

Corruption, Trade Openness and Environmental Quality: Evidence from Developing Countries

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Abstract

The effects of corruption and trade on environmental quality have significance in open economies. This study has explored the impact of corruption and trade openness on environmental quality in 70 developing countries by using panel GMM technique over the period of 2002 to 2016. To measure the trade openness and environmental quality, various proxies have been used. The results show that the impact of trade openness has mixed findings with environmental quality variables of CO₂ and N₂O emissions. Corruption has a positive effect on CO₂ and N₂O emissions. The study has also suggested some policies to improve the environmental quality.

Keywords: Environmental Quality, Corruption, Trade Openness, Developing Countries.

JEL Classification: Q56, D73

1. Introduction

In late twentieth century the economists introduce the term development later on it was replaced by the sustainable development. The definition of sustainable development is as follows “balancing the fulfillment of human needs with the protection of the natural environment so that these needs can be met not only in the present, but also in the infinite future” (Rehman et al., 2007). So, the sustainable development occurs when the future generations can live as well as the current generation. Four different parts of sustainable development are: social sustainability, political sustainability, environmental sustainability, and economic sustainability. It is a vast and deep sense, but we mainly focus on some of them due to time factor.

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The environmental sustainability includes “the ability of the environment to continue to function properly indefinitely” (Damania et al., 2003). So, it explains that to meet the needs of the present generation, we should not endanger the needs of the future generations is so called the environmental sustainability. The unsustainable environment is when we use the resources at the faster rate than their reproduction. So, these should be used in a proper way naturally.

In any case, a large portion of nations normally and the third world particularly have the unsustainable method of the creation. In this way, if these developing nations need to develop at along these lines of un-sustainability, they will confront an extremely dull future for their up and coming eras. These verbal confrontations have spurred us to lead the examination for LDCs and especially for selected developing nations. Since these nations have seen a considerable measure of the atmosphere changes in type of rising temperature, heavy rain falls and floods in most recent couple of decades. Furthermore, the feeble foundations and the abnormal state of corruption in these nations made extraordinary issues for the environmental improving and economic development (Rogers, 2005). Corruption is the key factor which reduces the development of the country. It also increases the income inequality as well. Due to which the rich become richest and poor become the poorest. It also increases the rimes because the poor and needy want to fulfill their desires by the illegal ways. Due to corruption the entire system of the country goes into panic and, the law and order system reduce. So, when there is no law and order system there is no development in the country.

Trade is the basic element by which the countries share their excessive production to the other country which is not producing or producing in low amount according to their needs. So, they sell or purchase from one another. Trade openness is the most important element in the development of the country. Due to which the people and the country meets their requirements and needs. When there is no trade openness they can't meet their requirements and the country cannot develop in the better way (Leitão, 2010).

It is extremely fundamental to think about the degree and presence of corruption and trade openness in making measures about environmental quality. Environmental quality is an arrangement of properties and attributes of nature, either summed up or local, as they encroach on individuals and different organisms. It is a measure of the

state of a domain with respect to the necessities of at least one species or potentially to any human need or reason. Environmental quality is a general term which can allude to fluctuated attributes that identify with the common habitat and also the constructed condition, for example, air and water purity or pollution, potential and the other impacts which such attributes may have on mental and physical health caused by human activities. In this study the main focus is on the corruption and trade openness, that how they affect the environmental quality. The experimental proof proposes that nations with more open trade approaches tend to have stricter environmental controls, specifically where the level of corruption is high (Lopez and Galinato, 2005).

The rest of the paper is structured as: section 2 secured the review of literature about environmental quality, trade openness and corruption. Section 3 is based on methodology, data and model specification. Section 4 shows the results and discussion of data. Section 5 gives the conclusion and policy implications.

2. Literature Review

This section contains the literature review about corruption, trade openness and environmental quality.

The research gap of the study shows that some studies were at corruption and trade openness, some were at corruption and environmental quality, some were at trade openness and environmental quality and very few were at facts and causes of corruption. None of the above studies showed the combined impact of corruption, trade openness and environmental quality for evidence from developing countries. So, in this study, we analyzed the combined impact of all variables from developing countries. As talk about the proxies of environmental quality, some of the studies use Carbon Dioxide (CO₂) as a proxy of environmental quality, some studies use Sculpture Dioxide (SO₂) as a proxy, and some use Nitrous Oxide (N₂O) as a proxy, but this study used both CO₂ and N₂O as the proxies of environmental quality. One more important fact of the study is that in this study we measure the trade openness in two different types.

Table 1
Summary of the Studies on Corruption, Trade Openness and Environmental Quality

Reference	Time Period Covered	Country	Model Specification	Methodology	Main Results	
Rehman, Ali and Nasir (2007)	1983-2006	South Asian Countries	Dependent: Environmental Quality Independent: Corruption, trade openness	Fixed Effect Model	Findings of the study were that a decrease in emission of CO ₂ would be a cause for better environmental quality, its means that these two variables had a significant relationship. Reason is that when emission of dangerous gases reduced, at the same time environmental quality got better. If corruption index increased means corruption level fall, at the same time emission of CO ₂ decreased, because corruption level had an absolute impact on environment as compare to trade openness.	
Shabbir and Anwar (2007)	2000-2005	Developing Countries	Dependent: Corruption Independent: Economic Freedom, Development, income distribution and Globalization	GMM	Results of the variables described that economic freedom had negative and significant impact at corruption, globalization and economic development had also negative and significant impact at corruption, education level had positively and significantly correlated with corruption. In this study the authors used economic and non-economic determinants, and the results showed that non-economic indicators didn't contributed to reduce corruption level in developing countries.	
Shahbaz, Aamir and Butt (2007)	1971-2006	Pakistan	Dependent: Income inequality Independent: Trade Openness	Dickey-Generalized Square (DF-GLS)	Fuller Least	Results of the study explained that the trade openness had significant and negative impact at rural-urban income gap. The main reason for this result was that when trade open in a country, the jobs created at the same time, but most of the jobs for skilled labor, and urban labor was more skilled as compared to rural labor.
Solakoglu (2007)	1987-2000	Transition Countries	Dependent: Industrial Pollution Independent: Trade Openness	OLS GLS		Results of the study explored that the countries which were not the members of European Union had poor property rights as compared to European Union countries. So due to poor property rights those were more polluted due to higher deforestation rate. The countries with better property rights meet the quality environmental standards.
Azhar, Khalil and Ahmed (2007)	1990-1998	Pakistan	Dependent: Environmental Quality Independent: Trade Openness	Error Correction Model Technique Johansson co-integration Method		Results of the study reveal that scale effect and trade intensity was positively related to air pollution. The other results indicate that scale effect, trade intensity and technique effect were positively and significantly related to water pollution.

Table 1
Summary of the Studies on Corruption, Trade Openness and Environmental Quality (Continued)

Reference	Time Period Covered	Country	Model Specification	Methodology	Main Results
Butkiewicz and Yanikkaya (2008)	1970-1997	114 countries	Dependent: Economic Growth Independent: Trade Openness, Capital inflow	Linear regression Model	Estimation results showed that in long run those countries grow faster which had higher flows. Challenging that countries must get threshold level benefits or level of development from capital flows. Overall the results of the study showed that trade liberalization and capital inflow was best to support the growth or development of developed as well as the developing nations.
Kono (2008)	1950-2000	157 Countries	Dependent: Trade Openness Independent: Democracy	Robust-Cluster estimators	Results of the study showed that the trade discrimination in poor countries due to democratization. So that's why poor countries exported less as compared to rich countries and import more and more goods. When the imports were more than exports the trade deficit occurred in that country. If democracy continued then situation of hub-and-spoke trade created according to policy of author. So due to this situation developing countries would do trade with developed countries instead of trading to each other.
Bechtel and Tosun (2009)	1980-2004	670 cases of different countries	Dependent: Environmental Policies Independent: Trade Openness	OLS	The results of the study state that the countries which had low standards of environmental regulation were needed to innovate higher policy standards. While the countries with higher standards of environmental regulations were required to pull down their trade barrier and subsidies entrance to their local marketplace. The countries with low regulation standards often introduce legislation policies for pollution reduction, but this type of policies lead to asserting policy.
Ajaz and Ahmed (2010)	1990-2005	Pakistan	Dependent: Tax Revenues Independent: Corruption	Generalized Method of Moments (GMM)	Results of variables described that the per capita income coefficient was highly insignificant and very small, GDP regression coefficient was significant and positive, corruption regression coefficient was significant and positive, and governance variable was significant and positive.
Chandler and Graham (2010)	1990-2007	International Markets	Dependent: Trade openness, Independent: corruption, distance and violence	Partially Least Square Method (PLS)	Results of variables described that the most aspect of corruption were bribery and privacy. These two main things that were the origin of corruption and corruption totally depend at these two. And the impact of corruption at international trade was negative; means if corruption level in a country was high there would be deficit balance of trade.

Table 1
Summary of the Studies on Corruption, Trade Openness and Environmental Quality (Continued)

Reference	Time Period Covered	Country	Model Specification	Methodology	Main Results
Dutt and Traca (2010)	1980-2004	Hong Kong and China	Dependent: Trade openness, Independent: corruption, GDP, Tariff	Ordinary Least Square Method (OLS)	The results showed that tariff and corruption had significant and negative coefficients, if the value of tariff increased the chances of corruption would be increased. Trade enhancing effect could be produced by the corruption when tariff level was high. The implications of the study showed that if corruption's scope reduced, impediments to trade would be reduced in majority of cases.
Immordino and Pagano (2010)	1995-2008	Analysis of all countries	Dependent: Trade openness, Independent: Corruption, GDP	Theoretical Techniques	The results of the study explored that the trade openness had a positive and significant relation with per capita income, and a significant and negative relation with corruption.
Javaid (2010)	1996-2006	Pakistan	Dependent: Health, Education Independent: Corruption	Theoretical Techniques	Findings of the study were that corruption had negative and significant impact at health and education, mean that if the corruption level in a country was high the level of health and education would be low.
Mushtaq (2011)	1984-2007	Pakistan	Dependent: Economic Growth Independent: Corruption	Fixed Effect Model	The impact of corruption on growth was statistically significant and negative, means if corruption was high in a country then the growth rate would be low. The squared corruption coefficient would be positive and statistically significant.
Toguchi and Murofushi (2011)	1950-1990	Developing Countries	Dependent: Pollution, Independent: Trade Openness, GDP	Fixed effect Model	The results of the study were that the emission of Sulphur follow the pattern of environmental Kuznets curve, emission of carbon didn't follow the pattern of environmental Kuznets curve.
Agiboa (2012)	1998-2011	Nigeria	Dependent: Development, Independent: Corruption	Theoretical Techniques	The results of the variables concluded that the corruption had a significant and negative impact at the development of Nigeria, the reason of the result was described by the author that everybody pay for corruption direct or indirect, means saving a few starving the many. Immunity for criminals increased due to corruption. Organized crime's opportunities increased due to corruption, as well as the corruption encouraged the brutality of police.
Majeed (2014)	1984-2007	146 Countries	Dependent: Corruption, Independent: Trade openness	OLS	The results of the study proposed that in a linear description corruption increased due to trade while in a non-linear description corruption decreased due to trade. The worth of non-linear relationship was nothing showed by the analysis also helped to find the equation that why the relationship between corruption and trade was not conclusive.

3. Model, Data and Methodology

3.1 Model Specification

To estimate the impact of corruption and trade openness on environmental quality in the developing countries, the study uses the following equation:

$$EQ = f(OPEN, CPI, GDPG, (GDPG)^2, DEMOC, CPI * GDPG, CPI * OPEN)$$

Econometric form of the regression equation is:

$$EQ = \beta_0 + \beta_1 OPEN + \beta_2 CPI + \beta_3 GDPG + \beta_4 (GDPG)^2 + \beta_5 DEMOC + \beta_6 CPI * GDPG + \beta_7 CPI * OPEN + \varepsilon$$

Where:

EQ = Environmental Quality (CO₂ and N₂O emissions as proxy)

CO₂ = Carbon Dioxide emissions (metric tons per capita)

N₂O = Nitrous oxide emissions in energy sector (% of total)

OPEN = Trade Openness (OPEN1, OPEN2, OPEN3)

OPEN1 = Trade (% of GDP)

OPEN2 = Taxes on international trade (% of Revenue)

OPEN3 = Customs and other import duties (% of tax revenue)

CPI = Corruption Perception Index Score (out of 10)

GDPG = GDP Growth (annual %)

DEMOC = Democracy (Polity 2)

CPI*GDPG = Interaction term

CPI*OPEN = Interaction term

3.2 Data and Methodology

This study explores the impact of corruption and trade openness on environmental quality for developing countries. There are 140 developing countries but due to unavailability of data study use 70 countries. Developing countries are divided into three categories; low income countries (LIC), low middle-income countries (LMC) and upper middle-income countries. This study covers the panel data for the period 2002-2016. The data on democracy are taken from Polity-II and data on corruption perception index taken from Transparency International while the data on other variables are taken from World Development Indicators. In order to estimate the corruption, trade openness and environmental quality, we used the Generalized Method of Moments (GMM).

4. Results and Discussions

Generalized method of moments (GMM) used in this study to estimate the results of key variables due to endogeneity. The problem of endogeneity occurs when the explanatory variables are correlated with error term. So, due to endogeneity issue the study used the lag (-1) as an instrument.

4.1 CO₂ Emissions as a Measure of Environmental Quality for LICs

Table 2 shows the conclusion of regressions when Carbon dioxide is utilized as a substitute for environmental quality. To think about the effect of openness on Carbon dioxide emissions, Table 2 indicates three distinct factors that were utilized as indicators of free economy; custom and other import duties, taxes on international trade and trade in LICs.

The first segment of Table 2 illustrates from the relapse demonstration when trade is taken to exhibit openness. The findings reveal that negative association between trade openness and CO₂. The main reason of this relationship among the LICs is that in the developing countries the imports are high as compared to exports. Most developing countries import such goods which are pollution free, for example domestic consumption goods, IT products, surgical instruments and cleaner technologies. The same results were also described by (Shahbaz et al., 2007; Rehman et al., 2007; Higgins (2006; Mamoon and Murshad, 2006) and Damania et al., 2003). It means that trade openness and CO₂ emissions have a significant and negative relationship.

The next variable is CPI. The results suggest a positive and significant relationship between CPI and CO₂. The reason of the relationship is that when the corruption level increases in a developing country, the control of authorities on the policies of pollution will reduce. So, CO₂ emissions increase as the level of corruption increases. The positive and significant relationship between corruption and CO₂ emissions also described by (Peh and Drori, 2011; Ozen and Kusku, 2009; Koyuncu and Yilmaz, 2009; Lambsdorff, 2007; Cole, 2007 and Damania et al., 2003).

The relationship of CO₂ emissions and GDPG is positive and significant, as the income level increases in a developing country the emissions of CO₂ also increases. Some studies describe that when the income level increases the people more demanded for better

environment, but Khana and Plassmann (2004) suggests that even a high-income per capita country like USA did not reach at the level, where demand for better environment increases with level of income increases.

Table 2
GMM Estimates of Environment Quality for LICs

Explanatory Variables	Dependent Variable: CO ₂			Dependent Variable: N ₂ O		
	Trade (OPEN1)	Tax (OPEN2)	Import Duty (OPEN3)	Trade (OPEN1)	Taxes (OPEN2)	Import Duty (OPEN3)
OPEN	-0.0425** (0.0197)	0.0576*** (0.0104)	0.1537*** (0.0252)	-0.9166*** (0.1881)	2.6219*** (0.5038)	5.9627** (2.7736)
CPI	0.140565* (0.0842)	0.0444 (0.0559)	0.0919 (0.0781)	0.1790 (1.5500)	3.2522*** (1.1602)	1.1878 (2.9710)
GDPG	0.697498** (0.2756)	0.3006*** (0.0775)	0.8108*** (0.1432)	9.9816*** (2.5255)	8.5889*** (2.4362)	34.989* (17.810)
(GDPG)²	-0.0010 (0.0008)	-0.00023 (0.000601)	-0.0008 (0.0007)	-0.0173 (0.0199)	-0.0109 (0.0147)	-0.0353 (0.0663)
DEMOC	-0.0462** (0.019586)	-0.0222* (0.0132)	-0.0431*** (0.0162)	-0.4769* (0.2552)	-0.0146 (0.1890)	-0.6729 (0.5033)
CPI*GDPG	0.2495** (0.1066)	-0.1162*** (0.0290)	0.3182*** (0.0562)	3.9850*** (0.9354)	3.4765*** (0.920362)	13.656* (6.9691)
CPI*OPEN	-0.0154** (0.0071)	-0.0246*** (0.005465)	-0.0556*** (0.0096)	-0.3389*** (0.0620)	-1.1057*** (0.2119)	-2.242** (1.081)

Where, ***, **, * indicates significance at 1 percent, 5 percent and 10 percent respectively

According to Environmental Kuznets Curve (EKC), when GDPG increases initially, CO₂ emissions also increase. Dinda (2005) explains that at the initial level the CO₂ emissions continues because at this time the investment for abatement activity is not sufficient, but with the continuous increase in income level, there will be sufficient investment for abatement activity, means to control the further emissions of CO₂. The relationship among CO₂ emissions and GDPG is positive (See for example, Rehman et al., 2007; Pellegrini and Gerlagh, 2006; Damania et al., 2003; Khana and Plaassmann, 2004). Moreover, GDPG² has a negative and insignificant impact at CO₂ emissions.

The results exhibit that economic development alone, as measured by an adjustment in GDPG, is inadequate to enhance environmental quality. Political variable in the form of political institutions is also necessary for better environmental quality, is necessary. DEMOC and CO₂ emissions have a negative and significant relationship. Farzin and Bond (2006) also found the same relation.

Two interaction terms have been introduced in the model. The results show a positive and significant relation between interaction term CPI*GDPG and CO₂. The interaction terms point out that on average value of GDP, positive connection between CPI and CO₂

exists. The same relation is described by (Rothstein, 2011; Rehman et al., 2007; Rodriguez et al., 2005; Damania et al., 2003). Another interaction term $CPI*OPEN$ is negative which suggests that being on average value of CPI, as openness increases CO_2 also decreases. Swaleheen (2011), Rehman et al. (2007), Damania et al. (2003) also support the negative relation of $CPI*OPEN$ with CO_2 .

The third segment in Table 2 shows the results when tax is taken to measure openness in international trade. In this segment, the coefficients of openness, $GDPG$, $DEMOC$, $CPI*GDPG$ and $CPI*OPEN$ are statistically significant. However, the coefficients of $(GDPG)^2$ and CPI are statistically insignificant. The results indicate that the measuring of tax should be utilized with carefulness in such kind of study because in all LDCs collection and reporting of data on taxes have more biasness in comparison with trade.

The statistical significance and sign of the other factors and the possibility of EKC are maintained by the regression estimates shows in section 4 of Table 2, when import duties are used as measure of openness. The CPI and $(GDPG)^2$ are statistically insignificant as related to the results of taxes as measure of openness, while all other variables including both interaction terms are statistically significant.

4.2 N_2O Emissions as a Measure of Environmental Quality for LICs

The last three columns of Table 2 exhibit the results of regression when Nitrous oxide is used as measure of environmental quality. Table 2 depict that when we use trade as a measure of openness then all the variables are significant except CPI and $(GDPG)^2$. CPI , $GDPG$ and the interaction term $CPI*GDPG$ has positive relation with N_2O emissions, while all other variables like openness, $(GDPG)^2$, $DEMOC$ and $CPI*OPEN$ has a negative relation with N_2O emissions. The results show that all variables are statistically significant except two variable which are $DEMOC$ and $(GDPG)^2$ when we use taxes as a measure of openness. Table shows a positive impact of openness, CPI , $GDPG$ and $CPI*GDPG$ at N_2O emissions, while $(GDPG)^2$, $DEMOC$ and $CPI*OPEN$ has a negative impact at N_2O emissions. Our analysis expresses that in case of import duties as a measure of openness, the variables like openness, CPI , $GDPG$, and $CPI*GDPG$ have a positive impact at N_2O emissions while other remaining have a negative impact.

4.3 CO₂ emissions as a Measure of Environmental Quality for LMCs

Table 3 shows GMM estimates when Carbon dioxide is used to measure environmental quality. The results of the estimation express that, GDPG, DEMOC, and CPI*GDPG are statistically insignificant while the other variables are significant. Table 3 shows that openness has a negative effect on CO₂ emissions. Other variables CPI, GDPG and the interaction term CPI*GDPG have a positive relation with CO₂ emissions, while other variables have a negative relation. Openness has a positive impact at CO₂ emissions when we use taxes as a measure of openness according to the results of Table 3. While the sign of the other variables remains the same as in the column of trade as a measure of openness. When we use the import duty as a measure of openness, Table 3 expresses that openness and CO₂ has a positive and significant relationship.

Table 3
GMM Estimates of Environment Quality for LMCs

Explanatory Variables	Dependent Variable :CO2			Dependent Variable :N2O		
	Trade (OPEN1)	Taxes (OPEN2)	Import Duty (OPEN3)	Trade (OPEN1)	Taxes (OPEN2)	Import Duty (OPEN3)
OPEN	-5.869*** (1.484)	5.732*** (1.603)	0.516*** (0.084)	-0.1603** (0.073)	0.459** (0.193)	0.468*** (0.123)
CPI	0.558** (0.221)	0.509*** (0.081)	5.732*** (1.603)	3.265*** (0.840)	2.135*** (0.253)	2.162*** (0.307)
GDPG	0.2857 (0.368)	0.214** (0.105)	0.232** (0.1070)	3.782*** (1.446)	1.362*** (0.436)	1.660*** (0.408)
(GDPG)2	-0.0108*** (0.0039)	-0.001 (0.004)	-0.0016 (0.004)	-0.037 (0.027)	-0.007 (0.012)	-0.011 (0.014)
DEMOC	-0.0183 (0.0405)	-0.048* (0.029)	-0.048* (0.0291)	-0.054 (0.119)	-0.00033 (0.1090)	-0.0069 (0.111)
CPI*GDPG	0.0383 (0.122)	- 0.065*** (0.030)	-0.070** (0.030)	1.0995*** (0.406)	0.4497*** (0.1230)	0.535*** (0.117)
CPI*OPEN	-2.4242*** (0.520)	-0.002 (0.010)	-0.0028 (0.0098)	-0.062*** (0.021)	-0.166*** (0.062)	-0.1696*** (0.044)

Where, ***, **, * indicates significance at 1 percent, 5 percent and 10 percent respectively

4.4 N₂O Emissions as a Measure of Environmental Quality for LMCs

In the last three columns of Table 3, Nitrous oxide is used as measure of environmental quality. The result depicts that in this case openness is negatively related with N₂O emissions. Some variables have positive impact at N₂O emissions which are CPI, GDPG and an interaction term CPI*GDPG, while the other variables have a negative relationship with emissions of N₂O. Table 2 shows that when we use taxes as a measure of openness than the openness and emissions of N₂O has a positive and significant relationship. CPI*GDPG, CPI and GDPG have a positive relationship with N₂O emissions, means as these variables increases the emissions of N₂O also increases, while the other variables have a negative impact at N₂O emissions. Table 3 shows that in this case when we take import duty as a measure of openness, the emissions of N₂O positively and significantly related with openness. According to our results the all other variables have the same signs as they have in the previous openness.

4.5 CO₂ Emissions as a Measure of Environmental Quality for UMCs

Table 4
GMM Estimates of Environment Quality for UMCs

Explanatory Variables	Dependent Variable: CO ₂			Dependent Variable: N ₂ O		
	Trade (OPEN1)	Taxes (OPEN2)	Trade (OPEN1)	Taxes (OPEN2)	Trade (OPEN1)	Taxes (OPEN2)
OPEN	-0.033 (0.021)	0.280*** (0.037)	0.141*** (0.043)	-0.190** (0.080)	0.644* (0.385)	0.297*** (0.070)
CPI	1.393*** (0.175)	1.576*** (0.085)	1.552*** (0.089)	2.170*** (0.654)	1.799*** (0.249)	1.794*** (0.217)
GDPG	0.617 (0.540)	0.318* (0.189)	0.301 (0.247)	2.204 (2.363)	2.022** (0.819)	6.169* (3.698)
(GDPG) ²	-0.012 (0.008)	-0.006 (0.003)	-0.005 (0.004)	-0.021 (0.036)	-0.011 (0.007)	-0.006 (0.007)
DEMOC	-0.270*** (0.034)	-0.313*** (0.029)	-0.310*** (0.031)	-0.283* (0.156)	-0.155* (0.087)	-0.157* (0.082)
CPI*GDPG	-0.546 (0.340)	-0.086** (0.039)	-0.064 (0.053)	0.419 (0.525)	-0.158** (0.080)	-0.066 (0.067)
CPI*OPEN	-0.195** (0.088)	-0.071*** (0.008)	-0.045*** (0.011)	-0.041** (0.021)	-0.049 (0.034)	-0.066*** (0.021)

Where, ***, **, * indicates significance at 1 percent, 5 percent and 10 percent respectively

The analysis depicts that the CPI, CPI*openness and DEMOC are significant and the other variables are insignificant which is shown in Table 4. The two variables which are CPI*OPEN and DEMOC have negative impact on carbon dioxide emission (CO₂), while CPI has a positive impact at CO₂ emissions.

In our analysis, GDPG² is statistically insignificant when we employ tax as a measure of openness. The coefficient of, DEMOC, CPI*GDPG and CPI*OPEN are negative which express that these variables influence the CO₂ emission negatively, if any of these variables increase then the CO₂ emissions reduce. However, the impact of openness and CPI is positive at the emissions of CO₂ means that as these variables increase then the CO₂ emissions increases. The results suggest that one unit increase in openness leads to 0.280868 units increase in CO₂ emissions metric per tons per capita. The independent variables openness, CPI and GDPG have positive impact at CO₂ emissions, while the other variables are negatively related with CO₂ emissions.

4.6 N₂O Emissions as a Measure of Environmental Quality for UMCs

In this case when we use trade as a measure of openness the trade has a significant and negative impact at N₂O emissions. The other significant variables are CPI, DEMOC and CPI*OPEN, and the variables are significant at 1%, 10% and 5% respectively, while CPI has positive impact at N₂O emissions and other two variables have a negative impact. When we use taxes as a measure of openness then the results of the study show that from all variables which are statistically significant the openness, CPI and GDPG have a positive impact at N₂O emissions, and the other two variables have a negative impact which are DEMOC and CPI*GDPG. Results of the study show that five variables are statically significant. From these five variables, three variables affect N₂O emissions positively and two variables affect the dependent variable negatively. Positively affected variables are openness, CPI and GDPG, while negatively affected variables are DEMOC and CPI*OPEN.

4.7 CO₂ emissions as a Measure of Environmental Quality for Combined Countries

When we employ trade as a measure of openness the variable ((GDPG)²) is insignificant and the remaining variables are significant, as shown in Table 5. The variables openness, DEMOC and the interaction term CPI*OPEN affect the CO₂ emissions negatively,

while CPI, GDPG and the interaction term CPI*GDPG have a negative impact at CO₂ emissions. In our analysis except (GDPG)² and CPI*GDPG all other variables are significant at different levels of significance. The coefficient of openness, GDPG, and CPI are positive which express that these variables influence the CO₂ emission positively, if any of these variables increase then the CO₂ emission increases. On the other hand, the coefficient of CPI and CPI*OPEN are positive, which means that these variables affect CO₂ emissions negatively.

In this case the two variable (GDPG)² and CPI*GDPG are insignificant, while all other variables are significant. The fourth column of Table 4 shows that the positively related variables with the emissions of CO₂ are openness, CPI and GDPG, and the negatively related variables are CPI*OPEN and DEMOC.

Table 5
GMM Estimates of Environment Quality (Combined Developing Countries)

Explanatory Variables	Dependent Variable: CO ₂			Dependent Variable: N ₂ O		
	Trade (OPEN1)	Taxes (OPEN2)	Trade (OPEN1)	Taxes (OPEN2)	Trade (OPEN1)	Taxes (OPEN2)
OPEN	-0.348** (0.152)	0.3587** (0.162)	0.287* (0.173)	-0.550*** (0.145)	1.905*** (0.549)	0.712*** (0.229)
CPI	7.656*** (2.058)	5.283*** (0.808)	4.738*** (0.619)	12.561*** (2.580)	9.029*** (1.520)	8.910*** (1.411)
GDPG	6.386** (3.167)	2.226** (1.031)	1.980* (1.072)	10.014*** (3.011)	4.545*** (1.548)	4.152*** (1.292)
(GDPG) ²	-0.006 (0.013)	-0.001 (0.009)	-0.002 (0.007)	-0.010 (0.021)	-0.006 (0.015)	-0.001 (0.014)
DEMOC	-3.682*** (0.995)	-2.489*** (0.457)	-2.140*** (0.334)	-5.450*** (1.354)	-3.634*** (1.092)	-3.904*** (0.827)
CPI*GDPG	1.642* (0.864)	0.437718 (0.268394)	0.429 (0.290)	2.561*** (0.824)	1.071** (0.429)	0.953** (0.368)
CPI*OPEN	-0.114** (0.048)	-0.153*** (0.047)	-0.141*** (0.053)	-0.177*** (0.044)	-0.671*** (0.122)	-0.280*** (0.065)

Where, ***, **, * indicates significance at 1 percent, 5 percent and 10 percent respectively

4.8 N₂O Emissions as a Measure of Environmental Quality for Combined Countries

The outcome of the analysis expresses that coefficient of (GDPG)² is insignificant and all the coefficients of other variables are statistically significant. Table 5 shows that the emissions of N₂O are positively influenced by CPI, GDPG and CPI*GDPG and negatively influenced by openness, DEMOC and CPI*OPEN. In this case when we employ taxes as a measure of openness all the variables are statistically significant like CPI, GDPG, DEMOC, CPI*GDPG and CPI*OPEN except one that is (GDPG)². Positively influenced variables are openness, CPI, GDPG and CPI*GDPG, while the negatively influenced variables are DEMOC and CPI*openness. The study shows that except (GDPG)² all other variables are statistically significant like CPI, GDPG, DEMOC, CPI*GDPG and CPI*OPEN. From all the significant variables the four variables have a negative impact at N₂O emissions, which are openness, CPI, GDPG and CPI*GDPG. The two variables affect the emissions of N₂O negatively, the negatively affected variables are DEMOC and CPI*OPEN.

5. Conclusion and Policy Implications

This study has aimed to explore the impact of corruption and trade openness on environmental quality in the developing countries. The study has used the panel data from 2002-2016 of 70 developing countries. The panel GMM estimation is used to find the results of variables.

The conclusion shows that the impact of trade as measure of openness has a negative relation with CO₂ and N₂O emissions. It recommends that the nations which have more open trade have better environmental quality, means that the emissions of CO₂ and N₂O will lower. While the other openness such as taxes as a measure of openness and the import duties as a measure of openness have a positive impact at both CO₂ and N₂O emissions. Corruption which is an institutional variable has positive effect on CO₂ and N₂O emissions. The results of study suggest that environmental quality is a normal good, its means that the demand for better environment raises as the GDPG increases. According to Environmental Kuznets Curve, as GDPG increases first the CO₂ emissions increases while after continuous increase in GDPG, the emissions of CO₂ and N₂O decreases. So, we can say that GDPG has a positive impact at CO₂ and N₂O emissions in the short run. So, GDPG has positive relation with CO₂ and N₂O emissions, while (GDPG)² has a negative impact at emissions of CO₂ and N₂O. Another

political variable like Demos has a negative impact at CO₂ and N₂O emissions.

Based on findings, we may say that the emissions of CO₂ and N₂O reduce as trade opens, because the reasons are that the environmental quality gets better in all divisions of economy as trade opens. Policy makers may design policies to open trade for healthy and clean environment.

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