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Environmental Quality and Economic Growth: An empirical analysis in Asian countries

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Abstract
This study investigates the relationship between environmental quality and economic growth in Asian countries. The findings from Pooled Mean Group (PMG) estimator affirmed the existence of a long-run relationship between environmental quality and economic development. The higher the economic growth, the higher the CO_2 consumption. In the short run, economic growth exacts no harmful impact. Researchers and policymakers should be careful about the effect of economic growth and rising incomes on environmental pollution with the prioritisation of sustainable usage of environmental policy. Investment and consumption of renewable energy that is less harmful to the environment should be focused on minimising environmental pollution.

Keywords: environmental quality; economic growth; Asian countries; PMG

1.0 Introduction

In recent years, global emissions catching more and more attention as their impacts cause tremendous economic and social welfare loss. Emissions such as greenhouse gases are claimed to be the main culprit causing climate change, and this emission is mainly due to human activity (IPCC, 2018). Many environmental agreements have been signed and rectified to preserve the environment to curb this issue. Despite these agreements, the greenhouse gas emissions growth rate has doubled since 1970 (IPCC, 2018). Following International Environmental Agreement Database Project (2022), carbon dioxide (CO_2) emissions per cent changed per capita between 1990 to 2016, increasing drastically among the developing nations. Among others, China and India reported an increase of 278% and 156%, respectively. This is not surprising as these developing countries are currently experiencing decentralisation in their development path. According to the environmental Kuznets curve (EKC), the relationship between environmental pollution and economic growth is presented in an inverted U-shaped where the environmental pollution will increase as the economic growth and fall after reaching some threshold level. In the case of developing countries, environmental pollution is expected to improve their economic growth and will fall once they become wealthy. However, the empirical evidence has been found to hold a mixed result. This paper aims to re-examine the EKC model by using only Asian

countries. There are a few reasons to support the analysis that needs to be done on Asian countries. Firstly, Asia constitutes more than 45% of global GDP and is projected will reap above 50% of the share in 2030 (World Economics, 2021). The potential expansion of the Asian economy is slowly overtaking the advanced countries. Therefore, their contribution to global emissions needs to be treated with caution. Secondly, most Asian countries are developing countries with scarce capital and mainly rely on cumbersome technology which operates using fossil fuels. These cause the greenhouse gas emissions to be higher in these countries. Thirdly, some developing Asian countries are labelled as the heaven for dirty industries reallocation. Lax environmental regulation in these countries attracts the dirty industries from developed nations and allows abatement cost saving possible. The present study is a move in this direction to investigate the long-run relationship between environmental quality and economic growth in Asian countries.

The remainder of the paper is organized as follows: Section 2 contains a brief review of environmental quality and economic growth. Section 3 presents the theoretical framework and the methodology, while Section 4 discusses the empirical finding and robustness tests. And the last section concludes the paper.

2.0 Literature Review

The research on the correlation between economic growth and environmental quality has received extensive attention from academic and research circles. Most literature on environmental issues places the relationship between economic growth and environmental quality. There has been much empirical work sorting the nexus between per capita income and environmental health since the 1990s. It has continued as an active theme of research for environmental economists. Specifically, one strand of literature elaborates on the phenomenon of the Environmental Kuznets Curve (EKC), such as economic growth at intermediate stages pushes up the pollution but hampers it at later stages (see, for example, the seminal study by Grossman and Krueger (1991, 1995). Another strand of literature is researching the contributions of various factors such as urbanisation, population, energy consumption, trade, tourism, foreign direct investment, government expenditures, etc. towards environmental deterioration (see for a fool of literature, Nathaniel et al. (2020a); Hassan et al. (2019); Chin et al. (2018); Ameyaw and Yao (2018); Saidi and Mbarek (2017); Almulali and Ozturk (2015) etc. and the studies therein).

In addition, the nexus between economic growth and environmental quality has been intensively and empirically explored in recent years. Several studies have inquired about the relationship between environmental degradation and economic growth in recent years (see, for example, Richmond and Kaufman (2006); Fodha and Zaghoud (2010); Christopher and Douglason (2011); Jayanthakumaran et al. (2012); Saidi and Hammami (2014); Bastola and Omri et al. (2015)).

Finally, considering the nature of our recent research, we review some studies focusing on the link between economic development and environmental factor using panel data modelling techniques. The primary reason for focusing on these studies is that they are very close to the present study and impart some insights into the impact of economic progress on environmental deterioration. Shafik (1994) found a systematically significant relationship between economic growth and carbon dioxide emissions. In contrast, Soytas (2009) explored the impact of growth on environmental quality in OPEC countries. They pointed out that none of the sample countries needs to sacrifice economic growth to decrease environmental emissions.

Similarly, Richmond and Kaufman (2006) elaborated that there is no significant impact of carbon emissions on the growth process in their panel data study for OECD and Non-OECD countries while utilising the traditional fixed and random effects model. However, Arouri et al. (2012) found a significant positive impact of economic growth on CO2 emissions for the Middle East and North African countries using panel co-integration techniques during 1980-2005. Likewise, Omri et al. (2014), in their panel data study for a large sample of 54 countries, identified the causal link between economic growth and pollution but the latter's impact on the former. Thus, it is derived that the existing panel data studies have no consensus on the link and direction between economic growth and environmental performance.

Overall, the existing studies systematically analyse the nexus between economic growth and environmental quality, but still, there is room for further improvement. As most current studies are individual country-based or connect environmental degradation with different macroeconomic fundamentals, some only accentuate the EKC. At the same time, few discuss the actual structure of the nexus between environmental degradation and economic growth. The present study is designed to specifically inquire about the concerning phenomenon in a vast region of Asian countries through the most valid panel data estimators. It will explore the accurate picture of the concerned nexus for a large sample of Asian developing countries. Most are already vulnerable to persistent environmental degradation and stagnant economic growth. Additionally, this study covers the direct nexus between economic growth and environmental quality while considering the levels of economic development in different regions. Thus, it will augment the existing literature on a concerning theme to devise more accurate policy recommendations based on the real picture of the two fundamentals in a large region of Asian emerging and developing countries.

3.0 Methodology

This paper employed the PMG approach suggested by Pesaran et al. (1999) to assess the long-run relationship between environmental quality and economic growth in 43 Asian countries from 2002-2018 based on data availability. PMG estimation is appropriate for this study because it accommodates the long-run equilibrium and the heterogeneous dynamic adjustment process.

In line with the theoretical framework from Pao and Tsai (2011), the empirical model is generated by adding in an autoregressive distributed lag (ARDL)) ($p, q, q, …, q$) as follows:

$$CO2_{it} = \Sigma^p_{j=1}\, \lambda_{ij}\, CO2_{i,-j} + \Sigma^{q1}_{j=0}\, \gamma_{1ij}\, GDP_{i,t-j} + \Sigma^{q2}_{j=0}\, \gamma_{2ij}\, Ind_{i,t-j} ++ \Sigma^{q3}_{j=0}\, \gamma_{3ij}\, POP_{i,t-j} ++ \Sigma^{q4}_{j=0}\, \gamma_{4ij}\, FDI + \Sigma^{q5}_{j=0}\, \gamma_{5ij}\, GDP2_{i,t-j} + v_i + \epsilon_{it}$$

(1)

Where CO2 denotes Co2 emission as the proxy for environmental quality, GDP is a proxy for economic growth measured by per capita income, Ind refers to Industrial growth rate, POP is the representative variable for population, FDI is the net foreign direct investment and the square term of per capita income- GDP2 is also included in the specification to test the Environmental Kuznets Curve hypothesis. vi depicts unobserved country-specific effects, and ϵit reflects the error term. All the data were derived from Work Development Indicators (2019).

4.0 Findings

The findings from the regression analysis in Table 1 reports the PMG estimates on the relationship between environmental quality and economic growth. The PMG result is chosen based on the Hausman test; the Hausman test statistic of 0.995 failed to reject the null hypothesis of the restriction of the common long-run coefficient. Therefore, PMG is a more efficient and appropriate coefficient estimate as the common long-run coefficient is valid. From Table 1, the error correction of the adjustment coefficient is negative and significant (-0.397) at the one per cent level. The negative and significant error correction adjustment shows the short to long-run adjustment across the sampled Asian countries.

Table 1. PMG estimation of the relationship between environmental quality and economic growth

VARIABLES	PMG
Long-run coefficient	
Economic Growth	4.230***
	(0.202)
Industrial	0.001**
	(0.001)
Population	0.014***
	(0.001)
FDI	-0.001*
	(0.001)
GDPC2	-0.246***
	(0.011)
Error Correction Adjustment	-0.397***
	(0.055)
Short-run coefficient	
Δ Economic Growth	13.079
	(13.088)
Δ Industrial	0.002*
	(0.001)
Δ Population	-0.123
	(0.173)
Δ FDI	0.010*
	(0.005)
Δ GDPC2	-0.813
	(0.733)
Constant	-7.203***
	(0.980)
Number of countries	43
Observations	645

The findings from the PMG estimation provided some important implications. Economic growth deteriorates environmental quality in the long run by increasing Co2 emissions in Asian countries. The study affirmed the existence of a long-run relationship between environmental quality and economic development, which is consistent with previous findings (Kaya et al., 2017; Orubu & Omotor, 2011; Yirong, 2022). The higher the economic growth, the higher the CO2 consumption of the countries. In the short run, economic growth exacts no harmful impact. Similar to other emerging economies, economic growth at its initial level has no detrimental effects on environmental quality (Yeh and Lian, 2017). The estimation result is also consistent with non-Asian countries (Wu et al., 2018 & Jiang and Guan, 2016).

The estimate of FDI is negative and significant in the model. The vital role of FDI in controlling environmental quality cannot be underestimated. FDI improves the environmental quality in the long run. This implies that a 1 per cent increase in FDI increases Co2

emissions by 0.1%. In the short run, however, FDI increases CO2 emissions. Long-run and short-run effects are consistent with recent findings from Kaya et al. (2017); thus, the need for the government to regulate the flow of FDI is crucial as it can influence environmental quality. Encouraging FDI focusing on non-polluting sectors must be strengthened to attain the SDGs.

Meanwhile, GDP2 is negative and significant affects Co2 emissions, showing the validity of the Environmental Kuznets Hypothesis where the inverted U relationship between Co2 and per capita income exists. Consistent with existing empirical studies from Bardi & Hfaiedh (2021), both the long-run and short-run estimated coefficients of the industrial growth rate are positive and significant, indicating that higher industrial activities are associated with more significant CO2 emissions. This implies that a 1 per cent increase in industrial activities increases Co2 by 0.2 per cent and 0.1 per cent in the short and long run, respectively. In light of the findings in this study, researchers and policymakers should be careful about the effect of economic growth and rising incomes on environmental pollution with the prioritisation of sustainable usage of ecological policy. Investment and renewable energy consumption are less harmful to the environment; for instance, wind, rain, sunlight, and hydropower should be focused on minimising environmental pollution. Nevertheless, encouraging FDI focusing on non-polluting sectors must be strengthened to attain the SDGs.

4.1 Robustness Tests
Table 2 reports the robustness test results by using traditional panel data techniques which are fixed and random effects model. Fixed and random effect are relatively appropriate options in analysing the impact of environmental quality on economic growth for 43 Asian countries from 2002-2018. As seen in all two columns of table 2, our previous findings remain primarily robust. Economic growth's positive and significant impact on environmental quality at 1 percent level in both estimations. While the coefficient estimates for economic growth is smaller in random effects. The robustness check supports the contention that economic growth impacts higher levels of CO2. The significant of Hausman test suggests that fixed effect is appropriate to the random effect estimator.

Table 2. Robustness checks

VARIABLES	FE	RE
Economic Growth	3.098***	2.616***
	(0.272)	(0.245)
Industrial	0.000	0.000
	(0.001)	(0.001)
Population	0.011*	0.010*
	(0.006)	(0.006)
FDI	0.000	0.000
	(0.001)	(0.001)
GDPC2	-0.206***	-0.170***
	(0.017)	(0.015)
Hausman Test (p-value)		25.10***
Constant	-11.627***	-10.219***
	(1.042)	(0.972)
Observations	731	731
R-squared	0.179	
Number of countries	43	43

5.0 Conclusion & Recommendations
In this paper, we conduct a panel analysis of the relationship between environmental quality and economic growth in Asian countries. Specifically, the paper inspects whether or not economic growth has harmed the quality of the environment in Asian countries. We use Co2 emission as the proxy for environmental quality and GDP Per Capita as a proxy for economic growth. To this end, we also employed an annual panel dataset from 2002 to 2018 for 40 Asian countries. The Pooled Mean Group (PMG) estimator is chosen based on the Hausman test, which offers more efficient and appropriate coefficient estimates. The findings of this study provided some important implications. Economic growth deteriorates environmental quality in the long run by increasing Co2 emissions. The study affirmed the existence of a long-run relationship between environmental quality and economic growth. The higher the economic growth, the higher the CO2 consumption of the countries. In the short run, economic growth exacts no harmful impact. The estimate of FDI is positive and significant in the model. The vital role of FDI in controlling environmental quality cannot be underestimated. FDI improves the environmental quality in the long run. In the short run, FDI increases CO2 emissions. The robustness result of fixed and random effects supports the positive and significant effect of economic growth on environmental quality. In light of the findings in this study, researchers and policymakers should be careful about the effect of economic growth and rising incomes on environmental pollution with the prioritization of sustainable usage of environmental policy. Investment and consumption of renewable energy that is less harmful to the environment, for instance, wind, rain, sunlight, and hydropower should be focused on minimizing environmental pollution. Nevertheless, the

encouragement of FDI with the focus on non-polluting sectors needs to be strengthened to attain the SDGs. The government's effort should be directed toward prioritising sustainable usage of ecological policy.

Like any other study, this study has some limitations, which serve as possible extensions for future research. The first is the data limitations with the use of panel data from 40 Asian countries. We leave this to future researchers able to access a more complete dataset for all Asian countries to see the relationship between environmental quality and economic growth. In addition, a future study can be explored for each country to see how environmental quality affects human development from different country settings, economic structures, and characteristics to suggest particular policy implications and development strategies.

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Paper Contribution to Related Field of Study

This paper contributes to the study related to environmental quality and sustainable development goals.

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