Test statistic	P-value/Critical value
Peasaran CD	1.591	0.1117
Friedman’s test	28.028	0.5164

Source: Compiled results from STATA software

Table A3. Results of Heteroscedasticity and Autocorrelation

Test	Statistic	P-value	Conclusion
Modified Wald test for group-wise Heteroscedasticity	58763.35	0.0000	Heteroskedasticity exists
Wooldridge test for autocorrelation	22.298	0.0001	Autocorrelation exists

Source: Compiled results from STATA software