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Article

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Urbanization-Growth-Environment: How Are They Related? An Evidence from the Global Asia-Pacific Region

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ABSTRACT

Asia and the Pacific have made rapid progress in economic growth but still have work to do in environmental degradation. Logical consequence because pursuing economic progress has raised environmental problems and has become one of the central issues for development. The Asia-Pacific region became the most significant contributor and growth in carbon dioxide emissions compared to other regions. The research objective is to analyze the impact of urbanization on environmental quality and its interaction through economic growth using the standard dynamic model of the autoregressive distributed lag approach. The result show demonstrates consistency in developed countries and the High-Income countries categories. Urbanization has a significant negative effect on emissions, and the Growth variable is significantly positive; nevertheless, the EKC curve does not occur. Urbanization deteriorates the relationship between growth and emissions. It is not proven in developing countries and the lower and upper middle income. Equitable development needs to be carried out by every country by considering the quality and sustainable economic institutions and pro-environmental innovations, especially in developing or lower and upper-middle countries.

Keywords: Environment, Economic Growth, Urbanization
JEL Classifications: O11, O44, Q56

1. INTRODUCTION

Asia and the Pacific have experienced a surge progress in economic growth over the past five decades. Eventhough, increasing pressure in the environment degradation remained as unresolved development agendas (Asian Development Bank, 2018). In the new global economy, environmental degradation has become one of the central issues for development. Development that only pursues on economic progress has raised environmental problems such as air pollution, water problems, degradation, and others (Liu et al., 2023).

The relationship between economic growth and environmental damage has been widely studied through the Environmental Kuznet Curve (EKC) hypothesis with various findings, such as Apergis and Ozturk (2015), Hassan et al., (2015), Y. Liu and Lai, (2021). Xie et al., (2019) proved inverted U-shaped in EKC, while the EKC hypothesis at the global level is not proven (Wang et al., 2013) and in developing countries like Vietnam also show the same results (Al-mulali et al., 2015). The potential for the EKC hypothesis to occur is in high-globalization countries, on the other hand in, low-globalization countries EKC was not proven (Leal and Marques, 2020). Meanwhile, Pata and Caglar (2021) suggested a U-shaped quadratic relationship between pollution level and income level for both CO2 emissions and ecological footprint, suggesting that the EKC hypothesis does not hold for China. Recently, as evidenced, Mujtaba et al., (2022) found that a negative shock to economic growth would lead to a decrease in environmental quality.

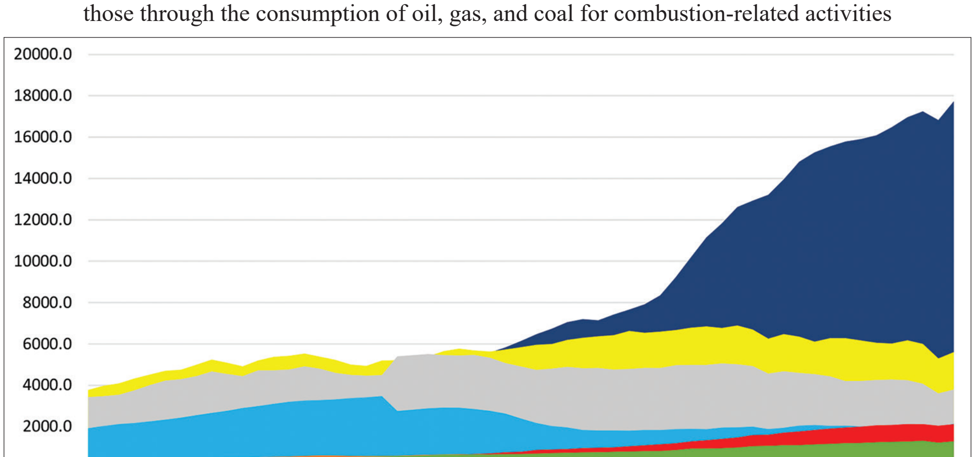
The rebound in economic growth was the main cause of the increase in carbon emissions in 2021. Energy-related emissions spiked substantially to levels comparable to 2019 in 2021. The reason for a significant rebound in emissions in 2021 was a rising economy. As the economy bounces back from lockdowns and other COVID-related measures, energy consumption has climbed dramatically. 2021 energy intensity and carbon intensity, to a lesser extent, unchanged (Statistical Review of World Energy, 2022). In addition, Figure 1 presents contributors to carbon dioxide emissions by region. From the 1990s to 2021, the Asia-Pacific region became the largest contributor and growth in carbon dioxide emissions compared to other regions. The countries in Asia-Pacific that have become the biggest contributors over the last few decades include China, Japan, India, South Korea, and Indonesia.

Not only the relationship between income (growth)-environment, along with its various contradictions, is interesting to be studied, but also the nexus between income (growth)- environment is also an important issue in sustainable development. In recent years until now, the income (growth)-environment issue has become wider by the addition of the relationship between urbanization and the environment (eco-environmental) (Bodin, 2017; Dong et al., 2019; Fang et al., 2021a; Grimm et al., 2008; Sikder et al., 2022) since urbanization has become a hot issue for research in earth system science and sustainability science.

It is undeniable that urbanization increases food, energy, housing, drinking water, and sanitation demand, which in the end, will increase economic growth. On the other hand, urbanization is also causing serious eco-environmental problems (Fang et al., 2021b). Initially, the study by Pata, (2018) stated that the biggest cause of environmental damage after economic growth is urbanization. The combined degree of coordination between urbanization and the eco-environment is generally at a very disproportionate stage of development. The main contributors to urbanization and eco-environmental subsystems are demographic urbanization and the contribution of the eco-environment (Dong et al., 2019; Fang et al., 2021a). Currently, Urbanization is one of the greatest social transformations, driven and driven by a variety of social, economic and environmental processes. The environmental impacts of urbanization are enormous and varied, manifesting at local, regional and global levels Urbanization is one of the greatest social transformations of modern times, driven by various social, economic, and environmental processes. The impact of urbanization on the environment is enormous and diverse and manifests on local, regional, and global scales (Bai et al., 2017) (Sim and Balamurungan, 1991). Furthermore, rapid urbanization, along with energy consumption and the use of natural resources, has led to an increase in environmental damage in the form of increased carbon dioxide emissions. As stated in the report of The International Renewable Energy Agency (IRENA), urban areas account for more than half of the world's population, as well as 65% of global energy demand and 70% of energy-related carbon dioxide emissions (Rigter et al., 2016). In contrast, an interesting fact is revealed that urbanization is uncorrelated to the environment with the support of good organizational quality, which can reduce the bad impact of urbanization towards emission and sustainable risks, particularly in less-developed countries (Yasin, Ahmad, and Chaudhary, 2020).

Recent empirical studies in several regions such as South Asia, East Asia, Latin America, the Caribbean, North America, the Middle East, and North Africa show that the population is directly proportional to environmental damage (increased emissions) (Mujtaba et al., 2022). In developing countries, there is a bidirectional causal relationship between urbanization and levels of CO2 emissions (Sikder et al., 2022). In China, population density and urbanization show a real impact on increasing environmental damage (emissions $PM_{2.5}$) (Xie et al., 2019), whereas, in Turkey, urbanization will increase carbon dioxide emissions (Pata, 2018). There are various findings for each of the four SAARC nations, Bangladesh, India, Pakistan, and Sri Lanka. While Sri Lanka and Pakistan's environmental impacts of urbanization are both scored as highly positive, the relationship between the rise of urbanization and the environment for Bangladesh and India is

Figure 1: Carbon dioxide emissions from energy based on regions 1965-2021 (Million tonnes). Notes: The carbon emissions above reflect only those through the consumption of oil, gas, and coal for combustion-related activities



Source: Statistical Review of World Energy, (2022) evaluated as highly negative is not significant (Azam and Khan, 2016). In line with research from Liu et al. (2023), which added urbanization to the EKC model and found that urbanization has no appreciable impact on environmental quality either in short term or in the long-term.

Theoretically, the existence of urbanization will lead to population concentration and transportation sector growth due to the concertation of commercial and industrial activities as well as the conversion of pre-existing land cover to urban land use. The existence of these three activities will increase metabolic activity, increase energy, and water consumption. In the end, it becomes urban emission (Heat, Gases and particulates, Water and water vapor). However, the generalisability of much-published research is problematic. Even though these results were based on data from over three decades ago in the Asia-Pacific region and the relationship between urbanization, growth, and the environment remains unclear.

Most developing countries in the Asia-Pacific have become middle-income countries but are still facing growing pressures on the environment. Important environmental problems experienced by those regions include air and water pollution, pressure on water resources, marine debris along beaches and coastal areas, inadequate waste management, deforestation, land degradation, and loss of biodiversity. Increasing pressure on the environment poses a challenge to sustainability and exacerbates existing vulnerabilities in the poor, who rely heavily on ecosystem services for livelihoods and food security. This research focuses on environmental degradation by using carbon dioxide emission indicators since Asia-Pacific is the largest contributor to carbon dioxide emissions compared to other regions. As stated before, several studies have been carried out on environmental degradation, there have been few empirical investigations into urbanization and environmental quality in the Asian-Pacific region (Fang et al., 2021b). This paper aims to first examine the impact of urbanization on environmental quality and second to answer the question of whether the existence of urbanization will accelerate environmental degradation through economic growth by using interaction variables.

This paper comprises several sections. The introduction has been explained in the first section, followed by the literature review in section 2. A methodology that includes data and empirical function is discussed in section 3, the results are discussed in chapter 4, and the conclusion of the study as a whole is withdrawn in the last section.

2. LITERATURE REVIEW

The Kuznet Curve environment was born from the view of Simon Kuznets, who made observations and then concluded that at the beginning of the stage of economic growth in a country, there would be a bad trend towards income distribution, but over time and moving on to the next stage this income distribution will begin to improve (Grossman and Krueger, 1991). This opinion was later known as the ""inverted U"" Kuznets Curve, because of a longitudinal change in the distribution of income that has been measured or calculated (Todaro and Smith, 2011). In general, the EKC is empirically estimated using regression analysis of the non-linear relationship between environmental variables (pollution concentration, pollutant emissions per capita, pollutant emissions per unit of GDP) and per capita income levels (Fang et al., 2021b). The equation of EKC is written as:

$$lnE_{it} = \alpha_{it} + \beta_1 lnU_{it} + \beta_2 lnU_{it}^2 + \varepsilon_{it}$$

where i and t represent different regions and time, respectively; lnE_{it} is the logarithmic form of the environmental pollution indicator; α_{it} it is a specific cross-sectional effect; lnU_{it} and lnU_{it}^2 represent the primary and quadratic forms of the logarithm of economic development or per capita income levels, respectively; ε_{it} is the random disturbance term.

3. METHODOLOGY

3.1. Data

This research uses observation from 1990 to 2021, across 37 Asia Pacific countries. The data are derived from the World Bank. From the data collection process, accumulated panel data are classified as an unbalanced panel. It is because only certain countries are accommodated with a complete database on certain variables. After data cleaning and filtering, it is obtained unbalance panel data of as many as 818 data with cross number (id) 29 and time period (years) 30, in which id*years uniquely identify each observation.

3.2. Empirical Function

In this research, empirical data are built using the basic model of partial adjustment model that refers to the Lintner Dividend-Adjustment Model based on the research conducted by Rahman and Al Mamun, (2015). Moreover, to capture the role of urbanization towards growth and emission, interaction variables are later added to the model. The partial adjustment model comprises two parts, a static part to describe how the desired amount is determined and the dynamic partial adjustment process, explicated as follows:

$$Emission_{it}^* = \alpha_0 + \alpha_1 \sum x_{it} + u_{it}$$

$$where: \sum x_{it} = Growth_{it}, Growth^2{}_{it}, urbanpop\_percent_{it}, \text{int}\,eraction_t$$

$$Emission_{it}^* - Emission_{it-1} = \lambda\left(Emission_{it}^* - Emission_{it-1}\right)$$

Where $Emission_{it}^*$ is the desired level of $Emission_{it-1}$ By substituting the expression for $Emission_{it}^*$ into the other equation, it is obtained the following estimating equation:

$$Emission_{it}^* = \alpha_0\lambda + (1-\lambda)Emission_{it-1} + \lambda\alpha_1 \sum x_{it} + \lambda u_{it}$$

We can estimate this equation as a general Autoregressive Distributed Lag (ARDL) model as follows:

$$Emission_{it}^* = \beta_0 + \beta_1 Emission_{it-1} + \beta_2 urbanpop\_percent_{it} + \beta_3 urbanpop\_percent_{t-1it} + \beta_4 urbanpop\_percent_{t-2it} + \beta_5 Growth_{it} + \beta_6 Growth^2{}_{it} + \beta_7 \text{int}\,eraction_t + v_{it}$$

In this case, for partial reconciliation the following limits apply:

$$\beta_3 urbanpop\_percent_{t-1it} = 0$$

In addition, the original equation parameter estimates include the desired y magnitude and the tuning parameter λ. For above:

$$\beta_1 = (1-\lambda) \Rightarrow \lambda = (1-\beta_1)$$

$$\beta_2 = \alpha_1 \lambda$$

$$\beta_0 = \alpha_0 \lambda$$

The tuning parameter λ measures the tuning speed and ranges from 0 to 1. The closer to 1, the faster the adjustment speed. An example of this model is the Lintner dividend adjustment model.

Details:
Emissions: Carbon dioxide emissions (kiloton)
Growth: Annual percentage growth rate of Gross Domestic Product (%)
Growth2: the quadratic value of Gross Domestic 'product 's growth
Urbanpop_percentage: Percentage of Urban population (%)
Urbanpop_percent$_{t-1}$: Lag Urban population
Emissions$_{t-1}$: Lag Emissions lag
Interaction: variable interest rate and Growth

β_0, β_1, β_2, β_3, β_4, β_5, β_6: coefficient where, I is 1,…N, countries; t is 1,…T, years, or time intervals; the definitions of the variables used are as follows: Emissions are carbon dioxide emissions from burning fossil fuels and manufacturing cement. Statistical concepts and methodologies for this variable include carbon dioxide produced from solid, liquid, and gaseous fuel consumption and gas flaring. Anthropogenic carbon dioxide emissions are primarily due to the burning of fossil fuels and cement production. When burned, different fossil fuels emit different amounts of carbon dioxide for the same amount of energy. Oil emits about 50% more carbon dioxide than natural gas and coal, about twice as much. During cement production, approximately 0.5 tonnes of carbon dioxide are released for every tonne of cement produced. Carbon footprint data include gases from fossil fuel combustion and cement production but excludes emissions from land use such as deforestation. The unit is kt (kiloton).

Growth is defined as the GDP's annually growth rate in constant domestic currency at market prices. Based on 2015 fixed prices given in USD, aggregate is calculated. GDP is calculated as the sum of all producers' gross value added, product taxes, and subsidies that aren't already factored into the price of their output. This is determined without taking into account the wear and tear on manufactured assets or natural resource depletion and degradation. The anticipated squared value of the GDP growth rate is represented by Growth2, on the other hand.

Urbanpop_percent is the urban population refers to people living in urban areas. Urbanpop_percent is calculated using World Bank population estimates and urban conditions from the United Nations Global Urbanization Prospects. To estimate urban population, the World Bank uses the ratio of United Nations cities to total population to estimate total population. Different countries classify their populations differently. The population of a city or metropolitan area varies across borders.

Interaction is defined as variable interaction between Growth and Urbanization. The existence of this carriable aims to capture the role of urbanization towards emission. This research inserts the interaction variable between two independent variables (growth and urbanization), which refers to a variable calculated as the simple observation-by-observation product of growth and urbanization. The model iss built using two approaches, number and percentage, to test the consistency of results, also growth squares to indicate the presence of EKC growth2.

4. RESULTS AND DISCUSSION

The Asia Pacific region consists of countries that stretch from the continent of Asia, Australia, and the archipelago in the Pacific Ocean. Based on GNI per capita, countries in the Asia Pacific in this study are divided into countries with low income 2.70%, lower-middle income 37.84%, upper-middle income 24.32%, and high income 35.14%. The World Bank compiled the classification with the following categories: Low income: <$ 1,046, Lower-middle income: $ 1,046 - $ 4,095, Upper-middle income: $ 4,096 - $12,695, High income: >$12,696, in which this classification is employed as one of the factors to determine a country that meets the requirements to use World Bank facilities and products, including loan pricing. Besides, it is also set as an indicator of economic resilience and the sustained steady growth of a country in recent years. From this classification, in general, 35.14% of countries in the Asia Pacific are classified as developed countries, and 64.86 percent are developing countries. It appears that countries in the Asia Pacific have good economies and the potential to grow yearly. In line with the EKC theory, the level of environmental damage will increase at the beginning of economic growth.

The first part of the discussion is descriptive statistics and data distribution patterns, as shown in Table 1.

The empirical model testing was processed using the panel regression method with the help of Stata v17 software. The selection of the best panel model is carried out by using the Hausman test. The model is built based on first, the categorization of developed and developing countries and second, based on 4 categories of GNI division. Grouping of objects and repeated estimation is performed to test the consistency of the estimation results.

Table 2 presents 3 estimates for groups of developed, developing, and all countries. From these 3 estimates, the best model is selected for the developed country, which is the random effect model. In developed countries, urbanization has a significantly negative effect on emissions, which means that the increasing number of people who lives in cities will reduce carbon emissions. Meanwhile ini developing countries, urbanization has no significant effect towards emission. This finding inline with research from Liu et al., (2023) Urbanization has no significant direct or long-term impact on environmental quality. In addition, the Growth variable demonstrates significant positive results, which means that economic activities are the source of environmental damage.

Table 1: Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
Id	818	20.473	10.92	1	37
Country car	818	2.748	0.815	2	4
Countrylev	818	0.237	0.426	0	1
Years	818	2005.05	8.521	1990	2019
Urban pop percent	818	49.125	26.311	12.978	100
Growth	818	4.078	4.757	−34.809	30.612
Emissions kt	818	331335.85	1280339.1	10	10707220
Growth 2	818	39.234	75.083	0.001	1211.641
L1urban pop percent	796	48.906	26.294	12.978	100
L2urban pop percent	774	48.679	26.281	12.978	100
L1emissions kt	796	322150.11	1243589.2	0	10502930
Interaction (urban_pop_percent* growth)	818	193.363	292.503	−2285.714	3061.225

Table 2: Estimation results for the division of countries based on types of countries, developed countries, and developing countries

y=emissions	Developed		Developing		All	
	FE	RE	FE	RE	FE	RE
L1emissions	0.956***	1.000***	1.006***	1.038***	1.007***	1.038***
	(0.0277)	(0.00304)	(0.00434)	(0.00199)	(0.00380)	(0.00173)
Urban_pop_percent	−21052.9**	−17237.2*	11784.7	13861.1	4596.7	5502.1
	(10520.1)	(10015.7)	(20649.3)	(20554.8)	(16218.1)	(16309.7)
L1urban_pop_percent	40828.2**	35947.6*	457.7	−8736.1	10707.8	3695.2
	(19986.6)	(19171.7)	(39288.7)	(40499.6)	(30890.5)	(32143.8)
L2urban_pop_percent	−20437.9**	−18640.3*	−11830.5	−5432.6	−14976.4	−9371.5
	(10149.6)	(9634.5)	(20293.7)	(20617.1)	(15859.7)	(16264.4)
Growth	11666.9***	14036.6***	−1547.1	−932.6	364.3	1220.1
	(3301.9)	(2691.2)	(1579.7)	(1476.7)	(1034.8)	(945.0)
Growth 2	−8.503	−4.019	152.2*	223.0***	41.74	69.31*
	(16.00)	(13.87)	(78.29)	(76.78)	(42.78)	(39.26)
Interaction	−113.6***	−136.7***	39.40	24.74	3.910	−2.319
	(34.22)	(28.31)	(33.94)	(31.31)	(15.82)	(14.99)
_cons	68681.7*	−10056.6	−16663.6	−1307.1	−16310.3	−3528.2
	(39383.4)	(14804.9)	(24246.7)	(8000.2)	(24985.1)	(6074.1)
bic	4001.3	.	14407.8	.	18684.6	.
aic	3975.7	.	14372.9	.	18647.5	.
ll	−1979.9		−7178.5		−9315.8	
Hausman (Prob $>\chi^2$)	0.2668		0.0000		0.1031	

Standard errors in parentheses. *P<0.1, **P<0.05, ***P<0.01

Developed countries tend to be established, sensitive to the environment and sustainability, and have been through phases, experiences, and innovation.

The interaction variable in this study tends to capture an interaction that might occur when an independent variable has a different effect on the outcome depending on the values of another independent variable. In other words, to investigate the interaction between urbanization and economic growth and whether the existence of urbanization will strengthen or weaken the relationship between economic growth and environmental damage. With a significant negative result, it can be concluded that the existence of urbanization deteriorates the relationship between growth and emissions. The equation designated for a developed country shows that the EKC curve does not occur. It can be seen from the variable of growth2, which is insignificant.

For the equation that is divided based on income groups, the country is classified into 4 groups based on income: high income, upper-middle income, lower-middle income, and low income. However, in the Asia Pacific, only 1 country is included in the category of low-income countries: North Korea. So, it is excluded from the estimate.

By using the division of 4 GNI categories, the estimation results show consistency with Table 2; namely, the best model is the High-Income countries model. In addition, EKC did not occur in Asia Pacific countries in all GNI groups. The estimation results in Table 2 and 3 demonstrate consistent results in which urbanization significantly negatively affects emissions.

Although these results contradict previous studies, such as Wang et al. (2022), in which, on a global scale, urbanization has a positive effect on carbon emissions, there are several studies stated that urbanization can be negatively related to environmental damage if supported by good governance (Abaidoo and Agyapong, 2022).

The negative effect of urbanization on environmental degradation can be explained for several reasons. First, urbanization can increase productivity because of positive externalities and economies of scale. Urban areas can produce the same goods with fewer resources. In this sense, urbanization reduces environmental degradation.

Table 3: Estimated result for the distribution of countries based on gross national income (GNI)

y=emissions	Low middle income		Upper middle income		High income	
	FE	RE	FE	RE	FE	RE
L1emissions	1.054***	1.051***	1.005***	1.032***	0.956***	1.000***
	(0.0116)	(0.00514)	(0.00802)	(0.00361)	(0.0277)	(0.00304)
Urban_pop_percent	−329.3	−717.1	15900.2	−5344.1	−21052.9**	−17237.2*
	(3166.8)	(3056.6)	(49311.4)	(48434.7)	(10520.1)	(10015.7)
L1urban_pop_percent	2624.2	2743.0	29034.0	40926.7	40828.2**	35947.6*
	(6149.0)	(6033.3)	(92434.6)	(93155.4)	(19986.6)	(19171.7)
L2urban_pop_percent	−2257.9	−2072.2	−43580.2	−35892.4	−20437.9**	−18640.3*
	(3206.2)	(3089.6)	(47721.6)	(47193.3)	(10149.6)	(9634.5)
Growth	−11.64	9.820	−5967.3	4328.9	11666.9***	14036.6***
	(199.5)	(189.7)	(6735.3)	(6059.6)	(3301.9)	(2691.2)
Growth2	−6.707	−8.231	827.9***	778.6***	−8.503	−4.019
	(9.850)	(9.625)	(277.9)	(250.4)	(16.00)	(13.87)
Interaction	3.728	4.596	85.87	−87.87	−113.6***	−136.7***
	(5.637)	(5.367)	(116.0)	(101.2)	(34.22)	(28.31)
_cons	−1703.5	972.1	−92641.3	−17930.9	68681.7*	−10056.6
	(3589.6)	(1463.1)	(78848.6)	(27522.5)	(39383.4)	(14804.9)
aic	7574.3	.	5365.0	.	3975.7	.
bic	7605.7	.	5391.7	.	4001.3	.
ll	−3779.2		−2674.5		−1979.9	
Hausman (Prob >χ^2)	0.8378		0.0001		0.2668	

Standard errors in parentheses. *P<0.1, **P<0.05, ***P<0.01

Second, the development of the service sector in developed countries over the past few decades has been remarkable. The sector needs urbanization as it requires a concentration of customers. This aspect of urbanization also benefits the environment, as services are generally less polluting than industry. Third, green infrastructure and utilities such as water, sanitation and solid waste disposal are much easier and more economical to build, maintain and operate in urban environments. Urbanization will allow more people to have access to affordable eco-friendly amenities and services.

Fourth, innovation—including green technology—is fueled by urbanization. The long-term viability of the green economy will be determined by environmentally friendly tools, machinery, vehicles, and equipment. Finally, the improved housing, health care, education, and nutrition that come with urbanization will benefit all people. Revenues from urban growth are used to finance infrastructure improvements, ease traffic, and enhance public health. (Charfeddine and Mrabet, 2017).

Political institutions, open trade, and urbanization positively affect the environment. The beneficial environmental impacts of urbanization that offset the detrimental effects may be due to many reasons. For example, urbanization comes with rising income levels, which not only promotes green service sectors but also increases demand for environmental quality and lowers Environmental degradation. Furthermore, urbanization lessens Due to greater access to amenities and higher living standards than rural areas (due to the overall population of urban areas), environmental degradation may be reduced through study, development, and innovation (Yasin et al., 2020).

5. CONCLUSION

Global climate change which lead to environmental degradation is primarily caused by carbon dioxide emissions, fossil fuel such as coal, oil, and gas release large amount of CO2 when burned or used in industrial processes which increase as long with higher urbanization rates. The challenge of sustainable urban development in Asia Pacific countries is to keep these cities growing organically into a safe, comfortable, productive, and the sustainable residential environment without causing degradation in environmental quality, which will be very detrimental to the next generation. Investigating the role of urbanization on environmental damage in this study reveals the significant differences between developed and developing countries in responding to adapt with environmental changing. In develop countries urbanization could lead to decreasing environmental degradation. This is due to complete infrastructure support and has taken into account green infrastructure, in other words, awareness of environmental damage in big cities in developed countries is greater than in big cities with densely populated areas in developing countries. The EKC literature itself is far from consensus, as evidenced by some of the aforementioned sources as well as the finding from this research. Researchers frequently update, revise, and categorically reject empirical evidence; therefore, in future research, it is necessary for more advanced study on existing and the role of EKC.

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