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Impact of Kyoto Protocol and Institutional Factors on Carbon Dioxide emissions in Asia-Pacific Region

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Abstract

This study investigates the impact of Kyoto Protocol and four institutional factors i.e. political stability, property rights, corruption and freedom of trade on the growth of per capita CO_2 emissions in Asia and the Pacific region for the period of 1971-2009. The region consists of East Asia, South Asia and the Pacific islands are the fastest growing economic region and the source of global greenhouse gas emissions. A dynamic panel data model based on the Generalised Method of Moments (GMM) technique is utilized to examine these impacts. The findings indicate only Kyoto commitment (K_{com}), Kyoto Clean Development Mechanism (K_{cdm}) and Corruption (COR) describe statistically significant positive effects on CO_2 emissions.

Keywords: CO_2 emissions; GMM; Kyoto Protocol Commitment; Clean Development Mechanism; Institutional factors.

1. Introduction

The United Nations Environment Programme (UNEP) 2012 report has hinted that the Asia and the Pacific region will contribute an estimated 45 percent of global energy-related CO_2 emissions by 2030 and may increase to 60 percent by 2100. This is not surprising since the region is home to the top two largest emitters of CO_2 i.e. China and

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India, as well the smallest emitters i.e. the Pacific Island nations. Any effects of climate change are expected to be felt most by these countries, the very countries that are least prepared to deal with them. It is understood the dilemma facing by the governments across this region their need to balance between boosting economic growth to eradicate poverty while simultaneously controlling the increased in carbon emissions. GDP per capita is the most common indicator of a country's economic development and is believed to be a prime variable that affects the level of carbon emissions. This is proven by earlier empirical studies relating them to the well-known Environmental Kuznets Hypothesis. Another fundamental factor that is perceived to be closely related to economic growth and CO_2 emissions is energy consumption. The introduction of an extended version of the IPAT framework known as the Kaya identity that includes energy consumption has become a central attention. Studies on energy-related carbon emissions use the identity to decompose emissions and energy use into the effects of population, per capita income, energy intensity of output and the carbon intensity of energy. This method can illustrate whether changes in CO_2 emissions reflect a decline in carbon-energy ratio or improvements in energy efficiency, changes in economic growth or changes in population growth (Aldy, 2007). The Kaya identity for energy consumption is given by:

$$Energy = Population \ x \left(\frac{GDP}{Person} \right) x \left(\frac{Energy}{GDP} \right)$$

and CO_2 emissions is outlined as:

$$CO_2 \ Emissions = Population \times \left(\frac{GDP}{Person} \right) \times \left(\frac{Energy}{GDP} \right) \times \left(\frac{CO_2}{Energy} \right)$$

However majority of the studies conducted focuses on the unit root and cointegration approaches and estimates Granger causality between them. So long economic development is being a major concern in this region socio-economic factor such as GDP per capita, energy usage, fossil fuel energy consumption, urbanization, industrial and agriculture activities are the crucial factors that may impact the level of CO_2 emissions.

Countries signatory to the Kyoto Protocol has somehow demanded them though not mandatory to put effort in reducing the CO_2 emissions. Iwata and Okada (2010) stated the 1997 Kyoto Protocol an international agreement aiming to reduce GHG emissions is a precious milestone to prevent and mitigate global warming has placed stringent emissions limit for developed countries but the merit of the protocol too depends on the actions of developing countries. It is vital to observe and analyze the effects of the Kyoto Protocol as the organizational body to UNFCCC that governs the control of CO_2 emissions in order to provide policy implications that would enhance further its functions. The role of Kyoto Protocol is an interesting aspect to look into whether its function as a stable institutionalised platform is adequate and efficient to coordinate all its members and incorporate new members specifically developing countries to shape strong partnership and foster innovation for the sake of future progress in controlling CO_2 emissions and combating global warming.

Thorstein Veblen the original proponent of Institutional Economics in 1896 stated the role and value of institutions is crucial in creating the potential for stability and progress whilst the 1990s saw North (1994) and Coase (1998) highlighted the principal role of institution and its relationship with progress, development and stability incorporating as well the market mechanisms. Accordingly, it is of essential to include and observe the effect of institutional factors particularly emphasizing political stability, legal structure and security of property rights, corruption and freedom to trade on the level of CO_2 emissions in this particular Asia and the Pacific region. Thus, it is fruitful to observe their impact in the context of the region. There is no concrete evidence on what determines the level of CO_2 emissions, and whether the role of Kyoto Protocol and the four institutional factors described earlier may affect the level of CO_2 emissions. Hence, this issue should be of interest and remain open for discussion so as to explore all possible determinants in order to understand the complex process of the world's climate change.

The objective of this study is to investigate the significance of the Kyoto Protocol and the four institutional factors (i.e. political stability, legal structure and security of property rights, corruption and freedom to trade) in determining the growth of per capita CO_2 emissions in Asia and the Pacific region. The study aims to examine the effect and relationship between the abovementioned factors and growth of CO_2 emissions by employing the Arellano and Bond GMM estimator that involves a dynamic panel specification within a multivariate framework which is rather limited in this area of research. The paper is organized as follows. Section 2 briefly reviews the empirical literature whilst section 3 describes the methodology for conducting the analysis. Section 4 provides the sources of data for each variable while the main empirical findings are presented and discussed in Section 5. The final section 6 concludes the study.

2. Literature Review

In 1971 two scientists Paul Ehrlich and John Holdren have initially addressed the issue on environmental problem by presenting the famous IPAT model. Thereon extensive studies have been conducted linking the model with the socio-economic causes of deterioration in environmental quality. When Cramer (1998) and York, Rosa and Dietz (2003) begin to give more attention to CO_2 emissions per se, Schmalensee et al. (1997), and Friedl and Getzner (2003) in their works clearly name CO_2 emissions to be the main greenhouse gases causing problem on a global scale. The 1990s witnessed the concept of Environmental Kuznets Curve (EKC) is being much utilized to investigate the relationship between economic growth and CO_2 emissions. The study becomes more extensive when energy consumption is identified to be closely linked to economic growth. Salim et al. (2008) points out the issue that remains unsettled is concerning with the question whether economic growth is the cause or effect of energy consumption of which Payne (2008) adds the need to understand the impact of energy consumption on economic growth is crucial in the formulation of both energy and environmental policies. The various empirical evidences have one common outcome i.e. they have proved to show energy usage is indeed a critical factor in affecting the level of CO_2 emissions (Ang 2008; Apergis and Payne 2009, 2010). However Liu (2005) estimates on 24 OECD countries found adding energy consumption implies a negative relation between income and CO_2 emissions. This outcome is supported by Lee and Oh (2006) study on 15 APEC countries divided into three income groups saw energy intensity effect contributed negatively to CO_2 emissions growth in developed but positively with developing countries except China.

Stern (2004) has expressed concerned on the econometric works that fail to note testing different variables individually is subject to the problem of potential omitted variables bias. Noting this there are studies conducted to examine the relationship not only among these three core variables CO_2 emissions, economic growth, and energy consumption but to look as well within a multivariate and integrated framework including other economic and socio-economic variables into the study. Alam et al. (2007) has added population and urbanization growth show a positive impact on environmental degradation yet negatively significant to Pakistan economic development in the long run. But Zhang and Cheng (2009) study on urban population in China do not show significant impact on carbon emissions. Sharma (2011) has included trade openness and urbanization on 69 panels of countries divided into three income panels found negative impacts on the CO_2 emissions from global perspective.

As stated earlier it is of essential to include and observe the role of Kyoto Protocol and the effect of institutional factors particularly emphasizing the political stability, economic freedom and corruption on the level of CO_2 emissions. Though a limited number of studies have been conducted on the issue with regards to CO_2 emissions per se, quite a number of studies have been popularly conducted basically concentrated on the impact of these variables on economic growth. With the world's unstoppable demographic growth coupled with the needs of economic development, the challenges are foreseeable hence an interesting aspect to look in the literature is the study whether the Kyoto Protocol able to function adequately and efficiently as a stable institutionalised platform to coordinate all its members and incorporate new members to shape strong partnership and foster innovation for the sake of future progress in controlling CO_2 emissions and combating global warming. Ecchia and Mariotti (1998) described two main obstacles limiting the effectiveness of negotiations and agreements of international environmental cooperation lies firstly in the strategic nature of the context and secondly the lack of institutions with well defined and effective enforcement powers. Thus they argued international institutions should be allowed to intervene in the framing of the strategic interactions between countries for instance setting the rules of negotiations game as well as influence the actual agreement achieved when different outcomes of the negotiation game can be equilibria. Earlier studies on assessing the Kyoto protocol concentrated more on the issue of emissions trading as a mechanism for abatement commitments among the Annex I parties.

A global study conducted by Kumazawa and Callaghan (2010) on the effect of Kyoto protocol on carbon dioxide emissions on 177 countries from 1980 to 2006 found the developed countries which are subject to reduction emissions target, their carbon dioxide emissions decline since signing the agreement but the effect on per capita income is much larger. An empirical study by Iwata and Okada (2010) prove that the protocol obligations do have positive impact in reducing the carbon emissions for both developed and developing countries. They found in the case of N_2O is insignificant whilst HFCs, PFCs and SF6 have positive significant effects on the protocol commitments. Swinton and Sarkar (2008) in their analysis have come up to forward four main advantages for developing countries to sign the protocol that is firstly comparative advantage, secondly attract the relative abatement capital investment, thirdly create opportunities to develop along a clean path and finally help the countries to expand their markets as they are able to negotiate trade agreements. The most obvious is they believe the protocol might offer them an opportunity to participate as leaders in a new market for pollution control.

Most of the studies conducted on the institutional factors are pertaining to their impact on economic growth rather than pollution. Even the discussion on pollution is general and not specific on CO_2 emissions. Carlsson and Lundstrom (2003) examine the direct effects of different economic freedoms and political freedom has on CO_2 emissions. They found among the economic freedom variables, price stability and legal security show a decreasing effect on the level of CO_2 emissions for countries with a small industry share of GDP, but an increasing effect in countries with a large share. The effect of political freedom on CO_2 emissions is insignificant, most probably because it has become a global environmental problem that subject as well to free-rider problem. Other studies such as Scruggs (1998) analyzed and tested the hypothesis that political and economic equality result in lower levels of environmental degradation. He concluded preferences for environmental degradation probably cut across traditional income and power groups, social choices about this issue are made at many levels of society under variety institutional conditions, and that economic equality and democracy do not explain the variations in environmental quality. Barret and Graddy (2000) found with a number of pollution variables, an increase in civil and political freedoms significantly improves environmental quality including suggesting political reforms are as important as economic reforms in improving environmental quality worldwide. Lopez and Mitra (2000) look at the implications of corruption and rent-seeking behaviour by the government for the relationship between pollution and growth. It shows corruption is not likely to rule out the existence of an inverted U-shaped Kuznets environmental curve under both cooperative and non-cooperative interaction between the government and private firm. Ivanova (2011) investigates how the effectiveness of regulatory framework for instance audits effectiveness and transboundary spillovers affect both actual and reported levels of SO_2emissions. Their empirical analysis on 39 European countries confirms countries with effective regulation are likely to have relatively high reported emissions of sulphur. However it does not indicate a weak environmental performance rather to prove their actual pollution levels is lower than nations with less effective regulation.

3. Theoretical Framework

Basically the idea of the model was established by Ehrlich and Holdren (1971) termed as IPAT model to address the issue on environmental problem generally. The IPAT model theoretical framework conventionally was formulated in the form of equation shown as follow:

$$\text{Environmental Impact } (I) = \text{Population } (P) * \text{Affluence } (A) * \text{Technology } (T) \qquad (1)$$

Cramer (1998) stated though the model is simple, it is rather tautological and thus had converted the model to a stochastic specification to make it empirically researchable showing in the logarithm form of standard economic production function as follow:

$$ln(I) = b_0 + b_1 \, ln(P) + b_2 \, ln(A) + b_3 \, ln(T) + e \quad (2)$$

On the other hand, Cole and Neumayer (2004) forward an empirical estimation based on Dietz and Rosa (1997) referred to as the stochastic IPAT model (STIRPAT) to examine the impact of demographic factors on air pollution. The model is shown as:

$$I_i = aP_i^b \, A_i^c \, T_i^d \, e_i \quad (3)$$

where,
a = constant
b, *c* and *d* = exponent of *P*, *A* and *T* respectively
e = residual or error term
i = cross-sectional units of a country

The cross-sectional and time-series nature of data can be expressed in logarithms form so that it becomes additive to be:

$$ln \, I_{it} = a_i + k_t + b(ln \, P_{it}) + c(ln \, A_{it}) + d(ln \, T_{it}) + e_{it} \quad (4)$$

Equation (4) provides a basic estimating equation to allow a country specific study indicated by a constant, *a*, with subscript *t* denotes the time period and hence with a panel data, it is able to capture country specific time invariant determinants of I other than P, A and T for which Neumayer (2002) claimed such determinants could be climatic differences and geographical factors. It is also noted that a time specific constant for each year, k, captures effects common to all countries but which change over time, other than P, A and T. Consequently, this becomes the basis for the specification of our model.

4. Empirical Analysis

In order to get a clearer analysis, we begin investigating the relationship of eight socio-economic variables (i.e. GDP, EUS, EFF, FDI, URB, IND, AGR and EDU) and level of per capita CO_2 emissions. Therefore applying the Arellano and Bond (1991) and Blundell and Bond (2000) GMM estimator with natural logarithms (*ln*) to equation (7) given earlier the following equation is obtained:

$$lnCO_{2\,it} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnEUS_{it} + \beta_3 lnEFF_{it} + \beta_4 lnFDI_{it} + \beta_5 lnURB_{it} + \beta_6 lnIND_{it} + \beta_7 lnAGR_{it} + \beta_8 lnEDU_{it} + \varepsilon_{it} \qquad (5)$$

where, $\beta_1, \beta_2, \beta_3 > 0$; $\beta_4, \beta_5 > 0$; $\beta_6, \beta_7 > 0$; and $\beta_8 < 0$;

i = 126 countries
t = time frame 1971-2009
gCO_2 = growth rate of CO_2 emissions
*g*GDP = growth rate of per capita GDP
EUS = per capita total energy usage (kg of equivalent per capita)
EFF = fossil fuel energy consumption (% of total energy consumption)
FDI = foreign direct investment (% of GDP)
URB = urbanization (% of urban population growth)
IND = industrial sector production (% of GDP)
AGR = agricultural sector production (index of production)
EDU = education level proxy by average year of total schooling (% of group aged 15+)

To eliminate country-specific effects and solve the problem of correlation between the lagged dependent variable and the error term, a dynamic panel specification with lagged levels of CO_2 emissions are applied, thus the equation will be in the form of:

$$lnCO_{2_{i,t}} = \beta_0 lnCO_{2_{i,t-1}} + \beta_1 lnGDP_{it} + \beta_2 lnEUS_{it} + \beta_3 lnEFF_{it} + \beta_4 lnFDI_{it} + \beta_5 lnURB_{it} + \beta_6 lnIND_{it} + \beta_7 lnAGR_{it} + \beta_8 lnEDU_{it} + \mu_{i,t} + \varepsilon_{i,t},$$

$i = 1,\ldots, N; \qquad t = 1,\ldots, T \qquad (6)$

where,

$lnCO_{2i,t-1}$ = log of per capita CO_2 emissions of country *i* at time *t-1*
β_i = parameter to be estimated
μ = country-specific effects
ε = error term

Using the panel ordinary least square (OLS) estimator is problematic since the lagged dependent variable is correlated with the error term, so, the option is to employ the Arellano and Bond (1991) as country-specific effects can be eliminated. This is so because the method first differences the regression model resulting with: $E(\varepsilon_{i,t} - \varepsilon_{i,t-1}) = 0$ but $(gCO_{2i,t-1} - gCO_{2i,t-2})$ is dependent of $(\varepsilon_{i,t} - \varepsilon_{i,t-1})$. The method provides a much better solution when one uses two or more lags of the first difference of CO_2 emissions.

The second part of the investigation is to answer the second objective of which to analyse the effect of two sets of Kyoto Protocol (Kyoto commitment and Kyoto Clean Development Mechanism) and four quality governance dimensions (political stability, property rights, corruption and freedom of trade) representing the institutional factors effects on CO_2 emissions. The procedure is to estimate CO_2 emissions with these institutional factors plus the control variables refer to the eight socioeconomic determinants discussed earlier. The equation will be as follows:

$$lnCO_{2_{i,t}} = \beta_0 lnCO_{2_{i,t-1}} + \alpha_1 Kcom_{i,t} + \alpha_2 Kcdm_{i,t} + \alpha_3 lnPS_{i,t} + \alpha_4 lnPR_{i,t} + \alpha_5 lnCOR_{i,t} + \alpha_6 lnFOT_{i,t} + \psi X_{i,t} + \mu_{i,t} + \varepsilon_{i,t}$$

$i = 1,....., N; \quad t = 1,...., T$ (7)

where, $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_6 < 0$ and α_5(+/-);

i = 126 countries
t = time frame 1971-2009
$lnCO_{2i,t-1}$ = log of per capita CO_2 emissions of country i at time $t-1$
Kcom = Kyoto Protocol’s commitments
Kcdm = Kyoto’s flexible mechanism the CDM
PS = political stability
PR = property rights
COR = corruption
FOT = freedom of trade
X = control variables

Similar to the first part of the study, the GMM technique is utilized to estimate the equation in level and then in first difference. The first estimate uses lagged variables in level of at least one period of instruments of the equation in first difference in order to remove unobserved time invariant and individual characteristics. This complies with the conditions that the error term is uncorrelated and that explanatory variables are weakly exogenous. The second estimate uses variables in first difference lagged of at least one period as instruments of the equation in level. Though the priori expectations are given for each variable with the exception of corruption (ambiguous), the associations of quality governance with carbon emissions are still relatively new and thus open for discussion in these developing regions.

5. Dataset

FDI is measured by inward FDI flows based on percentage of GDP extracted from UNCTAD. Urban population computed as an annual percentage of urban population growth whilst industrial production valued as a percentage of GDP comprises of value added in mining, manufacturing, construction, electricity, water, and gas, both data are collected from WDI. Agriculture is measured by the index of agriculture production merely because the data is available for all developing countries. The data is extracted from Food and Agriculture Organization of the United Nations (FAOSTAT). For a standardized measurement for level of education, Barro and Lee (2010) new data set on educational attainment is utilized.

Kyoto commitments takes the value of one, if a country has ratified the protocol otherwise it takes the value zero. The variable takes the value one from the year in which the country has ratified the protocol onwards and most of the countries with emission reduction obligations ratified the protocol in 2002. Kyoto Flexible mechanism CDM is based on the number of CDM projects the country has implemented or taken up with the help of developed countries. The data on the number of implemented CDM projects by host country are gathered from the most recent UNEP Risoe Centre. A point to note is countries like China and India are expected to have a large number of projects compared with other developing countries hence normalization on the number of projects is applied in order to achieve a more reasonable value. Corruption and political stability measures are taken from the Worldwide Governance Indicators, 2011. The estimate of governance ranges from approximately -2.5 as weak to 2.5 as strong governance performance, respectively. Data on legal structure and security of property rights and index of freedom to trade internationally data are extracted from the Economic Freedom of the World, 2010 Annual Report under Area 2 and Area 4 respectively. These data are compiled by James Gwartney, Joshua Hall, and Robert Lawson from Fraser Institute.

6. Results and Discussion

Before discussing the results, it is preamble to note four fundamental empirical criteria with regards to the estimations of the variables. First the time period understudy is 1971-2009 involving 31 countries, the panel data are time period corresponding to a five-year average for example 1971-1975, 1976-1980, 1981-1985 and so on, thus the overall region analysis for instance will have time dimension T=8 and the country dimension N=31. Relying on five year intervals as stated in the literature is a standard procedure to mitigate the persistence in the data. Second is the issue on data availability; PS and COR indicators start off with years 1996, 1998, and 2000 then continues on yearly basis from 2002 until 2009. PR and FOT data is available every five years from 1975 up to 2000 thereon it is recorded annually. Third the raw data values of each variable are utilized for estimations purpose except for K_{cdm} of which the number of projects in each country is normalized to bring them to a common scale. Fourth it is foresee the problem of multicollinearity to arise among the institutional variables even though they differ individually yet could possibly overlap amongst each other due to the fact that they might convey essentially the same information.

The choice of estimating alternative GMM methods from the first-difference-GMM (Arellano and Bond, 1991) to system-GMM (Arellano and Bover, 1995; Blundell and Bond, 1998) is to obtain the most relevant, appropriate and reliable estimations. Table 1 describes the parameter estimates while in parenthesis is the t-statistic of the parameter estimates and a selection of diagnostic statistics. The socioeconomic factors are quite robust since the statistical significant coefficient values specify five

Table 1: Effect of institutional factors on per capita CO_2 emissions for Asia and the Pacific region.

Log of carbon dioxide per capita emissions	GMM 1- SYS
Log of CO_{2t-1}	-0.047
	(-1.01)
Log of GDP/cap	1.003
	(43.98)***
Log of EUS	0.119
	(4.50)**
Log of EFF	0.282
	(1.85)
Log of FDI	0.159
	(11.86)***
Log of URB	0.130
	(0.83)
Log of IND	0.286
	(0.71)
Log of AGR	-2.487
	(-35.06)***
Log of EDU	-3.022
	(-13.57)***
Kcom	0.229
	(6.19)**
Kcdm	0.025
	(3.89)*
PS	-0.002
	(-0.03)
PR	-0.016
	(-0.41)
COR	0.144
	(4.69)*
FOT	0.003
	(0.11)
No. of observations	22
m_1-test	0.366
m_2-test	0.317
Hansen test	1.000
Difference-Hansen	1.000
No. of instruments	22

Notes: 1. EUS = Energy Usage; EFF = Fossil Fuel Energy; FDI = Foreign Direct Investment; URB = Urbanization; IND = Industrial Production; AGR = Agriculture Production; EDU = Education; Kcom = Kyoto Commitment; Kcdm = Kyoto Clean Development Mechanism; PS = Political Stability; PR = Property Rights; COR = Corruption; FOT = Freedom of Trade.
2. Shown in parentheses are t-statistics. *, ** and *** denote significance at 10%, 5% and 1% level, respectively.
3. The values reported for m1 and m2 are the *p*-values for first and second order auto correlated disturbances.
4. The values reported for F-statistic, Hansen and the Difference-Hansen tests are the *p*-values.

major variables which are per capita GDP, EUS, FDI, AGR and EDU. The findings confirm the effects of four main variables GDP, EUS, FDI and AGR have on per capita CO_2 emissions in this region. On the other hand the empirical results for the institutional indicators show three indicators K_{com}, K_{cdm} and COR describe a statistically significant positive coefficient values. A significant K_{com} at 5 percent level of significance may interpret the commitment of the region in tackling the issue of carbon emissions. This is further emphasized by the significant coefficient value of K_{cdm} which is another key aspect of the protocol. The collaboration of various projects activities of clean development mechanism taken up in this region particularly in China, India and the South East Asian nations are very encouraging and largely substantial to combat emissions problem. Although a positive coefficient might indicate a higher emission level, the values are rather small i.e. 0.229 and 0.025 respectively for both factors. The corruption coefficient in the region that portrays a significant positive relationship with per capita CO_2 emissions has implied a low index score of COR (high level of corruption) causes a low emission.

The diagnostics part of the table portrays three main diagnostic tests of the appropriateness of the instruments used. The findings indicated only the one-step system GMM is the most relevant. The standard Hansen J-test of over-identifying restrictions is to verify the validity of the instruments whereas the Difference-Hansen test that is closely related to the Hansen test checks the validity of a subset of instruments. As explained by Roodman (2008, 2009) a perfect Hansen statistic with *p*-value of 1.000 may imply instrument proliferation which can overfit endogenous variable and fail to expunge their endogenous components. It weakens the power of the test to detect invalidity of the System GMM instruments hence provides a lesson on the difficulty of short-panel econometrics. His advice is researchers should report the number of instruments in the regressions besides testing for robustness by reducing the instrument count, limiting the lags and collapsing instruments. There is no precise guidance on what is a relatively safe number of instruments but merely keeping the instrument count below N does not safeguard the J-test. Third the tests of first and second-order serial correlation m_1 and m_2 respectively of which the value m_1 fails to reject the null of no autocorrelation hence indicating no evidence of first-order autocorrelation. Nevertheless the test for second-order serial correlation (m_2) does not reject the null of no second-order autocorrelation, in other words no evidence of second-order autocorrelation. The m_2 test is more significant because it is able to detect autocorrelation in levels.

7. Conclusions

This study investigates three major sets of factors on the growth of per capita CO_2 emissions. First we examined the socio-economic factors, second the effect of Kyoto Protocol and third a set of institutional factors over the period of 39 years. The empirical evidence based on the one-step system GMM estimations has proven the significant effects of four main variables GDP, EUS, FDI, AGR and EDU on per capita CO_2 emissions in this region. The remainder three variables namely EFF, URB and IND disclose an insignificant effect on CO_2 emissions. Energy usage is essential to generate growth but could lead to higher carbon emissions, thus the region needs to embrace more energy conservation policies as a way to control the emissions. Foreign direct investment is another significant factor in boosting growth yet it is necessary to set up institutional bodies to be able to monitor the inflows of the investment.

As such, the focus should be on the four core determinants of CO_2 emissions and any policy prescriptions should centre on these variables. However, without effective legal structure implemented such as strict standard procedures, rules and regulations, it will not be possible to help to cut the emissions level. It is observe a positive relationship for both Kyoto Protocol commitment and clean development mechanism with carbon emissions that imply both factors may lead to higher carbon emissions. Even though the countries have agreed to commit to cut their emissions level, it is still not mandatory for them to do so. Achieving a high growth continues to be their main target. As for Kyoto clean development mechanism, it is still relatively recent to evaluate its impact though the region is actively participating and cooperating in various projects with the developed nations. On the other hand, out of the four institutional factors three do not illustrate a significant impact on the growth of carbon emissions except for corruption that has a positive significant effect on carbon emissions. Thus it is a wise step for the government in the Asia-Pacific to cooperate and come up with anti-corruption legal framework to control the problem. Corruption may bring negative effects not only on economic development but also a country to face political instability.

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Appendix

List of countries in Asia and the Pacific region

Afghanistan	Nepal
Bangladesh	Pakistan
Bhutan	Palau
Cambodia	Papua New Guinea
China	Philippines
Fiji	Republic of Korea
India	Samoa
Indonesia	Singapore
Kiribati	Solomon Islands
Lao PDR	Sri Lanka
Malaysia	Thailand
Maldives	Timor-Leste
Marshall Islands	Tonga
Micronesia Federation of States	Vanuatu
Mongolia	Vietnam
Myanmar	