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Do Corruptive Practices of a Country Inflate Unbalanced Carbon Dioxide Emissions? A Panel Data Analysis from Select Countries

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ABSTRACT

Global warming causing changes in climate has turned out to be a crucial menace to all countries owing to quick emissions of carbon dioxide (CO2) and other green house gases (GHG). So, this endeavor tries to evaluate the effect of corruption along with high level of energy consumption on carbon dioxide emissions as well as finds out the causal relationship among them using panel data of 10 emerging economies of Asia over the period 1980–2019using Estimated Generalized Least Square (EGLS) approach. The result suggests that countries with embracing of more corruptive practices along with high energy consumption are found to have causing more environmental degradation through excessive emission of carbon dioxide in the long run. The study also indicates the presence of unidirectional causalities directing from carbon dioxide emission to energy consumption. We found no short run causal connection between corruption and CO2 emission in the study.

Keywords: CO2 Emissions, Energy Consumption, Asian, Corruption

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1. Introduction

Irrespective of developing and developed countries, carbon dioxide emissions have been a seriously and broadly researched and an extensive range of theoretical and empirical studies. During the last few decades, owing to indiscriminate discharge of carbon dioxide coupled with several green house gases, global warming resulting erratic changes in climate has turn out to be a most important menace for almost all the nations. The corrupt economies are expected to have higher level of pollution emissions because gradual widening of corruption in an economy initiates weaker enforcement of environmental laws thus reducing social welfare. Directly, corruption in form of embezzlement and bribery might decay public funding for environmental programs and reduces way to reduce carbon dioxide emissions. On the other hand, indirectly, corruption turns out a country less efficient, causing more harm to the environment.

Cole (2007) opined that corruption might absolutely have an effect on pollution emitting level through its unequivocal consequence on per capita income. Consequently, corruptive practices have unswerving and meandering influences on the environmental upbringing. The environment degraded mainly owing to emergent requirements of economic growth, which have often consequential impact on both emergent and advanced countries. The rapid urbanization, industrialization in numerous countries lead to economic growth ensuing boost in consumption of energy level. Moreover, corruptive practice in countries plays a lot in carbon dioxide emission. Corruption directly may exacerbate environmental contamination if in any way environmental regulations curtails down or environmental policies are undermined. It

might ultimately diminish or enhance level of environmental pollution which is made possible by reducing income levels (Li & Liu, 2013). Jin & Wu (2014) observed that corruption might pessimistically have an effect on environmental pollution by way of deteriorating economic growth.

So, corruption seems to have a significant character in escalating pollution level in the environment. But, empirical exploration on such a topic is still deficient. To contribute to such a vital environmental issue, this research endeavour ,by analyzing the causal connection between carbon emission and corruption in the select emerging economies , displays a novel move towards understanding the affiliation between corruption and degradation of environment and fills the gap on the issue.

More precisely, we concentrate our study on 10 emerging Asian countries in order to understand cointegration in the long-run causal connection in between carbon emission, energy consumption, also corruption because Asian countries presently confront with growing economic development and investment in green and renewable energy (Kannan et al., 2007; Balamurugan et al., 2012; Ali et al., 2017). As a result, some unique factors like corruption, energy consumption etc among the Asian countries might report for innovative substantiation in influencing carbon emission that may differ from prior studies.

In view of the above prelude, the article aims to find out the influence of corruption and energy consumption on emissions of carbon dioxide and also to search for the causal affiliation among them in selected 10 Asian economies for a period of 40 years from 1980-2019.

1.1 Theoretical Background Behind Linkage between Corruption and Environmental Degradation

It is well recognized fact that corruption associates economic, political as well as some social costs. Apart from misallocating resources, lowering productivity of public expenditure, slowing down growth of economy, it degrades environment challenging basic need of housing, sanitation, pure water and health care. There is an admired conviction that corruptive practice of government is entwined with degradation of environment. Several theories like grabbing hand, principal-agent and institutional theories are very much prioritized to explain their interrelationship. The grabbing hand theory ,as contrasted with Adam Smith's 'Invisible Hand' theory, explains that when government officials are involved for their self interest in inefficiently misallocating resources, certainly this could lead to degraded ,uneven economic growth, increasing doing business costs, despairing investment possibilities and overall declined economic and social welfare. Amidst prevailing corruptive practices adopted by government servants looking for short-term gains from resource exploitation, corruption hampers long term sustainability of environment and escalates cost of doing businesses in resource rich economies. Institutional theory suggests vigorous enforceability of rule of law, anti corruptive mechanisms which might protect environmental degration, failing which it may create favourable opportunities for corruption leading to possible threats of unfavourable environmental degradation via exploitation. It is quite obvious that weakness on the part of government as institution, regulatory bodies as executive authorities of government become vulnerable to be decomposed by corruptive attraction

In pursuance of principal agent theory, corruptive practices adopted by regulatory bodies to maximize personal interest as agents in presence of governmental organization as principal bodies destabilizes the strength of this relationship leading to laxity in enforcement of environmental regulations. This corruptive misfeasance might cause environmental degradation.

Environmental degradation is more prominent in a resource rich economy that resource distressed country because abundance of resource might generate rent seeking opportunities and corruption which again might create resource mismanagement and degradation of environment. This type of corruptive practices ultimately can assist economic activities outside legal framework which we call it a 'shadow economy'. Consequently pulling out of uncontrolled resources might be possible outside regulatory framework leading to pollution and degradation of environment, possibly causing laxity of enforcement of environmental laws. On the other hand, if environmental agencies responsible for protecting environment under weaker governance are under-funded, the officers under those departments are compelled to take backhander for survival. This in turn makes governments less approachable to public and more responsible for environmental damage.

In a nut shell, prevalence of corruption in a society within greater domain of environment of a country is not supposed to be directly environment disparaging. But practice of adopting corruptive measures might attract underprivileged regulatory framework via poor governance. This might instigate shocking policy formulation and poor enforcement of such policies, thereby posing threat to sustainability of environment.

2. Review of Existing Literature

In current scenario, quite a lot of research initiatives have given attention on exploring the connection among corruption, energy consumption, and emissions of CO_2. Amidst voluminous research studies on the issue, we concentrate our investigation whether or not corruption has a causal association with carbon emission resulting climate changes.

Practical proofs substantiate the presence of an opposite affiliation between corruption and the environment. For example, Desai (1998) considered the corruption- environment association in 10 emergent Economies. The observed findings suggested that corruption is a powerful factor for degrading environment. Damania (2002) takes a somewhat diverse approach while investigating the influence of corruption upon environmental regulations by means of assessing the dynamic interactions among prosecution rate, monitoring rate and also fines. With an escalating number of global environmental agreements, several governments had to frame and promulgate rigorous environmental regulations.

Fredriksson &Mani (2002) found that corruptive practices have an adverse impact on rigidity of environmental regulatory laws. Findings of Damania et al. (2003) suggest that corruption decrease pollution tax but consumer awareness increases the pollution tax and in presence of corruption, this relation is violated. Additionally, in a cross section study of the European Union (EU). Welsch (2004), taking instances of European Union, established the existence of an affirmative direct relationship between corruption and pollutions emissions level. Morse (2006), by using the CPI and ESI index, established that environmental sustainability declined as income declined whereas corruption worsened.

Pellegrini &Gerlagh (2006),using corruption perception index(CPI) and environmental regulatory regime index(ERI), showed that there is a statistically significant affiliation between corruption and environment and magnitude of corruption level adds to degradation of environment much more than what per capital income does. Cole (2007) studied over 94 countries for a period of1987-2000 to judge direct and indirect impact of corruptive practices on pollution emission and came to a conclusion that corruption will implicitly have an effect on pollution emissions level by means of its explicit effect on per capita income. Thus, corruption has direct and indirect effects on the environment. Goel et.al (2013),using data of more than 100 countries for the period 2004-07 found that low levels of documented emissions are more likely to be found in corruptive countries with sturdy shadow sectors. Sekrafi &

Sghaier (2018, p. 81) find, “a negative and significant relationship between control of corruption and environmental quality (CO_2)” for their research in Tunisia, whereas, Zhang et al. (2016) found the diverse effect of corruption on CO_2 emissions in APEC and also found “The total effect appears positive, which indicates corruption may worsen environmental quality overall in APEC countries” (Zhang et al., 2016, p. 220).

On the whole, our literature review usually shows that there seems to be no empirical studies that have attempted to consider simultaneously the effects of some environmental factors and economic factor like energy consumption, and one socio-political factor namely corruption(measured through corruption perception index) on carbon dioxide emissions.

After careful review of literature, it is evident that most of the studies concentrate on co-integration approach to analyze long run affiliation among factors affecting carbon dioxide emission. We have used somewhat different econometric measures to analyze long run as well as short run relationship among these variables under consideration. The choice of method and rationale behind such choice in our study is mainly guided by situation arising out of systematic step by step adoption of econometric techniques. In the study, EGLS method is used to estimate the relationship between CO_2 emissions, corruption and energy consumption, taking into account the panel structure of the data (multiple countries or regions over time) and addressing issues like cross-sectional dependence and heteroscedasticity.

The Granger causality test is appropriate in analyzing the relationships between carbon dioxide emissions, corruption, and energy consumption because it helps to decide whether one of these variables can predict or "Granger-cause" another. While correlation merely points out an arithmetical connection between variables, granger causality helps resolve if one variable accurately precedes and foretells another, signifying a more basic causal connection.

Hence, the current study fills the research gap by incorporating effects of all these factors in evaluating the nexus among carbon emissions, energy consumption, corruption, etc using econometric model in the selected Asian countries.

3. Methodology

Data has been collected from the World Bank database, specially from World development indicators for a period of 40 years from 1984 to 2019.The study takes into consideration several financial parameters of 10 Asian economies like India, Korea republic, Japan, Thailand, Singapore, Pakistan, Bangladesh, China, Hongkong, SriLanka.In analytical process, the gathered data was analyzed using first generation panel unit root test for checking stationary. All the variables have been converted into natural logarithm for use in the analysis to avoid heteroscadasticity as far as practicable. Before modeling the data, unit root tests have been adopted by exiting methods to check stationary property as well as to avoid spurious results.

Maddala & Wu (1999) proposed for the first time the first generation unit root test which incorporates Im, Pesarvan and Shin (IPS) ,Levin, Lin and Chu’s test , the Fisher-type test. The major obstacle of these tests is that those methods are erected under the postulation that the individual time-series are cross-sectionally independent in the panel .Considering all variables under our consideration as cross sectionally independent ,Levin, Lin, & Chu (2002), Im, Pesaran, and Shin (2003), and Fisher-type tests like ADF-Fisher and PP-Fisher are computed for each variable to test the unit root (Maddala & Wu, 1999; Choi, 2001). Variables are traditionally examined on the basis of level as well as the first difference with intercept, intercept and trend or none of them included in the test equation separately. Common unit root process has been deduced by Levin, Lin,& Chu (2002) and subsequently the others deduce individual unit root process. In order to comply with the methods, null hypothesis designates

prolongation of unit roots while alternative hypothesis indicates that there are no unit roots. Upshot of the unit root tests generally exhibit that all variables at the level order have unit roots. Conversely, the null hypothesis can be rejected when the variables are renewed to their first difference. All variables, normally, do not have noteworthy unit roots at their first difference order.

Johansen (1988) recommended estimation of maximum likelihood .It has been usually chosen for envisaging long-run equilibrium interaction. In contrast to single-equation methods, the procedure proficiently includes the short-run dynamics in the estimation of the long-run model structure. The major benefit of the Johansen's methodology is the ability of testing and estimating the multiple long-run equilibrium relationships. It is assumed that all the variables are non-stationary at level but when they are transformed to the first difference, and then they become stationary. So Johansen test can be applied. After getting conintegrating equation, Estimated GLS (EGLS) model has been applied for investigating the influence of the independent study variables on CO_2 emissions and finally panel granger causality for getting causal relationship between the study variables has been conducted. Before applying EGLS model, panel cross section heteroscadasticity LR test has been conducted to be acquainted with whether there exist any heteroscadasticity in the series respectively.

EGLS is predominantly realistic in times of handling with data that demonstrates autocorrelation or heteroscedasticity, which are familiar issues in time-series as well as panel data like CO_2 emissions, corruption and energy consumption. The EGLS technique, which is a robust method for panel data analysis, is often applied to estimate possible cross-sectional dependence and heterogeneity across different countries or regions.

This method has been chosen in the study keeping aside other techniques like FMOLS,DOLS,OLS etc. because data exhibits heteroskedasticity (unequal variance across observations) or autocorrelation (correlation between error terms in different time periods). It combines the strengths of different estimation techniques to provide more reliable estimates. Moreover, the entire study proceeds with systematic application of stationarity tests , cointegration tests, granger causality tests etc**.**

Research Questions:

- **Q1.** How do corruptive practices influence carbon dioxide emission, taking into account energy consumption as an intervening factor, in select countries?
- **Q2.** What is the affiliation between energy consumption and CO_2 emissions, and how is this relationship influenced by corruptive practices?
- **Q3.** Can the EGLS method successfully incarcerate the intricate interactions between corruptive practices, energy consumption, and environmental degradation (via CO2 emissions)?

Hypothesis:

- **H_{01}**: There is no impact of corruptive practices on carbon dioxide emission in select countries.
- **H_{02}**: There is no impact of energy consumption on carbon dioxide emission in select countries.
- **H_{03}**: There is no causal connection between energy consumption and carbon dioxide emission in select countries.
- **H_{04}**: There is no causal connection between corruptive practices and carbon dioxide emission in select countries.

Model and Variables:

In the investigation, CO_2 emissions is considered to be the dependent, while energy consumption and corruption are independent variables which are shown in Table 1.

Table 1: Description of Dependent and independent variable and list of 10 Asian Economies surveyed

Name	Description	Abbreviation used
CO2 emissions	CO2 emissions in kilo tonne (kt)	CO2
Energy consumption	Energy use (kg of oil equivalent per capita)	ECON
Corruption	Corruption Perception Index collected from Transparency International	CPI
List of 10 Asian Economies: India, Korea republic,Japan,Thailand,Singapore,Pakistan,Bangladesh,China,Hongkong,SriLanka,		

The two independent variables are briefly defined below:

Energy consumption: It assesses the usage of energy which can be acquired through burning of fossil fuels. The energy use is measured by the kg of oil equivalent per capita,which indicates energy consumption per head of the population of a country. Owing to the boost in energy consumption, the CO_2 emission level is expected to raise also. Thus, we suppose a positive association.

Corruption:

It is represented by corruption perception index published since 1995 per annum by Berlin-based Transparency International which prepares ranks countries by their apparent levels of public sector corruption. The CPI normally characterizes corruption as an abuse of entrusted authority for personal gain. This may take place in the form of bribery, embezzlement, felicitation payment, fraud, collusion, extortion, patronage and nepotism etc. The countries with more corruptive practice are responsible for more carbon emission in their economic activities undertaken expecting a positive relations between two.

Therefore, a basic structure of the study is founded upon the model presented below:

CO_2=f(ENCON, CPI)

The experiential model mentioned below is envisaged to evaluate the consequence of the corruption on CO_2 emissions in a country i (i = 1,2,3 . . . , 10) in time dimension t (t = 1980-2019). Consequently, the regression model is redrafted as:

$$(CO_2)_{it} = \beta_0 + \beta_1 ENCON_{it} + CPI_{it} + \varepsilon_{it}$$

Where ε_{it} is the error term, which has zero mean and constant variance.

4. Analysis of Results

Figure 1 demonstrates the trend of emissions which is escalating as corruption enhances. Emission level also increases with increases in energy consumption level. The following three figures show the trend in CO2 emissions, energy consumption, and corruption in select Asian countries.

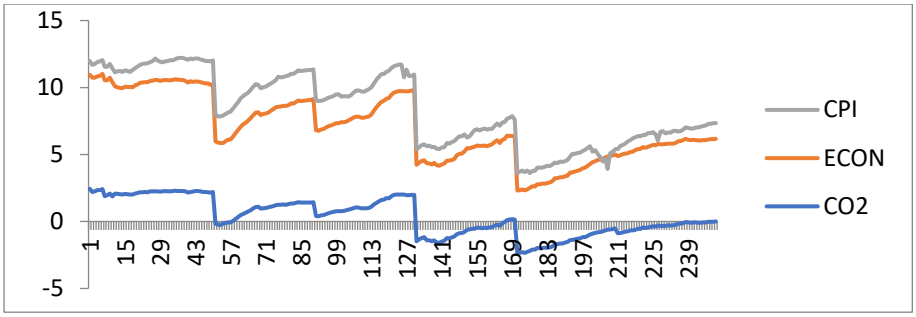

Figure 1: Trend in carbon dioxide emission, energy consumption and corruption

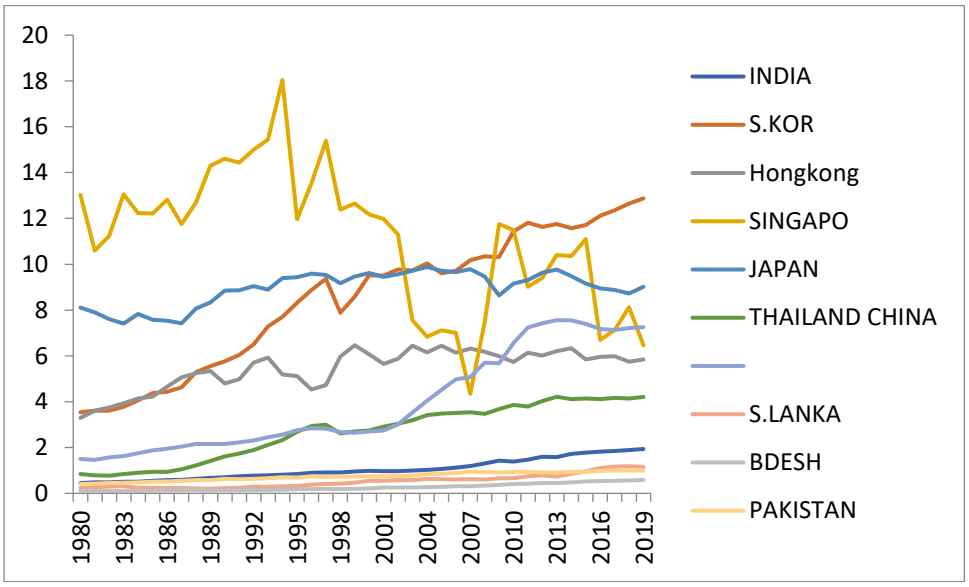

Figure 2: Trend in CO2 emissions in select Asian countries

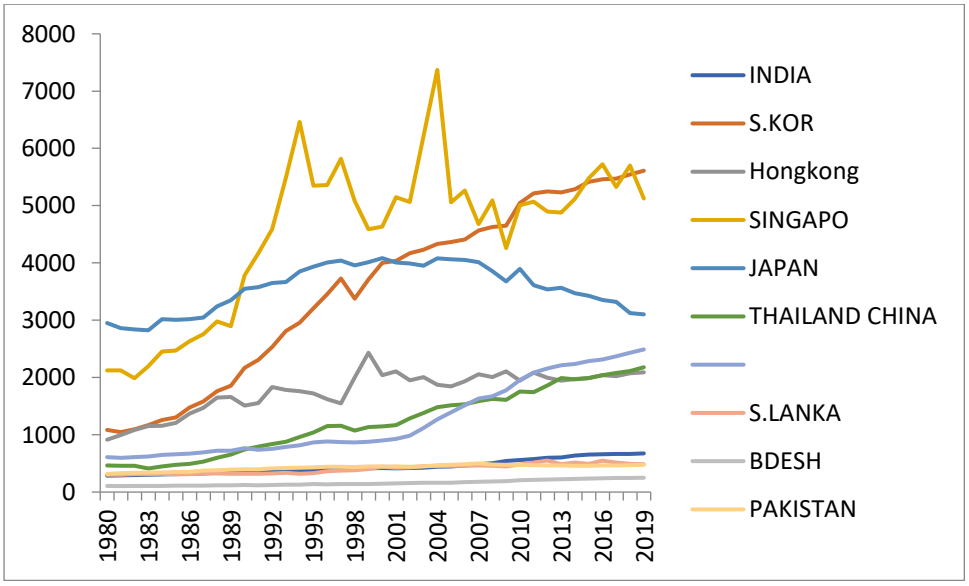

Figure 3: Trend in Energy consumption in select Asian countries

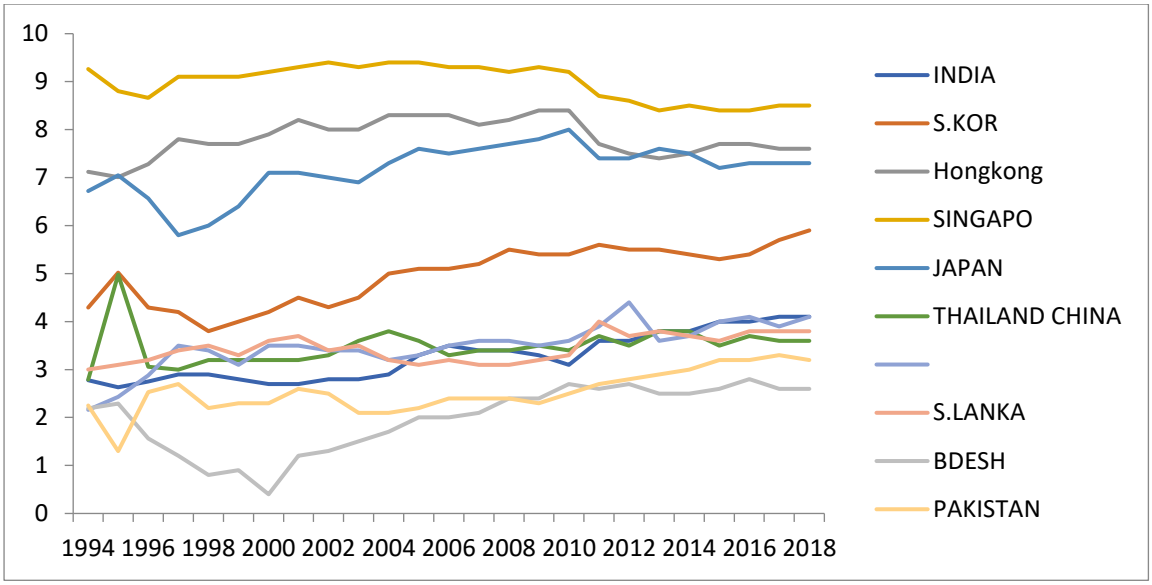

Figure 4: Trend in Corruption in select Asian countries

Before interpreting the actual results, we examine the order of integration and also unit root test of the data series are conducted to ensure whether the concerned variables are stationary at levels I(0), or non-stationary at levels and become stationary after taking their first differences I(1) and to prove that none of them are stationary at second difference *I(2)* and above. In all those experiments adopted in the study, the null hypothesis that a series has a unit root is experimented against its alternative of stationarity. Table 2 summarizes the result of unit root tests of the natural logarithms of the variables at levels and at their first difference.

The result of the unit root tests in several forms such as Levin, Lin& Chu, Im,Pesaran&Shin, ADF-Fisher, PP-Fisher indicates that all the variables are not stationary at their level forms but they all attained stationery after taking their first differences I(1), indicating that none of the variables are I(2) or beyond.

The output of the unit root test results in all types of unit root tests (Levin, Lin& Chu, Im,Pesaran&Shin, ADF-Fisher, PP-Fisher) indicates that all the variables are not stationary at their level forms but they all attained stationery after taking their first differences I(1), demonstrating that none of the variables are I(2) or beyond. This implies the possibility of cointegrating relationships. After authenticating that all the variables are stationary, either at levels or in their first differences, we undertake Johansen Fisher panel cointegration test to examine the presence of a long-run or cointegrating relationship among the variables.

Table 2: First Generation Panel Unit Root Tests

		Unit Root Tests			
		Levin, Lin& Chu	Im,Pesaran &Shin	ADF-Fisher	PP-Fisher
Level	**CO2**	-2.77 (0.0027)	0.089 (0.5354)	24.17 (0.235)	33.14 (0.0326)
	ENCON	-1.70571 (0.0440)	0.58841 (0.7219)	25.5495 (0.1812)	36.8522 (0.0122)
	CPI	-1.27929 (0.1004)	-1.16320 (0.1224)	20.1857 (0.1244)	29.1488 (0.0100)
First Difference					
	CO2	-7.7 (0.0000)	-9.42 (0.0000)	126.09 (0.0000)	227.27 (0.0000)
	ENCON	-5.44860 (0.0000)	-7.62802 (0.0000)	99.4175 (0.0000)	213.764 (0.0000)
	CPI	-7.10638 (0.0000)	-7.10432 (0.0000)	93.3571 (0.0000)	198.488 (0.0000)

Source: Own estimate
Note: p-values in parenthesis.
****Indicates significance at 1%.*

We have also conducted Johansen Fisher Panel Co integration Test(Table 3). Both common test results and individual cross-section results of trace tests and eigenvalue statistics demonstrate that there are at most two co integration equations. While taking into account the individual results, these are significant and noteworthy statistically at the level of 5 % significance level. In other words, a substantial relationship between the variables is detected for five economies.

Table 3: Johansen Fisher Panel Co integration Test

Series: CO2 ENCON CPI				
Hypothesized No. of CE(s)	**Fisher Stat.* (from trace test)**	**Prob.**	**Fisher Stat.* (from max-eigen test)**	**Prob.**
None	149.1	0.0000	63.65	0.0000
At most 1	95.60	0.0000	38.89	0.0000
At most 2	62.59	0.0000	37.68	0.0000

Source: Own estimate

Table 4 shows the result of heteroscadasticity test. Since the p value (0.0000) of Likelihood Ratio is less that 0.05, we reject the null hypothesis of homoscadasticity in the residual in favour of the alternative hypothesis that there exist heteroscadasticity in the residual.

Table 4: Panel cross section Heteroscadasticity LR test

Statistic	**Value**	**Probability**
Likelihood Ratio	205.97	0.0000
LR test summary:	-181.48	
Restricted logL	-78.48	
Unrestricted logL		

Source: Own estimate

Here, serial correlation problem was checked by panel cross section heteroscadasticity LR test. Since the p value (0.0000) of Obs*R-squared is less that 0.05, we reject the null hypothesis of no serial correlation in the residual in favour of the alternative hypothesis that the model specification is serially correlated.

For envisaging a particular cointegrating vector in panel settings, we use Estimated generalized Least Square (EGLS). If the variables are cointegrated, EGLS model could be useful otherwise

we shall not apply it. This method is best suited here because there is presence of serial correlation and heteroscadasticity in the panel data set. More number of time series data(T) is greater than no of cross sections(N) used .Common group values are compared to identify general affecting components.

Table 5: Panel Estimated generalized least square(EGLS)

Dependent Variable: CO2 **Method: Panel EGLS (Cross-section random effects)** **Sample (adjusted): 1981- 2019** **Periods included: 40** **Cross section:3** **Swamy and Arora estimator of component variances**				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
ENCON	0.591255	0.056193	10.52190	0.0000
CPI	0.127427	0.032384	3.934875	0.0001
Effects Specification			S.D.	Rho
Cross-section random			6.70E-07	0.0000
Idiosyncratic random			0.175096	1.0000

Source: Own estimate

Table 5 shows the results from panel EGLS. According to the table, the coefficient for energy consumption (ENCON), and corruptive practice(CPI) of an economy are statistically significant and are having significant positive impact on carbon emission as a whole. This signifies that carbon dioxide emission increases with the increase in energy consumption, The rapid increase in corruptive practice of a country enhances carbon dioxide emission also. It means that control of corruption may be a tool for curbing environmental degradation.

Table6: Pairwise Granger Causality Tests

Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**	**Decision**	**Results**	**Direction of Causality**
ECON does not Granger Cause CO2	380	1.38169	0.2524	Did not reject	$ECON \not\Rightarrow CO_2$	Unidirectional causality
CO2 does not Granger Cause ECON		14.7157	0.0000007	Reject null at 1% level	$CO_2 \Rightarrow ECON$	
CPI does not Granger Cause CO2	236	0.53505	0.5864	Did not reject	$CPI \not\Rightarrow CO_2$	No causality
CO2 does not Granger Cause CPI		0.21283	0.8085	Did not reject	$CO_2 \not\Rightarrow CPI$	

Source: Own estimate

H_0: X does not Granger causeY; H_1: X Granger causes Y

The Granger causality test dictates whether any causal connection exists among the observed variables as shown in Table 6.

Unidirectional causality is noticed between energy consumption (ECON) and carbon dioxide emission (CO_2) which runs from CO2 to ECON[carbon dioxide emission to energy consumption]. Another prominent observation from granger causality test is that countries with more corruptive practices are found to have created more carbon dioxide emission (from EGLS results) but there is no causal connection between the two variables under consideration.

5. Conclusion and Findings

The empirical results demonstrate that regardless of the conditions being adopted to the data, as corruptive practices enhance, carbon dioxide emissions boost up. It has been observed that 1% increase in corruption enhances carbon dioxide emission by nearly 0.13%. This indicates that any form and kind relaxation of regulation regarding environment instigates

polluters to discharge further tons of pollutant for extracting tons of precious natural resources.

With growing energy consumption and corruption, environmental degradation through abrupt carbon oxide emission occurs in our selected Asian countries. Unidirectional causality is noticed among carbon dioxide emission in one hand and on the other, energy consumption. Unidirectional causal connection between energy consumption and carbon dioxide emission suggests that carbon emission can be reduced by adopting some improved technology. Another prominent observation from granger causality test is that countries with more corruptive practices are found to have created more carbon dioxide emission (from EGLS results) but there is no causal connection between the two variables under consideration.

In a nut shell, it is obvious that corruptive practices in select countries lead to more pollution. This is because of the fact that corruptive practices enhance voluminous bribes and allure ecological bureaucrats, persuading environmental guidelines less stringent. Therefore, self-governing regulatory bodies under governmental close monitoring should be established to appraise energy intensive projects in select countries. Privatization of the energy market might be one possible solution in state-controlled utilities for upholding the requisite competence and guarantee accountability. Policymakers ought to put into practice more authoritarian, administrative, and corruption control measures and must reflect on raising citizens' responsiveness through designing edifying devices regarding decarbonization.

In view of the above scenario, it has turned out to be an utmost priority for the policymakers as well as government administrators in respective countries of our study to cautiously employ policies for progressing the excellence of the environment. The countries concerned should set unambiguous specifications in legal framework with unwavering penalties to evade any room for corruption. There should be well-built implementation of the law through monitoring, inspecting and applying the appropriate regulatory approach. The large manufacturing sector should employ environmental friendly techniques in production process curbing pollution by reducing emission level. Moreover, carbon dioxide emission is a universal phenomenon which may call for creating regional cooperation among these Asian countries to build up unified environmental acts so that it can assist to mitigate carbon dioxide emissions.

In conclusion, our findings assist us to understand that energy use and, above all, adoption of more corruptive practice may cause threat to the environment in selected Asian countries since it leads to an increase in the CO_2 emissions. It endows with valued insights into the multifaceted association between ecological sustainability and developmental issues restricting corruptive practices and monitoring restricted energy consumption.

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