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Clean energy projects in Asian economies: does FDI and stock market matter for sustainable development?

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ABSTRACT

The FDI and the stock market are the key sources of finance for clean energy projects to become a reality on a global level, and are considered significant drivers of green growth. Therefore, this study examines the effects of the FDI inflows and the stock market development on clean energy production in the top-FDI receiving countries. The data in this regard spans from the time period pertaining to the years 1991 to 2019. The empirical results of the group-wise estimates show that the FDI inflows, and the stock market development play a significant role in promoting clean energy production in the long run. Furthermore, the economy-wise estimates also show that the FDI inflow tends to positively affect the clean energy production in China, Singapore, Russia, India, Indonesia, and South Korea. However, the development experienced in the stock market also positively affects clean energy production in all the selected Asian economies. Thus, it can be affirmed that the governments should also encourage foreign investors, and at the same time divert stock market funds to Asia's renewable energy projects.

1. Introduction

Foreign direct investment (FDI) is considered to be a vital source of financing for clean energy projects on a global level, and this is because it influences the clean energy projects in many ways (Chen et al., 2021; Paramati et al., 2016; Su et al., 2021). For instance, the inflows of FDI permit individuals easier and cheaper access to external capital that can be utilized for technological innovation in clean energy projects. Also, FDI inflows transmit modern technologies to the economies with several expectations to significantly, and positively, enhance their clean energy intensity, while also mitigating their CO_2 emissions (Mirza et al., 2020, p. 2; Paramati et al., 2017; Umar et al., 2021d). Countries enhance their investment in clean energy projects and strengthen their investment in the environment by transferring traditional

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energy investment incentives towards projects that are relevant to clean energy initiatives (Guo et al., 2022; Ji & Zhang, 2019; Su et al., 2020).

Capital markets contribute significantly in raising resources for investing in clean energy projects around the world. Moreover, these markets also play a substantial role in enhancing economic development (Bibi et al., 2021; Kutan et al., 2018; Su et al., 2021a). However, the capital supply that is needed to bring these projects to reality is very limited due to very few suppliers around the world. Under these circumstances, it is very challenging to effectively transfer capital towards green investments targeted towards renewable energy projects. In this perspective, investors are therefore stimulated to invest in publicly traded corporations. Similarly, a study by (Schwabe et al., 2012) claimed that investors could invest capital assets in publically traded corporations by effectively stimulating renewable energy-related projects. It has further been argued that capital markets can deliver green investments that offers higher returns. Furthermore, investors can also enlarge their investments for various other assets in order to minimize the risk and enhance their risk-adjusted returns (Ielasi et al., 2018; Kaiser & Welters, 2019). Therefore, we can effectively affirm that Renewable energy projects have high demand in the future in each of the economies that have been taken into account.

The stock market's development can support investments in clean energy in several ways. For instance, the stock market can deliver new arrangements of financial support, by listing the shares of clean energy on the stock exchange markets (Mirza et al., 2020; Naqvi et al., 2017; Rizvi et al., 2021). Moreover, economies of the world need to offer diverse tax incentives to individual investors, with stakes in the clean energy frameworks, thus formulating an effortless capital attainment process. In this manner, economies can produce the adequate amount of capital required for clean energy projects, and it is projected that it will support governments and policymakers to enhance the production of clean energy, and also encourage their utilization in the economy in the context of several other productive uses (Su et al., 2021d; Umar et al., 2022; Zeqiraj et al., 2020). Therefore, the economies should familiarize efficient policy designs, in order to effectively minimize the usage of outdated energy sources. They can do this imposing additional environmental taxes, or by raising the prices of the traditional sources of energy. If this comes into play, the higher energy prices discourage the consumption of traditional energy sources, and then efficiently enable clean energy consumption (Su et al., 2021c; Wang et al., 2021; 2021b).

The current literature has started to investigate the sources of funding for renewable energy projects. In this perspective, two ground-breaking studies have been undertaken by (Paramati et al., 2017, 2016). In this regard, Paramati et al. (2016) investigated the role of the stock market and the FDI on clean energy consumption for twenty emerging economies. The study reported that both the stock market capitalization and the FDI inflows have contributed significantly towards enhancing clean energy consumption. Moreover, both the sources are more important for renewable energy ventures. Similarly, Paramati et al. (2017) explored the influence of the stock market and FDI on clean energy consumption for the OECD, G20, and EU economies panel. The findings concluded that the stock market development and the FDI inflows play a fundamental role in enhancing clean energy consumption and production across economies (Gozgor et al., 2020; Ji et al., 2021a; Yan et al., 2022).

The researcher also explored the role of the stock market development and the inward FDI on renewable energy projects (Paramati et al., 2017, 2016; Raghutla et al., 2021; Zeqiraj et al., 2020). It is noteworthy information that FDI permits corporations to experience easier and cheaper access to capital stock that aids in the development of speedy industrialization, growth of the manufacturing sector and the transportation sector that lead towards increased energy (Tang, 2009; Tang & Zhang, 2016). Meanwhile, the FDI inflows provide technological innovations to host economies that lead towards the boost of green growth activities, consequently increasing the demand for clean energy (Sadorsky, 2010). In contrast, FDI inflows raise the efficiency of energy that then leads to the mitigation of the energy demand (Sbia et al., 2014). At the same time, FDI inflows exert mixed influence on the energy demand. Similarly, the arrangement of new technological innovations in clean energy projects is, by nature, costly and intensive in terms of the capital involved (Qin et al., 2020; Umar et al., 2021c; Wei et al., 2020). Therefore, developing countries worldwide are transforming inflows of FDI towards clean energy projects, as propagate that the advanced and new technology would ultimately be supportive in the establishment of clean energy projects. Likewise, the development and growth of the stock market permits businesses that are relevant to clean energy to experience easier availability of financial assets. With the establishment of confidence across customers and businesses, the development and growth of the stock market would tend to encourage equity financing. In this regard, Mankiw and Scarth (2008) suggested that an increase in the activities of the stock market produces a wealth effect that raises the confidence level of investors and businesses, hence following such impacts, the investment initiatives tend to increase. Moreover, the Development of the stock market also raises additional availability of funds for clean energy projects that effectively produce higher levels of consumption of clean energy (Liming, 2009). These studies encourage us to empirically explore the impact of the stock market development and the FDI inflows on renewable energy production. The extant literature based on this discipline does not offer economy-wise results in the empirical analysis.

From the above discussion, it is obvious that the stock market developments and the FDI inflows are imperative for the development of any economy, and ultimately their influence on renewable energy production cannot be denied. In this perspective, the present study observes the impact of the inward FDI and the stock market development on renewable energy projects for selected Asian economies, such as China, Singapore, Russia, India, Vietnam, Japan, Indonesia, Thailand, and South Korea. The sample considered includes the top FDI-receiving Asian economies.

This study contributes to the prevailing literature in several ways. Firstly, it explores the contribution of inward FDI and stock market development contribution towards renewable energy ventures in some of the selected Asian economies. Secondly, the study employs the panel unit root test, and the cross-sectional dependence test in order to investigate the cointegration linkage, and the unit root properties of the considered variables. The long-run impact of FDI and stock market development, economic development, and carbon emissions on renewable energy projects have also been explored by employing the FMOLS and DOLS estimation techniques. Furthermore, this study fills the research gap in the existing literature by examining

the impacts of FDI and stock market development on renewable energy projects, economy-wise. The study will help policymakers to design policies that can be used to enhance the investment for renewable energy projects.

2. Literature review

With the identification of global ecological threats, there is an urgent need to address the issues of climatic change. Various ways have been adopted, such as energy conservation, development of environmental-related technologies, and enhancement of energy efficiency (Lei et al., 2021; Yang, 2020). Besides these, renewable energy production is also a vital solution for alleviating carbon emissions (Ullah et al., 2020; Usman et al., 2021). Renewable energy production can balance the contradictions of the energy market and improve the current energy mix, thus preserving environmental sustainability (Lei et al., 2021; Umar et al., 2020). Hence, renewable energy production becomes a vital source of transformation towards a carbon-free economy at the regional and national levels (Hussain et al., 2020). Renewable energy projects have attained vast attention (Sohail et al., 2021). The quest for clean energy projects is becoming a challenge as clean energy sources could fulfill almost fifty percent of energy demand by the year 2050. Moreover, the transition towards a carbon-free economy becomes possible after substituting fossil fuels sources with renewable energy sources (Ji et al., 2021b; Umar et al., 2021a).

In literature, it is well-documented that access to financial capital is fundamental to accelerating clean energy-related projects (Li et al., 2022). The access to financial capital is driven by foreign direct investment and stock markets. The deployment of clean energy projects needs financial capital that can be directly obtained from the stock markets (He et al., 2021; Naqvi et al., 2017). The significant contribution of stock markets in deploying clean energy projects is rather undeniable. (Brunnschweiler, 2006) reported a positive association between renewable energy production (i.e., biomass, geothermal, solar, and wind) and commercial banking. (Best, 2017) concluded that domestic credit is positively associated with wind energy in the sample of 137 economies. In the case of G-20 and OECD economies, (Shahzad et al., 2017) confirmed that domestic credit provision to the private sector can significantly influence power generation and clean energy projects. Additionally, after exploring energy consumption and financial development association in Central and Eastern European frontier countries, (Sadorsky, 2010) found that access to financial credit is fundamental for examining the patterns of energy production and consumption. (Corsatea et al., 2014) also denoted the significance of financial credit accessibility for clean energy projects. The literature revealed that governments have considerable sources to support energy transition from fossil fuels to clean energy sources by enlarging public expenditures on clean and renewable energy projects (Su et al., 2021b; Sun et al., 2021).

Energy sector enterprises consider it easier to access financial credit from public sources than private sources (Umar et al., 2021b). As nuclear energy projects and geothermal energy projects need capital-intensive long-term investments. Thus, governments should provide strong financial support for such types of clean energy

development projects in countries where state-owned organizations are more dominant in the energy sector (Tao et al., 2021; Wang et al., 2021a). An efficient public finance system through tax credits, subsidies, and R&D investments can accelerate the deployment of clean energy projects (Rizvi et al., 2020; Umar et al., 2021d; Yarovaya et al., 2020). (Olmos et al., 2012) revealed that privately-owned energy enterprises should replace less liquid capital stock. The study also added that an increase in the deployment of clean energy projects needs more investment in renewable and clean energy-related technologies. Such technologies can be supported by inflows of FDI that bring financial capital and managerial expertise, know-how, diversified skills, and efficient work culture in developing economies (Taghizadeh-Hesary & Yoshino, 2020). The study done by (Cosbey et al., 2005) revealed that inflows of FDI through mutual projects could stimulate clean energy development mechanisms that positively impact the human environment and environmental related technologies of the host economy.

(Paramati et al., 2017) concluded that FDI enables host economies to overcome the shortfall of financial capital for clean energy projects. (Gallagher & Zarsky, 2007) reported the positive impact of FDI on energy conversion towards clean energy sources. (Keeley & Ikeda, 2017a) study also reported a positive association between FDI and clean energy growth accompanied by green environmental-related technologies. (Kumar & Sinha, 2014) reported that FDI brings energy efficiency, reduces the supply and demand gap in the energy sector, and enhances social-economic development through the diffusion of affordable, clean, reliable, and secure energy resources. Although literature highlights several aspects through which environmental sustainability can be achieved, there is still a need to explore more. Literature argued that environmental sustainability could be enhanced by transitioning from fossil fuel sources to clean energy sources. Hence, there is a need to increase investment in clean energy projects. Moreover, it is obvious from the current stock of literature that credit from stock markets and FDI can be used to overcome the shortage of financial credit for clean energy projects. In this perspective, this study makes an effort to explore the impact of the stock market and FDI on clean energy projects.

3. Model, methods, and data

The theoretical literature shows that FDI inflows support clean energy projects by allocating financial capital for green technology in host economies (Gallagher & Zarsky, 2007). FDI is deliberated as one of the important sources of financing renewable energy ventures in each economy (Paramati et al., 2021). FDI transfers advanced technologies to the host economies by increasing renewable energy production. The theoretical framework shows that the stock market, directly and indirectly, influences renewable energy projects (Raghutla et al., 2021). Stock market development directly influences renewable energy projects by giving the funds, while indirectly influences renewable energy projects by increasing technology innovation. Thus, FDI enhances the diffusion of technological innovation by improving renewable energy projects. To achieve environmental aim, we have followed the model from Zeqiraj et al. (2020) and Raghutla et al. (2021).

$$\text{REP}_{it} = \varphi_0 + \varphi_1 \text{FDI}_{it} + \varphi_2 \text{SMD}_{it} + \varphi_3 \text{CO}_{2,\ it} + \varphi_4 \text{GDP}_{it} + \alpha_i + \varepsilon_{it}$$

where REP, FDI, SMD, CO_2, and GDP represent renewable energy production, FDI inflows, stock market development, carbon dioxide emissions, and GDP per capita. The i stated countries ($i = 1, \ldots \ldots, 9$), while t denotes the time period ($t = 1, \ldots \ldots, 30$). In model, φ_1, φ_2, φ_3, and φ_4 are the elasticities of renewable energy production with respect to FDI, stock market development, CO_2 emissions, and GDP per capita. While α_i is unobservable mean effects, and εit is the error terms in the model.

Regarding empirical analysis, firstly, the level of cross-sectional dependence arising from the economic, social, financial, and political factors is related to the degree of connectedness in the panel of Asian countries. We have applied the (Pesaran, 2007) cross-section dependency test in panel data for testing. Our study confirms the order of integration of concern variables by using Fisher-Augmented Dickey-Fuller (ADF) (Choi, 2001); Im, Pesaran, and Shin (IPS) (Im et al., 2003); and Levin, Lin, and Chu (LLC) (Levin et al., 2002). To test the long-run linkage among the concern variables, we use the Fisher-type panel data cointegration test offered by Maddala and Wu (1999).

The study uses workhorse panel data econometric approaches for long-run estimates, such as FMOLS (fully modified OLS) and DOLS (dynamic OLS). Both econometric approaches are widely used in empirical panel studies (Zafar et al., 2020). The FMOLS is one of the non-parametric estimation approaches that solve the problem of serial correlation in the panel model. The DOLS is another parametric cointegration approach that overcomes the endogeneity problem. Both parametric and non-parametric econometric approaches are based on cross-sectional dependence that gives us country-specific long-run efficient and consistent estimates (Pedroni, 2004). In addition, DOLS is less biased than FMOLS in small samples (Sadorsky, 2010; Su et al., 2021c). According to their empirical analysis, the DOLS estimator better performs than FMOLS. To avoid possible uncertainty in empirical robust results in symmetric models, we selected both the methods, i.e., FMOLS and DOLS.

This study empirically examines the FDI and stock market impact on renewable energy projects, spanning the period of 1991–2019. The sample is selected based on their top FDI receiving Asian countries in 2019 (Bank, 2020). The top-9 FDI receiving countries are China, Singapore, Russia, India, Vietnam, Japan, Indonesia, Thailand, and South Korea. The data on FDI net inflows (% of GDP), stock market development is total value (% of GDP), CO_2 emissions are measured in kilotons, and GDP per capita (constant 2010 US\$) are obtained from World Bank, but renewable energy production that is measured as renewables and other production (quad Btu) data offered by IEA. To achieve renewable energy projects, governments need domestic and foreign financial support. Therefore, FDI inflows provide access to foreign financial capital through various transmission channels and a kind source of technology diffusion (Raghutla et al., 2021). FDI fetches modern technology, which helps renewable energy projects in selected Asian nations. A stock market is an important tool for providing green finance for renewable energy investments (Zeqiraj et al., 2020). The CO_2 emissions reinforce the policymakers for renewable energy projects

(Kutan et al., 2018). The economic performance is also encouraging for renewable energy production (Przychodzen & Przychodzen, 2020). Theoretically, we considered FDI, stock market, CO_2, and GDP are key factors of renewable energy production. To best estimates, we have transformed stock market development, CO_2, and GDP into natural logarithms.

4. Empirical results and discussion

Before performing the regression analysis, preliminary outcomes of the cross-sectional dependence test are reported in Table 1. The findings report that there exists cross-sectional dependence among variables. The outcomes of unit root tests are exhibited in Table 2. The findings confirm that all the variables are stationary at the first difference, i.e., I(1). The outcomes of the panel cointegration test are described in Table 2. The concern variables have a long-term relationship in top-9 major FDI-receiving countries from 1991–2017. The long-run impacts of inward FDI and stock market developments on renewable energy projects are investigated by employing FMOLS and DOLS approaches. Table 3 displayed the results of OLS, FMOLS, and DOLS estimates for group-wise selected Asian economies, and Table 4 displayed the country-wise outcomes of FMOLS and DOLS estimates.

Table 1. Cross-sectional dependence.

Cross-sectional dependence					
Pesaran's test of cross sectional independence	11.10	9.011	6.102	0.132	1.795
Prob.	0.000	0.000	0.000	0.895	0.075
Average absolute value of the off-diagonal elements	0.582	0.522	0.307	0.385	0.407

Note: ***$p < 0.01$; **$p < 0.05$; and *$p < 0.1$.
Source: Author's Estimations.

Table 2. Panel unit root tests results and cointegration test.

	LLC		ADF		IPS		
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	Decision
REP	−0.356	−1.751*	−0.671	−12.93***	−0.289	−3.598***	**I(1)**
FDI	−0.544	−6.765***	−0.366	−5.821***	−0.210	−2.542**	**I(1)**
SM	−0.321	−2.708**	−0.200	−2.365**	−0.185	−2.112**	**I(1)**
CO_2	−0.985	−2.745**	−0.385	−2.578**	−0.175	−2.151**	**I(1)**
GDP	−0.899	−2.815**	−1.023	−8.736***	−0.589	−6.269***	**I(1)**
Cointegration test							
DHg	5.875***						
DHp	6.675***						

Note: ***$p < 0.01$; **$p < 0.05$; and *$p < 0.1$.
Source: Author's Estimations.

Table 3. FMOLS estimates of selected Asia.

	OLS		FMOLS		DOLS	
	Beta	t-stat	beta	t-stat	Beta	t-stat
FDI	0.069**	2.200	0.120***	7.570	0.010***	9.170
SM	0.670***	4.560	0.100***	8.770	0.250*	1.690
CO_2	0.993***	4.940	1.110***	6.520	1.220***	23.35
GDP	0.887***	3.810	2.640***	27.22	3.450***	4.710

Note: ***$p < 0.01$; **$p < 0.05$; and *$p < 0.1$.
Source: Author's Estimations.

Table 4. FMOLS and DOLS estimates of Country-wise.

	FMOLS				DOLS			
	FDI	SM	CO_2	GDP	FDI	SM	CO_2	GDP
China	0.910***	1.020***	5.320***	10.91***	0.280***	1.100***	1.050***	11.80***
	12.66	6.750	5.650	14.02	2.700	6.790	3.580	6.470
Singapore	0.001*	0.010***	0.020**	0.040***	0.000	0.030***	0.030**	0.050***
	1.870	11.71	2.490	9.620	0.600	8.620	2.490	12.36
Russia	0.010***	0.020**	0.230***	0.000	0.070***	0.060**	1.320***	0.030
	2.870	2.120	7.160	0.160	3.180	2.280	8.360	0.760
India	0.140**	0.250*	1.980***	1.000***	0.490***	0.890***	0.750	2.030***
	2.130	1.670	2.330	4.560	8.130	6.090	1.350	3.530
Vietnam	0.000	0.070*	0.760***	1.790***	0.010***	0.240	1.960***	4.060***
	0.380	1.810	5.870	7.710	13.74	1.280	6.650	4.420
Japan	0.050	0.140***	1.690***	5.460***	0.890***	0.130**	0.990	3.680***
	1.090	4.990	6.530	17.76	5.300	2.340	1.160	5.880
Indonesia	0.020***	0.030***	0.050**	0.560***	0.040***	0.050**	0.560***	1.270***
	6.580	3.260	2.060	14.72	5.690	2.350	8.750	4.920
Thailand	0.000	0.020***	0.400***	0.770***	0.030**	0.040	0.220	0.490**
	0.720	2.940	6.530	10.52	2.500	1.220	1.400	2.030
South Korea	0.020*	0.030**	0.030	0.220***	0.040*	0.200***	0.260	0.610***
	1.790	2.260	0.250	2.590	1.710	6.090	1.040	3.290

Note: ***$p < 0.01$; **$p < 0.05$; and *$p < 0.1$.
Source: Author's Estimations.

4.1. Group-wise analysis

In Table 3, the group-wise findings of OLS, FMOLS, and DOLS models reveal that increase in FDI inflows has a positive effect on renewable energy projects. The coefficient estimates for all three models show that due to a 1 percent rise in FDI inflows, renewable energy production increases by 0.069 percent, 0.120 percent, and 0.010 percent, respectively. This finding is reliable with prior literature (Paramati et al., 2017; Raghutla et al., 2021). The technologies can be effectually reinforced by inward FDI that usually bring sufficient capital, managerial expertise, efficient work culture, and skills base diversifies networks in developing economies. This implies that inflows of FDI through combined projects can stimulate clean energy progress mechanisms categorized by the positive impact on the pro-environment evolution of technology in the host economy. Our finding is also supported by (Keeley & Ikeda, 2017), who noted that foreign capital is more important in renewable energy projects than it reduces the problem of financial constraints. This finding is also backed by (Paramati et al., 2017), who found that the FDI empowers the host economy to certainly overcome the shortfall of capital stock for renewable energy projects. Similarly, (Gallagher & Zarsky, 2007) reported a positive impact of FDI on energy transformation toward renewable energy projects. The study further concluded that the above transformation is supported by technological evolution that occurs due to green technological generation and best practices of environmental management transmitted through FDI. These findings are also in line with (Kumar & Sinha, 2014), who reported that FDI brings larger energy efficiency, mitigates the supply-demand gap of the energy sector, supports the usage of renewable energy sources, and enhances social-economic growth through the distribution of reliable, secure, affordable, and clean energy resources. This result is inconsistent with (Przychodzen & Przychodzen, 2020), who infer that FDI does not invest in renewable energy projects connected to the energy

transition. Inflows of FDI transfer innovation production and technology processes to the host economies that can certainly speed up and promote renewable energy production. Furthermore, FDI permits business easier and cheaper access to financial capital stock that can be utilized to stimulate the arrangements of technologies for renewable energy. Due to higher inflows of FDI, economies can improve their energy efficiency and produce a carbon-free economy by reducing carbon emissions to the lowest level. These economic implications infer that FDI has influenced renewable energy projects via two transmission channels, e.g., additional sources of finance and technology diffusion (Liu et al., 2016).

The study found that the stock market also positively impacts renewable energy projects in all three models in terms of stock market developments. The findings show that in response to a 1 percent increase in stock market developments, renewable energy production rises by 0.670 percent, 0.100 percent, and 0.250 percent, respectively. This finding is backed by (Raghutla et al., 2021), who noted that stock market development provides a platform for the investor community to expand their investment through several assets to attain higher risk-adjusted returns. This infers that FDI stock market developments and inflows can play an imperative role in green energy projects. (Mankiw & Scarth, 2008) documented that a well-established stock market generates the wealth effect, increasing producers' confidence. The stock market development is considered a vital economic determinant, and increased stock market activity is considered a signal of prosperity and economic development that reinforces business in renewable energy projects. Precisely, stock market development flourishes business activities through increased renewable energy investment (Jiang et al., 2021).

It is evident from findings that the impact of stock market developments on renewable energy projects is more significant than the impact of FDI inflows, revealing that the stock market contributes largely to expanding renewable energy production. In terms of control variables, CO_2 emissions and GDP positively impact renewable energy projects, revealing that both determinants play an active role in enhancing renewable energy production.

4.2. Economy-wise analysis

In Table 4, the country-wise outcomes of FMOLS disclose that FDI has a positive effect on renewable energy projects in the case of China, Singapore, Russia, India, Indonesia, and Korea. The coefficient estimates reveal that due to a 1 percent increase in FDI inflows, renewable energy production increases by 0.910 percent in China, 0.001 percent in Singapore, 0.010 percent in Russia, 0.140 percent in India, 0.020 percent in Indonesia, and 0.020 in case of South Korea. In terms of stock market developments, the findings infer that the stock market significantly impacts renewable energy projects in all selected Asian economies. The respective coefficient estimates demonstrate that in response to a 1 percent upsurge in stock market developments, renewable energy production increases by 1.020 percent in China, 0.010 percent in Singapore, 0.020 percent in Russia, 0.250 percent in India, 0.070 percent in Vietnam,

0.140 percent in Japan, 0.030 percent in Indonesia, 0.020 percent in Thailand, and 0.030 percent in South Korea.

CO_2 and GDP lead to significantly increased renewable energy production in most economies regarding control variables. The coefficient estimates reveal that due to a 1 percent increase in carbon emissions, renewable energy production tends to rise by 5.320 percent in China, 0.020 percent in Singapore, 0.230 percent in Russia, 1.980 percent in India, 0.760 percent in Vietnam, 1.690 percent in Japan, 0.050 percent in Indonesia, and 0.400 percent in Thailand. The coefficient estimates of GDP reveal that a 1 percent upsurge in GDP results in increasing renewable energy production by 10.91 percent in China, 0.040 percent in Singapore, 1.000 percent in India, 1.790 percent in Vietnam, 5.460 percent in Japan, 0.560 percent in Indonesia, 0.770 percent in Thailand, and 0.220 percent in South Korea. In the case of a country-wide investigation, the findings of the DOLS model are quite similar to the conclusions of the FMOLS model.

5. Conclusion and implications

Clean energy significantly reduces harmful influences of fossil fuels and protects the environmental quality in Asia. International organizations and societies have initiated to force countries to decrease their pollution emissions by increasing renewable energy ventures. Though, it is very significant to recognize the economic factors that can considerably encourage renewable energy production. This research work determines the elements affecting renewable energy production in major FDI-receiving selected Asian economies from 1991 to 2019. In doing so, we have applied panel econometric approaches for analysis. The empirical outcomes established the existence of a long-term relationship between renewable energy production, FDI, stock market, CO_2 emissions, and GDP.

A group-wise panel analysis shows that inward FDI and stock market developments substantially promote renewable energy production in selected Asian economies. CO_2 emissions and GDP have a positive effect on renewable energy production. Robustness in the method is also found similar results in group-wise analysis. An economy-wise outcome shows that FDI inflows have a considerable positive impact on renewable energy production in China, Singapore, Russia, India, Indonesia, and South Korea. Furthermore, the stock market plays a substantial role in promoting renewable energy production in all selected economies. The country-wise analysis of long-run renewable energy production elasticities also provides robust estimates. Therefore, our robust analysis shows that CO_2 emissions and GDP significantly influence renewable energy production in selected economies.

Based on empirical findings, Governments should pay more devotion toward increasing development of stock market to raise green finance for clean energy projects. The government should increase political diplomacy for other economies for inward FDI into clean energy projects. Political cooperation can play a significant role in terms of FDI inflow. Authorities should encourage public-private partnership green investments projects by offering non-monetary incentives. Asian countries should also provide local and international investors tax benefits by getting more

green funds for renewable energy. Governments should also divert stock markets funds to renewable energy projects. It is suggested that governments should adopt such policies and provide incentives so that the financial assets can easily flow towards clean energy projects. Governments should also increase investment in human capital and take other necessary actions to determine strategies for clean energy projects. Moreover, trade should be enhanced; thus, clean energy-related technologies and innovation can transfer from developed economies to developing economies.

This study ignores some important aspects of renewable energy projects in analysis. Our study ignores the impact of financial institutions and financial markets on renewable energy projects. Future studies may explore the factors of renewable energy projects using financial institutions and financial markets. The upcoming research should incorporate the clean energy investment variables in panel and time-series empirical analysis. Alternative panel data cross-sectional panel approaches based on non-linear structures may also produce efficient and different policy outcomes. The application of asymmetric approaches should be more interesting for empirical analysis in a policy context. Future research may also consider the influences of COVID-pandemic and political institutions on clean energy projects in Asian economies.

Disclosure statement

Funding

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