

# Measuring Economic, Social and Environmental Wellbeing of Asian Economies

Mowshumi Sharmin (✉ [mowshumi405@gmail.com](mailto:mowshumi405@gmail.com))

Bangladesh Institute of Governance and Management (BIGM) <https://orcid.org/0000-0002-5988-4459>

Sima Rani Dey

Bangladesh Institute of Governance and Management (BIGM)

Tariqul Islam

University of Nottingham

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## Research Article

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# Abstract

This study aims to address the economic, social and environmental wellbeing issues simultaneously by measuring the carbon intensity of wellbeing (CIWB) of Asian economies employing Prais-Winsten and pooled OLS estimator. The measure of carbon intensity of wellbeing (CIWB) is made taking into account a ratio of the two indicators-CO<sub>2</sub> emissions per capita and life expectancy at birth. There is paucity of studies that concentrate on human and social wellbeing indicators (i.e., water, sanitation, life expectancy) together applying Environmental Kuznets Curve (EKC) hypothesis. Therefore, we have also investigated the EKC hypothesis as this theory hypothesizes the link involving human and environmental wellbeing and development. The findings utilizing the two econometric techniques indicate that in both the estimation models urban population access to an improved water source and total population access to improved water source has consistently negative and significant effects on CIWB. The fertility rate and prevalence of HIV poses no threat to CIWB. These findings demonstrate that social and human wellbeing indicators of the Asian economies are sustainable to this moment as they are lowering CIWB which is desirable. Contrary, GDP per capita, exports as a percent of GDP and urban population have a significant and positive impact on CIWB which pose a challenge for the sustainability issue. We also have found the existence of EKC hypothesis indicating environmental quality will increase past a turning point. The findings of the paper are well matched with the view of 'Economic and ecological modernization' theory and 'human ecology' theory.

JEL Classification: Q54; Q56; R11

## 1. Introduction

Over the last few decades, wellbeing study has acknowledged greater attention as a source of *good* or *quality life* (Summers et al. 2014; 2017). While wellbeing indicators are over and over again related to economic and social policies, and environmental development issues are lagging behind addressing the wellbeing indices even though the environment plays a crucial role in the sustainability and quality of wellbeing (Wainger & Price, 2004; Smith et al. 2013). Measuring environmental issues on sustainability and their influence on economic, social and human wellbeing becomes clear, particularly while considering both economic growth and quality life together (Jordan et al., 2010). Usually, wellbeing has multidimensional aspects and can be seen as subjective and objective wellbeing. If we define subjective wellbeing, it is often based on human perception, therefore, not directly measurable (Sirgy, 2012). Conversely, objective wellbeing takes account of fundamental economic, social and environmental essentials, therefore, directly measurable (Parris & Kates, 2003; Talberth et al., 2007). This study aims to incorporate the economic, social, and environmental indicators to measure wellbeing in the context of the sustainable development perspective in an Asian context.

How to ensure the human wellbeing exclusive of environmental degradation remains, an essential inquiry for sustainability? Sustainable development is termed as satisfying human needs without compromising natural and social capital. Therefore, the goal of sustainability is to achieve wellbeing by preserving the natural environment. There are different schools of thought in environmental sociology regarding the interactions between economic growth, degradation of the environment, and wellbeing. Modernization theories, including 'economic and ecological modernization', are in favor of the positive role of economic growth in achieving sustainability and wellbeing (Knight & Rosa, 2011; York et al., 2003). On the other hand, the 'treadmills of production' theory postulates that, rapid economic development and growth led to a huge demand for energy consumption, which negatively impacted the environment (Knight & Rosa, 2011; York et al., 2003). The 'human ecology' theory encompasses a wider perspective and views of wellbeing, including health and climate conditions (Bubolz & Sontag, 2008; Dietz, Rosa, & York, 2009). This study addresses which of the prevailing theories are appropriate for the Asian economy as a whole, taking some indicators of choice that proxy for the economic, social and environmental wellbeing that ultimately ensures human wellbeing.

As a wellbeing indicator, life expectancy is an inclusive evidence of individual wellbeing and happiness that embraces the usual standard of livelihood, physical state, mental contour, societal ambiance, ecological atmosphere and even the political structure (D'Albis & Bonnet, 2018; Hill & Jorgenson, 2018). Therefore, it is crucial to investigate the improvement of countrywide indices while measuring economic, social and human wellbeings. These measurements are interrelated, predominantly as civilization progress towards the postindustrial knowledge and information era where economic achievement greatly relies on investment in human competency improvement. Urbanization is a universal phenomenon though it has a diverse impact in different contexts as a social wellbeing indicator. Urbanization development focused on human and environmental concerns is an essential sustainable development issue and Sustainable Development Goals (SDGs) have a specific goal regarding the sustainability of cities (Sachs, 2015). It is also an integral element of human-induced land use transformation and therefore, this issue needed to be reflected while modeling regional climate issues (Hu et al., 2015).

As a matter of fact, the studies related to CO<sub>2</sub> emissions, development, and wellbeing could be biased if the analysis is done by overlooking the regional disparities, combining all nations of the world in a common sample (A. Jorgenson et al., 2012; A. K. Jorgenson & Clark, 2013). In this context, we examine the relationships between environmental, economic, and social wellbeing indicators for all Asian countries to

eliminate regional bias addressing the key issues of sustainable environmental development. In the present study a ratio term between per capita CO<sub>2</sub> emission and average life expectancy at birth as a wellbeing indicator is used. GDP per capita and export to capture the economic development aspect is incorporated. Urbanization, along with other urban and human wellbeing attributes (i.e., water, sanitation, fertility rate, prevalence of HIV) are factored into the analysis to represent social indicators. All these mentioned indicators are incorporated to analyze the impact of economic, social, and environmental wellbeing focusing on the sustainable environment development issue of Asian economies.

The organization of the paper is structured as follows: Sect. 1 is designed for introduction and in Sect. 2, dynamism of Asian economies is portrayed. It is followed by Sect. 3, a succinct review of literature. Section 4 illustrates data sources and econometric methodology. Empirical results and their interpretations are analyzed in Sect. 5. In the final section conclusion and policy implications are drawn.

## 2. Dynamism Of Asian Economies

The World Bank defines economy for the current fiscal year 2021 based on per capita GNI; <\$1,035 to low-income, \$1,036 - \$4,045 to lower middle-income, \$4,046 - \$12,535 to upper middle-income, and > \$12,535 to high-income economies (World Bank 2019). As Asian upper and lower middle income and lower income economies if taken separately enclose a small number of countries, we have organized these three income categories as developing economies following World Bank definition. Therefore, most of the economies of Asia are developing economies with few exceptions. The country by GDP per capita scenario provided in Appendix I, also demonstrates that other than China, Japan, India, South Korea, Indonesia, Saudi Arabia, Turkey, Taiwan, Thailand and Iran, the countries follow the comparable GDP per capita scenario.

The dynamism of Asian economies (economies considered for this study is listed in Appendix II) lies within the fact that most of the economies can be portrayed as developing, albeit there is disparity amongst them. On the one hand, the continent contains one of the most economically developed nations of the world, Japan. On the other hand, it includes the poorest countries like Afghanistan, Cambodia, and Nepal. There are also regional varieties among Asian economies. According to the World Bank category 2019, the largest part of Southwest Asia clubs in one of the middle-income categories, including high-income economies i.e., Israel, Kuwait, Qatar, and the United Arab Emirates. Economies of North and Central Asia are predominantly low-income economies apart from Russia (World Bank 2019). The South Asia region mostly falls in lower-middle-income economic category. The most affluent side of the continent is East Asia.

Furthermore, countries in Asia are following the trends of rapid urbanization and industrialization compared to the rest of the world though a bulk of the populace are still occupied in agricultural activities. The trade-related interdependence of economies grew considerably during the late 20th century. Energy consumption (per capita) in Asia is lower than the world standard except for the oil-producing economies. China is the largest producer of energy and the largest CO<sub>2</sub> emitter, simultaneously the leading investor in renewable energy as well. As emission-related issues have a trans-boundary effect, we have taken the whole Asian sample to measure wellbeing.

The study focused on this group of economies for some specific reasons. There has been an unanticipated growing demand for energy in low- and middle-income countries since the last two decades (Culver, 2017). Most of the Asian economies fall within this group. This phenomenon requires more significant investigation as more energy consumption leads to greater emission (Baek & Kim, 2013; Alam et al., 2011; Sharma, 2011; Pao, Yu, & Yang, 2011 and Sadorsky, 2014) that will risk human wellbeing. For the sustainability of the environment CO<sub>2</sub> emission and wellbeing studies need special attention for the Asian economies. Against the above circumstances, the study focuses on measuring the environmental wellbeing of Asian economies with other predictors i.e., real GDP per capita, exports as percentage of GDP, percentage of urban population.

## 3. Literature Review

### 3.1 Carbon intensity of wellbeing (CIWB) and Economic Development

The scholars termed the link between CO<sub>2</sub> emissions and human wellbeing as the carbon intensity of wellbeing (CIWB) or Ecological Intensity of human wellbeing (EIWB) that measures environmental and human wellbeing simultaneously (Jorgenson, 2014; Dietz et al., 2012). There are nascent literatures that concentrate on the assumption that a larger value of CIWB refers to a higher level of CO<sub>2</sub> emission, whereas a lesser value denotes a lower level of CO<sub>2</sub> emission (Jorgenson, 2014; Jorgenson & Dietz, 2015). Studies of Dietz et al. (2009), Dietz & Jorgenson (2013), and Jorgenson & Dietz (2015) concentrates on the wide-ranging ecological intensity of wellbeing context as well. In their opinion, it is a ratio of environmental pressure to human wellbeing which is operationalized taking the ratio between per capita CO<sub>2</sub> emission and average life expectancy indicators. The (CIWB) concentrates on sustainable development issues by joining the environmental and human wellbeing indicator together into one indicator.

The study on the link between CO<sub>2</sub> emission and economic development receives substantial consideration, however, a very limited degree of attention has been paid to the relationship between CO<sub>2</sub> emissions and wellbeing indicators by emphasizing economic development (Knight & Rosa, 2011). Moreover, most studies concentrate on single or broad indicators, i.e., life expectancy, human development index, life satisfaction, apart from few exceptions (O'Neill, Fanning, Lamb, & Steinberger, 2018). There are studies that have concentrated on fundamental socio-technical changes that convey message to keep economic development, energy use and emissions within the boundary of ecological wellbeing (Lamb, 2016; Sulkowski & White, 2016).

The relationship between economic development (growth) and environmental wellbeing is elucidated utilizing the Environmental Kuznets Curve (EKC) theory of Grossman and Krueger in 1995 (Press & Journal, 2010). There are innumerable studies that deal with EKC hypothesis (e.g., Hamit-Haggar, 2012; Friedl & Getzner, 2003; Al-Mulali, Saboori, & Ozturk, 2015 and Sharmin & Tareque, 2020). These studies have postulated that each economy is unique in terms of underlying aspects that impels the link involving human and environmental wellbeing and development. There is not known studies that concentrate on social wellbeing indicators (i.e., water, sanitation, life expectancy issues) applying EKC hypothesis on Asian economies.

### ***3.2 Economic development, urbanization, energy consumption and CIWB***

Rosa et al. (2010) establish that the impact of economic development on CIWB is a sustainability issue concerning the links among environmental, social and economic growth. Givens (2015) has identified that level of economic development and urbanization are linked with higher CIWB. This study also finds that a healthy urban development could lower the Carbon intensity of wellbeing. Dietz & Jorgenson (2013) investigate population dynamics with affluence as a stimulator of environmental impacts to show human-environment connections. Another study (Sadorsky, 2015) examined the effect of urbanization on CO<sub>2</sub> emissions in 7 emerging economies. The study of Sharmin & Tareque (2018) have investigated that growth exploits energy consumption which is the reason behind the increase of CO<sub>2</sub> emissions that hinders the quality of environment in Bangladesh. This study has found along with growth and energy use; urbanization, industrialization is the catalyst behind CO<sub>2</sub> emission as well.

Urbanization is increasing energy consumption as found from the study of A. K. Jorgenson, Rice, & Clark, (2010) and their findings suggest that energy consumption is indispensable for quality of life improvement. In this respect, CIWB has a direct relationship with CO<sub>2</sub> emissions and quality of life. Corresponding to that, it has a positive correlation with CO<sub>2</sub> emissions (A. K. Jorgenson, Auerbach, & Clark, 2014). In connection with environmental and other human wellbeing issues, Liu et al. (2010) found that most arable land is transformed to urbanization and it is harmful to those countries that have a high depletion rate but a low potential for sustainable development. The study of Mazur (2011) has found that increased energy and electricity use is vital for poor nations to improve wellbeing and is not associated with improved wellbeing of industrialized nations. Some studies are in favor of using renewable energy instead of non-renewable energy to sustain environmental and human wellbeing (e.g., Baek & Kim, 2013; Al-Mulali, 2014; Sharif, Raza, Ozturk, & Afshan, 2019; Sharmin, 2021). In their view, more use of renewable energy might have positive impact on overall wellbeing indicators and could reduce ecological footprint.

From the above-mentioned empirical evidence, it is discernible that a large amount of literature investigates the connection linking economic activities and its impact on the environment. But there is a paucity of studies that concentrate on social and human wellbeing indicators (i.e. water, sanitation, life expectancy, health issues) along with environmental issues applying EKC hypothesis on Asian economies. This study aims to contribute to above-mentioned less explored areas of literature.

## **4. Data Sources And Econometric Methodology**

### **4.1 Data**

The scales of analysis of this study are country level. The study uses data on 47 Asian countries for the period 1990-2019 for panel analyses. Annual data of all study variables are collected from the World Development Indicators (WDI) database (World Bank, 2019). The list of Asian countries is available in Appendix I. China and Hong Kong is treated as separate nations in this study as World Bank provides separate datasets for them. The description of the included variables can be found in Table 1.

**Table-1.** Variable Description

Variables	Measurements
CO <sub>2</sub> emissions	per capita in metric tons
Life Expectancy	total life expectancy at birth
Carbon Intensity of Well-being (CIWB) per capita	Ratio between CO <sub>2</sub> emissions and life expectancy
GDP per capita	Constant U.S dollars (2010)
Exports	% of GDP
Urban population	% of total
Improved water source, urban	% of urban population with access
Improved sanitation facilities, urban	% of urban population with access
Improved water source	% of population with access
Improved sanitation facilities	% of population with access
Fertility rate, total	births per woman
Prevalence of HIV, total	% of population ages 15-49
Note: Author's compilation	

All variables included in this study are transformed into natural logarithms. Log transformation would help to measure the elasticity of estimated coefficients that would represent the percentage change in the dependent variable (CIWB) for a percentage in the independent variable (York et al., 2003).

#### 4.2 Dependent Variable

The measure of the carbon intensity of wellbeing (CIWB) is a ratio between CO<sub>2</sub> emissions per capita and life expectancy at birth which is consistent with others (e.g., Dietz et al., 2012; A. K. Jorgenson, 2014; A. K. Jorgenson & Givens, 2015). But one complicity arises with a ratio as a measure when the range and variability differs substantially and creates the problem of the numerator or denominator dominance. In our dataset, the coefficient of variation of CO<sub>2</sub> emissions per capita is 0.903, and the range is 0.097-5.46. The coefficient of variation of life expectancy is 0.092, and the range is 50.33- 84.93. To solve the issue of dominance, a constant is added to the numerator, which shifts the mean with changing the variance, thereby help to balance the coefficient of variation of our numerator and denominator (e.g., Givens, 2015; Dietz et al., 2012). For this study, the coefficient of variation of life expectancy and CO<sub>2</sub> emissions per capita has been made equivalent by adding 7.915466 to CO<sub>2</sub> emissions per capita. Further, it was multiplied by 100 to scale the ratio. The carbon intensity of well-being (CIWB) is measured as:

$$CIWB = ((CO_2 \text{ emissions per capita} + 7.915466)/\text{life expectancy}) \times 100$$

Therefore, the CIWB measures the human wellbeing obtained for each unit of CO<sub>2</sub> emitted; a lower CIWB is more likely expected than a high CIWB for making the economic development and other social indicators sustainable.

#### 4.3 Independent Variable

The independent variables of interest are the real GDP per capita, exports as a percentage of GDP, percentage of the urban population. Following Givens (2015), the percent of the urban population with access to an improved water source and improved sanitation facilities as well as a percent of the total population with access to an improved water source and improved sanitation facilities are taken in this study to address further urban social attributes. Another two variables are incorporated; expectation to have a considerable impact on overall health and CO<sub>2</sub> emissions. And those are the total fertility rate and the prevalence of HIV (A. K. Jorgenson & Rice, 2016).

#### 4.4 Model Specification

Following Givens (2015), the functional form of the tested model is given as:

$$CIWB = GDP_{pc} + Export + Urbanization + Water\ Access\ (Urban) + Sanitation\ Access\ (Urban) + Water\ Access\ (Total) + Sanitation\ Access\ (Total)$$

$$CIWB = GDP_{pc} + Export + Urbanization + Water\ Access\ (Urban) + Sanitation\ Access\ (Urban) + Water\ Access\ (Total) + Sanitation\ Access\ (Total) + Fertility + HIV$$

#### 4.5 Model Estimation Technique

The study uses the time-series cross-sectional Prais-Winsten regression model with panel-corrected standard errors (PCSEs). The Prais-Winsten regression model is suggested by Beck & Katz (1995) because the Feasible Generalized Least Squares (FGLS) method<sup>[1]</sup> produces incorrect standard errors. In STATA 14, PCSEs assume by default that the disturbances are heteroskedastic and contemporaneously correlated across panels. First-order autocorrelation, AR(1), within panels is corrected for estimation (Sweidan & Alwaked, 2016), and a two-way fixed-effect technique is employed to control for country-specific and time-specific disturbances. To check the robustness of the estimation, the pooled OLS (Driscoll-Kraay standard errors, which are more robust in the presence of heteroscedasticity and autocorrelation up to some lags in the error term) method is also applied.

### 5. Empirical Findings And Their Interpretations

#### 5.1 Descriptive Statistics

It is fundamental to understand the underlying characteristics of studied variables before any adoption of estimation techniques in econometric analysis. Table 2 presents the descriptive analysis of the studied variables from 1990–2019 under investigation.

Table-2					
Summary Statistics					
Variables	Count	Mean	Standard deviation	Min	Max
Carbon Intensity of Well Being (CIWB)	1363	2.519776	.1364384	2.232054	3.003861
GDP per capita (constant 2010 US\$)	1315	8.300426	1.464898	5.247104	11.15166
Exports of goods and services (% of GDP)	1249	3.523849	.9479813	-5.225669	5.433695
Urban population (% of total population)	1410	3.882175	.5586387	2.180869	4.60517
Drinking water services, urban (% of urban population)	683	4.541347	.0924525	3.901719	4.60517
Drinking water services (% of population)	843	4.449669	.2300012	3.324025	4.60517
Sanitation services, urban (% of urban population)	682	4.399729	.2358965	3.387306	4.60517
Sanitation services (% of population)	835	4.289753	.4357813	2.298918	4.60517
Fertility rate, total (births per woman)	1363	.9743254	.422774	– .10425	2.15246
Prevalence of HIV, total (% of population ages 15–49)	928	-1.849881	.7544196	-2.302585	.7419373
Source: Author's calculation					

The mean carbon intensity of wellbeing (CIWB) of the panel is 2.519, and the mean GDP per capita of the samples is 8.3 US\$. The average percentage of people living in urban areas is 3.882, and the mean exports percentage is 3.523. The mean percentage of services (water and sanitation) of the urban and total population is almost same and all those are around 4.45. The mean fertility rate of the panel is below one, and the mean prevalence of HIV among people of reproductive age group is -1.849.

<b>Table-3</b>										
Correlation Matrix										
Variables	CIWB	GDPpc	Exports	Urbanization	Drinking water (% of Urban)	Drinking water (% of Pop)	Sanitation (% of Urban)	Sanitation (% of Pop)	Fertility Rate	HIV Prevalence (% of Pop)
CIWB	1.00									
GDPpc	-0.63***	1.00								
Exports	-0.21***	0.40***	1.00							
Urbanization	-0.47***	0.82***	0.31***	1.00						
Drinking water (% of Urban)	-0.35***	0.50***	0.44***	0.50***	1.00					
Drinking water (% of Pop)	-0.45***	0.56***	0.31***	0.67***	0.88***	1.00				
Sanitation (% of Urban)	-0.31***	0.60***	0.32***	0.64***	0.55***	0.54***	1.00			
Sanitation (% of Pop)	-0.41***	0.63***	0.27***	0.74***	0.58***	0.71***	0.89***	1.00		
Fertility Rate	0.45***	-0.48***	-0.24***	-0.46***	-0.58***	-0.58***	-0.43***	-0.48***	1.00	
HIV Prevalence (% of Pop)	-0.06	-0.08*	0.07	-0.27***	-0.06	-0.23***	-0.04	-0.26***	-0.22***	1.00
Note: * $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$										

The correlation matrix of the studied variables is reported in Table 3. The table shows that GDP per capita and urbanization are negatively correlated with CIWB. The urbanization is positively correlated with GDP per capita, where the fertility rate is negatively correlated with GDP per capita. Basic citizen services, e.g., drinking water and sanitation, are also positively correlated with GDP per capita and urbanization. But those services are negatively correlated with CIWB.

## 5.2 Panel Unit Root test

<b>Table-4</b>				
Panel Unit Root Tests				
Variables	Without trend		With trend	
	ADF-Fisher	PP-Fisher	ADF-Fisher	PP-Fisher
GDP per capita	89.2607 (0.5022)	89.2607 (0.5022)	290.0031 (0.000)	290.0031 (0.000)
$\Delta$ GDP per capita	715.8310 (0.000)	715.8310 (0.000)	640.0251 (0.000)	640.0251 (0.000)
Exports (% of GDP)	181.6066 (0.000)	181.6066 (0.000)	163.2781 (0.000)	163.2781 (0.000)
$\Delta$ Exports (% of GDP)	1102.3679 (0.000)	1102.3679 (0.000)	954.2279 (0.000)	954.2279 (0.000)
Urbanization	1016.2471 (0.000)	1016.2471 (0.000)	420.4920 (0.000)	420.4920 (0.000)
$\Delta$ Urbanization	197.3791 (0.000)	197.3791 (0.000)	367.4158 (0.000)	367.4158 (0.000)
Drinking water services, urban	347.0541 (0.0000)	347.0541 (0.0000)	754.9256 (0.0000)	682.8383 (0.0000)
$\Delta$ Drinking water services, urban	779.3366 (0.0000)	779.3366 (0.0000)	757.9251 (0.0000)	757.9251 (0.0000)
Drinking water services, pop	791.1844 (0.0000)	791.1844 (0.0000)	451.8477 (0.0000)	451.8477 (0.0000)
$\Delta$ Drinking water services, pop	613.3418 (0.0000)	613.3418 (0.0000)	865.7791 (0.0000)	865.7791 (0.0000)
Sanitation water services, urban	668.5889 (0.0000)	668.5889 (0.0000)	626.0461 (0.0000)	553.9587 (0.0000)
$\Delta$ Sanitation water services, urban	523.1803 (0.0000)	523.1803 (0.0000)	523.8915 (0.0000)	451.8042 (0.0000)
Sanitation water services, pop	774.4264 (0.0000)	774.4264 (0.0000)	876.2206 (0.0000)	876.2206 (0.0000)
$\Delta$ Sanitation water services, pop	710.5767 (0.0000)	710.5767 (0.0000)	678.2597 (0.0000)	678.2597 (0.0000)

Two panel unit root tests with and without trend were conducted to check the stationary property of the datasets and presented in Table 4. Both ADF-Fisher and PP-Fisher tests confirmed that all variables become stationary at levels except GDP per capita. The GDP per capita becomes stationary after first differencing. Therefore, the order of the integration of GDP per capita is  $I(1)$  and all other variables are  $I(0)$ .

## 5.3 Panel Cointegration

<b>Table-5</b>		
Kao Test for Panel Cointegration		
Ho: No cointegration		
Ha: All panels are cointegrated		
	Statistic	P-value
Modified Dickey-Fuller t	0.476	0.317
Dickey-Fuller t	3.7523	0.0001
Augmented Dickey-Fuller t	3.0764	0.001
Unadjusted modified Dickey-Fuller t	0.3562	0.3608
Unadjusted Dickey-Fuller t	3.6498	0.0001

To test the long-run relationship of the studied variables, the study has conducted a Kao test for testing panel cointegration (Table 5). Out of the five, three statistics of the Kao test have rejected the null hypothesis of no cointegration. This outcome leads us to conclude that the variables have a long-run relationship.

## 5.4 Panel Regression



Table 6

presents the detailed findings for the estimated models using Prais-Winsten estimator and pooled OLS estimator. Both models contain all 47 countries included in the analyses and controls for the following: GDP per capita; exports as a percent of GDP; urban population as a percent of the total population; the percent of the urban population with access to an improved water source; the percent of the urban population with access to improved sanitation facilities; the percent of the total population with access to an improved water source; and the percent of the total population with access to improved sanitation facilities. Regression outputs report the regression coefficients, significance level, panel corrected standard errors, R-squared statistic, and the number of observations.

<b>Table-6</b>		
Effects of studied variables on Carbon Intensity of Wellbeing		
	Prais-Winsten Estimator	Pooled OLS Estimator
GDP per capita (constant 2010 US\$)	0.276*** (0.0224)	0.276*** (0.0272)
Square of GDP per capita	-0.0216*** (0.00122)	-0.0216*** (0.00147)
Exports of goods and services (% of GDP)	0.00653* (0.00297)	0.00653*** (0.00149)
Urban population (% of total population)	0.129*** (0.00865)	0.129*** (0.00714)
Drinking water services, urban (% of urban population)	-0.0856* (0.0340)	-0.0856 (0.0606)
Sanitation services, urban (% of urban population)	-0.000345 (0.0157)	-0.000345 (0.0228)
Drinking water services (% of population)	-0.191*** (0.0168)	-0.191*** (0.0230)
Sanitation services (% of population)	-0.0160 (0.00830)	-0.0160 (0.0102)
Constant	2.518*** (0.156)	2.518*** (0.290)
Observations	606	606
R <sup>2</sup>	0.472	0.472
Standard errors in parentheses. * $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$		

Table 6 presents the detailed findings for the estimated models using Prais-Winsten estimator and pooled OLS estimator. Both models contain all 47 countries included in the analyses and controls for the following: GDP per capita; exports as a percent of GDP; urban population as a percent of the total population; the percent of the urban population with access to an improved water source; the percent of the urban population with access to improved sanitation facilities; the percent of the total population with access to an improved water source; and the percent of the total population with access to improved sanitation facilities. Regression outputs report the regression coefficients, significance level, panel corrected standard errors, R-squared statistic, and the number of observations.

In the Prais-Winsten and pooled OLS estimator models, GDP per capita is positive and statistically significant in the total sample of countries. Both estimator models exhibit the same coefficient for GDP per capita, confirming the robustness of the model. In both estimation techniques, the environmental Kuznets hypothesis is sustained that describes the overall relationship between GDP per capita and CIWB. Since GDP per capita is the indicator for the level of development of an economy for the linear term, so having a positive and significant association between GDP per capita and CIWB is undesirable. If the CIWB increases with the increase of per capita GDP, then it may threaten economic sustainability in the long run as lower CIWB is desirable and is an attribute of human wellbeing. On the other hand, a negative coefficient for the square of the GDP per capita resulting an inverted U-shaped pattern which is envisaged by the Kuznets theory. It postulates that a boost up in economic affluence from the lowest levels to a mid-level tends to increase the CIWB, but past a turning point, carbon intensity per unit wellbeing decreases which is desirable.

Exports as a percent of GDP correspond to the connection to the world economy, is significant as well as the urban population is positive and significant for the sample of countries. In terms of the findings of specific interest, urban population access to an improved water source and total population access to an improved water source has consistently negative and significant effects on both estimation models. But the urban population access to improved sanitation and total population access to improved sanitation is negative and insignificant in models.

<b>Table-7</b>		
Effects of studied variables on Carbon Intensity of Well-being		
	Prais-Winsten Estimator	Pooled OLS Estimator
GDP per capita (constant 2010 US\$)	0.149*** (0.0166)	0.149*** (0.0239)
Square of GDP per capita	-0.0138*** (0.000937)	-0.0138*** (0.00136)
Exports of goods and services (% of GDP)	0.0117*** (0.00226)	0.0117*** (0.00215)
Urban population (% of total population)	0.123*** (0.00615)	0.123*** (0.00636)
Drinking water services, urban (% of urban population)	-0.176* (0.0543)	-0.176* (0.0755)
Sanitation services, urban (% of urban population)	0.0365 (0.0204)	0.0365 (0.0282)
Drinking water services (% of population)	-0.186*** (0.0203)	-0.186*** (0.0204)
Sanitation services (% of population)	-0.0291** (0.0111)	-0.0291** (0.0137)
Fertility rate, total (births per woman)	-0.00612 (0.0108)	-0.00612 (0.00813)
Prevalence of HIV, total (% of population ages 15–49)	-0.0173*** (0.00358)	-0.0173*** (0.00374)
Constant	3.286*** (0.212)	3.286*** (0.319)
Observations	462	462
R <sup>2</sup>	0.539	0.539
Standard errors in parentheses. * $p < 0.05$ , ** $p < 0.01$ , *** $p < 0.001$		

Two additional control variables were taken in the estimation procedure with the expectation that they might have an impact on the overall wellbeing of human and the environment, and those are total fertility rate and the prevalence of HIV in the population of 15–49 year olds (Table 7). This table shows the findings for the estimated models using Prais-Winsten estimator and pooled OLS estimator. Both models contain all 47 countries included in the analyses and control variables are the same as Table 6. Regression outputs report the regression coefficients, significance level, panel corrected standard errors, R-squared statistic, and the number of observations. The outputs of Table 7 are not so different from the obtained findings of the previous table (Table 6). Here, the results also support the environmental Kuznets hypothesis.

Exports as a percent of GDP, is significant as well as the urban population is positive and significant for the sample countries. Specifically, urban population access to an improved water source and total population access to an improved water source has consistently negative and significant effects on both estimation models. But the urban population access to improved sanitation and total population access to improved sanitation is negative and insignificant in models. Both the fertility rate and the prevalence of HIV are interlinked with a decrease of the CIWB in the case of Asian countries showing no harmful impact. The findings are also desirable to lower CIWB.

## 6. Discussions

If we further go deeper into the findings we have got from the two models, the results are consistent and follow theoretical explanation. The assumption of EKC hypothesis is straightforward that an increase in per capita GDP (affluence) will decrease environmental stress and enhance sustainability therefore wellbeing. Our findings support EKC hypothesis. The findings of this study for Asian economies as a whole is supporting 'economic and ecological modernization' theory and opposing the 'treadmills of production' theory which is different from the findings of Dietz et al. (2012) and Knight & Rosa (2011). The reason might be unlike their studies we have incorporated issues like social wellbeing indicators (i.e. water, sanitation, fertility rate, prevalence of HIV etc.) while applying EKC hypothesis. The factors other than per capita GDP could play a substantial role in well-being and sustainability, as suggested by both the above-mentioned studies is working here. The study of Rice (2008) put forward that in comparison to developed economies, developing economies have a higher level of marginal utility of environmental utilization. As from figure in Appendix I, shows the GDP per capita of Asian economies are mostly developing economies other than few developed economies. This could be another reason that the findings supporting 'economic and ecological modernization' theory and 'human ecology' theory for Asian economies.

The findings of this study are also compatible with the findings of A. K. Jorgenson (2014) as long as the African economies are concerned though in present decades, their growth-CIWB relationship is becoming slightly unsustainable. However, considering Asian economies, the study found that with the increase in GDP per capita CIWB increases. This finding diverges from our finding that with the increase in growth, CIWB decreases as established by EKC theory. The rationale might be that the study of Jorgenson did not incorporate all the Asian economies and only concentrates on GDP per capita and CIWB whereas, our study includes other indicators also to see the relationship. The growth-CIWB association for North America, Europe and Oceania is positive because this region is generally pooled to the high-income economies and it is possible that they are burning more fossil fuels to ensure economic growth. Steinberger et al. (2012) have found that high-income countries are responsible for more carbon emissions and Fang et al. (2019) also address that G-20 countries are also following an unsustainable path for growth. These findings resonate with the study of Akenji et al. (2016) and they have found that the richest economies should reduce their expenditure whereas, the poorest economies could increase their growth to reduce the ecological pressure.

Due to limitations in data availability, the study uses unbalanced data on 47 Asian countries for the period 1990–2019 for panel analyses. Moreover, the inclusion and exclusion of different variables might show the dissimilar outcome.

## 7. Conclusion And Policy Implications

This study investigates the economic, social and environmental wellbeing issues by measuring the carbon intensity of wellbeing (CIWB) of Asian economies. 'Economic and ecological modernization' theory is of the opinion that for sustainability, economic development is fundamental and 'human ecology' theory encompasses a wider perspective and views of wellbeing considering human development and sustainable climate conditions. On the other hand, the 'treadmills of production' theory and political economy theory negates the necessity of economic development for sustainability. The findings of the paper are well matched with the view of the 'Economic and ecological modernization' theory that postulates that with the increase in economic growth environmental quality will be restored as well as with 'human ecology' perspective that is in favor of wellbeing including health and climate conditions. It is evident from the findings of this study that a negative coefficient for the square of the GDP per capita resulting an inverted U-shaped pattern and also from the other social indicators.

Employing Prais-Winsten and pooled OLS estimator, in both the estimation models urban population access to an improved water source and total population access to improved water source has consistently negative and significant effects on CIWB. The fertility rate and prevalence of HIV also pose no threat to CIWB. These findings as a whole demonstrate that social and human wellbeing indicators of the Asian economies are sustainable to this moment as they are lowering CIWB. These results confirm and relate to the study of Givens (2015). On the other hand, GDP per capita, exports as a percent of GDP and urban population is significant and positive for CIWB in the case of Asian countries, which pose a challenge for the sustainability issue as they are increasing CIWB. In this regard, the Asian economies should choose better urbanization and economic growth policies that ensure the sustainability of the human and environmental factors and reduces the impact on CIWB. More specifically, the use of renewable energy for the decarbonization of a country's economy is very crucial with environmental governance and better institutional quality for sustainability. Future studies should take into account the feminization of environmental issues in wellbeing research.

## Declarations

**Ethical Approval**-Not applicable.

**Consent to Participate**-Not applicable.

**Consent to Publish**-All authors have read and approved the manuscript to publish with this journal.

**Authors Contributions**-Conceptualization, writing, referencing and final format: Mowshumi Sharmin. Data analysis and result: Sima Rani Dey. Supervision, proofreading and review: Dr. Md Tariqul Islam

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**Availability of data and materials**-Data is available from the corresponding author upon request.

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