Dynamic Effects of Economic Growth, Foreign Direct Investment, and Trade Openness on Environmental Quality: Evidence From Asian Economies

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Abstract

The main purpose of this article is to investigate the impact of economic growth, foreign direct investment (FDI), and trade openness (TO), and the Asian and global financial crisis on environmental quality based on the environmental Kuznets curve (EKC) hypothesis on panel data of 32 Asian economies over the 1991–2019 period. Our study supports the EKC hypothesis, implying that economic growth increases emissions to a certain point, after which growth helps reduce carbon emissions. By employing several panel data econometric estimation techniques (such as ordinary least squares, fixed effects models, and difference-generalized method of moments estimations), the study also shows robust findings that FDI could reduce carbon emissions in the Asian region by welcoming environmentally friendly technology and know-how into the economy. However, though the study finds that financial crises reduce emissions in Asian countries, the increase of TO in this region leads to an increase in emissions and causes of environmental degradation. Thus, to ensure environmental sustainability, Asian policymakers should formulate lucrative policies to attract FDI, and trade policies should also be revised.

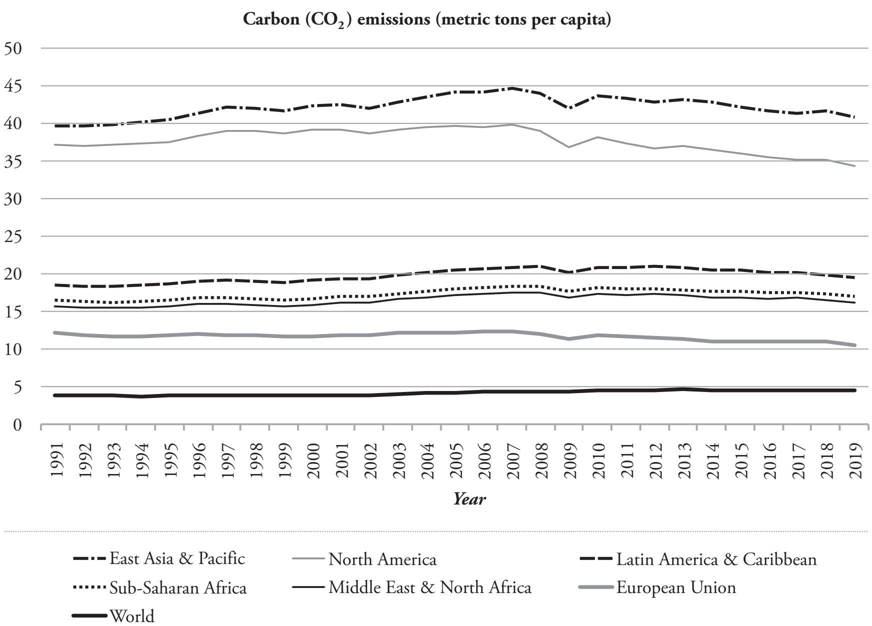
Keywords: foreign direct investment, trade openness, sustainable development, economic growth, carbon emission

JEL classification: F21, F10, Q01, F43, Q56

1 Introduction

Environmental sustainability is a precondition and one of the three main pillars of sustainable development. The sustainable development goal 9.4.1 (SDG-9) calls for sustainable earth by the reduction of carbon emissions that must be ensured for sustainable development. The world's largest production hubs are now in Asian regions, i.e., China, Japan, India, and Vietnam. Along with other economies of this region, these countries show a growing emission of carbon dioxide (CO_2) gas in the atmosphere. Environmental degradation and rapidly changing climatic conditions pose threats to this region. Though this region has the highest share of increased economic growth globally, it constantly faces challenges in controlling carbon emissions. Protecting the environment has also been an important issue on the world's political agenda. The Kyoto Protocol, adopted in 1997, issued an international strategy to restrict greenhouse gas emissions. Moreover, in congruence with the Rio+20 results, the United Nations' 2030 plan for sustainable development combines SDGs and the climate treaty achieved in Paris, succeeding the UNFCCC (United Nations Framework Convention on Climate Change). Following those steps, Asian Development Bank (ADB) supports complete, lasting, and transformational change for healthy growth in Asia and the Pacific areas. In 2007, the Intergovernmental Panel on Climate Change (IPCC) stated that the temperature of the earth would increase from 1.1 to 6.4 degrees Celsius and seawater would rise by about 16.5 to 53.8 centimeters by the end of the 21st century. Since 1991, carbon emission in Asia shows that South Asian economies tend to have the highest level compared to East Asia and Central Asian countries. One common feature is that all regions of Asia display increasing carbon emission. Asian countries are undergoing rapid industrialization, which explains the increased carbon emission rate. During 1991–2019, the world witnessed an increase in carbon emissions from different continents (Figure 1).

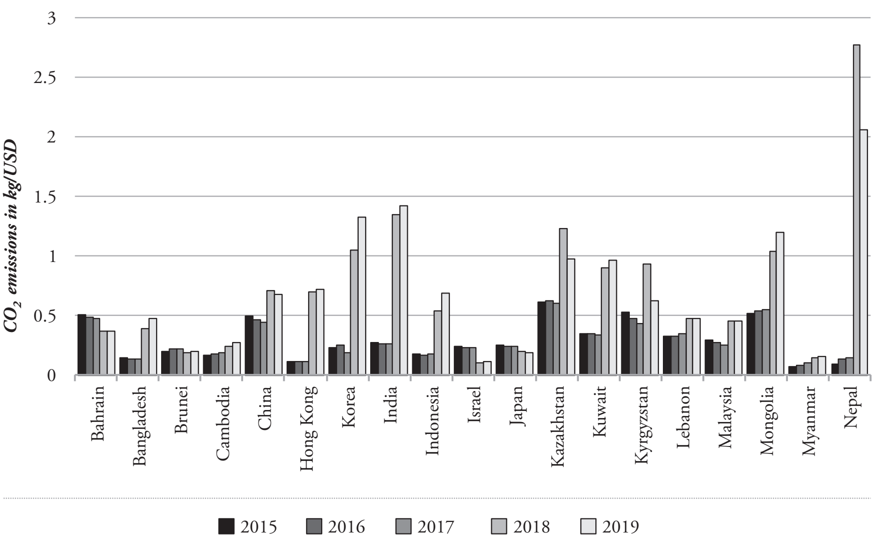
Figure 1: *Carbon Emissions*



Sources: WDI (World Bank) and authors' calculations.

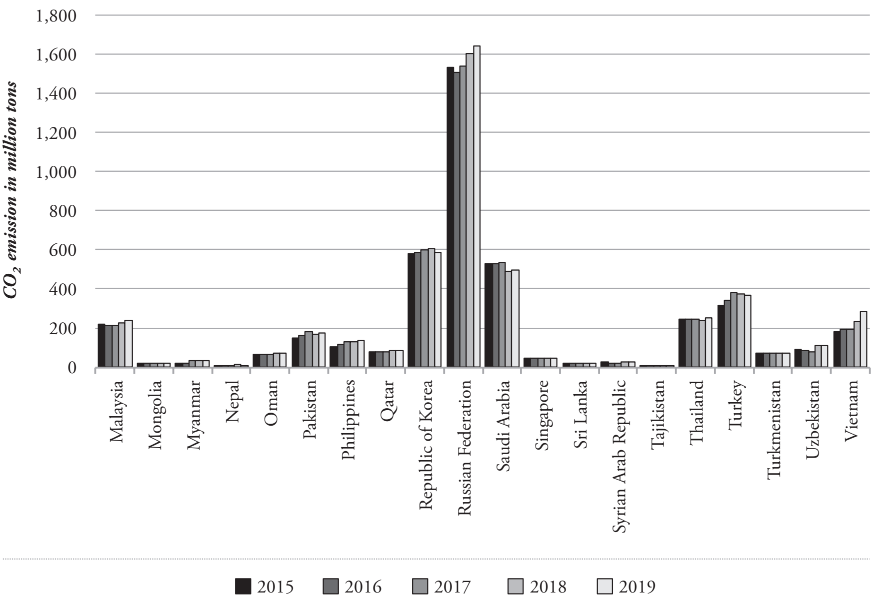
East Asia and the Pacific countries account for the most significant share of the world's carbon emissions, followed by North America, Latin America, the Caribbean, Sub-Saharan Africa, Latin America, the Middle East, North Africa, and European countries. World leaders, politicians, and policymakers have agreed with the concept of sustainable earth, which was made evident in SDG 9.4.1. It thus targets to reduce carbon emissions in UN member states to a fixed desired level. From the SDG goals, we see that the target amount of carbon emissions per unit of manufacturing value added is 0.3 kg/USD.

Figure 2: *Carbon Emissions Per Unit of Manufacturing Value Added (target 0.3 kg/USD)*



Source: Authors' calculations using UNDP SDG dataset.

Figure 3: *Carbon Emissions From Fuel Combustion (target 0.1 million tons)*



Source: Authors' calculations using UNDP SDG dataset.

Figure 2 and Figure 3 show the CO_2 emissions for manufacturing value added based on each USD for the first five years (2015, 2016, 2017, 2018, and 2019). As we see, 25 Asian economies are still above the expected carbon emissions borderline, and 14 Asian economies are within the stipulated line. SDGs have targeted the amount of carbon emissions from fuel combustion to be 0.1 million tons by 2030. But we see from the two figures that most Asian economies are far above the stipulated target line of carbon emissions, which means that economies are emitting more carbon than the desired level.

FDI and trade openness (TO) have been acknowledged as key drivers of economic growth, employment generation, and transfer of advanced technologies and ideas to the host countries. But apprehending the possible environmental costs, advanced economies are now very selective in the type of inflow of FDI, such as greenfield

FDI and environmentally friendly trade policies, manufacturing processes, and industrial production. Based on these facts, policymakers of emerging Asia are required to comprehend how environmentally friendly its economic growth is. Pressure is growing on Asian economies though they have the lowest share of environmental emissions than any other economic union of the globe. Countries are also legally pressurized to abide by international agreements on cutting emissions. Thus, the necessity to examine the impact of various macroeconomic contributing factors to increase emissions cannot be neglected. In this regard, the vital issue to extensively analyze is the impact of economic growth, foreign direct investment, and international trade on environmental sustainability.

Existing literature on the relationship between economic growth and environmental sustainability primarily focuses on indicators of economic growth, such as GDP growth. Some studies focus on financial development, energy consumption, trade, urbanization, and FDI, individually. Some follow the EKC hypothesis to validate or invalidate findings with existing literature (Sajeev & Kaur, 2020). However, studies regarding the impact of three key variables, such as growth, FDI, and trade, on the environment, particularly for Asian economies, are lacking. To the best of our investigation, no prior empirical analysis was conducted on measuring the impact of the Asian financial crisis (AFC) and global recession on the environment in an identical EKC model. Moreover, the existing empirical evidence on the relationship between FDI, TO, and environmental quality is indecisive. Based on the given importance, ensuring environmental sustainability through FDI and more international trade under the EKC hypothesis, particularly for the Asian region, requires close attention from policymakers and researchers. In order to contribute to the existing literature, this study aims to investigate whether FDI and trade openness is good or bad for the achievement of environmental sustainability of Asian economies. Apart from the main objective, we offer the first empirical confirmation, using both static and dynamic panel data models, whether the Asian financial crisis (AFC) and world recession have an adverse effect on environmental emissions. Lastly, this paper provides several policy implications for policymakers on how FDI and TO can promote the environmental sustainability of the Asian region.

The remaining paper is organized as follows. The following section gives an overview of the literature on the nexus between economic growth, FDI, and TO and environmental quality. Section three explains the data, variables, models, and methodology used in this analysis. Sections four and five describe the initial statistical tests and results and discussions, respectively. The last section presents the concluding remarks, policy recommendations, and further scope of research.

2 Literature Review

Grossman and Krueger's (1991) remarkable paper initiated the environment–growth literature to identify the association between growth and the environment. The environmental Kuznets curve (EKC), arising from the Kuznets curve hypothesis of economist Simon Kuznets (1955), is viewed and seems to be a perfect measure of the growth–environment relation. It states that as economies pass through different development stages, the impact of growth on the environment also changes. At the developing stage, if the economy grows, the environmental degradation rises, then after a certain level, it falls, posing the inverted U-shaped behavior. Trade openness and environmental relationship, in economic theory, is termed the pollution haven effect, which has shown some mixed results in different methods, regions, and research.

2.1 Economic Growth–Environmental Quality Nexus

Several empirical studies have been conducted to test the economic growth–environment literature. Some models have supported the EKC hypothesis whereas some others did not. In a recent paper, Li, Qiao, Li, and Wang (2022) examined the relationship between the environment and economic growth among 89 Belt and Road Initiative countries during 1995–2017 and identified both Kuznets and pollution haven hypothesis. The authors employed unit root, cointegration, and second-generation panel regression tests and found an inverted U-shaped relationship between economic growth and environmental pollution. The researchers suggested to use FDI and energy use policies based on regional priorities as FDI showed mixed results in different region-centric countries. Moreover, Liu, Sadiq, Ali, and Kumail (2022) investigated the relationship between economic growth led by tourism and travel and ecological footprint and inspected the EKC hypothesis in the case of Pakistan from 1980 to 2017. The researchers used the ARDL bounds and Bayer and Hanck tests, which stated that there were long-term associations among the variables. They found a tourism-led growth hypothesis and an inverted U-shaped Kuznets curve between the environment and growth in Pakistan. Saqib (2022) investigated the affiliation among economic growth, green energy, non-renewable energy, and financial development with carbon footprint using panel data of 63 emerging and developed economies during 1990–2020. The research exploits second-generation panel data methods, i.e., CIPS and CADF unit root tests, Westerlund bootstrap cointegration techniques, and AMG and CCEMG heterogeneous panel causality techniques. The author found that all variables are cointegrated in the long run, non-renewable energy consumption increases, and green energy decreases environmental degradation. The research suggested using more green energy to reduce environmental pollution. Arouri, Youssef, M'Henni, and Rault (2012) tried to diagnose the correlation between emissions of carbon, consumption of energy, and GDP (real) for the period from 1981 to 2005 in the case of 12 MENA states. The researchers used unit root tests, cointegration techniques, and other econometric tools to find the linkage and concluded that economic growth is positively affected by CO_2 emission.

On the other hand, some researchers found no existence of EKC in their research. For instance, Djellouli, Abdelli, Elheddad, Ahmed, and Mahmood (2022) discovered the dynamic effect of renewable energy, non-renewable energy, growth, and foreign direct investment on environmental pollution in 20 African countries from 2000 to 2015. The researchers assumed the EKC hypothesis and the pollution haven/halo hypothesis, applied panel ARDL models, and found that all predictor variables showed positive relationships with the dependent variable, except the renewable energy variable. Moreover, FDI holds a positive and significant relationship only in the long run, and they found no existence of the EKC hypothesis in the sampled countries but rather the pollution haven hypothesis. Pandey and Mishra (2015) attempted to observe the association between CO_2 emissions and economic growth. For the analysis, they used SAARC member nations as their sample of study and extended the research to cover the period from 1972 to 2010. They used various panel data estimation tools to analyze the data, i.e., panel unit root test, panel cointegration test, panel VECM and impulse response functions (IRFs), and variance decompositions (VDs). The results showed one-way causality from economic growth to carbon emissions, and economic growth to CO_2 emissions showed to have positive signs mutually. Therefore, the authors concluded that there was no presence of the EKC assumption in this revision.

Due to having various impacts of economic growth on environmental quality, some papers found varying effects on the Kuznets curve. Ridzuan, Ismail, and Fatah (2018) attempted to discover the impact of FDI and trade openness on sustainable development in Malaysia by using data from 1970 to 2013. For the analysis, they used three econometric models representing three main pillars of sustainable development, namely economic growth, environmental quality, and income inequality, and identified the models through the ARDL technique. The results show that FDI affects economic growth positively; it causes better income distribution and lowers carbon emissions, but trade openness leads to higher growth, better income distribution, and an insignificant impact on the environment. The mixed findings suggested that Malaysian policymakers revisit existing policies, pay more attention to attracting FDI, and scrutinize trade openness issues to ensure sustainable development by achieving SDGs. Omri and Kahouli (2014) used a dataset of 54 nation-states worldwide from 1990 to 2011 to investigate the relationships between FDI, CO_2 emissions, and economic growth. The researchers used simultaneous equations and dynamic panel data models for the analysis and found varying results for different regions. The outcomes demonstrated that unidirectional causality exists from CO_2 emissions to economic development in all panels aside from the Middle East, North Africa, and Sub-Saharan Africa, and bidirectional causality exists between FDI and financial development for all panels; however, bidirectional causality exists between FDI and CO_2 in all panels aside from Europe and North Asia.

2.2 Foreign Direct Investment–Environmental Quality Nexus

Whether lowering environmental laws leads to increased FDI is a necessary question to investigate. Some countries often get more inflow of FDI even with their stringent environmental regulations. Elekeleme and Hong (2023) confirmed the cogency of the EKC hypothesis for the share of Chinese FDI in respect to the Sino-African economic partnership of 41 African countries. They covered a time period of 2003–2018, used a panel regression analysis, and found an inverted U-shaped relationship between GDP per capita with CO_2 and CH4 emissions per capita and the share of Chinese FDI affecting the EKC in Sino-African ties or countries. Khan et al. (2021) examined the short- and long-run impact of foreign direct investment, electricity consumption, and real GDP on ecological footprints in respect to EKC and pollution haven hypothesis for India, China, and Pakistan during 1970–2016. The researchers used panel and time series models, i.e., cointegration test, FMOLS, and DOLS, to confirm the pollution haven and environmental Kuznets hypothesis. They identified U-shaped EKC in the case of China and India, and unidirectional causality from economic growth to the environment and bidirectional causality from electricity consumption and FDI to environmental degradation. Polloni-Silva, Ferraz, Camioto, Rebelatto, and Moralles (2021) examine the effects of foreign direct investment and economic growth on environmental degradation, i.e., carbon dioxide emissions in the case of 592 municipalities of Sao Paolo state, Brazil. The study found a non-linear association between economic growth and CO_2 emission and a negative relationship between FDI and carbon emissions. Khan (2021) studied the existence of the EKC hypothesis and its possible structural breaks in the case of Pakistan during 1980–2016. For the data analysis, he used the Gregory-Hansen cointegration tests, Zivot and Andrews unit root tests, and other time series econometric tests. The study used data for real GDP per capita, FDI, trade openness, and energy consumption and found the existence of the EKC hypothesis and the presence of structural breaks in the stated model. Researcher Balıbey (2015) inspected the causative interactions between economic growth, carbon dioxide emissions, and foreign direct investment for Turkey from 1974 to 2011. The researcher used the Johansen cointegration test, Granger causality test, and impulse-response and variance decomposition analysis of vector autoregressive (VAR) models and found that GDP, FDI, and CO_2 have long-term associations, and both FDI and GDP have a substantial influence on carbon emissions. The research outcomes validated the presence of the EKC hypothesis and concluded that economic growth led to the contamination of the environment and depletion of natural resources. Abdouli and Hammami (2017) explored the relationships among inflows of FDI, quality of the environment, and economic growth during 1990–2012 for 17 Middle East and North African (MENA) nations. The researchers employed both static and dynamic panel data models. They used CO_2 emissions as a substitution for environmental quality and got proof that incoming FDI contributes to enhancing nation states' economic growth, and economic growth negatively influences environmental quality. Researchers Zheng and Sheng (2017) initiated research on the Chinese economy's opening-up and analyzed the impact of FDI on the Chinese environment. For the analysis, the researchers used data from 1997 to 2009 for 30 provinces of China to estimate the environment; they used per capita emission and CO_2 emission intensity. They collected Chinese provincial CO_2 emission data from the Intergovernmental Panel on Climate Change (IPCC) and marketization and FDI data from Fan, Zhu, and Nyland (2012). The results of the analysis showed that FDI causes China's CO_2 emissions to increase. But due to reform in market orientation, this positive effect of FDI on carbon dioxide emissions started lowering subsequently. Next, when China's market orientation was expanding from coastal zones to the whole of China, the regional development and FDI's impact on CO_2 emission also showed an uneven nature. The researchers concluded that eastern area provinces typically showed lower CO_2 emissions from FDI and higher market development, whereas four western area provinces displayed higher CO_2 emissions from FDI and lower market development.

2.3 Trade Openness–Environmental Quality Nexus

Trade openness can bring both welfare and loss to the environment. Economists are divided into two groups in regard to evaluating the impact of trade openness on environmental quality. Intending to find the association between trade and the environment, Frankel and Rose (2005) investigated the relationship with a dataset of multiple countries for the period of the 1990s. In order to analyze data and produce accurate results, the researchers used both ordinary least squares (OLS) and instrumental variables (IV) regression. For capturing the environmental quality, researchers used seven (7) different pollution measures, i.e., carbon dioxide (CO_2), sulfur dioxide (SO_2), particulate matter (PM), nitrogen oxide (NO_2), deforestation, energy depletion, and clean water access of rural area. They found that trade openness tends to decrease three measures, i.e., SO_2, NO_2, and particulate matter but with high, moderate, and lacking statistical significance, respectively. The other measures of energy depletion, CO_2 emission, deforestation, and rural clean water access also showed a particular significance level concerning trade openness. Their analysis provided slight proof that trade openness has a damaging influence on the environment and their model supported the EKC hypothesis. Murshed et al. (2022) examined the effects of economic growth, FDI, intra-regional trade integration, and renewable energy transition on the environmental degradation of particular South Asian economies. The authors used econometric methods best suited for managing cross-sectionally dependent heterogeneous panel datasets. Finally, they found the EKC hypothesis for South Asia as a panel and Bangladesh, Sri Lanka, Nepal, and Bhutan but not for India and Pakistan as a country and accordingly suggested various environmental-sustainability-related policies. Fang, Huang, and Yang (2020) investigated the effect of GDP growth and trade openness on the environment in 261 Chinese cities during 2004–2013. For this purpose, they used two types of pollutants, i.e., industrial wastewater and sulfur dioxide, and three measures of trade openness. They found that the EKC hypothesis exists not only for the whole of China but also in diverse regions. They also found that the effect of export is largely correlated positively, and the impact of import is negatively associated with the environment for the whole of China and across regions. Belloumi and Alshehry (2020) explored the influence of international trade on sustainable development in Saudi Arabia. They attempted to identify the effect on growth and the environment, considering two crucial sustainable development indicators. For the study, annual data from 1971 to 2016 were used, and the analysis was done using the ARDL model. Quantitative results from the econometric analysis show that trade has no effect on economic growth and environmental quality in the short run, but international trade negatively affects economic growth and environmental quality over a more extended period. So, they reached the conclusion that trade openness in Saudi Arabia might have led to unfavorable sustainability conditions throughout recent years. Managi, Hibiki, and Tsurumi (2009) tried to estimate the association between trade and environmental quality. They used two panels, i.e., one panel containing data of 88 countries during 1973–2000 analyzing sulfur dioxide and carbon dioxide, and another containing data of 83 countries during 1980–2000 analyzing biochemical oxygen demand (BOD) emissions. For the analysis, they used the generalized method of moments (GMM) technique and found that the outcomes of OECD countries varied from those of non-OECD countries. They inferred that trade helped reduce pollution in OECD nations in both the short run and the long haul, but in non-OECD states, a 1 percent increase in trade openness drove a 0.920 percent increase in SO_2 and 0.883 percent increase in CO_2 emissions. Cherniwchan (2017) attempted to identify the link between trade liberalization and the environment in view of NAFTA and US manufacturing during the 1991–1998 period. To examine the relationship, the researcher used longitudinal data from two various sources, i.e., the National Establishment Time-Series data and the Toxics Release Inventory data about particulate matter and sulfur dioxide and other features of US manufacturing plants. The researcher used the log of pollution emissions as the dependent variable, and for controlling the external effects to produce unbiased results, the researcher also used the plant effects, industry-year fixed effects, and state-year fixed effects using specifications. The study found that trade liberalization accounted for nearly two-thirds of the reductions in emissions of pollutants, i.e., PM10 and SO_2, at affected plants in the USA due to the effect of NAFTA. The drastic fall in pollutants resulted from the changed relations with the Mexican market and the purchase of intermediate goods from the same place. The author finally concluded that plant responses in an industry determine the nature of international trade affecting the environment.

3 Data and Methodology

3.1 Data and Variable Selection

In order to analyze the impact of growth, FDI, and TO on environmental quality, our study collects panel data from 32 Asian economies, i.e., Bahrain, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Iran, Israel, Japan, Kazakhstan, Korea, Kuwait, Kyrgyzstan, Laos, Macao, Malaysia, Mongolia, Nepal, Oman, Pakistan, Philippines, Russia, Saudi Arabia, Singapore, Sri Lanka, Tajikistan, Thailand, Turkey, and Vietnam from 1991 to 2019 (29 years). The sample selection is based on the availability of data, and data have been collected from World Development Indicators (WDI) of the World Bank, International Monetary Fund (IMF), and United Nations Conference on Trade and Development (UNCTAD).

Environmental quality is one of the main pillars of sustainable development. This study uses CO_2 emission (metric tons per capita) as the alternative to environmental quality and the main dependent variable. The natural log of per capita GDP (lnGDP), FDI inflow as a percentage of GDP (FDI), and total volume of trade as a percentage of GDP (TO) are the indicators of economic growth, foreign direct investment, and trade openness, respectively, and the main explanatory variables of interest in this study. The squared term of GDP (GDP^2) is used as another explanatory variable to identify the existence of the environmental Kuznets curve (EKC). FDI brings newer technology to the host economy and radically impacts the environment of the host country through its various investment natures. On the other hand, openness encourages a higher volume of trade among participating economies, and thus to reap the highest benefits, economies engage in environmentally sensitive projects and production processes. The study considers several important control variables. For example, domestic investment (DI), proxied by gross fixed capital formation as a fraction of GDP, affects environmental quality by using investment funds in production activities. The second control variable is infrastructure (Infra), which plays a major role in affecting environmental quality because an improved infrastructure network leads to lower environmental degradation, and weak infrastructure drives a contaminated environment. We use fixed telephone line subscriptions (per 100) as a proxy for infrastructure. The third control variable is government consumption (GC), as government funds in economic and infrastructural activities lead to a change in the environment. We use government consumption as a percentage of GDP to indicate government consumption. This study considers two important crisis periods, namely the Asian financial crisis (AFC) during 1997–1998 and the world recession, i.e., the subprime mortgage crisis during 2007–2008, through a dummy variable that takes value 1 for crisis or recession period and 0 for all other years.

3.2 Model Specification

The study of the environment–growth nexus is divided into two groups based on the existing literature. One group supports the environmental Kuznets curve (EKC) hypothesis, and the other group does not. Under the EKC hypothesis, emission is articulated as a function of income, and it further assumes that income causes emission in a unidirectional way. Studies by Grossman and Krueger (1991), Panayotou (1993), Galeotti, Lanza, and Pauli (2006), and Orubu and Omotor (2011) have yielded results in support of EKC. A few studies do not uphold the EKC hypothesis because they could not help contradicting its idea, and they further accept that the unidirectional causality from income to emission may not occur consistently. Causality might run from emissions to income by the production process.

However, in this paper, we try to find the environment–growth nexus both in terms of EKC and without EKC using regression estimation tools. To test the EKC hypothesis, we use both linear and quadratic equations:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \varepsilon_{it} \tag{1}$$

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 (X_{it})^2 + \varepsilon_{it}, \tag{2}$$

where Y_{it} is CO_2 emissions (metric tons per capita) and X_{it} is the per capita GDP in country *i* at time *t*.

If the EKC hypothesis is valid, then the values of the parameters β_1 and β_3 should be positive and β_2 negative. The squared term in the model represents inverted U-shaped behavior, and the cubic term in the model represents monotonically rising pollution (N-curved terms). If the cubic term is insignificant, it can be removed from the model, and if the quadratic term is insignificant, the model would be in linear form. The cubic term in the model indicates various natures, i.e., an inverted U-shape (the EKC), a U-shape, an N-shape, an inverted N-shape, or an insignificant, i.e., flat pollution–income relationship. If β_1 is negative and statistically significant and β_2 is insignificant, then the indicators will improve the environment with rising per capita income. If β_1 is positive and statistically significant and β_2 is insignificant, then the indicators will display deterioration in the environment with rising per capita income. If β_1 is positive and statistically significant and β_2 is negative and statistically significant, then the projected EKC has a concentrated turning point. Now, the panel regression equation to check the existence of EKC and the basic formulation is formulated from the above quadratic model:

$$lnCO_{2it} = \beta_0 + \beta_1\, lnGDP_{it} + \beta_2\, (lnGDP_{it})^2 + \beta_3\, FDI_{it} + \beta_4\, TO_{it} + \beta_5\, DI_{it} + \beta_6\, GC_{it} + \beta_{71n}\, Infra_{it} + \beta_8\, AFC_{it} + \beta_9\, Recession_{it} + \varepsilon_{it}, \quad (3)$$

where FDI_{it}, TO_{it}, DI_{it}, GC_{it}, $Infra_{it}$, AFC_{it} and $Recession_{it}$ refer to the foreign direct investment inflow as percentage of GDP, trade openness (trade as percentage of GDP), domestic investment, government consumption, infrastructure, Asian financial crisis dummy, and world recession dummy, respectively.

Our aim is to find the influences of growth, FDI, and trade openness on environmental quality and to ensure the existence of EKC in Asian economies. We applied panel data fixed effects models as they fit for controlling the unobserved time invariant country features. Later on, as the fixed effects method could not account for the endogeneity problem, we checked the dynamic panel structure and applied the generalized method of moments (GMM). The lag value of the dependent variable was used as an instrument for controlling the endogeneity problem. Moreover, all other variables were transformed into the first difference so as to control the heteroskedasticity. So, the use of GMM methods is essential and the underlying regression equation now stands at:

$$\Delta lnCO_{2it} = \alpha \Delta lnCO_{2it\text{-}1} + \beta_1\, \Delta lnGDP_{it} + \beta_2\, \Delta(lnGDP_{it})^2 + \beta_3\, \Delta FDI_{it} + \beta_4\, \Delta TO_{it} + \beta_5\, \Delta DI_{it} + \beta_6\, \Delta GC_{it} + \beta_{71n}\, \Delta Infra_{it} + \beta_8\, \Delta AFC_{it} + \beta_9\, \Delta Recession_{it} + \Delta\varepsilon_{it} \quad (4)$$

3.3 Preliminary Statistical Test and Results

3.3.1 Variable Description and Correlation

Table 1 and Table 2 represent the descriptive statistics and correlation table of all variables used in this analysis. We find that environmental quality ($lnCO_2$) shows a mean of 1.032, with a total of 761 observations across the 32 Asian economies over

29 years. The average natural log of per capita income (lnGDP) stood at 8.189. FDI inflow indicated as a ratio of GDP into the Asian economy was on average 3.949. Trade as a percentage of GDP (trade openness) showed a mean of 96.991 with a standard deviation of 75.113, which means that trade openness in Asian economies varies widely, and all Asian economies are not open to the same degree.

Table 1: *Descriptive Statistics*

Variable		Mean	Std. Dev.	Min.	Max.	Observations		
$lnCO_2$	Overall	1.032	1.516	-2.997	3.527	N	=	911
	Between		1.485	-1.897	3.256	n	=	32
	Within		0.382	-0.614	3.459	T-bar	=	28.47
lnGDP	Overall	8.189	1.640	4.927	11.451	N	=	921
	Between		1.538	5.950	10.536	n	=	32
	Within		0.633	6.382	9.799	T-bar	=	28.78
$lnGDP^2$	Overall	69.748	26.949	24.277	131.128	N	=	921
	Between		25.462	35.804	111.011	N	=	32
	Within		9.926	39.233	95.613	T-bar	=	28.78
FDI	Overall	3.949	6.532	-37.173	58.519	N	=	912
	Between		4.669	0.211	21.795	N	=	32
	Within		4.617	-40.793	40.673	T-bar	=	28.50
TO	Overall	96.991	75.113	16.014	442.620	N	=	913
	Between		72.347	25.838	354.599	N	=	32
	Within		22.098	-2.297	220.051	T-bar	=	28.53
AFC	Overall	0.069	0.254	0.000	1.000	N	=	928
	Between		0.000	0.069	0.069	N	=	32
	Within		0.254	0.000	1.000	T	=	29.00
Recession	Overall	0.069	0.254	0.000	1.000	N	=	928
	Between		0.000	0.069	0.069	N	=	32
	Within		0.254	0.000	1.000	T	=	29.00
DI	Overall	25.590	8.337	6.296	68.023	N	=	893
	Between		6.360	15.677	49.194	N	=	32
	Within		5.478	8.590	47.972	T-bar	=	27.9063
GC	Overall	14.025	6.343	3.460	76.222	N	=	906
	Between		5.639	5.152	25.433	N	=	32
	Within		3.046	1.990	64.814	T-bar	=	28.31
Infra	Overall	17.008	16.408	0.042	62.086	N	=	924
	Between		15.948	0.531	57.030	N	=	32
	Within		4.688	-3.074	33.061	T-bar	=	28.88

Source: Authors' calculations.

Table 2: *Correlation Matrix*

	lnCO_2	**lnGDP**	**lnGDP^2**	**FDI**	**TO**	**AFC**	**Recession**	**DI**	**GC**	**Infra**
lnCO_2	1									
lnGDP	0.8341*	1								
lnGDP^2	0.8151*	0.9961*	1							
FDI	0.1244*	0.2323*	0.2453*	1						
TO	0.2428*	0.3608*	0.3754*	0.6863*	1.0000					
AFC	-0.0297	-0.0944*	-0.0907*	-0.0352	-0.022	1				
Recession	0.0158	0.0562	0.0525	0.0346	0.0255	-0.0741*	1			
DI	0.0274	0.033	0.0076	0.0394	0.008	-0.0397	0.0293	1		
GC	0.5526*	0.3894*	0.3775*	-0.1668*	-0.1052*	0.0189	-0.033	0.0011	1	
Infra	0.6180*	0.7755*	0.7837*	0.3115*	0.4130*	-0.0139	0.0381	-0.0094	0.1794*	1

Note: * represents significance at 5%.

Source: Authors' calculations.

From the findings of correlation coefficient, we find that economic growth has a strong positive correlation with the environmental quality factor, which is significant at a 5 percent level. The positive and significant coefficients of FDI, TO, GC, and Infra indicate that they have a positive contribution to the CO_2 emission. We investigate the strength and robustness of these relationships though econometric specifications considering the EKC hypothesis.

We first conduct the Pesaran test of cross-sectional dependence (CD), which is regarded as a test of the mean association between panel units. The null hypothesis in the Pesaran CD test is either strict cross-sectional independence (Pesaran, 2004) or weak cross-sectional dependence (Pesaran, 2015). Table 3 shows the results of the CD test and based on the results we can conclude that there exists cross-sectional dependence among the panel units in our model.

Table 3: *Results of Cross-Sectional Dependence*

Variable	**CD-test**	***p*-value**
$lnCO_2$	34.674	0.00***
lnGDP	106.874	0.00***
$lnGDP^2$	106.862	0.00***
FDI	14.437	0.00***
TO	15.898	0.00***
AFC	119.933	0.00***
Recession	119.933	0.00***
DI	7.488	0.00***
GC	3.729	0.00***
Infra	32.612	0.00***

Note: CD ~ N (0,1) values of *p* nearly zero indicate that the data are correlated across panel groups.
Source: Authors' calculations.

3.3.2 Second Generation Unit Root Tests

In Table 4, we use a second generation unit root test, i.e., Pesaran cross-sectional augmented Dickey-Fuller (PES-CADF) test, which was introduced by Pesaran (2003).

Table 4: *Results of Pesaran Cross-Sectional ADF Tests*

Variable	Levels		First difference	
	Constant	*Trend*	*Constant*	*Trend*
$lnCO_2$	-1.694**	-0.262	-17.657***	-16.034***
lnGDP	-4.757***	-1.723**	-14.793***	-12.639***
$lnGDP^2$	-4.006***	-1.212	-14.249***	-12.036***
FDI	-7.612***	-6.257***	-22.057***	-19.997***
TO	-3.752***	-2.739***	-16.793***	-14.579***
DI	-1.202	-0.513	-15.342***	-12.764***
GC	-3.991***	-2.753***	-18.025***	-15.525***
Infra	3.519	5.138	-9.641***	-7.281***

Notes: * indicates 10%, ** indicates 5%, and *** indicates 1% significance level. The panel is unbalanced, only the standardized Ztbar statistic was calculated for some variables. Therefore, we present only the Ztbar statistic value in the table.

Source: Authors' calculations.

It takes into consideration the cross-sectional dependence among the heterogenous panels and works on the basis of the augmentation process for the standard Dickey-Fuller (DF) regressions. This test is parallel to Im, Pesaran, and Shin (2003). Here, we found that the $lnCO_2$, $lnGDP^2$, DI, and Infra variables did not hold stationarity in level, but these variables held stationarity in the first difference. All other variables were stationary in both level and first difference in the case of constant and time trend.

4 Regression Results and Discussions

4.1 Pooled OLS Regression Results

Table 5 shows the results for ordinary least squares (OLS). In the first column, we see lnGDP (economic growth) has a significant and positive impact on carbon emission ($lnCO_2$) and $lnGDP^2$ also shows a negative significant influence on carbon emission ($lnCO_2$). This means it fulfills the conditions of the environmental Kuznets curve (EKC) and shows that the Kuznets curve exists in the case of Asian economy. From the OLS results, we see FDI and TO have a positive but insignificant impact on carbon emission. The second result contains the robust estimates of the OLS model which corrected the heteroskedasticity of the OLS model. Though the OLS model supports the EKC hypothesis in Asian economies, it contains a lot of problems, i.e., constant country level and time specific effects, and provides less reliable estimates in the case of panel data.

Table 5: *Results of Pooled OLS*

Dependent variable: Environmental Quality ($lnCO_2$)		
Variable	***(1) OLS***	***(2) OLS-robust***
lnGDP	2.740***	2.740***
	(0.191)	(0.192)
$lnGDP^2$	-0.131***	-0.131***
	(0.0119)	(0.0120)
FDI	0.00614	0.00614
	(0.00532)	(0.00520)
TO	0.000709	0.000709
	(0.000460)	(0.000462)
AFC	0.222**	0.222**
	(0.0950)	(0.0907)
Recession	-0.150	-0.150
	(0.0921)	(0.101)
DI	-0.0105***	-0.0105***
	(0.00307)	(0.00344)
GC	0.0620***	0.0620***
	(0.00457)	(0.0105)
Infra	0.00577**	0.00577**
	(0.00252)	(0.00231)
Constant	-13.05***	-13.05***
	(0.738)	(0.732)
Observations	928	928
R-squared	0.762	0.762
Adjusted R-squared	0.7592	0.7592
Number of countries	32	32
Robust SE	No	Yes

Notes: Standard errors are in parentheses; ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.1$.
Source: Authors' calculations.

4.2 Hausman Specification Test and Test for Existence of EKC Hypothesis

We conducted the Hausman (1978) specification test when deciding whether to use the fixed effects model over the random effects model or vice versa. We found the probability value is 0.000 and chi2(8) = 42.03, which denotes that the FE model is preferred over the RE model for our analysis. Later on, we checked the existence of EKC, which tends to differ based on different data and methods used. The relationships between economic growth and environmental pollution may fall in any of following categories: (i) U-shaped, (ii) inverted U-shaped (the EKC type), (iii) N-shaped, (iv) monotonically increasing, (v) monotonically decreasing, (vi) insignificant, (vii) none.

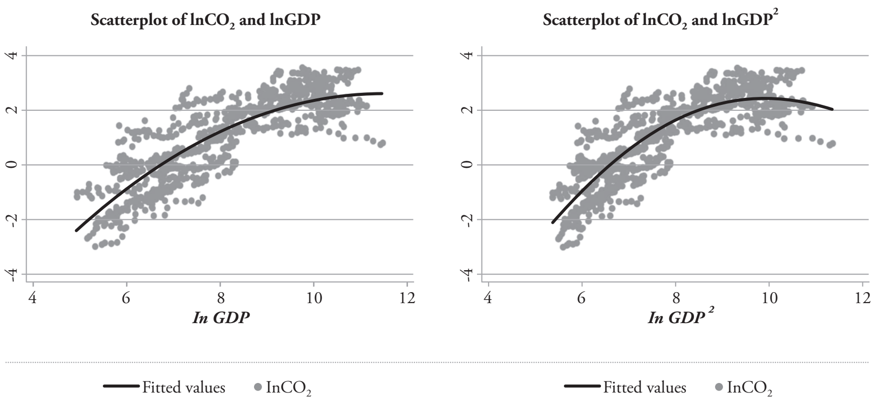
Table 6: *Results of Fixed Effects*

Variable	(1) FE	(2) FE
lnGDP	0.414***	1.602***
	(0.0149)	(0.0841)
$lnGDP^2$		-0.0773***
		(0.00540)
Constant	-2.342***	-6.683***
	(0.122)	(0.323)
Observations	907	907
R-squared	0.470	0.571
Number of countries	32	32

Notes: Standard errors are in parentheses; ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.1$.
Source: Authors' calculations.

To test the EKC hypothesis, we examined the two different equations, i.e., linear and quadratic and found various results. The results of these models presented in Table 6 show the fixed effects regression of the linear and quadratic model, the dependent variable being environmental quality ($lnCO_2$). If the EKC hypothesis is valid, then the value of parameter β_1 should be positive and β_2 negative. Here, we see in (1) β_1 is positive and significant, which means that if GDP increases, then CO_2 emissions also increase, and in (2) β_1 is positive and β_2 is negative and both are significant, which means that with the increase of GDP, CO_2 emission firstly increases and then decreases, which supports the inverted U-shaped behavior. So, this confirms the presence of the environmental Kuznets curve hypothesis in Asian economies as in the studies of other researchers, i.e., Orubu and Omotor (2011), and Apergis, Christou, and Gupta (2017).

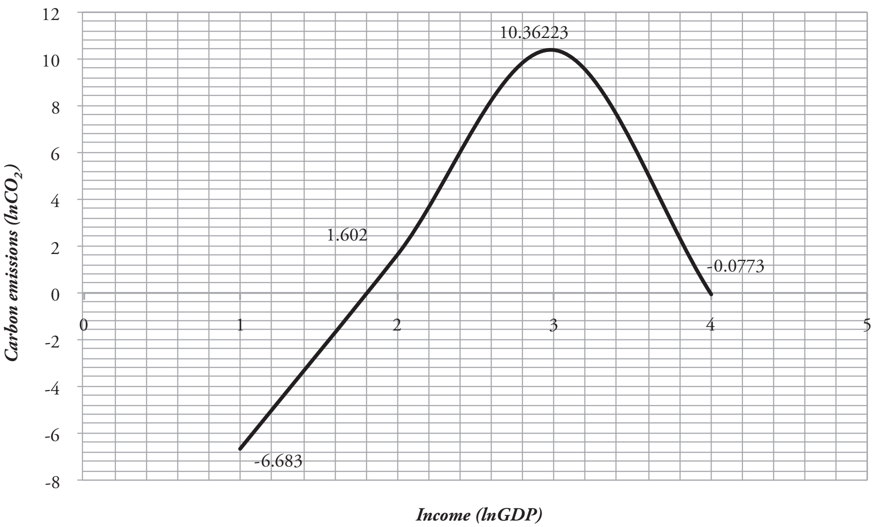
Figure 4: *Scatterplot of $lnCO_2$ and lnGDP*



Source: Authors' calculations.

From Figure 4, we see that in the earlier stage of income (lnGDP), carbon emissions increase, and when income (lnGDP) further increases, then the carbon emissions tend to fall, supporting the existence of the environmental Kuznets curve. Based on the regression findings (Table 6, column 2), we have found the turning point of the curve (Figure 5), which is 10.36223. That is the so-called "turning point" of the environmental Kuznets curve – the income level up to which emissions are increasing and beyond which emissions decline.

Figure 5: *Environmental Kuznets Curve*



Source: Authors' calculations.

4.3 Fixed Effects Regression Results

We employed the panel data FE model (static) estimation technique in this stage as the results from the pooled OLS model are less reliable and produce inconsistent results. The results of the FE estimations are presented in Table 7. Column 1 represents the heteroskedasticity adjusted FE estimator of all explanatory and independent variables as we have found group-wise heteroskedasticity in our model through the modified Wald test. We find that economic growth (lnGDP), squared term of economic growth ($lnGDP^2$), and TO are significant at the 0.01 level and FDI at the 0.05 level of significance. Here, lnGDP is positive and significant at a 0.01 level of significance, stating that the coefficient of 1.272 means that when economic growth rises by 1 percent, the carbon emission increases by 1.272 percent. The squared term $lnGDP^2$ is negatively significant at a 1 percent level, indicating that if economic growth increases further by 1 percent in Asian economies, the carbon emission decreases by 0.06 percent. We also see that FDI negatively affects carbon emission ($lnCO_2$) and is significant at a 0.05 level of significance, which means that if FDI increases by 1 percent in Asian economies, then carbon emission will be decreased by 0.0044 percent in this area. This supports the claim that inward FDI brings green and cleaner technology to the host country, and the introduction of green and sophisticated technology to the Asian economies produces less carbon emission, thus protecting the environmental quality. Trade openness (TO) shows positive and significant impacts on carbon emission, stating that a 1 percent rise in trade openness leads to a 0.0012 percent rise in carbon emission. This can be supported by the fact that when countries open up, they tend to have more trade and more profit, thereby reducing the safety and quality standards and producing more emissions of CO_2 in the air.

In column 2, we applied the time or year fixed effects regression to control the effect of time or year over the dependent variable. The outcomes show that all independent variables of interest except FDI are significant at the 0.01 level, all other things being equal. As cross-sectional dependence is an issue in macro panels containing data over 20–30 years (Baltagi, 2008), we perform both Pesaran (2004) and Friedman (1937) tests of cross-sectional independence. From the results, we see that the Friedman (1937) test shows significant and the Pesaran (2004) test shows insignificant results (p-value is 0.0079 and 0.1166, respectively), which indicates mixed evidence of the presence of cross-sectional independence or the absence of cross-sectional dependence. Still, we employ Driscoll-Kraay standard errors, serial correlation corrected FE first-order autoregressive (AR(1)), and panel corrected standard errors (PSCE) approach to minimize the heteroskedasticity, cross-sectional dependence, and first-order autocorrelation problems in the short panel model and robustness test of our findings. In column 5, the squared term of economic growth ($lnGDP^2$) shows a negative relationship with carbon emission ($lnCO_2$), and it is significant at a 1 percent level of significance, which supports the existence of the EKC hypothesis in respect to Asian economies. The squared term ($lnGDP^2$) coefficient is -0.043, which denotes that if economic growth rises in Asian economies by 1 percent, then carbon emission will reduce by 0.043 percent, all other things remaining equal.

Table 7: *Results of Fixed Effects Models*

Dependent variable: Environmental Quality ($lnCO_2$)					
Variable	**(1) FE**	**(2) Year-FE**	**(3) Driscoll-Kraay**	**(4) FE AR(1)**	**(5) PCSE**
lnGDP	1.272***	1.280***	1.272***	1.165***	1.206***
	(0.0847)	(0.0841)	(0.0847)	(0.148)	(0.219)
$lnGDP^2$	-0.0605***	-0.0606***	-0.0605***	-0.0501***	-0.0430***
	(0.00526)	(0.00539)	(0.00526)	(0.00921)	(0.0132)
FDI	-0.00415**	-0.00283	-0.00415**	-0.00230*	-0.00216
	(0.00178)	(0.00178)	(0.00178)	(0.00118)	(0.00153)
TO	0.00120***	0.00189***	0.00120***	0.000585	0.000782
	(0.000363)	(0.000389)	(0.000363)	(0.000407)	(0.000494)
AFC	0.0237	0.114*	0.0237	0.00755	0.00464
	(0.0293)	(0.0585)	(0.0293)	(0.0183)	(0.0174)
Recession	-0.0756***	0.0217	-0.0756***	3.13e-05	-0.00170
	(0.0281)	(0.0668)	(0.0281)	(0.0181)	(0.0196)
DI	0.00244	0.00228	0.00244	-0.000587	-0.00122
	(0.00151)	(0.00152)	(0.00151)	(0.00155)	(0.00206)
GC	-0.00958***	-0.0129***	-0.00958***	-0.00298	0.0163***
	(0.00269)	(0.00283)	(0.00269)	(0.00275)	(0.00358)
Infra	0.00850***	0.0101***	0.00850***	0.00906***	0.00815***
	(0.00187)	(0.00198)	(0.00187)	(0.00279)	(0.00259)
Constant	-5.302***	-5.485***	-5.302***	-5.134***	-6.269***
	(0.316)	(0.349)	(0.316)	(0.588)	(0.888)
Observations	862	862	862	862	862
R-squared	0.581	0.608	0.581	-	0.385
Number of countries	32	32	-	32	32
Number of groups	-	-	32	-	-
Robust SE	Yes	No	No	No	Yes
Correction of AR(1)	No	No	No	No	Yes
Correction of CSD	No	No	Yes	No	Yes

Source: Authors' calculations.

From columns 1 to 5, we see that almost all results show a significant positive relationship between $lnCO_2$ and lnGDP, which means that economic growth contributes to increased carbon emission in Asian economies. Nevertheless, if economic growth further increases, then carbon emission tends to decrease, thus supporting the EKC curve. FDI showed significant adverse effect on carbon emissions in columns 1 and 4 and insignificant adverse effect in columns 2, 3, and 5. It can be inferred that the inflow of FDI contributes to reducing carbon emissions, thus sustaining the environment in Asian economies. Trade openness showed significant positive effects on carbon emissions in columns 1, 2, and 3 and insignificant positive impacts in columns 4 and 5. So, it is also evident that trade openness leads to increased carbon emissions, which deteriorate the ecological footprints in Asian economies. In all columns, AFC shows a positive impact on carbon emission, and recession shows both positive and negative effects. However, both are not significant in most cases, thus indicating their negligible impacts on the environment. Other control variables, i.e., domestic investment and government consumption, showed mixed results except for infrastructure, which positively impacted environmental quality. So, to confirm the results of the above models and to check their robustness, we later used dynamic panel models.

5 Robustness of the Findings Through Dynamic Panel Model

This study uses one-step and two-step difference GMM estimation techniques to check the robustness of the results of the static model as well as to deal with the possible problem of endogeneity. On the basis of Equation 4, difference GMM estimation results are presented in Table 8. From Table 8, we find that both one-step and two-step difference GMM produce almost the same results for the explanatory variables. Both results show a significant positive influence of the lagged dependent variable on the dependent variable. This means that the carbon emission of the current year is positively dependent on the carbon emission of the last year. In the one-step GMM, the coefficient of the lagged dependent variable

($l.lnCO_2$) states that a 1 percent increase in carbon emission in the last year causes carbon emission to increase by 0.465 percent in the current year, and it thereby supports the dynamic panel concept. The coefficient of GDP states that a 1 percent increase in economic growth causes carbon emission ($lnCO_2$) to increase by 1.533 percent, and it is significant at a 5 percent level. This has been supported by the findings of Liu et al. (2022) and Pandey and Mishra (2015), which also showed growth aggravating the CO_2 emissions. The coefficient value of the squared term of economic growth ($lnGDP^2$) shows a negative and significant impact on carbon emissions, explaining that a 1 percent further rise in economic growth in Asian economies will generate a 0.0814 percent drop in carbon emission. This means that when economic growth increases, carbon emission also increases; when economic growth further increases ($lnGDP^2$), then carbon emission ($lnCO_2$) tends to fall, consequently supporting the environmental Kuznets curve (EKC) hypothesis in Asian economies. This finding is somewhat akin to Li et al. (2022), who found EKC in respect to Belt and Road Initiative countries, Balıbey (2015), who proved the EKC hypothesis in the case of Turkey, and the findings of Frankel and Rose (2005). The two-step difference GMM also states the same and supports the EKC hypothesis in the case of Asian economies. Thus, it supports and validates the results found in fixed effects and panel PCSE models. In both one-step and two-step difference GMM, it is observed that FDI is negative and significant at 10 percent, asserting that FDI welcomes greener technology and raw materials which do not hamper the environment and reduce the emission of carbon dioxide. This finding validates the results found in the FE model and it goes in the opposite direction of the popular results of Djellouli et al. (2022) and Zheng and Sheng (2017), who found a positive impact of FDI on environmental quality. Trade openness (TO) is positive and significant at 5 percent and 10 percent levels consistently in one-step and two-step difference GMM, which means that if Asian economies are opening up for trade, this will worsen the environmental quality by producing more carbon emissions. This might happen due to strict competition increasing trade among countries, thereby not following the sustainable environment guidelines.

Table 8: *Results of One-Step and Two-Step Difference GMM*

Dependent variable: Environmental Quality ($lnCO_2$)		
Variable	**(1) Diff. GMM (One-step)**	**(2) Diff. GMM (Two-step)**
$l.lnCO_2$	0.465***	0.853***
	(0.142)	(0.115)
lnGDP	1.533**	0.532**
	(0.567)	(0.255)
$lnGDP^2$	-0.0814**	-0.0285*
	(0.0312)	(0.0144)
FDI	-0.00363*	-0.00525*
	(0.00202)	(0.00280)
TO	0.00103**	0.000807*
	(0.000458)	(0.000473)
AFC	-0.159*	-0.0335*
	(0.0787)	(0.0185)
Recession	-0.00483	0.0105
	(0.0187)	(0.0256)
DI	0.00552	0.00366
	(0.00417)	(0.00274)
GC	-0.00236	-0.00214
	(0.00371)	(0.00241)
Infra	-0.00251	-0.00343
	(0.00221)	(0.00326)
Constant	-	-
Observations	791	796
Number of countries	32	32
R-squared	-	-
F-statistic	239.43	301.32
Robust SE/corrected SE	Yes	Yes
Groups/instruments	32/13	32/13
AR(1)	0.026	0.001
AR(2)	0.256	0.588
Sargan test	0.378	0.694
Hansen J-statistics	0.688	0.568

Notes: ***, **, and * indicate statistical significance levels at 1%, 5%, and 10%, respectively; standard errors are given in parentheses by using robust measures; p-values have been tested for AR(1), AR(2), Sargan test, and Hansen statistics. Estimation techniques of GMM estimator use xtabond2 of STATA (Roodman, 2009).

Source: Authors' calculations.

This confirms the findings of the fixed effects models, and is also supported by Fang et al. (2020), who found a positive influence of trade on CO_2 emission in China. Here, AFC shows a negative and significant impact on carbon emissions. In contrast, recession shows an insignificant impact on Asian economies, explaining that during the Asian crisis, production and trade dramatically decreased, which contributed to emitting a lower volume of carbon into the environment. Grenville (2017) concluded that financial sectors are not self-disciplining. For that reason, due to their dissimilarity, there are differences between the responses to the crises of 1997–1998 (AFC) and 2007 (world recession). As for other control variables, domestic investment shows positive signs whereas government consumption and infrastructure show negative signs for coefficients in both estimates of the difference GMM. Two relevant post-estimation test outcomes, such as Arellano-Bond for serial correlation (AR1 and AR2) and the test of over-identifying restriction (Sargan test and Hansen J-statistic), are reported in Table 8, which indicates that the instruments used in difference GMM estimation are exogenous and the over-identifying restrictions are valid in both GMM models.

6 Conclusion, Policy Recommendations, and Limitations

This study investigates the effects of FDI and trade openness on carbon emissions to check the environmental quality status of Asian economies. Moreover, it has tested the existence of the environmental Kuznets curve (EKC) and showed the progress toward SDG 9.4.1 by Asian economies. For data analysis, both static and dynamic regression techniques have been employed. From the regression results, we see that the Kuznets curve exists in Asian economies. FDI inflows showed a negative and significant impact on carbon emission, which means that FDI brings sophisticated processes and technologies to Asian economies, thus ensuring a green environment. Trade openness showed positive and significant influences on carbon emissions, which asserts that openness creates unhealthy competition among Asian economies and produces negative environmental externalities. The lagged term of the dependent variable showed a positive and significant sign that supports the dynamic panel. The Asian crisis shock also showed a negative impact on carbon emissions, which supports the claims that Asian financial and economic activities fell sharply during the shock period and led to a healthy environment.

Asian governments and policymakers should formulate and implement lucrative policies to attract FDI in safe and environmentally friendly green sectors, which pave the way for sustainable environment. The openness policies ought to be revisited and revised as openness leads to the increased emission of carbon in Asia, which pollutes the environment. Moreover, governments in Asia should closely monitor infrastructural budgets, which should be invested in green sectors that make the environment carbon-free. Asian economies must place focus on sustainable environment because an unhealthy and sick environment leads to severe diseases and causes irreparable losses to human and other living beings. Therefore, Asian economies must use part of their proceeds from growth to invest in creating and maintaining a healthy environment.

It is always cumbersome to have expected signs and significance for variables in different econometric measures. More authentic results and inferences could be drawn if all required data could be found. We had to exclude many Asian countries from our sample due to data unavailability, which led to a significant reduction in sample size and observations. A study regarding the classification of development stages of countries could be an excellent addition. The revision and assessment of policies regarding FDI, trade openness, and economic growth to identify sustainability is another exciting topic for future researchers.

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