AKKAYA science publishing
International Journal of Economics and Management Vol. 1 Issue **(1)** pp 8 - 18, 2019

The Urbanization Effect on CO_2 Emissions: New Evidence of Dynamic Panel Heterogeneity in Asian Countries

Jain Yassin*
Faculty of Business, Economics and Accountancy, University Malaysia Sabah
*Corresponding author E-mail: jain.ucsfmalaysia@gmail.com

Sarma Binti Aralas
Faculty of Business, Economics and Accountancy, University Malaysia Sabah

Abstract
The great debates whether the transaction from rural to cities brings a better life or in the way around in Asia Countries have captured global attention. This study provides empirical evidences on the urbanization-CO_2 emissions nexus for a sample of 34 Asian countries from 1990 to 2016 which obtained from the time series databased of Emissions Database for Global Atmospheric Research (EDGAR) and World Development Indicator (WDI). This article aims to assess the possibility of urbanization role in counteract the growth of CO_2 emissions by examine the possibilities of non-linear relationship or specifically the possibility of the Kuznets' hypothesis. Due to the structural heterogeneity exists widely across countries in Asian countries, this paper employ Stochastic Impact by Regression on Population, Affluence, Technology (STRIPAT) model as its analytical framework and estimate using the Dynamic Common Correlated Effects (DCCE) estimator to address the heterogeneity, cross-section dependence, and dynamics nature of carbon emissions. The result shows that, initially, the CO_2 emissions intensify along with the growth of urbanization, and at higher urbanization bound to reduce the CO_2 emissions as presented in quadratic functional. Nevertheless an N-shape relationship observe in cubic functional. The finding of this paper have important implication on the Asian countries policymakers in archiving the sustainable urban society.
Keywords: Asian Countries, Urbanization, Carbon Emissions, STRIPAT, Dynamic Common Correlated Effects (DCCE)

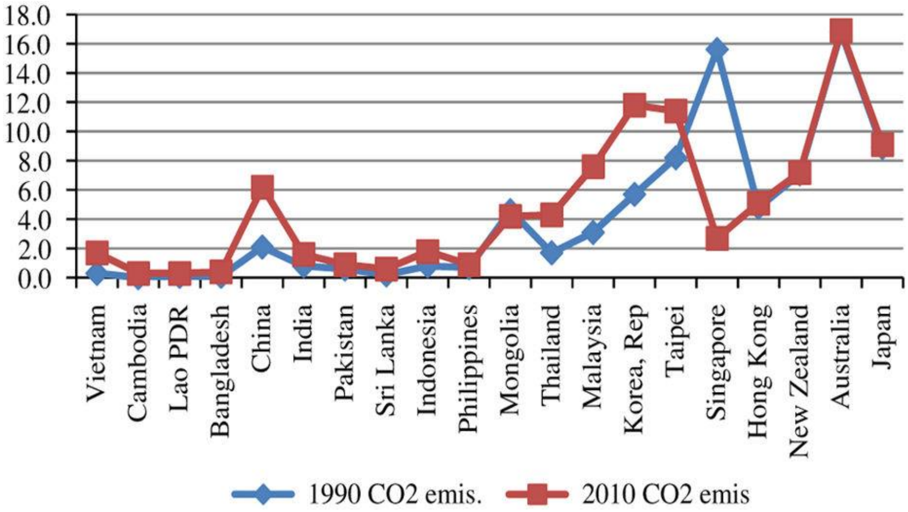
1.Introduction

Driven by the escalate of urban transformation growth, to date, Asia takes the blame as the malefactor for global anthropogenic pollution emission, especially when China outperformed other countries as the greatest emitter of pollution emissions Salim et al. (2017). Empirically, the urbanization has been viewed by many researchers as the major contributor to global CO2 emissions (Li & Lin, 2015; Martínez-Zarzoso & Maruotti, 2011; Sadorsky, 2014). According Adusah-Poku (2016), the movement of the human resource and people from rural to urban area become the main driving force that shaping the economic structure due to its positive effect on promotes the development of industrial sector. The rapid growth of production and manufacturing which are the major components of industrialization will create negative environmental externalities such as CO_2 emissions (Dhami et al., 2013).

Nevertheless, Asia's rapid urbanization might as well create an unprecedented opportunity to create sustainable and more livable cities (ESCAP, 2017). The theory of ecological modernization and compact city theory proposed that high urbanization densities will benefit to the environment as a result of society awareness and the economics of scales for urban public infrastructure (Poumanyvong & Kaneko, 2010). On the other hand, the urbanization might play a significant role in driving the Environmental Kuznets Curve (EKC) even though evidence to support it still insufficient and to date, there are limited studies (Rafiq et al., 2016; N. Zhang et al., 2017) have found evidence of inverted-U shaped relationship which supported the compact city and theory ecological modernization theory. However to date, past empirical studies do not estimate whether the moderating effect of urbanization on pollution emissions is permanent or just temporary.

The study on the urbanization-CO_2 emissions nexus for Asian Countries merits investigation for two reasons. First, Asian region is the most diverse continent with population almost 60 per cent of the global population and experience a skyrocketing shift of economics structure and urban transformation (Asian Development Bank, 2011). Moreover, according to ESCAP (2017), it is estimated that approximately 60 per cent of high-income Asian cities have already met strict WHO air quality guidelines for one of the most-health harmful pollutants. However, the CO_2 emissions trends in Asian countries rather interesting as the highly urbanize countries like Singapore shows a sharp drop in CO_2 emissions from 1990 to 2010 as presented in figure 1. On the other hand, the developed countries such as Japan experiences a slowdown of change in the emission. This clearly signify that the study on the effect of urbanization expansion on pollution is a serious academic and policy requirement, which leave unnoticed by earlier studies.

Figure 1: Changes in CO_2 emissions per capita in Asian during 1990 and 2012



Source: (Ota, 2017)

Second, the structural heterogeneity that exists widely across countries in Asian countries (Felipe et al., 2016). This suggests that in spite of fast growth in economic growth, Asian countries has not done equally well in structural transformation and economic performance (Sen, 2016). According to Rafiq et al. (2016), to assume that factor that influence the CO_2 emission across countries are homogenous is quite unrealistic. Furthermore, according to Sohag et al. (2017) in same regions countries such as Asian, there is a possibilities that a vertical and horizontal trends of CO_2 emissions exists in cross countries. Specifically, the CO_2 emissions in one county can affect another country CO_2 emissions level. Nevertheless, the prior studies that take consideration on the cross-sectional dependence among Asian countries rather scarce.

The current study mainly provides three contributions, first, in prior literatures such as N. Zhang et al. (2017) and Rafiq et al. (2016), their provide the evidence of inverted-U shaped association between the urbanization-pollution nexus, nonetheless, to date study that investigated whether the presence of EKC inverted-U shaped is permanent or not is not exist. Thus, on the theoretical side, it is the first study to explore the expansions effects of the urbanization which the introduction of the cubic terms in non-linear frameworks. On the other hand, we introduce an alternative variable to represent the affluence effect in the non-linear STRIPAT model; industrial and services value added. The inclusion of these variables mainly due to urbanization process generally promotes the development of industrial and services sectors. Second, on the empirical side, this study employ the newly developed Dynamic Common Correlated Estimators of Chudik and Pesaran (2015) so as to provide more robust estimates and confront the potential bias emerge from problems such as endogeneity, heterogeneity and cross-country dependence that may have affected previous empirical works. To date, the number of study that used a panel regression that allows for heterogeneous slope coefficients and cross-section dependence to investigate is still very limited (Salim et al., 2017). Moreover, a panel regression that allows for heterogeneous slope coefficients and also consider the endogeneity of dynamic panel due to the inclusion of the lagged dependent variable not existence in this Asian countries. Third, this study also clarifies the urbanization effect and its implication for sustainable development and climate change policies in archiving the sustainable urban society. Hence, the main novelty of this study also lies on its estimation methodology as this empirical investigation have not been used in previous studies of EKC frameworks specially on Asian Countries. Due to limitation form the existing empirical literatures, this study attempts to contribute to the empirical evidence by investigate the cumulative effects of rising urbanization on the carbon emissions in non-linear framework for 34 selected Asian countries from 1990 to 2016.

The remaining of this paper is organized in the following manner. The second section presents the theoretical arguments and past empirical studies related this current study, the third section discuss the theoretical background and model specification, the fourth section exposes the empirical results and finding, and the last section discussion on the finding as well as conclusion.

2. A Brief Review of the Literature

From the theoretical point of view, there are three theories in related to the effects of urbanization on environment emissions have been discussed extensively by existing studies (Poumanyvong & Kaneko, 2010). First, the compact city theory which argued that an increase in urbanization population will increases the economies of scale for public infrastructure such as schools, hospital and electricity production which tend to lower the environmental damages. Second, the ecological modernization theory argued that urbanization is a process of social restructure which encouraged a structural change from an industrial to a service based economy and indirectly reduce the negative impact on environment. Third, urban environmental transition theory argue that as urbanization rate increasing the demand for energy and manufacturing activities will increase.

The urbanization and population have been viewed by some researchers as one of the major contributors to global CO_2 emissions. Zhu and Peng (2012) explain three different channels on how the urbanization affects CO_2 emissions. First, an increase in city's population will increase the residential consumption and energy demand thereby surge the CO2 emissions. Second, the urbanization generally boost demand for housing and naturally raised the demand for housing material which known as the major sources of CO_2 emissions. Thirdly, the clearing of trees and grasslands activities as more demand for housing will increase which emitted the carbon stored in the trees. The positive relationship between urbanization and CO_2 emissions is also confirmed by number of studies. The positive effect of urbanization on carbon emissions supported by numbers of studies. Poumanyvong and Kaneko (2010) adopted the Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) model for 99 countries spanning for period 1975 to 2005 and static panel estimators to examine the urbanization effect on energy consumption and CO_2 emissions in different stage of development. The result shows that the urbanization effect on emissions found to be positive for all income group. Similarly, Adusah-Poku (2016) employ the Pooled Mean Group (PMG) estimators also acknowledges the positive relationship between urbanization and CO_2 emission both in the long and short run in 45 Sub-Saharan African (SSA) countries from 1990 to 2010.

Nevertheless, several studies shows that the impact of urbanization on emissions are varies for different group of countries. Martínez-Zarzoso and Maruotti (2011) shows that the urbanization elasticity is negative and significant for the upper-middle-income group, whereas it is positive and significant for lower-middle and low-income countries in explaining the CO_2 emissions. The ambiguous effect also shown in different countries by Azam and Khan (2016) who evaluate empirically the impacts of urbanization on environmental degradation proxy by carbon dioxide emissions for India, Bangladesh, Sri Lanka, and Pakistan over the period of 1982 to 2013. They found out that the urbanization have significantly negative effect on environment found in India, while significantly positive on environmental in case of Sri Lanka and insignificantly positive for Pakistan.

Several empirical studies provided an illustration of an inverted-U shape relationship between urbanization and carbon dioxide emissions. This inverted-U shaped relationship confirmed Rafiq et al. (2016) which adopted a heterogeneous linear and nonlinear panel estimation that allow for cross-sectional dependence to analyse the impact of urbanization and trade openness on emissions and energy intensity in emerging economies. This study identified significantly positive impacts from urbanization to energy intensity, but it is insignificant influence emissions. This portrays the EKC hypothesis nevertheless not significant. On the other hand, N. Zhang et al. (2017) adopt a two-way fixed effects model based on the extended STIRPAT model to analyse the urbanization impact on carbon dioxide emissions for 141 countries over the period of 1961 until 2011. This study also consider the linear and nonlinear tests and concludes that the existence of an environmental Kuznets curve between urbanization and carbon intensity found in OECD countries but insignificant in non-OCED countries.

3. Methodology: Theoretical Background and Model Construction

This study employs the dynamic panel analysis of 34 Asian countries[1] for the period of 1990 to 2016. The chosen group countries due to rapid urbanization paces in Asia countries compare to other regions and in the coming decades (Salim et al., 2017) and to observe the countries heterogeneity. In next sub-section, we will discuss the theoretical model, the proposed empirical equation, the data sources, and the estimation method.

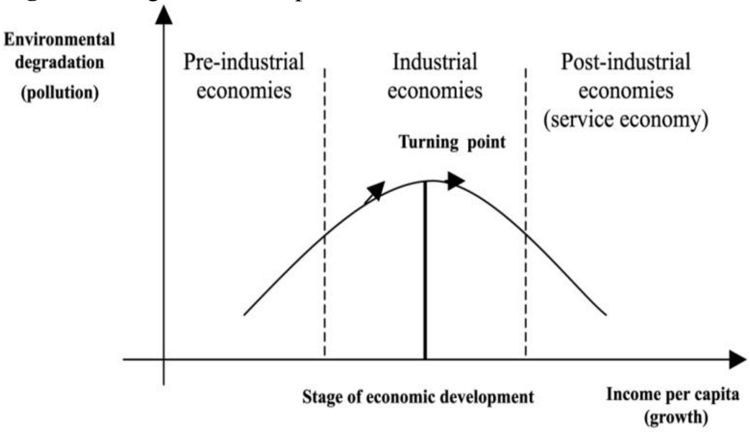
3.1 The Environmental Kuznets Curve (EKC) Model and Urbanization

According to Panayotou (1993), the EKC hypothesis postulates that in the early stages of economic growth as nations become progressively richer, the rate of environmental degradation initially rises but after reached the turning point the environment degradation will be alleviated as presented in figure 2. The inverted-U shaped believed due to the sectoral transformation from pre-industrial to industrial economics, and finally to services economics.

The sectoral transformation generally aligned with the expansion of urbanization. According to N. Zhang et al. (2017), in the early stage of urbanization, an increase demand for infrastructure encourage more industrialization in the city that induce higher carbon emissions. Later at higher urbanization intensity, due to shift in demand for better services and green technology innovation, it leads to lower carbon emissions. In past empirical studies, the validities of Environmental Kuznets Curve (EKC) hypothesis estimate within the nonlinearity association between urbanization and carbon dioxide emissions with the inclusion of a quadratics term of urbanization (U^2) (Shahbaz et al., 2016).

[1] Bahrain, Bangladesh, Bhutan, Brunei, Cambodia, China, India, Indonesia, Iran, Japan, Jordan, Kazakhstan, Israel, Korea, Rep, Kuwait, Lebanon, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Sri Lanka, Tajikistan, Thailand, Turkmenistan, UAE, Uzbekistan, Vietnam and Yemen.

Figure 2: Stages of Development in EKC Framework



Source: (Panayotou, 1993)

3.2 Model Construction: STRIPAT Model

This paper analyses the decomposed factor that affects the environment based on Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) model which extended form the IPAT equation by Ehrlich and Holdren (1971). The standard specification of STIRPAT model is as follow:

$$I_{it}=a_i P_{it}^{b} A_{it}^{c} T_{it}^{d} e_{it} \tag{1}$$

Where, I_{it} is pollution, P_t is population effect, A_t is affluence effect, T_t is technology effect and e_{it} is the error term. All the series are transformed into natural log form. Due to the use of panel estimation, countries are represented by the subscripts i (=*1,….,N*) and time period are denoted by the subscripts t (t=1,….,T); a_i denote the country-specific effect and e_{it} represents the random error term. The elasticities for the following variable can be represented by b, c and d. The model is interpreted based on the estimates coefficients (b, c, d). For this paper, the population effect highlighted the share of urban population (Poumanyvong et al., 2012; Sadorsky, 2014), the Affluence effect proxy by the income per capita, and technological effect proxy by the energy intensity. As previous study claimed that the lagged CO_2 emissions significantly influence the current level of CO_2 emissions (Kais & Sami, 2016), thus, it is important to consider the dynamic nature of CO_2 emissions. Taking natural logarithms of equation (1) provides a non-linear specification in dynamic panel and is designated as **Model 1**.

$$InZ_{it} = \beta_0 InZ_{it-1} + \beta_1 lnU_{it} + \beta_2 lnU_{it}^{2} + \beta_3 lnU_{it}^{3} + \beta_4 InA_{it} + \beta_5 T_{it} + \lambda_i f_t + \varepsilon_{it} \tag{2}$$

Equations 2 indicate that environmental impact (Z_{it}) proxy by CO_2 emission influence by population effect proxy by urbanization intensity (U_{it}), affluence effect is proxy by income per capita (A_{it}), and technology effect proxy by energy intensity (T_{it}). We include non-linear variable proxies by the square (U_{it}^{2}) and cubic term (U_{it}^{3}) of the urbanization. The combined effect of all the above factors on environmental pollution can be represented by a non-linear specification for panel estimation where countries are denoted by the subscript i (i = 1… N), and time is denoted by the subscript t (t = 1… T).The model include the unobserved country specific effect (f_t) that includes the individual heterogeneity factor loadings (λ_i), and ε_{it} represents the random error term.

We augment equation (2) to replace the income per capita with the two selected sectoral composition; industrial value added and services value added which designated as **Model 2**.

$$InZ_{it} = \beta_0 InZ_{it-1} + \beta_1 lnU_{it} + \beta_2 lnU_{it}^{2} + \beta_3 lnU_{it}^{3} + \beta_4 Inindu_{it} + \beta_5 Inserv_{it} + \beta_6 T_{it} + \lambda_i f_t + \varepsilon_{it} \tag{3}$$

In model 1, the second term denotes the population effect which special focus on the shares of the urban population. According to Guo et al. (2016), the urbanization associated with the redistribution of population between urban and rural areas where urbanization expected to have a positive relationship with pollution emissions. The third and fourth terms represent the expansion effects of urbanization which proxies by the square (U^2) and cubic (U^3) terms of urbanization. According to the compact city theory, at higher urbanization level, people will demand for better services and encouraged expansion the service based economy and reduce the negative impact environment. Thus, the square and cubic terms expected to negatively affect the CO_2 emissions which aligned with the inverted-U shaped of EKC theory. The fifth term indicates the affluence effect proxies whereby an increase in income per capita (G) represents the rise in the level of affluence (A) of the country at time t. Economic growth generates waste production, and rapid resource use induces increases in environmental pollution. Thus, it is expected that Affluence effect will have a positive effect on pollution. The sixth term denoted the energy used per unit of output, or energy intensity, which represents the technology (T) effect. By lowering the energy intensity and carbon emission intensity, which indicates the enhancement in the efficiency of energy use, it is expected to moderate the growth effect in the environment.

In model 2, the sectoral share of value added for industrial and services sector are replacing the Income per capita as proxies the affluence effect. According to the EKC hypothesis, the industrialization process will induce environmental pollution, while the teritarization process may lower environmental pollution. Thus, it is expected that industrialization may increase the pollution, while services sector will lower the pollution level. The above equations is a dynamic heterogeneous panel model as we consider the vector of slope coefficients as heterogeneous across N.

3.3 Data

This study estimates the environmental pollution by adopting the Carbon Dioxide (CO_2) per capita in metric tons from Emissions Database for Global Atmospheric Research (EDGAR). The CO_2 emissions include burning of fossil fuels and cement manufacturing. The dependent variables decomposed into the three effects, namely affluence effect, population effect, and technology effect. The first group of variables that explaining the pollution level include the affluence effect represent by the per capita income, which is defined as Income per capita (measured in real dollars) which widely used to measure the economy's performance. The income is the total gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Data are in constant 2010 U.S. dollars. Income divided by midyear population to get Income per capita as it more useful measure when comparing the economics across country. The affluence effect later decomposed into two main sector, namely: industrial and services sector which based on the value added. The industrial value added represents a country's industrial activities such as mining, quarrying, manufacturing, construction, and electricity, gas and water. The services include transport, communications, retail trade, banking, insurance public administration, and others services. Second, the population effect measured using urban population as share in total population and according to World Bank to measure the expansion level of urbanization, the square and cubic term of urbanization included. Next, the Technology effect is measured using the energy intensity where it often expressed as total energy use per dollar income. The dependent variables adopted from World Development Indicator (2018) dataset from 1990 to 2016.

3.4 Dynamic Common Correlated Effects (DCCE)

Given the nature of our dataset and the dynamic nature in CO_2 emissions, a panel data estimation that consider a potential endogeneity and cross-sectional dependency employed. Thus, to estimate the model 1 and 2, this study employ the Dynamic Common Correlated Effects (DCCE) model with heterogeneous coefficients as developed by Chudik and Pesaran (2015). According to Chudik and Pesaran, the estimator becomes more consistent if $\sqrt[3]{T}$ a lag of cross-section means is added. The DCCE is not only robust to unknown types of error cross section dependence due to the presence of common shocks and interdependencies such as trade activities but also address the heterogeneity among countries and the problem of dynamic panel setting. For a clear explanation, lets the model simplify as follow:

$$y_{it} = \alpha_i + \lambda_i y_{it-1} + \beta_i x_{it} + \sum_{\iota=0}^{pT} \delta'_{it} \bar{z}_{t-1} + \varepsilon_{it} \tag{5}$$

Where:

$\bar{z}_t = (\bar{y}_t, \bar{y}_{t-1}, \bar{x}_t)$

pT −The number of lags (pT=$\sqrt[3]{T}$)

λ_i − Individual heterogeneity factor loadings

β_i −The heterogeneous coefficient and randomly distribute around common mean, $\beta_i = \beta + \nu_i, \nu_i \sim IID(0, \Omega_V)$

From equation 5, λ_i and β_i are stacked into $\pi_i = (\lambda_{it}, \beta_i)$. The mean group coefficient estimates as in equation 6:

$$\hat{\pi}_{MG=\frac{1}{N}\sum_{i=1}^{N} \hat{\pi}_i} \tag{6}$$

Where $\hat{\pi}_i$ and $\hat{\pi}_{MG}$ are consistently estimated with convergence rate $\sqrt{N}$ if $(N, T, pT) \Rightarrow \infty$.

Under the full rank of factor loading, the asymptotic variance can be consistently estimated by:

$$Var(T_{MG}) = N^{-1} \sum_{\pi}^{\wedge} = \frac{1}{N(N-1)} \sum_{i=1}^{N} (\hat{\pi}_i - \hat{\pi}_{MG})(\hat{\pi}_i - \hat{\pi}_{MG})' \tag{7}$$

The mean group estimates have the following asymptotic distribution (Chudik & Pesaran, 2015):

$$\sqrt{N}(\hat{\pi}_{MG} - \pi) \overset{d}{\to} N(0, \sum\nolimits_{MG}) \tag{8}$$

On the other hand, the pooled group estimator also allow for Pooled Mean Group (PMG) estimations in dynamic panel with dependence between countries. According to M. H. Pesaran et al. (1999) the PMG estimators is intermediate between the homogeneous coefficients with pooled estimations and the heterogeneous coefficients with the mean group estimations.
Then the estimators controls for dependence by adding cross sectional means and lags, as proposed by Pesaran (2006) and Chudik and Pesaran (2015). To correct for small sample time series bias, the jackknife correction method and the recursive mean adjustment proposed by Chudik and Pesaran (2015a). The mean group estimate of the Jackknife bias-corrected CCE estimators as follow:

$$\hat{\pi}_{MG} = 2\hat{\pi}_{MG} - \frac{1}{2}(\hat{\pi}_{MG(a)} + \hat{\pi}_{MG(b)}) \tag{9}$$

Where,
$\hat{\pi}_{MG(a)}$ −Mean group estimate of the first half (t=$\frac{T}{2} + 1, \ldots, T$))
$\hat{\pi}_{MG(b)}$ − Mean group estimate of the second half (t=1… $\frac{T}{2}$)

The Mean Group estimate of the Jackknife derived from the variance of multiple Mean group estimate with the average value of the Mean Group Dynamic Common Correlated Effect estimations for the first half of the existing time period ($\hat{\pi}_{MG(a)}$) and the second half ($\hat{\pi}_{MG(b)}$). In this regression, the test for cross-sectional dependence (CD) devised by Chudic and Pesaran (2015) is included. The CD test under the decision of null hypothesis: the error term are weakly cross sectional dependent. The employment of the Dynamic Common Correlated Effects (DCCE) model due to several reasons. First, the inclusion of the lagged value of CO_2 emissions make the equation dynamic. Second, the impact of growth, population, and technology on CO_2 emissions might be different across countries, thus it is essential to consider heterogeneities in countries. Third, as mentioned before, there is a possibilities that a vertical and horizontal trends of CO_2 emissions exists in cross countries. The Dynamic Common Correlated Effects Estimators address all the issue raises and will produces more robust estimations on the effect of the urbanization on the CO_2 emissions.

4. Results

To observe the property of the data, this study adopted the second generation panel unit root of Pesaran (2007) CIPS test. The CIPS test is a Dickey Fuller regression augmented with the cross-section average of lagged level and first differences on the series. This test assumes that one or more common unobserved factors produce cross-country dependence. The results presented in table 1 and show that test for all variables rejects the unit root hypothesis and conclude that the variables is stationary for call series including with trends-stationary process. This results implied that any shock affecting the series is likely to have temporary effect and it can be used for forecasting. Hence, we can consequently estimate the model.

Table 1: Panel Unit Roots Test based on Pesaran (2007)

Variable	CIPS	
	Without Trend	With Trend
InCO_2	-1.330**	-1.877**
$Afluence\ (G)$	-2.145**	-2.338**
$Urbanization(U)$	-2.222**	-1.964**
$Technology\ Effect\ (lnT)$	-2.117**	-2.819***
$Industrial\ Value\ Added\ (lnindu)$	-1.773**	-2.263***
$Services\ Value\ Added(lnser)$	-2.423***	-3.053***

Notes: CIPS test developed with the command of xtcips of stata 14 with 3 maximum lags; the critical value for CIPS statistics at (***) 1 percent, (**) 5 percent, and (*) 10 percent level. The null hypothesis is that the variable is homogeneous non-stationary.
The estimate results of the model 1 using the Dynamic Common Correlated Effects (DCCE) estimators in Asian Countries presented in table 2. The results of estimations using Mean Group Dynamic Common Correlated Effect (DCCEMG), Pooled Mean Group Dynamic Common Correlated Effect (DCCEPMG), and also taking account

the estimations using Jackknife bias correction robustness analysis check. In this table, the lagged value of CO_2 emissions is positively and statistically significantly related with the current value of CO_2 emissions.
In model 1, the expansion of accumulation urbanization effect proxy by square term and cubic term of share of urban population on pollution emissions provide the possibility of a non- linear relationship. Initially, the urbanization effect found to be positively and statistically significant in all estimations. This implied that 1 per cent increase of urban population will increase the CO_2 emission by 4.099 to 7.767 per cent in DCCEMG, DCCEPMG, and Jackknife bias correction, respectively. Further, the quadratic term of urbanization exerts a significant negative effect. Referring to the results, the expansion of urbanization, a rise in the square term of urbanization by 1 per cent mitigate the CO_2 emissions by 0.142 to 0.362 per cent. The finding provides evidence of non-linearity relationship between urbanization and CO_2 emissions and confirmed the existence of inverted U-shaped at higher urbanization. Nevertheless, as the urbanization increase further, at a very high value of urbanization, the CO_2 emissions will again intensify. This implied that there is an N-shaped associations between urbanization and CO_2 emissions.
On the other hand, the estimated coefficient for affluence and technology effect proxy by the energy intensity found to be significantly positively related on the CO_2 emissions. The result implied that 1 per cent increase in income per capita will increase CO_2 emissions between 0.567 to 1.205 per cent, while the energy intensity will cause the CO_2 emissions to increase by 0.466 to 0.555 per cent.
The CD statistics and its P-value that test for the cross dependences, show that the result do not reject the null hypothesis which claimed that the error terms are weakly cross sectional dependence(p-value > 0.005). The value of goodness-of-fit measures (R-square) for all model indicates the model (1) explains 49 to 51 per cent of the cross-country variation.

Table 2: Result Estimation for Non-Linear Dynamic STRIPAT Model 1 using the DCCE Estimators for Asian Countries

Dynamic Common Correlated Effects (DCCE)			
Variable	Mean Group (MG)	Pooled Mean Group (PMG)	Jackknife Bias Correction
In$CO_{2_{it-1}}$	0.201* (.1099)	0.096** (0.1010)	0.082 (0.1260)
$Afluence\ Effect\ (lnG)$	1.205* (1.281)	0.567* (0.9475)	0.679* (1.186)
$Urbanization(U)$	7.767* (4.808)	4.099** (2.066)	6.362** (3.411)
$Square\ \ urbanization(U^2)$	-0.362* (0.066)	-0.142** (0.066)	-0.235** (.1230)
$Cubic\ urbanization(U^3)$	0.021* (.2327)	0.001** (0.001)	0.002** (0.001)
$Technology\ Effect\ (lnT)$	0.555* (0.3207)	0.466** (0.1916)	0.555** (0.414)
Constant	78.23** (10.80)	14.676*** (10.65)	29.352*** (16.07)
Obs.	884	884	884
R-squared	0.51	0.49	0.47
CD Statistic *(p-value)*	-0.89 (0.375)	-0.76 (0.446)	-1.32 (0.1860)

Notes: The dependent variable is the carbon dioxide emissions (CO2). All variables are expressed (*) significant at the 10 per cent level, (**) significant at 5 percent level, and (***) significant at the 1 per cent level. The analysis

AKKAYA science publishing
International Journal of Economics and Management Vol. 1 Issue **(1)** pp 8 - 18, 2019

use dynamic common correlated effects estimation developed by Chudik and Pesaran (2015). Figure in parentheses are standard error, Cross Sectional Dependence (CD) test which is p-value and the null hypothesis is that the error terms are weakly cross sectional dependent.

Turning to Model 2, the income per capita replaces with the two selected sectoral composition; industrial value added and services value added. First, the lagged value of CO_2 emissions confirmed to positively and statistically significantly correlate with the current value of CO_2 emissions. This result confirmed that the dynamic lags of CO_2 emissions will spur additional of the current CO_2 emissions in Asian countries.

Similar with the model 1, initially, the urbanization confirmed to statistically positive effect on CO_2 emissions based on DCCEPMG and with Jackknife bias correction but not statistically significant in DCCEMG. Specifically, 1 per cent increase in urbanization in Asian countries will increase the CO_2 emissions by 2.49 and 18.2 per cent based on the DCCEPMG and with Jackknife bias correction method. When the urbanization level enters into the advanced stage proxy by the square term, the urbanization shows to negatively relate with the CO_2 emissions or specifically reduce by 0.098 and 1.664 per cent based on the DCCEPMG and with Jackknife bias correction method respectively. However, at very high value of urbanization, the CO_2 emissions confirmed to move the same direction with the cubic term of urbanization. The result shows that as the cubic term of urbanization increase 1 per cent, the CO_2 emissions will increase by 0.001 and 0.034 per cent based on the DCCEPMG and with Jackknife bias correction method. The association between urbanization and CO_2 emissions in Asian Countries basically conforms to the N-shaped curve.

Interestingly, the industrial and services value added produce different results. The coefficient estimate of the industrial value added is positive and significant and demonstrated that a 1 per cent increase in urbanization will lead to an increase of CO_2 between 0.020 to 0.194 per cent. This result is as expected as the industrial sector consists of extremely energy-consuming activities such as manufacturing and mining which required huge amount of energy that emitted more pollution. On the other hand, the coefficient estimate of the services value added is negative and significant. Specifically, a rise in the services value added by 1 per cent mitigate the CO_2 emissions by 0.028 to 0.124 to per cent. The services sector may include activities such as healthcare, hospitality, telecommunication, and many more that less energy-consuming and environmental-friendly activities. The technology effect found to be not statistically significant in explaining CO_2 emissions in all estimators.

The CD statistics and its P-value that test for the cross dependences, show that the result do not reject the null hypothesis which claimed that the error terms are weakly cross sectional dependence (*p*-value > 0.005). The value of goodness-of-fit measures (R-square) for all model indicates the model (2) explains 55 to 64 per cent.

Table 3: Result Estimation for Non-Linear Dynamic STRIPAT Model 2 using the DCCE Estimators for Asian Countries

Dynamic Common Correlated Effects (DCCE)			
Variable	Mean Group (MG)	Pooled Mean Group (PMG)	Jackknife Bias Correction
$\text{In}CO_{2_{\text{it}-1}}$	-0.009 (0.098)	0.028* (0.113)	0.037* (0 .155)
$Industrial\ Value\ Added\ (lnindu)$	0.0240* (0.0399)	0.194* (0.042)	0.020* (0.042)
$Services\ Value\ Added (lnser)$	-0.8919* (0.6760)	-0.0280* (0.091)	-0.124* (0.133)
$Urbanization(U)$	3.126 (29.00)	2.497** (1.211)	1.802** (0.480)
$Square\ \ urbanization(U^2)$	-1.368 (1.340)	-0.098** (0.041)	-1.664** (1.310)
$Cubic\ urbanization(U^3\ )$	0.023 (0.243)	0.001** (0.001)	0.034** (0.028)
$Technology\ Effect\ (lnT)$	0.020 (0.393)	0.192 (0.262)	-0.083 (0.362)

Constant	-38.10 (46.27)	28.20*** (27.20)	13.38*** (11.78)
Obs.	884	884	884
R-squared	0.64	0.62	0.55
CD Statistic *(p-value)*	-0.17 (0.861)	-0.82 0.4099	-1.15 (0.251)

Notes: The dependent variable is the carbon dioxide emissions (CO2). All variables are expressed (*) significant at the 10 per cent level, (**) significant at 5 percent level, and (***) significant at the 1 per cent level. The analysis use dynamic common correlated effects estimation developed by Chudik and Pesaran (2015). Figure in parentheses are standard error, Cross Sectional Dependence (CD) test which is p-value and the null hypothesis is that the error terms are weakly cross sectional dependent.

5. Conclusion and Discussion

This study investigated the impact of expansion of urbanization on CO_2 emissions and also investigated whether the presence of EKC inverted-U shaped is permanent or not in selected Asian countries. Firstly, the result confirmed that the affluence effect is positively related with the CO_2 emissions. It is means that CO_2 emissions will tend to increase as the income increase and consistent with existing literature such as Beck and Joshi (2015) and Ahmad et al. (2016). Next, the inclusion of square term of urbanization also suggests that there is an inverted-U shaped relationship between urbanization and CO_2 emissions for both model. This results in line with the previous studies conducted by Rafiq et al. (2016) and N. Zhang et al. (2017). This trends can be explain based on the close linkage between the urbanization and structural change in influence the CO_2 emissions. In the theoretical point of view, the ecological modernization theory argue that as at higher level of urbanization rate, people will demand for better services and this encourage the expansion of services sector which in the end will surpass the industrial sector. According to Hocaoglu and Karanfil (2011), the reduction share of industrial sector and growing share of the services sector in line with the declining rate of CO_2 emissions. This declining trends may due to service sector become more energy efficient from time to time (L. Zhang et al., 2014) and this argument also demonstrated in our current result where the coefficient estimates of industrial output playing important role in intensify the CO_2 emissions while the services output moderating the CO_2 emissions. Nevertheless, the moderating effect of urbanization is not permanents as the cubic term of urbanization representing the higher urbanization rate indicate that the CO_2 emissions intensify as the urbanization expanding further. This result may be explained by the fact that the continuous concentration in urban area will increase the CO_2 emissions and revealing the N-shaped relationships as the expansion of services sectors eventually lead to an increase in sub-sectors that emitting a large degree of CO_2 emissions such as transportation sector (Al Mamun et al., 2014). Moreover, in Asian perspective, N. Zhang et al. (2017) believed that Asian's rapid urbanization will adversely affect the air quality due to unplanned expansion and the current policy that has little power to facilitate the moderation of carbon in the atmosphere. Thus, this study provide evidence of N-shaped relationship between urbanization and CO2 emissions which not existence in previous studies for Asian countries. On the other hand, the coefficient of energy intensity as a proxy of technology effect found to be positively related with the CO_2 emissions in model 1. The positive association between energy-extensive technology and CO_2 emissions and consistent with existing literature such as Ameer and Munir (2016) and Ahmad et al. (2016). However, the same relationship unable to establish in model 2.

Several policy implication were identified through this study. Firstly, the violent growth in urbanization may enlarge the pollution activities, thus the policy maker should consider the urban agglomeration effects and the sustainability development in urban area. Less developed countries should refer to urban policy from other developed and highly urbanize country as references such as Singapore. Secondly, although the expansion of services sector also enlarge the less-energy intensive activities, however due to high dependency on manufacturing and production activities, it may counteract the benefit of the services activities on environment. Therefore, each of Asian countries should reconstruct both sectors by employing and importing more green-technology that less energy intensive. Moreover, the fiscal policy should emphases in establishment of more less-energy intensity, such as banking, schools, and eco-tourism as a subsector of services to achieve the sustainability development without limiting the economic development. On the other hand, improvement in public transportation will reducing the consumption of personal cars and reducing the consumption of energies especially fossil fuels (Taghvaee & Parsa, 2015). Lastly, as the affluence effect will most likely characterized by human activities that sacrificing the environment through pollution emissions emitted into the atmosphere, continuous effort in discourage the expansion of fossil fuels extensive activities and shift to much more eco-friendly need to be done by imposed to the pricing of carbon emissions either through taxes or cap as proposed by several study such as Sadorsky, 2014.

For the future studies, the analysis of effect of each sectors or specifically the non-linear relationship between sectoral output and pollution emissions could clarify the EKC arguments and explain the association between urbanization and sectoral output. The future research may include other type of pollution emissions such as PM10 and nitrogen dioxide and can be extended into firm level analysis to produce more robust finding.

References

1. Adusah-Poku, F. (2016). Carbon dioxide emissions, urbanization and population: empirical evidence from Sub-Sahran Africa. Energy Economics Letters, 3(1), 1-16.
2. Ahmad, A., Zhao, Y., Shahbaz, M., Bano, S., Zhang, Z., Wang, S., & Liu, Y. (2016). Carbon emissions, energy consumption and economic growth: An aggregate and disaggregate analysis of the Indian economy. Energy Policy, 96, 131-143.
3. Al Mamun, M., Sohag, K., Mia, M. A. H., Uddin, G. S., & Ozturk, I. (2014). Regional differences in the dynamic linkage between CO2 emissions, sectoral output and economic growth. Renewable and Sustainable Energy Reviews, 38, 1-11.
4. Ameer, A., & Munir, K. (2016). Effect of Economic Growth, Trade Openness, Urbanization, and Technology on Environment of Selected Asian Countries.
5. Asian Development Bank, A. (2011). Key Indicators for Asia and the Pacific 2011: Asian Development Bank.
6. Azam, M., & Khan, A. Q. (2016). Urbanization and environmental degradation: Evidence from four SAARC countries—Bangladesh, India, Pakistan, and Sri Lanka. Environmental Progress & Sustainable Energy, 35(3), 823-832.
7. Beck, K. A., & Joshi, P. (2015). An Analysis of the Environmental Kuznets Curve for Carbon Dioxide Emissions: Evidence for OECD and Non-OECD Countries. European Journal of Sustainable Development, 4(3), 33-45.
8. Chudik, A., & Pesaran, M. H. (2015). Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors. Journal of Econometrics, 188(2), 393-420.
9. Dhami, J. K., Singh, H., & Gupta, M. (2013). Industrialization at the cost of environment degradation-a case of leather and iron and steel industry from Punjab economy. Innovative Journal of Business and Management, 2(01).
10. Ehrlich, P. R., & Holdren, J. P. (1971). Impact of population growth. Science, 171(3977), 1212-1217.
11. ESCAP, U. (2017). Economic and social survey of asia and the pacific 2017. In: United Nations publication
12. Felipe, J., Bayudan-Dacuycuy, C., & Lanzafame, M. (2016). The declining share of agricultural employment in China: How fast? Structural Change and Economic Dynamics, 37, 127-137.
13. Guo, J., Xu, Y., & Pu, Z. (2016). Urbanization and its effects on industrial pollutant emissions: An empirical study of a chinese case with the spatial panel model. Sustainability, 8(8), 812.
14. Hocaoglu, F. O., & Karanfil, F. (2011). Examining the link between carbon dioxide emissions and the share of industry in GDP: Modeling and testing for the G-7 countries. Energy Policy, 39(6), 3612-3620.
15. Kais, S., & Sami, H. (2016). An econometric study of the impact of economic growth and energy use on carbon emissions: panel data evidence from fifty eight countries. Renewable and Sustainable Energy Reviews, 59, 1101-1110.
16. Li, K., & Lin, B. (2015). Impacts of urbanization and industrialization on energy consumption/CO2 emissions: does the level of development matter? Renewable and Sustainable Energy Reviews, 52, 1107-1122.
17. Martínez-Zarzoso, I., & Maruotti, A. (2011). The impact of urbanization on CO2 emissions: evidence from developing countries. Ecological Economics, 70(7), 1344-1353.
18. Ota, T. (2017). Economic growth, income inequality and environment: assessing the applicability of the Kuznets hypotheses to Asia. Palgrave Communications, 3, 17069.
19. Panayotou, T. (1993). Empirical tests and policy analysis of environmental degradation at different stages of economic development. Retrieved from
20. Pesaran. (2007). A simple panel unit root test in the presence of cross-section dependence. Journal of applied econometrics, 22(2), 265-312.
21. Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association, 94(446), 621-634.
22. Poumanyvong, P., & Kaneko, S. (2010). Does urbanization lead to less energy use and lower CO2 emissions? A cross-country analysis. Ecological Economics, 70(2), 434-444.
23. Poumanyvong, P., Kaneko, S., & Dhakal, S. (2012). evelopmnet iscussion olicy aper.
24. Rafiq, S., Salim, R., & Apergis, N. (2016). Agriculture, trade openness and emissions: an empirical analysis and policy options. Australian Journal of Agricultural and Resource Economics, 60(3), 348-365.
25. Sadorsky, P. (2014). The effect of urbanization on CO2 emissions in emerging economies. Energy Economics, 41, 147-153.
26. Salim, R. A., Rafiq, S., & Shafiei, S. (2017). Urbanization, energy consumption, and pollutant emission in Asian developing economies: An empirical analysis. Retrieved from
27. Sen, K. (2016). The Determinants of Structural Transformation in Asia: A Review of the Literature.

28. Shahbaz, M., Loganathan, N., Muzaffar, A. T., Ahmed, K., & Jabran, M. A. (2016). How urbanization affects CO2 emissions in Malaysia? The application of STIRPAT model. Renewable and Sustainable Energy Reviews, 57, 83-93.
29. Sohag, K., Al Mamun, M., Uddin, G. S., & Ahmed, A. M. (2017). Sectoral output, energy use, and CO2 emission in middle-income countries. Environmental Science and Pollution Research, 24(10), 9754-9764. doi:10.1007/s11356-017-8599-z
30. Taghvaee, V. M., & Parsa, H. (2015). Economic growth and environmental pollution in Iran: evidence from manufacturing and services sectors. Custos E Agronegocio Line, 11(1), 115-127.
31. World Bank Group, W. (2018). World development indicators 2018: World Bank Publications.
32. Zhang, L., Hu, Q., & Zhang, F. (2014). Input-output modeling for urban energy consumption in Beijing: dynamics and comparison. Plos one, 9(3), e89850.
33. Zhang, N., Yu, K., & Chen, Z. (2017). How does urbanization affect carbon dioxide emissions? A cross-country panel data analysis. Energy Policy, 107, 678-687.
34. Zhu, Q., & Peng, X. (2012). The impacts of population change on carbon emissions in China during 1978–2008. Environmental Impact Assessment Review, 36, 1-8.