Ecological Indicators 57 (2015) 324–330

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Investigating the validity of the environmental Kuznets curve hypothesis in Cambodia

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ARTICLE INFO

Article history:
Received 18 March 2015
Received in revised form 2 May 2015
Accepted 6 May 2015

Keywords:
CO_2 emissions
Governess
Corruption control
Growth

ABSTRACT

This study investigates whether better governess and corruption control help to form the inverted U-shaped relationship between income and pollution in Cambodia for the period of 1996–2012. The outcome from the Generalized Method of Moments and the Two-stage Least Squares revealed that GDP, urbanization, energy consumption, and trade openness increase CO_2 emission while the control of corruption and governess can reduce CO_2 emission. It is fundamental to note that the environmental Kuznets curve hypothesis was not confirmed in Cambodia. Based on the retrieved results, we recommend for urban planners to utilize policies that will allow them to improve urban planning by controlling sewage, industrial waste, and solid waste which are some of the major causes for the environmental deterioration in Cambodia's major cities. It is also crucial to implement pollution and trade-related actions and strategies to increase the environmental protection from trade. Additionally, it is important for Cambodia to increase the corruption control as this step will strengthen the environmental regulations which will reduce pollution. Finally, a better governess is also important to improve the quality of the environment.

1. Introduction

During the period of 2004–2012, Cambodia witnessed a substantial boost in its economic development as indicated by the economic development indicators. The country had witnessed stable annual economic growth rates of 8% during the period of 2004–2012. Furthermore, despite the reduction in the growth rate which was caused by the global financial crisis, the country's gross domestic growth (GDP) rate maintained its positive stability during the period of 2008–2009 (World Bank, 2013a,b). In 2012, Cambodia's GDP growth increased to 7.3%. Moreover, the poverty level has fallen sharply. According to the World Bank (2013a,b), it was indicated that Cambodia achieved the Millennium Development Goal (MDG) by reducing its poverty rate to a half in 2009. In addition, a number of investments and projects were established to help the improvement of the material healthcare, child early health care, and primary education programs. Therefore, the mortality rate based on the death per 100 thousand live births decreased over 50% during the period of 2005–2010 (World Bank, 2013a,b).

Despite the remarkable economic development that the country witnessed in a short period of time, there are several ramifications for this progress. The improvement in economic development might increase the environmental pressure because the increase in the growth of economic development increases the demand for energy to engine that growth. Therefore, in the period of 1996–2012, the level of energy consumption increased over 35% in the country. Moreover, Cambodia is facing a number of challenges, such as, the lack of effective management of land planning which might result in an unplanned urbanization and the negative effect of untreated sewage, industrial waste, and solid waste which most of the Cambodian cities suffer from. In addition, the country suffers from the lack of good governess and corruption control (World Bank, 2013a,b). These factors can cause a huge environmental pressure for Cambodia which already seen a 50% increase in its CO_2 emission during the last 17 years (World Development Indicators, 2014).

The increase in economic development and life quality (the increase in income per capita, increase in the access to an improved water source, life expectancy at birth, and the reduction in infant mortality rate) that the country witnessed over the last 17 years (World Development Indicators, 2014) will increase the demand for enhancing the quality of the environment. This statement reflects the environmental Kuznets curve (EKC) hypothesis. The EKC hypothesis shows the relationship between economic developed

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http://dx.doi.org/10.1016/j.ecolind.2015.05.018
1470-160X/

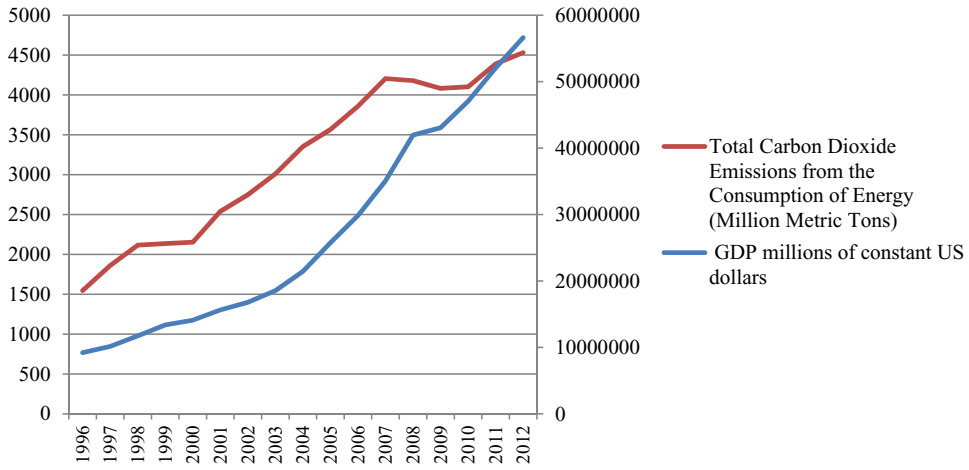

Fig. 1. Gross domestic product–CO_2 emission relationship.

and environmental degradation in the early phase of economic development the rise in economic growth will worsen the environmental degradation indicators until it reaches to a certain point were the relationship between economic growth and environmental degradation is negative. This negative relationship takes place as the country experiencing an increase in the environmental awareness, energy efficiency, and renewable energy; achieving a sustainable economic development. This phenomenon depicts the scenario of Cambodia because the country is still in the early stages of development. Consequently, the level of CO_2 emission in Cambodia is increasing correspondingly with the increase in GDP growth, which can be seen in Fig. 1. However, the hypothesis explains also that, in a certain level, the positive relationship between the environmental degradation and economic development changes to be negative. This phenomenon is caused by the improvement in economic development which will, in turn, increase the public demand for a better life quality and cleaner environment. Thus, the relationship between income and the environmental degradation will take an inverted U-shaped form (Shafik, 1994).

The boost in economic development that most of the countries, especially from the emerging economies, have witnessed and its effect on the environmental pressure attracted the attention of many scholars. Therefore, there are several studies that examined the existence of the environmental Kuznets curve (EKC) hypothesis in different countries, particularly the emerging ones, such as Brazil, China, India, Association of Southeast Asian Nations (ASEAN), Turkey, and South Africa. Moreover, a number of developed and less developed countries were also examined (Table 1). To examine whether the inverted U-shaped relationship exists or not, most of the studies utilized the gross domestic product (GDP) as an economic indicator and CO_2 emission as an indicator of the environmental degradation. Most of the studies in the literature, which implemented different methodologies, confirmed the existence of an inverted U-shaped relationship between income and environmental degradation which indicates the environmental Kuznets curve (EKC) hypothesis.

The EKC hypothesis was present mostly in the developed and the emerging countries compared to the less developed countries (Table 1) which is consistence with the EKC hypothesis. Scholars utilized different variables as an indicator of environmental degradation such as CO_2 emission (Ang, 2007; Atici, 2009; Apergis and Payne, 2009; Jalil and Mahmud, 2009; Acaravci and Ozturk, 2010; Marrero, 2010; Guangyue and Deyong, 2011; Zilio and Recalde, 2011; Pao and Tsai, 2011b; Kim et al., 2011; Saboori et al., 2012; Ozturk and Acaravci, 2013; Cho et al., 2014; Farhani et al., 2014; Apergis and Ozturk, 2015; and so forth), Biological oxygen demand emissions (Apergis and Payne, 2010), and Ecological footprint (Al-mulali et al., 2015). In addition, a number of variables were used as main determinants of environmental degradation as such as GDP growth and its square (Ang, 2007; Atici, 2009; Apergis and Payne, 2009; Jalil and Mahmud, 2009; Acaravci and Ozturk, 2010; Marrero, 2010; Apergis and Payne, 2010; Lee et al., 2010; Lean and Smyth, 2010; Guangyue and Deyong, 2011; Zilio and Recalde, 2011; Pao and Tsai, 2011a; Kim et al., 2011; Shahbaz et al., 2012; Saboori and Sulaiman, 2013; Chandran and Tang, 2013; Kohler, 2013; Robalino-López et al., 2014; Al-mulali et al., 2015; Apergis and Ozturk, 2015; and so forth), energy consumption (Ang, 2007; Atici, 2009; Apergis and Payne, 2009; Marrero, 2010; Lean and Smyth, 2010; Pao and Tsai, 2011a; Arouri et al., 2012; Saboori and Sulaiman, 2013; Chandran and Tang, 2013; Shahbaz and Leitão, 2013; Ozturk and Acaravci, 2013; Kohler, 2013; Farhani et al., 2014; and so forth). Moreover urbanization (Shahbaz et al., 2014; Al-mulali et al., 2015), trade openness (Atici, 2009; Jalil and Mahmud, 2009; Lee et al., 2010; Shahbaz et al., 2012; Ozturk and Acaravci, 2013; Kohler, 2013; Lau et al., 2014; Al-mulali et al., 2015) were also used as environmental degradation determinants. However, from the literature reviewed in Table 1, it is clear that there is a lack of studies that examined the EKC hypothesis in Cambodia despite the remarkable boost in its economic development. Cambodia has managed to achieve a substantial boost in its income, economic development, and life quality. This indicates the existence of the demand for better environmental quality which is evident in the efforts made by the Cambodian ministry of environment to promote the quality of the environment by implementing natural resource conservation policies as well as improving the coastal, forest, marine, and urban management to reduce the environmental damage (World Bank, 2013a,b). All these efforts might help to form the inverted U-shaped relationship between the income and the environmental degradation.

Therefore, this study will examine the EKC hypothesis in Cambodia. Since a number of studies found a strong relationship between governess (Li and Reuveny, 2006; Midlarsky, 1998), corruption (Leitão, 2010; Cole, 2007; Biswas et al., 2012), and the environmental damage, this study will investigate whether a better governess and a better corruption control can help to form the inverted U-shaped relationship between income and the environmental degradation in Cambodia.

2. Methodology and data treatment

Annual data was utilized in this study for the period of 1996–2012. To examine the EKC hypothesis, a time series model

Table 1
Summary of the literature on the environmental Kuznets curve.

Author	Period	Country/region/organization	Methodology	Variables used in the study	EKC hypothesis
Ang (2007)	1960–2000	France	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes
Atici (2009)	1980–2002	Central and Eastern Europe	Random and fixed effects model.	CO_2 emission, GDP, GDP square, energy consumption, and trade openness.	Yes
Apergis and Payne (2009)	1971–2004	Central America	Pedroni cointegration, fully modified OLS model, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes
Jalil and Mahmud (2009)	1975–2005	China	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, energy consumption, and trade openness.	Yes
Acaravci and Ozturk (2010)		Europe	ARDL and the VECM Granger causality.	CO_2 emission, GDP and GDP square.	Yes for Denmark and Italy
Marrero (2010)	1990–2006	Europe	Panel OLS, generalized method of monuments, and fixed effects model.	CO_2 emission, GDP, GDP square, energy consumption in aggregate and disaggregate level.	Yes
Apergis and Payne (2010)	1992–2004	Commonwealth of independent states	Pedroni cointegration, fully modified OLS, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes
Lee et al. (2010)	1980–2001	97 countries by region.	Generalized method of moments (GMM)	Biological oxygen demand emissions, GDP, GDP square, GDP cubed, trade openness, and population density.	Yes in America and Europe. No in Africa and Asia and Oceania.
Lean and Smyth (2010)	1980–2006	ASEAN	Johansen Fisher panel cointegration test, dynamic OLS, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes
Guangyue and Deyong (2011)	1990–2007	China	CRDW, DF, and ADF residual based cointegration and panel mixed least squares estimation method (PLS).	CO_2 emission, GDP and GDP square.	Yes for eastern and central China No for western China
Zilio and Recalde (2011)	1970–2007	Latin America	Pedroni cointegration	Energy consumption, GDP, and GDP square.	No
Pao and Tsai (2011a)	1980–2007	Brazil	Johansen cointegration, OLS model, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes
Pao and Tsai (2011b)	1980–2007	BRIC countries	Pedroni, Fisher and Kao cointegration, OLS model, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes
Kim et al. (2011)	1945–2004	United States of America	Panel fixed effects	Income equality, GDP, GDP square, human capital, and college attainment.	No
Pao et al. (2011)	1990–2007	Russia	Johansen cointegration, OLS model, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	No
Saboori et al. (2012)	1980–2009	Malaysia	ARDL and the VECM Granger causality.	CO_2 emission, GDP and GDP square.	Yes
Arouri et al. (2012)	1981–2005	MENA	Cross Correlated Effects (CCE), boots trap panel test cointegration, and VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	No
Wang (2012)	1971–2007	98 different developed and developing countries.	Pedroni cointegration, fully modified OLS, threshold effect model	CO_2 emission, GDP and GDP square.	Yes
Shahbaz et al. (2012)	1971–2009	Pakistan	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, energy consumption, and trade openness.	Yes

Table 1 (*Continued*)

Author	Period	Country/region/organization	Methodology	Variables used in the study	EKC hypothesis
Saboori and Sulaiman (2013)	1971–2009	ASEAN	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption.	Yes in Singapore and Thailand
Chandran and Tang (2013)	1971–2008	ASEAN	Johansen cointegration, VECM Granger causality.	CO_2 emission, energy consumption, GDP, and GDP square,	No
Shahbaz and Leitão (2013)	1790–2009	Portugal	OLS estimator, the regression with Newey-West standard errors, and ARMA model	Energy consumption, economic growth, international trade and CO_2 emissions	Yes
Ozturk and Acaravci (2013)	1960–2007	Turkey	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, energy consumption, trade openness, and the financial development.	Yes
Shahbaz et al. (2013)	1970–2011	Malaysia	ARDL and the VECM Granger causality.	CO_2 emission, GDP, financial development, financial development square, energy consumption, and trade openness.	Yes
Kohler (2013)	1960–2009	South Africa	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, energy consumption, and trade openness.	Yes
Ozcan (2013)	1990–2008	Middle East	Westerlund (2008) panel cointegration, fully modified OLS, VECM Granger causality.	CO_2 emission, GDP, GDP square, and energy consumption	No
Cho et al. (2014)	1971–2000	OECD countries	Pedroni cointegration, and fully modified OLS.	CO_2 emission, energy consumption, GDP, and GDP square.	Yes
Robalino-López et al. (2014)	1980–2025	Ecuador	Stock and Watson (2010) cointegration.	CO_2 emission, GDP and GDP square.	Yes
Lau et al. (2014)	1970–2008	Malaysia	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, foreign direct investment, and trade openness.	Yes
Farhani et al. (2014)	1971–2008	Tunisia	ARDL and the VECM Granger causality.	CO_2 emission, GDP, GDP square, energy consumption, and trade openness.	Yes
Shahbaz et al. (2014)	1975–2011	UAE	ARDL and the VECM Granger causality.	Electricity consumption, Growth, CO_2 emissions, urbanization	Yes
Al-mulali et al. (2015)	1980–2008	99 countries classified by income level	GMM and panel data models	Ecological footprint, GDP, energy consumption, urbanization, trade openness, and financial development	Yes, the validity of the EKC hypothesis increases as a country's income increases
Apergis and Ozturk (2015)	1990–2011	14 Asian countries	GMM and panel data	CO_2 emissions, GDP per capita, population density, land, industry shares in GDP	Yes

for pollution was established. The dependent variable represented CO_2 emission as an indicator of pollution while urbanization, gross domestic product (GDP), energy consumption, and trade openness were the independent variables. The variables mentioned above were implemented by different studies as determinants of the environmental degradation (Table 1). However, this study added two more variables in the model, namely, the control of corruption and governess to investigate whether these variables can help to form the inverted U-shaped relationship between pollution and income. The model is presented below:

$$LCO2_t = f(LUR_t + LGDP_{it} + LGDP2_t + LEN_t + LTP_t + COR_t + GOV_t) \quad (1)$$

LCO2 is the log of total carbon dioxide emission from the consumption of fossil fuels energy such as petroleum, coal, and natural gas measured in thousands of metric tons.

LGDP is the log of the GDP measured in millions of 2000 constant US dollars as an indicator of income. It is basically the amount of 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. Moreover, LGDP2 is the log of the square of the GDP measured in millions of 2000 constant US dollars.

LEN is the log of total electricity consumption as an indicator of energy consumption measured in billion kilowatt-hours. LEN measured at the stations of all alternator sets in a station. The variable covers hydropower, coal, oil, gas, nuclear power generation,

geothermal, solar, wind, and tide, wave energy, and combustible renewable and waste.

Moreover, LTP is the log of the sum of export and imports of total goods and services as an indicator of the trade openness measured in millions of 2000 constant US dollars.

COR is the control of corruption index which shows the perceptions of the degree to which public power is exercised for private gain, it includes both petty and grand forms of corruption, and elites and private interests. The index varies between −2.5 and 2.5 with higher values correspond to better corruption control.

GOV is government effectiveness index which shows the quality of public services, the quality of the civil service, the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The index ranges approximately between −2.5 and 2.5 with higher values depict the better governance. The data mentioned above are all retrieved from the Euromonitor International Database (2013).

Since short time series was used, it was not enough to utilize econometric techniques, such as cointegration or Granger causality, as it could cause inconsistent estimates. Moreover, since this study used different macroeconomic variables in the analysis, which is well known to be highly correlated, a regression that is able to control correlation was needed. The utilization of any time series regression involves the right side variables not to be correlated with the disturbance term. However, if the variables are correlated, the retrieved results from the simple time regressions will be biased and unpredictable. To solve this problem, there are numerous approaches that implement instruments to eliminate the effect of correlation between the variables and the residuals. These approaches include the Generalized Method of Moments (GMM) which is developed by Arellano and Bover (1995) and the Two-stage Least Squares (TSLS) regressions proposed by Cumpy (1983). Both of these approaches are utilized in this study. The instruments of lagged difference and the constant for the variables were utilized. Moreover, the validity of the instruments' variables for the GMM model was examined by utilizing the Sargan test (Sargan, 1988). This test is essentially a Chi-square test that determines whether the residuals are correlated with the instrument variables. If we cannot reject the null hypothesis of the Sargan test, there is no indication of instrument misspecification and, therefore, the instruments are valid. The GMM and TSLS models are presented below:

$$\begin{aligned} \mathrm{LCO2}_t &= \beta_{0i} + \beta_{1i}\mathrm{LGDP}_t + \beta_{2i}\mathrm{LGDP}_t^2 + \beta_{3i}\mathrm{LUR}_t + \beta_{4i}\mathrm{LEN}_t \\ &\quad + \beta_{5i}\mathrm{LTP}_t + \beta_{6i}\mathrm{COR}_t + \beta_{7i}\mathrm{GOV}_t + \alpha\mathrm{LCO2}_{t-1} + u_t \end{aligned} \quad (2)$$

The equation above is the GMM equation, which is essentially a dynamic time series equation that contains dynamic effects ($\mathrm{LCO2}_{t-1}$) and an error term (u). β_0, β_1, β_2, β_3, β_4, β_5, β_6, and β_7 are the slope coefficients. t is the time period from 1996 to 2012. Moreover, this study included the square of GDP to examine the existence of the EKC hypothesis in the investigated countries.

To determine whether the EKC hypothesis does exist, the significance of the slope coefficients of the GDP and the GDP square need to be examined. If we concluded that the slope coefficient of the GDP is positive and significant ($\beta_1 > 0$) and the slope coefficient of the GDP square is negative and significant ($\beta_2 < 0$), an inverted U-shaped relationship will be concluded between income and pollution which signifies the existence of the EKC hypothesis.

3. Empirical results

As time series data is used in the econometric analysis the presence of multicollinearity (collinearity) might take place (see also León et al., 2013). Therefore, the multicollinearity among the covariance is tested. The results in Table 2 revealed that there is no collinearity problem among the covariance. Thus, we can proceed in utilizing the TSLS and GMM regressions.

Table 3 presents the TSLS and the GMM test results. The TSLS results revealed that urbanization, energy consumption, and trade openness are the main factors that increase pollution because of their positive effect on CO_2 emission while the control of corruption and governess lessens it by its negative effect on CO_2 emission. The increase in urbanization, energy consumption, and trade openness by 1% will increase CO_2 emission by 4.454246, 0.276140, and 0.208786 percent respectively. However, the increase in the corruption control and governess by 1% will reduce CO_2 emission by 0.225742 and 0.372774 percent correspondingly.

The results obtained from the GMM regression were similar to the results of TSLS test which indicate that urbanization, energy consumption, and trade openness have a positive effect on CO_2 emission while the control of corruption and governess have a negative effect on CO_2 emission. The increase in urbanization, energy consumption, and trade openness by 1% will increase CO_2 emission by 3.598589, 0.269238, and 0.085141 percent respectively. On the other hand, a 1% increase in the corruption control and governess will reduce the CO_2 emission by 0.116700 and 0.440702 percent respectively. Moreover, both regressions revealed that the relationship between GDP and CO_2 emission is negative while the relationship between GDP square and CO_2 emission is positive. This indicates a U-shaped relationship which is not consistent with the EKC hypothesis. The results of both tests indicate that urbanization is one of the main determinants that increase pollutions by its positive effect on CO_2 emission.

4. Discussion of results

The results obtained from the Two-stage Least Squares (TSLS) and the Generalized Method of Moments (GMM) indicated similar conclusions as both tests showed that urbanization is one of the main determinants that increase pollution by its positive effect on CO_2 emission. Moreover, Cambodia is witnessing urban environmental challenges because of the rise in the Cambodian economy which continues to incite people to move toward the main urban centers. One of the ramifications of this phenomenon is the increase in the untreated domestic sewage, industrial waste, and solid waste which are causing surface and ground water pollution in many Cambodian cities, such as Phnom Penh, Kandal, Prey Veng, and Takeo (World Bank, 2013a,b).

The results showed that the increase in energy consumption will increase pollution in Cambodia by its positive effect on CO_2 emission. The positive relationship between energy consumption and CO_2 emission is expected since most of Cambodia's electricity consumption comes from fossil fuels as it represented 94% in 2011 (World Development indicators, 2014). This source of energy is well known to be the main source of pollution. These results correspond to the outcomes of several other studies that include Cho et al. (2014), Atici (2009), Lean and Smyth (2010), Saboori and Sulaiman (2013), Ang (2007), Apergis and Payne (2009), Farhani et al. (2014), Shahbaz et al. (2013), Arouri et al. (2012), and Marrero (2010).

The results revealed that trade openness increases CO_2 emission in Cambodia. This country witnessed a remarkable boost in its trade level which increased its contribution to GDP as it reached to over 60% in 2012. Although this remarkable increase helped to

Table 2
Ordinary covariance correlation test.

Correlation	LEM	LGDP	LGDP2	LEC	LTD	LUR	COR	GOV
LEM	0.110934							
	1.000000							
LGDP	0.187683	0.341303						
	0.964544	1.000000						
LGDP2	6.348221	11.58211	393.1115					
	0.961307	0.999907	1.000000					
LEC	0.164934	0.272107	9.189533	0.262945				
	0.965710	0.908316	0.903864	1.000000				
LTD	0.243397	0.421361	14.25935	0.361548	0.547002			
	0.988072	0.975191	0.972406	0.953321	1.000000			
LUR	0.039489	0.069776	2.364178	0.056675	0.088359	0.014675		
	0.978716	0.985949	0.984325	0.912383	0.986222	1.000000		
COR	−0.024774	−0.044608	−1.515668	−0.038764	−0.050491	−0.008075	0.015363	
	−0.600106	−0.616027	−0.616742	−0.609892	−0.550783	−0.537768	1.000000	
GOV	0.003659	0.008515	0.288718	0.004518	0.013242	0.002442	0.005433	0.007336
	0.128273	0.170167	0.170019	0.102861	0.209051	0.235330	0.511729	1.000000

Note: the null hypothesis is that there is no multicollinearity among the variables.

Table 3
The regression results CO_2 emission as the dependent variable.

	Two-stage Least Squares (TSLS)	Generalized Method of Moments (GMM)
LGDP	−6.865544[b] (−2.421872)	−5.067915[a] (−5.092069)
$LGDP^2$	0.177138[b] (2.370207)	0.134435[a] (4.498869)
LUR	4.454246[a] (3.454597)	3.598589[a] (5.205559)
LEN	0.276140[b] (2.520178)	0.269238[b] (3.207606)
LTP	0.208786[b] (3.044006)	0.085141[c] (1.716667)
COR	−0.225742[c] (−1.870512)	−0.116700[c] (−1.788631)
GOV	−0.372774[b] (−2.587313)	−0.440702[a] (−8.514038)
Adjusted R^2	0.781557	0.879822
Sargan	–	0.977092
Durbin–Watson statistic	2.045181	–
LM test	5.318810 (0.1499)	–
Heteroskedasticity Test	2.131615 (0.1554)	–

Notes: The numbers in brackets are the *t*-statistics.
[c] Statistical significance at 10% level.
[b] Statistical significance at 5% level.
[a] Statistical significance at 1% level.

expand Cambodia's economic, it also amplified its contribution to CO_2 emission. Moreover, the positive relationship between trade openness and CO_2 emission indicates that the exports and imports of goods and services that Cambodia is trading are not environmentally friendly. Similar results are documented by Farhani et al. (2014), and Lau et al. (2014).

The results for the corruption control and the governess indicated the existence of a negative effect on CO_2 emission in Cambodia. This negative relationship between the variables illustrates that a better corruption control will reinforce the environmental regulations in the country. Therefore, this will compel the industries to follow these regulations which can, in turn, reduce their pressure on the environment. Moreover, the improvement in Cambodia's governess can also reduce pollution because a better governess can improve the aim of the environmental interest groups by stimulating the political freedom and independency of information circulation. This will, in turn, elevate the public awareness as well as the support for the environmental legislation. Thus, the rise in public awareness toward the environment will increase the public demand for improving the environmental quality. However, from our results, the inverted U-shaped relationship between GDP and its square with CO_2 emission was not confirmed and the EKC hypothesis is not present. Therefore, the results revealed that the control of corruption and better governess did not help to form the inverted U-shaped relationship between income and pollution despite their significant negative effect on CO_2 emission. Moreover, the results also confirm that Cambodia's rapid economic development did not reach a point where the economic development–pollution relationship is negative. Consequently, it can be said that the country is still in the early stages of its economic development. Basically, the inverted U-shaped relationship only takes place when the country reached to a level of economic development when the technologies that improve energy efficiency and renewable energy are available which is not present in Cambodia. This can be seen the levels of energy efficiency and renewable energy is low in compared to the rest of South East Asian countries such as Singapore, Malaysia, and Thailand (Euromonitor International Database, 2013). Moreover, fossil fuels is still the dominate source of energy due the most of Cambodia's electricity consumption comes from fossil fuels as it represented 94% in 2011.

5. Conclusion and policy implications

The aim of this study was to examine the validity of the environmental Kuznets curve (EKC) hypothesis in Cambodia. To realize the aim of this research, a model that represents pollution was established taken the period of 1996–2012. The results from the Two-stage Least Squares (TSLS) and the Generalized Method of Moments (GMM) showed that GDP, urbanization, energy consumption, and trade openness increase CO_2 emission while the control of corruption and governess can reduce CO_2 emission. Moreover, the environmental Kuznets curve hypothesis was not confirmed in Cambodia.

From the outcomes of this research, it can be noted that although Cambodia increased its investments and projects to enhance energy

efficiency and renewable energy, these projects and investments are low compared to the other ASEAN countries. Moreover, it is essential for the urban planners to utilize policies to improve urban planning by controlling sewage, industrial waste, and solid waste which are causing huge environmental problems in Cambodia's major cities. As trade increases pollution, a trade-related actions and strategies to increase environmental protection is needed to reduce the environmental pressure induced by trade. Furthermore, it is important to increase the corruption control to reduce the pollution since it can help to strengthen the environmental regulations. Finally, a better governess is also important to improve the quality of the environment which can be achieved by increasing the quality of public services, quality of the civil service, the independency from political pressures, and the quality of policy formulation and implementation.

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