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# How are FDI and green recovery related in Southeast Asian economies?

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**Abstract**
This study is to examine how FDI and green economic growth are related in Southeast Asian economies. It also attempts to find out the role of fiscal policy development in the relationship between FDI and green growth in the economies of the region. For this purpose, a dynamic panel threshold model is used for the data over the period 2000–2018. The main results show that FDI has a positive impact on the progress of green growth in these economies, with a stronger impact in the group of Southeast Asian economies with high fiscal development. This result confirms the pollution halo hypothesis, which states that FDI can promote green growth in a country. Aligning economic priorities to improve green fiscal policies, reforming fiscal integration programs, planning for green job creation, and implementing policies to attract FDI are recommended as important policy implications over the COVID-19 period.

**Keywords** Green recovery · Fiscal policy development · FDI · The pollution halo hypothesis · GMM approach · Southeast Asia

**JEL Classification** O33 · J21 · F21

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## 1 Introduction

Foreign direct investment (FDI) is one of the economic development tools that use the principle of capital liquidity in the global economy. Gotz and Jankowska (2022) believe that FDI plays a unique role during the fourth industrial revolution. Many developing countries use this financial instrument to harness the potential of investors from other countries to develop infrastructure, promote R&D and innovation (Erdal and Gocer 2015), improve trade flows, and globalize their economies. If we consider all dimensions of developing an economy in terms of sustainable development goals (SDGs) as defined by the United Nations in 2015, FDI helps many developing countries in achieving sustainable development indicators such as green economic growth, which is considered to be an acceptable strategy to address the threat of climate change. According to OECD (2011), green economic growth can be defined as "promoting economic growth and development while ensuring that natural resources continue to provide the resources and environmental services on which our well-being depends". Therefore, the question for conducting this study can be focused on the importance of FDI flows in achieving green economic growth and sustainable development.

Many previous studies (Nistor 2014; Iamsiraroj and Ulubasoglu 2015; Makiela and Ouattara 2018; Osei and Kim 2020; Zamani and Tayebi 2021; Ogbonna et al. 2022) have suggested that FDI is an essential factor to enhance economic growth by enabling capital inflows, job creation, technology transfer, and labor mobility. According to the World Bank database, economic growth in regions such as East Asia & Pacific, South Asia, North America, and Europe & Central Asia has turned negative since 2017. The main reasons for this continued decline in economic growth were the trade war between the U.S. and China (Bown 2021), the divergence in the EU (Brexit challenge) (Bibao-Ubillos and Camino-Beldarrain 2021), and the global oil marketvolatilities (Alamgir and Amin 2021).

In terms of green economic growth, the role of FDI inflows is not clear. In addition, the impact of fiscal policy development, which can be seen as a positive signal for FDI inflows and green economic growth, should be addressed as well.

Despite neoclassical and endogenous economic growth models show that FDI can be considered as an accelerator of economic growth in a country (due to its potential to promote R&D, innovations, employment, job creation, and production efficiency), empirical studies have not provided similar evidence on the impact of FDI on green economic growth. Some scholars view FDI as a way to shift polluting activities from countries to the host country of the investment, implying that FDI cannot help nations deal with the threat of climate change. Haug and Ucal (2019) and Salahuddin et al. (2018) showed that FDI has a positive impact on $CO_2$ emissions, which are an obstacle to green economic growth, while a group of scholars have highlighted the important role of FDI in technological improvement and financing green projects, which ensure the existence of green economic growth and reduce the risk of climate change.

The paradox in the relationship between FDI and green economic growth is becoming increasingly important for Asian countries, especially the Southeastern

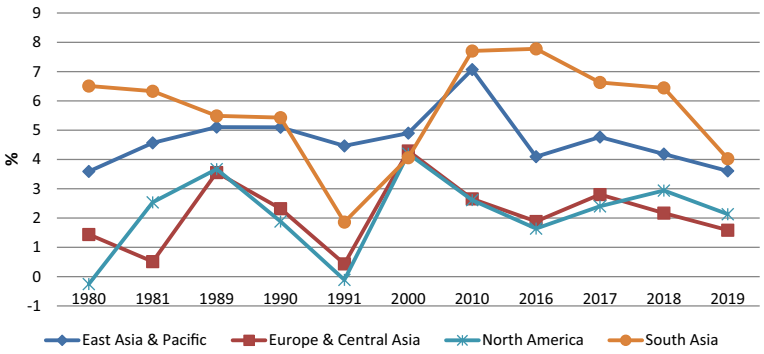


**Fig. 1** Economic growth in different regions, 1980–2019, %. Source: Authors' compilation from The World Bank. Regarding FDI trends, Fig. 2 illustrates a uniform negative trend in this variable in East Asia and the Pacific, while other regions show a growth in FDI in 2019

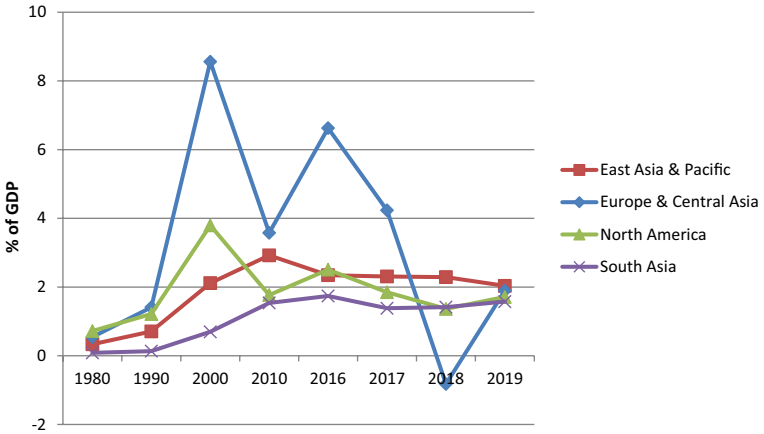


**Fig. 2** Foreign direct investment, net inflows (% of GDP), 1980–2019. Source: Authors' compilation from The World Bank

economies, where various measures have been taken in the last decade to increase FDI inflows to promote inward investment flows as the main source of capital and technology (Diaconu 2014). Among these measures, Singapore's Local Industry Upgrading Program (LIUP), Malaysia's export-led growth strategy, USAID/CAMBODIA CDCS 2020–2025, and Indonesia's Five-Year Plan (2020–24) stand out for their clear plans to attract foreign investment. According to the UNCTAD (2020) report, FDI inflows to this region increased by 5% to US$156 billion in 2020, showing that the region is the growth engine for FDI in Asia Figs. 1 and 2.

However, the region faces the challenge of pollution and green economic growth as carbon dioxide emissions have increased over the past decade. Figure 3 shows $CO_2$ emissions (in tons per capita) in the economies of Southeast Asia. It can be seen that $CO_2$ emissions have increased in all economies in this region

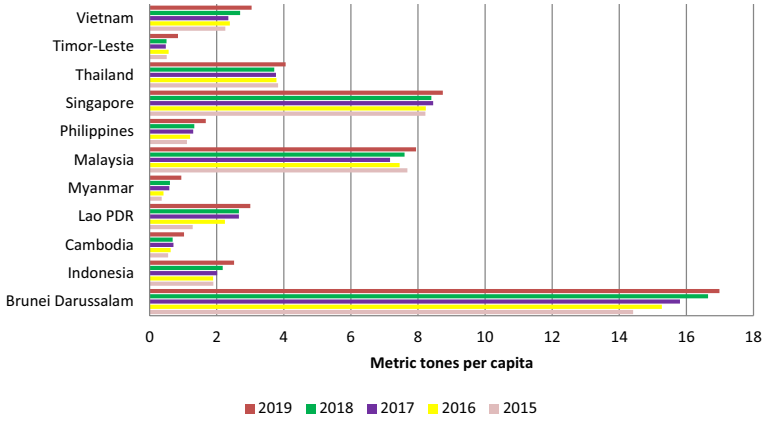


**Fig. 3** $CO_2$ emissions in Southeast Asian economies, 2015–2019, metric tones per capita. Source: Authors' compilation from The World Bank and BP (British Petroleum)

during 2015–2019, which shows the importance of studying green economic growth in this region.

In terms of the contribution of FDI to reducing $CO_2$ emissions and promoting green growth, two different hypotheses can be studied: the pollution halo hypothesis and the pollution port hypothesis. According to the pollution halo hypothesis, FDI inflows from abroad to a country lead to various opportunities to promote green production technologies in the host country of the FDI, which reduce emissions and improve green growth progress. Conversely, the pollution port hypothesis states that FDI accelerates emissions in the host country. It is based on the claim that developed countries seek to establish factories abroad through FDI flows, which leads to more emissions and pollution (Cole (2004) expresses this statement as migration of dirty factories from developed to developing countries).

In this paper, we try to explore how FDI can change green economic growth in the Southeast Asia region to understand whether FDI has a positive role (stimulating role) or negative role (deterrent role) to improve green economic growth in this region. In other words, the existence of the pollution hypothesis and the halo hypothesis is tested in this study. For this purpose, we grouped the countries of Southeast Asia based on the development level of fiscal policy and then used the GMM approach to obtain the coefficients of the variables. However, to check the threshold effect, a dynamic panel threshold method was proposed by Kremer et al. (2013), which enabled us to analyze the presence of a maximum threshold for fiscal policy development in the relationship between FDI and green economic growth.

In addition, this study contributes to the existing literature in the following aspects:

i. It contributes to the current understanding of inclusive green economic growth discussed by McKinley (2010) for the case of Southeast Asian economies. This

composite indicator includes social, economic and governance factors and is a better indicator of green economic growth of countries.

ii. It attempts to detect the significance of fiscal policy development on the signs and magnitudes of the relationship between FDI and green economic growth.

iii. It tests the presence of the pollution haven hypothesis and the pollution halo hypothesis in the relationship between FDI and green economic growth in Southeast Asian economies. According to the pollution hypothesis, FDI increases emissions, while according to the pollution halo hypothesis, FDI brings more environmentally friendly technologies and advances that promote green economic growth in a country.

iv. Modeling green economic growth in Southeast Asian economies can represent the degree of sensitivity of this variable to the explanatory macro variables (e.g., inflation, FDI) of these countries, which offers several practical and fruitful strategies for policymakers in this region and the rest of the world.

The remainder of this paper is organized as follows. In Sect. 2, the literature gap is introduced based on the previous related studies. Then, Sect. 3 discusses the data and methodology. Section 4 provides empirical results, and Sect. 5 uses two different robustness check strategies to ensure the validation of the empirical results. Finally, Sect. 6 concludes the paper and provides practical policy implications.

## 2 Literature review

To identify the literature gap, the existing studies can be divided into two different strands. The first strand of literature focuses on green economic growth and investment as a general case of countries, while the second strand focuses only on the Southeast Asian region.

The first stream of literature includes the studies on green economic growth and investment as a general theme for countries. In a study, Scholtens expressed that green tax policies had a positive impact on economic growth and net tax revenues in the Netherlands during the period 1995–1999. Gao and Zhang (2013) investigated the impact of FDI on environmental efficiency in China. The main empirical results showed that FDI can lead to better environmental quality and also higher local innovation capacity. Kardos (2014) focused on the role of FDI in the sustainable development of the European Union. He concluded that it was better to increase the share of green investments in total FDI inflows. This can help countries to promote their infrastructures and mechanisms for green economic progress. Doval and Negulescu (2014) attempted to model green investment for Romania. The main results showed that promoting green investment required more cooperation from the private sector. Using a panel data approach for 17 MENA economies, Abdouli and Hammami (2021) investigated the role of FDI and other explanatory variables to mitigate $CO_2$. They concluded that FDI accelerates environmental degradation, and their results showed that the pollution haven hypothesis exists. Pisani et al. (2019) investigated whether FDI affected the environmental sustainability of cities, and found that FDI

can help cities become greener and have better air quality. Capasso et al. (2019) identified several drivers of green growth. Leveraging foreign investment for greener technologies was identified as one of the key drivers in this study. In another study, Estevao (2020) proposed climate-friendly fiscal policies (e.g., green investment and environmental taxes) as a potential tool to promote economic growth during the crisis of COVID-19. Tawiah et al. (2021) investigated various aspects of green growth, and concluded that developing countries should pay more attention to FDI and trade to manage the progress of green growth.

Alshubiri et al. (2021) conducted an academic study to find out how FDI can affect green and fossil fuel consumption. Their results for the members of OPEC showed a positive relationship between FDI and $CO_2$ emissions and a negative relationship between FDI and green energy production. Zhou and Zao (2021) provided empirical evidence of enhancing green economic growth by increasing FDI (pollution halo). In a similar study, Khan et al. (2021) found that FDI inflows can lead to an acceleration of green economic growth, but this depends on transparent and relevant policies and regulations related to FDI and green growth progress. Demiral and Demiral (2021) employed a multidimensional approach to study the stimulators of green growth. One of the main findings of their study is that FDI can be considered as a motivator of green growth. In another recent study, Vo and Ho (2021) attempted to investigate the relationships between FDI, economic growth, and environmental degradation in the case of Vietnam. The main findings demonstrated that FDI degraded environmental quality in the long-run. Nawaz et al. (2021) focused on the relationship between green finance and environmental protection in N11 countries, and suggested that FDI had a significant impact on promoting green finance as the main component of the green economy. Opoku et al. (2021) studied the relationship between FDI and environmental pollution in African countries. The empirical result of this study showed the negative impact of FDI on emissions. Adeel-Farooq et al. (2021) tried to investigate how FDI could affect environmental indicators in 76 countries during 2002–2012. The main results showed that FDI from developed countries could help low- and lower-middle-income countries improve their environmental quality. Castellani et al. (2022) analyzed the impact of green FDI on environmental technologies as an important input for production and economic growth in Europe. The results show that FDI plus R&D (green-tech R&D FDIs) is efficient and fruitful to transfer green technologies between countries. In another recent study, Chaouachi and Balsalobre-Lorente (2022) examined the different aspects of FDI to achieve green economic growth in Algeria. The main findings demonstrated the long-term relationship between FDI and environmental protection in the country.

The second strand of literature contains all the studies on the relationship between investment, tax policy and green economy in Southeast Asian economies. In general, the issue of FDI and green economy in Southeast Asian countries has been ignored by many scholars. In a recent study, Ahmed et al. (2022) tried to explore how green innovation can promote green growth in South Asian countries. They concluded that FDI can increase green innovation in these economies, which has a positive relationship with green growth. Kang et al. (2021) studied the impact of FDI on green energy consumption in South Asian economies using the panel cointegration estimation technique and annual data over the period 1990–2019, and according to the

main findings, policymakers in South Asian economies should consider GDP and FDI as basic policy instruments for environmental sustainability. Murshed (2021) found that higher FDI inflows can reduce overall renewable energy use, while higher economic growth and $CO_2$ emissions can catalyze renewable energy use in South Asia. Caglar (2020) examined the importance of green energy consumption and FDI inflows in reducing pollution in nine countries. The main results showed significant long-term relationships between FDI, renewable energy consumption, and economic growth. Mahbub and Jongwanich (2019) investigated what factors influence the volume of FDI in the energy sector of Bangladesh. The results suggested that regulatory issues have the greatest influence on firms when it comes to FDI in the energy sector. Doytch and Narayan (2016) analyzed the relationship between FDI and green energy in 74 countries from 1985 to 2012, and found that sectoral FDI had a significant positive impact on the development of green energy infrastructure. In another study, Sbia et al. (2014) attempted to examine the impact of FDI on carbon emissions using the UAE as an example. They concluded that FDI reduces energy demand and energy intensity. Diaconu (2014) identified the characteristics of FDI in the Southeast Asian region. He found that economies in the region had many unique competitive advantages that resulted in attracting foreign investors to the region. In a pioneering study, Lucas (1993) looked at FDI in seven East and Southeast Asian countries. The main estimation results showed that FDI inflows are less elastic with respect to the cost of capital (including taxes) than with respect to wages and more elastic with respect to aggregate demand in export markets than domestic demand.

Given the above brief review, a clear gap in the literature can be filled, namely the evaluation of FDI and green growth in Southeast Asian economies through an econometric technique. Our research will therefore attempt to fill this gap in the existing literature.

## 3 Research methodology and data description

### 3.1 Variables specification

In this paper, a panel of 11 Southeast Asian economies from 2000 to 2018 is analyzed to examine the relationship between FDI and green economic growth. The main reason for selecting 11 Southeast Asian economies is that the study of the relationship between FDI and green economic growth is becoming increasingly important for Asian nations, especially for Southeast Asian economies where various measures have been taken in the last decade to promote FDI inflows to encourage inward investment flows as the main source of capital and technology (Diaconu 2014). However, the challenge of environmental pollution and green economic growth in the region is that carbon dioxide emissions have increased over the last decade.

The dependent variable is the inclusive green growth index, which includes three different aspects: Economic Growth, Social Equity, and Environmental Sustainability. The variables for each aspect can be found in Jha et al. (2018). We collected the raw data from the World Bank, British Petroleum, and UNCTAD, and calculated

the index for all 11 Southeast Asian economies. In terms of explanatory variables, FDI inflows as % of GDP are from the World Bank, and fiscal policy developments (with three proxies of tax revenue (% of GDP), expenditure (% of GDP), and CPIA fiscal policy rating 1 = low to 6 = high) are from the World Bank database. In addition, some control variables (inflation rate, renewable energy consumption, $CO_2$ emissions per capita, and labor force participation rate) are included in the empirical model based on previous literature on their impact on economic growth. Table 1 provides the description of all variables included in our empirical model.

### 3.2 Theoretical specification

To obtain a better result of the analysis of green growth through FDI, we consider all 11 Southeast Asian economies as a panel and also divide them into 2 groups based on the development level of fiscal policy and re-estimate the coefficients for each group of Southeast Asian economies. A general equation for economic growth (Eq. 1) can be considered as our basic econometric model for estimation:

$$gG_{i,t} - gG_{i,t-1} = (\beta - 1).gG_{i,t-1} + \alpha.Z_{i,t} + \theta_t + \mu_t + \varepsilon_{i,t} \quad (1)$$

where $gG$ stands for the inclusive green growth indicator, $\theta_t$ and $\mu_t$ are time-fixed effects and time invariant country-specific effects, respectively. $Z$ stands for all explanatory variables and $\varepsilon_{i,t}$ stands for the idiosyncratic shocks. Following the economic growth literature that addresses the endogeneity problem, the estimation is done using the Generalized Method of Moments (GMM) proposed by Blundell and Bond (1998), which solves the problem of unobserved heterogeneity and simultaneity in the empirical model. This estimator employs the lagged dependent variables and explanatory variables as instruments to solve the above problems. As an identification test, the Hausman test is applied to examine whether the correlating random or fixed effect exists in the model.

Following Osei and Kim (2020), a linear interaction model is used for the interaction between FDI and fiscal development level. Then, the estimated interaction can be included as a variable in the empirical estimation model to investigate whether FDI depends on the level of fiscal policy development. For this end, Eq. 1 can be reformulated into Eq. 2:

$$gG_{i,t} - gG_{i,t-1} = (\beta - 1).gG_{i,t-1} + \delta FDI_{i,t} + \alpha.Z_{i,t} + \theta_t + \mu_t + \varepsilon_{i,t} \quad (2)$$

There is a significant interaction between the level of fiscal policy development (FDEV) and the coefficient of FDI in Eq. 2:

$$\delta = \gamma_1 + \gamma_2.FDEV_{i,t} \quad (3)$$

Considering Eq. 3 and Eq. 2, the green growth equation (Eq. 4) can be obtained as follows:

**Table 1** Data description

| Role in empirical model | Variable | Symbol | Unit | Source |
|---|---|---|---|---|
| Dependent variable | Inclusive green growth indicator | GGRO | – | Calculation based on Jha et al. (2018) |
| Explanatory variable | Inwards FDI | FDI | % of GDP | World Bank's World Development Indicators database |
| Interfering variable (fiscal policy development) | Tax revenue | Tax | % of GDP | World Bank's database |
| | Expense | EXP | % of GDP | |
| | Fiscal policy rating | FP | 1 = low to 6 = high | |
| Control variables | Inflation rate | INF | % | World Bank's World Development Indicators database |
| | Renewable energy consumption | REN | % of total energy consumption | World Bank's World Development Indicators database |
| | CO2 emissions | CO2 | Metric tones per capita | World Bank's World Development Indicators database |
| | Labor force participation rate | LFO | % of total population ages + 15 | World Bank's World Development Indicators database |

Source: Authors

$$gG_{i,t} - gG_{i,t-1} = (\beta - 1).gG_{i,t-1} + \gamma_1 FDI_{i,t} + \left(\gamma_2 FDI_{i,t} * FDEV_{i,t}\right) + \gamma_3 FDEV_{i,t} + \alpha.Z_{i,t} + \theta_t + \mu_t + \varepsilon_{i,t} \quad (4)$$

By estimating the coefficients of the variables in Eq. 4, we can investigate whether the level of fiscal policy development of Southeast Asian economies plays an important role in FDI green growth in this region. To perform the GMM estimation, the variables are lagged for the level equation and lagged for the difference equation.

Furthermore, a dynamic panel threshold model (Hansen 1999; Caner and Hanes 2004) that allows for endogeneity among the regressors is run to find out whether there is a threshold for the development of fiscal policy related to FDI and green economic growth in the Southeast Asian economies. The dynamic panel threshold equation is shown in Eq. 5:

$$gG_{i,t} = \mu_i + \alpha_1 FDI_{i,t} I\left(FDEV_{i,t} \le \gamma\right) + \delta_1 I\left(FDEV_{i,t} \le \gamma\right) + \alpha_3 FDI_{i,t} I(FDEV_{i,t} > \gamma) + \omega.Z_{i,t} + \varepsilon_{i,t} \quad (5)$$

In Eq. 6, $\gamma$ indicates the threshold level. To estimate the threshold level, Arellano and Bover's (1995) method is used. The forward orthogonal deviations (FOD) approach is recommended by previous studies such as Aydin et al. (2016) and Zhang et al. (2019) to ensure that the error terms are not correlated.

It is worth mentioning that to account for instruments (as a strategy to control for simultaneity and unobserved heterogeneity) in the GMM approach, the variables are lagged twice for the difference equation and once for the level equation. In addition, the "collapse" option in the STATA comment "xtabond2" is used to address the instrument multiplication problem (*see* Roodman 2009). Furthermore, following Zakari et al. (2022), to conduct a GMM estimation, it is necessary to

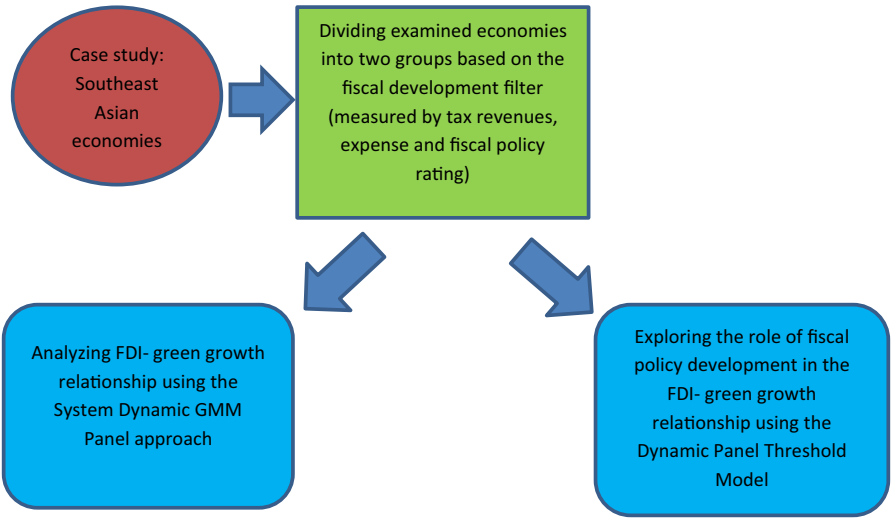


**Fig. 4** Conceptual framework of research procedure. Source: Authors

**Table 2** Classification of Southeast Asian economies based on fiscal policy development level

| High level of fiscal policy development (HFDEV) (higher than the average) | Low level of fiscal policy development (LFDEV) (lower than the average) |
|---|---|
| Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam | Brunei, Cambodia, East Timor, Laos, Myanmar |

Source: Authors

**Table 3** Hausman identification test

| Dependent variable | Chi Square stat | Chi Square d.f | *P*-value | Decision |
|---|---|---|---|---|
| Inclusive green growth indicator | 60.48244 | 12 | 0.000 | Fixed effect |

Source: Authors

pass three different procedures namely identification (considering years as strictly exogenous), simultaneity (adding lagged variables as instruments) and exclusion restrictions(employing the difference in Hansen test).

To clarify the procedure of the empirical part, the following conceptual framework (Fig. 4) can be presented:

## 4 Empirical findings and discussions

First, the 11 countries studied in Southeast Asia are classified into 2 groups (high and low fiscal development level). The fiscal development level is calculated based on the three variables of tax revenue, expenditure and fiscal policy rating (we converted the measurement of this variable (range of 1–6) into %). Table 2 shows the two subsets of Southeast Asian economies.

Then, the Hausman identification test is applied, which proves the adequacy of the random effect. The results are reported in Table 3 as follows:

Now we can estimate the coefficients for the entire sample (11 economies in the region) and the subsets of the sample (6 economies with high levels of fiscal policy development and 5 economies with low levels of fiscal policy development). Table 4 shows the results of the estimation based on the system dynamic panel GMM as follows:

Table 4 shows that FDI has a positive impact on the inclusive green growth indicator for the whole sample and the two groups of economies with low and high levels of fiscal policy development. However, the variable coefficient is larger for the group of Southeast Asian economies with high levels of fiscal development than for the group of economies with low levels of fiscal development in the region. This result is consistent with Rioja and Valev (2004), who demonstrated that countries should have higher levels of fiscal and financial policies to use FDI more efficiently

**Table 4** Results of system dynamic panel GMM

| Variable | Panel of 11 economies | Sub-sample groups of countries | | Interaction | | |
|---|---|---|---|---|---|---|
| | | LFDEV | HFDEV | Tax | EX | FP |
| FDI | 0.10* | 0.04** | 0.24** | 0.09** | 0.09** | 0.14* |
| INF | −0.32** | −0.48* | −0.17* | −0.11* | −0.27** | −0.19** |
| REN | 0.05* | 0.01** | 0.19* | 0.07** | 0.01 | 0.05 |
| CO2 | −0.31** | −0.11* | −0.26* | −0.15 | −0.18* | −0.06** |
| LFO | 0.05 | 0.06 | 0.11** | 0.01* | 0.04** | 0.09** |
| Tax | – | – | – | −0.07* | – | – |
| FDI*Tax | – | – | – | −0.27** | – | – |
| EX | – | – | – | – | −0.01** | – |
| FDI*EX | – | – | – | – | −0.26* | – |
| FP | – | – | – | – | – | −0.22 |
| FDI*FP | – | – | – | – | – | −0.43 |
| F-stat for FDI | – | – | – | 4.57* | 4.79* | 3.54* |
| Countries | 11 | 6 | 5 | 11 | 11 | 11 |
| Observation | 209 | 114 | 95 | 209 | 209 | 209 |
| Instruments | 7 | 4 | 4 | 9 | 9 | 9 |
| Hansen's J test | 0.313 | 0.515 | 0.301 | 0.253 | 0.267 | 0.189 |
| AR(1) test | 0.462 | 0.123 | 0.392 | 0.229 | 0.392 | 0.205 |
| AR(2) test | 0.904 | 0.260 | 0.664 | 0.489 | 0.664 | 0.493 |
| Sargen Over-idnetifying restrictions test | 0.193 | 0.214 | 0.184 | 0.229 | 0.391 | 0.261 |
| Difference in Hansen test for instruments | 0.031 | 0.049 | 0.193 | 0.059 | 0.003 | 0.048 |
| Fisher | 103,323.19 | 219,430.39 | 149,201.03 | 179,430.49 | 131,035.29 | 122,043.95 |

Note 1: LFDEV and HFDEV indicate low fiscal policy development and high fiscal policy development, respectively. In addition, FDI, INF, REN, CO2, LFO, Tax, EX, and FP are foreign direct investment, inflation rate, renewable energy consumption, carbon dioxide emissions, labor force participation rate, tax revenue, expense, and CPIA fiscal policy rating, respectively

Note 2: * and ** show significance at the 5% and 10% level, respectively

Source: Authors

for economic growth. For developing countries, FDI can lead to significant improvement in R&D and green innovation (Erdal and Gocer 2015), which is an essential prerequisite for green economic growth. They can bring about renewable energy development, green project promotion, green job creation, and green industrialization (Dermena and Afesorgbor 2020), which are crucial for developing Asian countries.

To deepen the results, linear interaction analysis was used to test whether the coefficient of FDI is related to the development level of fiscal policy. Table 3 shows that the interaction term for tax revenue (Tax) and expenditure (EX) has a negative sign and is statistically significant, which means that the growth effect of FDI is reduced by increasing the level of fiscal policy development. However, if we consider FP (fiscal policy rating) as a representative of the level of fiscal policy development in a country, the interaction term is not statistically significant. Moreover, for the panel of all Southeast Asian economies, the inflation rate has a negative impact on the green growth indicator, which means that any increase in the general price level of goods and services in this region can slow down the progress of green growth. This result is in line with previous studies (e.g., Sahnoun and Abdennadher 2019; Haseeb et al. 2019) that found a negative impact of inflation on supply chain activities and consequently on the growth of an economy, while this result is in contrast with Benhabib and Spiegel (2009), Adaramola and Dada (2020), and Dabbous and Tarhini (2021), who found a positive impact and neutrality of the inflation rate on the growth of an economy. The sign of the coefficient for renewable energy consumption is positive and statistically significant, which highlights the important contribution of promoting green energy consumption to green growth. The result supports the conclusions of Radmehr et al. (2021), who described the positive influence of renewable energy consumption on the reduction of carbon dioxide and thus on the development of green growth. Moreover, we found the negative impact of $CO_2$ on inclusive green growth in Southeast Asian economies, which is in line with Hao et al. (2021) who found a negative relationship between green growth and $CO_2$ emissions in G7 countries. Interestingly, the empirical estimations did not reveal the influence of labor force participation rate on inclusive economic growth in the region, implying that green growth in the region is still not dependent on labor force participation, which means that labor force is not a significant factor for green growth in the Southeast Asian region. The result highlights the importance of green employment (as argued by Bowen et al. 2018) in the region to increase the role of labor input in the progress of green growth of economies in this region. However, when we consider the groups of economies based on their level of fiscal policy development, the estimation results show the positive and statistically significant impact of labor force participation rate on the inclusive green growth of the HFDEV group, which means that in countries with higher fiscal policy development, green economy employment may be higher and consequently the impact of labor input tends to be larger than in countries with low fiscal policy development in the Southeast Asia region. Moreover, the magnitude of the negative impact of inflation on green growth is lower in the countries in the high fiscal development group than in the low fiscal development countries. This result is supported by Hung (2003), who argued that a country with better fiscal policy development can provide more efficient inflation rate control. To ensure the appropriateness of conducted GMM approach, as reported in Table 4, a number of tests to check identification, simultaneity and exclusion restrictions have been employed. Arrelano-Bond tests for AR (1) in first differences and for AR (2) in first differences approved no autocorrelation in

**Table 5** Results of dynamic panel threshold model

| | Tax |
|---|---|
| Threshold Confidence intervals | 94.51 [88.59, 96.19] |
| FDI impact | |
| $\alpha_1(FDEV > \gamma)$ | −0.035 (0.045) |
| $\alpha_2(FDEV \leq \gamma)$ | 0.150* (0.053) |
| INF | −0.094** (0.014) |
| REN | 0.231* (0.014) |
| CO2 | −0.095 (0.065) |
| LFO | 0.007 (0.011) |
| $\delta_1$ | 0.006 * (0.005) |
| Observations | 209 |
| Time period | 2000–2018 |
| Countries | 11 |

Note: numbers in () show standard errors, *and ** report significance at the 10% and 5% level, respectively. Tax stands for tax revenue. Source: Authors

the model. Moreover, the over-identifying restrictions test show the appropriate of number of instruments in running the GMM approach.

Due to the shortcomings of linear interaction analysis and distributed sample regressions, a dynamic panel threshold model is used to estimate Eq. 5 to capture the threshold level of fiscal policy development (with the tax revenue (tax) in the linkage between FDI and the inclusive green growth indicator for Southeast Asian economies. The estimation results of this model are presented in Table 5 as follows:

According to Table 5, the threshold value is 94.51, which can be considered as 94.51% of the green growth indicator. About 20% of the observations in our sample are above the threshold of 94.51. Based on the regime-dependent marginal effects ($\alpha_1 and \alpha_2$), FDI inflows have a positive and statistically significant impact on the green growth indicator when the tax (tax revenue) is below the threshold, while the impact of FDI becomes insignificant when the tax is above the threshold. Moreover, the signs of the explanatory variables inflation rate and renewable energy consumption are plausible and significant. The results in Table 4 suggest that there is a potential fiscal development threshold in the relationship between FDI and green growth. Therefore, the determination of efficient fiscal policy in Southeast Asian economies is essential because of its impact on the magnitude of the relationship between FDI and green growth. On one hand, tax rules and public spending in these economies should be optimized, and on the other hand, these economies should consider all options to address the fiscal deficit challenge under the COVID-19 circumstances that have negatively affected the public health system, trade flows, capital mobility, and economic activities (Sciortino and Saini 2020; Malahayati et al. 2021).

**Table 6** Robustness checks

| Independent variables | Coefficient | Standard error | *P* value |
|---|---|---|---|
| *Part A: Results of PMG estimations (First robustness check)* | | | |
| *Long-run*: | | | |
| FDI | 0.245 | 0.038 | 0.004 |
| *Short-run*: | | | |
| ΔFDI | 0.009 | 0.224 | 0.024 |
| *Part B: Short-term country specific results (second robustness check)* | | | |
| Country | ECT | FDI | |
| Indonesia | −0.166 | 0.06** | |
| Malaysia | −0.059 | 0.320* | |
| Philippines | −0.231 | 0.015* | |
| Singapore | −0.139 | 0.09** | |
| Thailand | −0.004 | 0.065* | |
| Vietnam | −0.088 | 0.084** | |
| Cambodia | −0.104 | −0.034* | |
| Myanmar | −0.516 | 0.239** | |
| Laos | −0.144 | 0.006* | |
| East Timor | −0.144 | 0.021 | |
| Brunei | −0.584 | 0.009 | |

Source: Authors

## 5 Robustness check

To ensure the validation of the empirical results, we apply two different robustness check strategies.

In the first strategy, we consider the growth model used by Rahman and Alam (2021), where economic growth is a function of per capita energy consumption, per capita trade, per capita capital, FDI inflows, and human capital index, obtained from the World Development Indicators, the World Bank database, BP and Feenstra et al. (2015). To find a suitable estimation technique, the cross-sectional dependence test, the cross-sectional augmented Dickey Fuller (CADF) of Pesaran (2007) and the panel cointegration test of Kao (1999) are conducted. Based on the results of the preliminary tests, the long-run and short-run estimates are performed using the pooled mean group (PMG) technique. Table 6 (Part A) shows the results of the PMG estimates. Table 6 (Part A) shows that the coefficients of FDI are positive and significant in both the long-run and short-run, demonstrating the positive impact of this variable on the indicator of inclusive green growth in 11 Southeast Asian economies, which is consistent with the results in Table 4. The Second strategy of robustness check follows the first strategy and involves analyzing the relationship between FDI and green growth at the country

level in Southeast Asian economies. Table 6 (Part B) presents the results of the country-level short-term analysis. The results show that FDI has a positive impact on the green growth indicator in the short-run in most economies in the region (Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, Cambodia, Myanmar, and Laos), while in East Timor and Brunei, the coefficient of FDI is not statistically significant. Since in most cases (9 out of 11 economies) the relationship between FDI and green growth is similar to that in Table 4, the empirical results of this study are reliable and confirmed.

## 6 Conclusion and policy implications

This paper attempts to examine the relationship between FDI inflows and green economic growth for the case of 11 economies in Southeast Asia. Moreover, the role of fiscal policy development on the direction and magnitude of FDI green growth of these economies is analyzed using 19 years of data (2000–2018) and employing a GMM estimation procedure. For this purpose, we first divided the total sample into two groups of countries based on the level of fiscal policy development and performed a linear system GMM. Then, to evaluate the threshold, the dynamic panel threshold method was applied to investigate whether there is a maximum fiscal policy development threshold in the relationship between FDI and green growth in the region.

### 6.1 Concluding remarks

The empirical results show that, on one hand, FDI has a positive impact on the progress of economies in terms of green growth, with a stronger impact in the group of Southeast Asian economies with high levels of fiscal development. This result is in contrast to the pollution haven hypothesis, which states that FDI increases emissions, while it is consistent with the pollution halo hypothesis, which states that FDI can promote green growth in a country.

Moreover, there is a fiscal policy development threshold that establishes a positive relationship between FDI and green growth in Southeast Asian countries. As for the explanatory variables, inflation rate has a negative impact on the green growth indicator, while renewable energy consumption has a positive contribution to green growth. Moreover, the negative impact of $CO_2$ on inclusive green growth in Southeast Asian economies has been demonstrated, highlighting the importance of carbon mitigation policies in the region. The empirical estimates found no evidence of the impact of labor force participation on inclusive economic growth in the region, implying that green growth in the region is still not dependent on labor force participation, suggesting that labor force participation is not a significant determinant of green growth in the Southeast Asia region. When we look at the groups of economies based on their level of fiscal development, we can conclude that labor force participation is an accelerating factor for inclusive green growth in the HFDEV group. Moreover, the magnitude of the negative impact of inflation on green growth

is lower in the countries in the group with high levels of fiscal development than in the countries with low levels of fiscal development.

### 6.2 Policy implications

From the concluding remarks, it can be inferred that:

i. To achieve a greater impact of FDI on the progress of green growth, Southeast Asian economies should align their economic priorities and policies to improve their fiscal policy development, especially their green fiscal policies (Yang et al. 2019; Chang et al. 2020; Dongyang 2021), which can be fruitful to positive impacts of FDI on green growth of countries in Southeast Asia. In other words, these economies urgently need effective fiscal policies to stimulate private investors from abroad through tax exemption, subsidy policies, and a regulatory framework that attracts investment;
ii. As a practical policy implication, countries, especially Southeast Asian economies, where there is no significant correlation between labor force participation and the green growth indicator, are recommended to plan for green job creation. For this end, using successful experiences such as the Green Action Plan (GAP) for SMEs issued in 204 for the EU and the Green Jobs Initiative of UNEP, ILO, IOE, and ITUC can be an appropriate policy for developing countries such as those in the Southeast Asia region. Creating green jobs can help workers improve their green skills and abilities, which is a way to promote green culture in a society;
iii. As the existence of the halo hypothesis of environmental pollution in Southeast Asian economies has been confirmed, green tax incentives, the development of green financial instruments such as green bonds, and the establishment of green economic zones can be used to attract more FDI. These measures are even more important in the era of COVID-19, which has negatively affected capital flows and globalization between countries. Global reports show that COVID-19 has had a strong impact on global FDI flows through the introduction of travel and economic restrictions. Therefore, it is necessary to consider various aspects of the impact caused by the pandemic in order to increase FDI flows in the post-COVID era.

### 6.3 Future recommendations

Despite several research limitations (e.g., the lack of up-to-date information on economic variables in 2022), the authors believe that the study makes a significant contribution to the existing literature on the relationship between FDI and green growth or between FDI and climate change; however, incorporating data on

green FDI and green fiscal policy would yield more fruitful results. Therefore, for future studies, it is recommended to extend the empirical model to include green FDI and green fiscal policy indicators. In addition, comparing the results across different Asian regions would provide better insights to policymakers in Asia on how fiscal policy can promote green growth. Conducting qualitative methods (e.g., Analytic Hierarchy Process or MADMs) is an excellent recommendation for future research that can evaluate the opinions of scholars and experts and would complement the quantitative estimation results.

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## References

Abdouli M, Hammami S (2021) Economic growth, FDI inflows and their impact on the environment: an empirical study for the MENA countries. Qual Quant 51:121–146

Adaramola AO, Dada D (2020) Impact of inflation on economic growth: Evidence from Nigeria. Invest Manag Finan Innov 17(2):1–13

Adeel-Farooq R, Riaz M, Ali T (2021) Improving the environment begins at home: Revisiting the links between FDI and environment. Energy. https://doi.org/10.1016/j.energy.2020.119150

Ahmed F, Kousar Sh, Pervaiz A, Triniad-Segovia J, Casado-Belmonte M, Ahmed W (2022) Role of green innovation, trade and energy to promote green economic growth: a case of South Asian Nations. Environ Sci Pollut Res 29:6871–6885

Alamgir F, Amin S (2021) The nexus between oil price and stock market: Evidence from South Asia. Energy Rep 7:693–703

Alshubiri F, Elheddad M, Jamil S, Djellouli N (2021) The impacts of financial depth and foreign direct investment on the green and non-green energy consumption of OPEC members. SN Bus Econom. https://doi.org/10.1007/s43546-021-00075-4

Arellano M, Bover O (1995) Another look at the instrumental variable estimation of error-components models. J Econom 68(1):29–51

Aydin C, Esen O, Bayrak M (2016) Inflation and Economic Growth: A Dynamic Panel Threshold Analysis for Turkish Republics in Transition Process. Procedia Soc Behav Sci 229:196–205

Benhabib J, Spiegel MM (2009) Moderate inflation and the deflation–depression link. J Money Credit Bank 41(4):787–798

Bibao-Ubillos J, Camino-Beldarrain V (2021) Reconfiguring global value chains in a post-Brexit world: A technological interpretation. Technol Soc 67:101716. https://doi.org/10.1016/j.techsoc.2021.101716

Blundell R, Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. J Econom 87(1):115–143

Bowen A, Kuralbayeva K, Tipoe E (2018) Characterising green employment: The impacts of 'greening' on workforce composition. Energy Econom 72:263–275

Bown C (2021) The US–China trade war and Phase One agreement. J Policy Model 43(4):805–843

Caglar A (2020) The importance of renewable energy consumption and FDI inflows in reducing environmental degradation: Bootstrap ARDL bound test in selected 9 countries. J Clean Prod 264:121663. https://doi.org/10.1016/j.jclepro.2020.121663

Caner M, Hanes BE (2004) Instrumental variable estimation of a threshold model. Econom Theor 20(5):813–843

Capasso M, Hansen T, Heiberg J, Klitkou A, Steen M (2019) Green growth – A synthesis of scientific findings. Technol Forecast Soc Chang 146:390–402

Castellani D, Marin G, Montresor S, Zanfei A (2022) Greenfield foreign direct investments and regional environmental technologies. Res Policy 51(1):104405. https://doi.org/10.1016/j.respol.2021.104405

Chang K, Wan Q, Lou Q, Chen Y, Wang W (2020) Green fiscal policy and firms' investment efficiency: New insights into firm-level panel data from the renewable energy industry in China. Renewable Energy 151:589–597

Chaouachi M, Balsalobre-Lorente D (2022) Environmental strategies for achieving a new foreign direct investment golden decade in Algeria. Environ Sci Pollut Res. https://doi.org/10.1007/s11356-021-18149-z

Cole M (2004) Trade, the pollution haven hypothesis and the environmental Kuznets curve: examining the linkages. Ecol Econ 48(1):71–81

Dabbous A, Tarhini A (2021) Does sharing economy promote sustainable economic development and energy efficiency? Evidence from OECD countries. J Innov Knowl 6(1):58–68

Demena B, Afesorgbor S (2020) The effect of FDI on environmental emissions: Evidence from a meta-analysis. Energy Policy 138:111192. https://doi.org/10.1016/j.enpol.2019.111192

Demiral M, Demiral O (2021) Where is the gray side of green growth? Theoretical insights, policy directions, and evidence from a multidimensional approach. Environ Sci Pollut Res. https://doi.org/10.1007/s11356-021-13127-x

Diaconu L (2014) The Foreign Direct Investments in South-East Asia during the Last Two Decades. Procedia Econom Finance 15:903–908

Dongyang Z (2021) Does a green-designed fiscal policy optimal firm innovation scheme on volatility? A firm level evidence in the Post-Covid-19 era. Resour Policy 74:102428. https://doi.org/10.1016/j.resourpol.2021.102428

Doytch N, Narayan S (2016) Does FDI influence renewable energy consumption? An analysis of sectoral FDI impact on renewable and non-renewable industrial energy consumption. Energy Econom 54:291–301

Erdal L, Gocer I (2015) The Effects of foreign direct investment on R&D and innovations: panel data analysis for developing Asian Countries. Procedia Soc Behav Sci 195:749–758

Estevao M (2020) Climate-smart fiscal policy can foster a lasting economic recovery. One Earth 3(3):273–276

Feenstra RC, Inklaar R, Timmer MP (2015) The next generation of the Penn world table. Am Econ Rev 105(10):3150–3182

Gao X, Zhang W (2013) Foreign investment, innovation capacity and environmental efficiency in China. Math Comput Model 58(5–6):1040–1046

Gotz M, Jankowska B (2022) When reality diverges from expectations Industry 4.0 FDI and post-transition economy. Technol Soc 68:101936. https://doi.org/10.1016/j.techsoc.2022.101936

Hansen BE (1999) Threshold effects in non-dynamic panels: estimation, testing and inference. J Econom 93(2):345–368

Hao L, Umar M, Khan Z, Ali W (2021) Green growth and low carbon emission in G7 countries: How critical the network of environmental taxes, renewable energy and human capital is? Sci Total Environ 752:141853. https://doi.org/10.1016/j.scitotenv.2020.141853

Haseeb M, Zandi G, Hartani NH, Pahi MH, Nadeem S (2019) Environmental analysis of the effect of population growth rate on supply chain performance and economic growth of Indonesia. Ekoloji Dergisi 28(107):417–426

Haug AA, Ucal M (2019) The role of trade and FDI for CO2 emissions in Turkey: nonlinear relationships. Energ Econs 81:297–307

Hung F (2003) Inflation, financial development, and economic growth. Int Rev Econ Financ 12(1):45–67

Iamsiraroj S, Ulubasoglu M (2015) Foreign direct investment and economic growth: A real relationship or wishful thinking? Econ Model 51:200–213

Jha S, Sandhu S, Wachirapunyanont R (2018) Inclusive green growth index. ADB. URL: https://www.adb.org/publications/inclusive-green-growth-index [Accessed on 20.10.2021]

Kang X, Khan F, Ullah R, Arif M, Rehman S, Ullah F (2021) Does foreign direct investment influence renewable energy consumption? empirical evidence from South Asian countries. Energies 14:3470. https://doi.org/10.3390/en14123470

Kardos M (2014) The relevance of foreign direct investment for sustainable development. empirical evidence from European Union. Procedia Economics and Finance 15:1349–1354

Khan M, Trinh H, Khan I, Ullah S (2021) Sustainable economic activities, climate change, and carbon risk: an international evidence. Environ Dev Sustain. https://doi.org/10.1007/s10668-021-01842-x

Lucas R (1993) On the determinants of direct foreign investment: Evidence from East and Southeast Asia. World Dev 21(3):391–406

Mahbub T, Jongwanich J (2019) Determinants of foreign direct investment (FDI) in the power sector: A case study of Bangladesh. Energ Strat Rev 24:178–192
Makiela K, Ouattara B (2018) Foreign direct investment and economic growth: Exploring the transmission channels. Econ Model 72:296–305
Malahayati M, Masui T, Anggraeni L (2021) An assessment of the short-term impact of COVID-19 on economics and the environment: A case study of Indonesia. Economia. https://doi.org/10.1016/j.econ.2021.12.003
McKinley, T. 2010. Inclusive Growth Criteria and Indicators: An Inclusive Growth Index for Diagnosis of Country Progress. ADB Working Paper Series, No.14, https://www.adb.org/sites/default/files/publication/28493/adb-wp14-inclusive-growth-criteria.pdf [Accessed 15.10.2021]
Murshed M (2021) Can regional trade integration facilitate renewable energy transition to ensure energy sustainability in South Asia? Energy Rep 7:801–828
Nawaz M, Sesadri U, Kumar P, Aqdas R, Patwary A, Riaz M (2021) Nexus between green finance and climate change mitigation in N-11 and BRICS countries: empirical estimation through difference in differences (DID) approach. Environ Sci Pollut Res 28:6504–6519
Nistor P (2014) FDI and Economic Growth, the Case of Romania. Procedia Econom Finance 15:577–582
OECD. 2011. Towards green growth. URL: https://www.oecd.org/greengrowth/48012345.pdf [Accessed on 20.10.2021]
Ogbonna O, Ogbuabor J, Manasseh Ch, Ekeochha D (2022) Global uncertainty, economic governance institutions and foreign direct investment inflow in Africa. Econ Chang Restruct. https://doi.org/10.1007/s10644-021-09378-w
Opoku E, Adams S, Aluko O (2021) The foreign direct investment-environment nexus: Does emission disaggregation matter? Energy Rep 7:778–787
Osei M, Kim J (2020) Foreign direct investment and economic growth: Is more financial development better? Econ Model 93:154–161
Pisani N, Kolk A, Ocelik V, Wu G (2019) Does it pay for cities to be green? An investigation of FDI inflows and environmental sustainability. J Int Bus Policy 2:62–85
Radmehr R, Henneberry S, Shayanmehr S (2021) Renewable energy consumption, CO2 emissions, and economic growth nexus: a simultaneity spatial modeling analysis of EU countries. Struct Change Ecoonm Dynam 57:13–27
Rahman M (2021) Exploring the driving factors of economic growth in the world's largest economies. Heliyon 7(5):e07109. https://doi.org/10.1016/j.heliyon.2021.e07109
Rioja F, Valev N (2004) Does one size fit all?: a reexamination of the finance and growth relationship. J Dev Econ 74(2):429–447
Roodman D (2009) How to do xtabond2: an introduction to difference and system gmm in stata. STATA J 9(1):86–136
Sahnoun M, Abdennadher C (2019) Causality between inflation, economic growth and unemployment in North African countries. Econom Alternat 1:77–92
Salahuddin M, Alam K, Ozturk I, Sohag K (2018) The effects of electricity consumption, economic growth, financial development, and foreign direct investment on CO2 emissions in Kuwait. Renew Sust Energ Rev 81:2002–2010
Sbia R, Shahbaz M, Hamdi H (2014) A contribution of foreign direct investment, clean energy, trade openness, carbon emissions and economic growth to energy demand in UAE. Econ Model 36:191–197
Sciortino R, Saini F (2020) Towards a comprehensive narrative and response to COVID-19 in Southeast Asia. Soc Sci Human Open 2(1):100058. https://doi.org/10.1016/j.ssaho.2020.100058
Tawiah V, Zakari A, Adedoyin FF (2021) Determinants of green growth in developed and developing countries. Environ Sci Pollut Res 28:39227–39242
UNCTAD (2020) Investment flows to developing countries in Asia could fall up to 45% in 2020. URL: https://unctad.org/news/investment-flows-developing-countries-asia-could-fall-45-2020 [Accessed on 26.10.2021]
Vo D, Ho Ch (2021) Foreign investment, economic growth, and environmental degradation since the 1986 "Economic Renovation" in Vietnam. Environ Sci Pollut Res 28:29795–29805
Yang D, Chen Z, Yang Y, Nie P (2019) Green financial policies and capital flows. Physica A 522:135–146
Zakari A, Li G, Khan I, Jindal A, Tawiah V (2022) Are abundant energy resources and Chinese business a solution to environmental prosperity in Africa? Energy Policy 163:112829. https://doi.org/10.1016/j.enpol.2022.112829

Zamani Z, Tayebi SK (2021) Spillover effects of trade and foreign direct investment on economic growth: an implication for sustainable development. Environ Dev Sustain. https://doi.org/10.1007/s10668-021-01597-5

Zhang Y, Zhai L, Sun H (2019) Does the level of financial leasing matter in the impact of bank lending on economic growth: Evidence from the global market (2006–2016). Financ Res Lett 30:352–359

Zhou X, Zao X (2021) Does diversified environmental regulation make FDI cleaner and more beneficial to China's green growth? Environ Sci Pollut Res. https://doi.org/10.1007/s11356-021-15937-5