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THE RELATIONSHIP BETWEEN GOOD GOVERNANCE AND CARBON DIOXIDE EMISSIONS: EVIDENCE FROM DEVELOPING ECONOMIES

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This paper examines the relationship between five dimensions of good governance (political stability, government effectiveness, regulatory quality, rule of law, and corruption) and carbon dioxide (CO_2) emissions in a cross-section of developing countries. Two measures of CO_2 emissions are utilized: CO_2 emissions in kilograms per 2000 US dollars of gross domestic product (GDP) and in metric tons per capita. Robust results are obtained for a number of variables when the dependent variable is CO_2 emissions in metric tons per capita. The results provide confirmation that political stability, the rule of law, and control of corruption are negatively and statistically significantly correlated with CO_2 emissions per capita. The results also provide evidence in support of the Environmental Kuznets Curve (EKC) and that trade openness and the size of industrial sector as other strong correlates of CO_2 emissions.

Keywords: Carbon Dioxide, Emissions, Governance, Developing Countries, Regulation
JEL classification: O13, O50, Q56, Q59

1. INTRODUCTION

Chemical by-products such as nitrogen oxides, carbon monoxide, suspended aerosol particulates and sulfur dioxides arising from market activities are some of the pollutants that are found to have significant detrimental effects on the natural environment (Roberts, Grimes and Manale, 2003; Friedl and Getzner, 2003). In its *Human Development Report*, the United Nations Development Program (UNDP, 2007, p. 3) notes that the stocks of greenhouse gases concentrations have reached 380 parts per million of CO_2 equivalent, exceeding the natural range of the last 650,000 years while the threshold for dangerous climate change as a result of greenhouse gases is a change in

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temperature by 2 degrees centigrade, in the course of the 21st century. Available statistics also reveal that in 2007, CO_2 emissions (metric tons per capita) by high-income countries averaged 12.5; and in the middle-income countries it was 3.3; while in the low-income countries it was 0.28 (World Bank, 2010).

Stiglitz (2002, p. 223) has argued that global warming caused by the industrial countries also affects those living in the developing economies as they are also the hosts to the world's major population concentrations. The changes in the global temperatures and the level of emissions as noted above can have detrimental effects on population well being as the degradation of the environment results in prolonged periods of drought, damaging storms and floods. The effects of CO_2 emissions by the developing world are equally important as the industrialized countries as an expansion in the economic activities in several developing countries is likely to raise emission levels now and in future. In their study of the distributional impact of climate change in the rich and poor countries, Mendelsohn, Dinar and Williams (2006) and Tol (2005) predict that poor countries will suffer the bulk of damages from climate change. Several developing countries particularly in Asia and Latin America sub-continents are now witnessing a strong expansion in their economic activities. Growth prospects for large developing countries like China, India and Brazil continues to be promising and so as the demand for fossils fuels will continue to rise which in turn will contribute to CO_2 gases.

To a large extent, industrial firms are responsible for their negative externalities: environmental degradation through their production processes that generate by products that are harmful to the physical environment. In their study, Dasgupta, Shyamsundar and Maler (2004) have argued that the study of environmental change and of institutions cannot be divorced from policies and economic reforms in poor countries. This is where the issue of the relationship between the quality of governance and maintaining a sustainable environment becomes relevant and makes a convincing case to investigate if good governance matters for CO_2 emissions in the developing countries. At the macro level, good governance is primarily concerned with three activities: the process by which governments are selected and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state of the institutions that govern economic and social interactions among them (Kaufmann, Kraay and Mastruzzi, 2003; and 2007). But the quality of governance at the macro level can matter in terms of formulating appropriate policies that could curb environmental damage. Thus, this paper examines the relationship between good governance and CO_2 emissions in the developing countries. The next section discusses the conceptual framework. Section three outlines the empirical model and discusses the choice of variables. Section four presents the empirical findings followed a conclusion in section five.

2. CONCEPTUAL FRAMEWORK

Available literature reveals consensus amongst researchers that the quality of governance can matter in terms of aiding long-term growth and development. However, literature is still rare in terms of relating the dimensions of governance to CO_2 emissions, particularly among the developing economies. One possible explanation is that institutions are still undeveloped in the developing economies. For example, North (1990) has argued that "the third World countries are poor because the institutional constraints define a set of payoffs to political/economic activity that does not encourage productive activity." In additions, Kirkpatrick and Parker (2004) have noted that institution building is one of the most difficult problems facing the developing and the transition economies at the present time. While the industrialized countries seem to have achieved most of their potential in good governance (Olson, 1996), the developing countries still lag behind.

Good governance can be argued to be an important link between production and environmental degradation as appropriate governance of market activities can facilitate the minimization of environmental degradation. New institutionalists (for example, Aron, 2000; Rutherford, 2001; and Jalilian, Kirkpatrick and Parker, 2006) argued that institutions are fundamental to the effective functioning of market-based economies. Institutions determine the behavior of individuals within a society; that institution building (establishment of the laws and political and social rules and conventions) is the basis for successful market production and exchange; and that they affect growth (Jalilian, Kirkpatrick and Parker, 2006).

Various aspects of governance can impose direct as well as indirect effects on the extent of CO_2 emissions. One such dimension of governance is the *rule of law*. Where the rule of law exists, the effects of market failures can be minimized. Specifically, Olson (1996) notes the quality of institutions (legal systems that can impartially enforce contracts and other forms of established rules of operation) can facilitate productive cooperation amongst market players. Acemoglu, Johnson and Robinson (2005) argued that good institutions are those that secure and protect property rights. When businesses earn entitlement for legal protection through registration, secure property rights creates incentives for using resources for efficient production (Solakoglu, 2007). Aron (2000) has noted that institutions may be weak because rules simply are absent, suboptimal, or useful rules are poorly enforced and may become counterproductive when costs of monitoring and enforcement are too high. Thus, the rule of law becomes an essential element in terms of compliance when it comes to CO_2 emissions. Where rules exist, are well articulated and clear, CO_2 emission control procedures may be easily enforced and firms would not feel hesitant to comply. Alternatively, loopholes in rules can work in favor of firms where CO_2 emission compliance may be difficult to enforce.

Another aspect of governance closely associated with the rule of law that can matter in terms of CO_2 emission is the absence of a legal mechanism for enforcing business contracts. If there are no enforcement mechanisms in place, firms may not comply with

the provisions of a contract. Thus, it can be hypothesized that the enforcement of contracts can help to create more compliance-oriented firms and those firms that comply with business contracts are likely to comply with national environmental policies.

Regulatory quality can also affect environmental outcomes (Esty and Porters, 2005). Djankov *et al*. (2002) argued that heavy regulation of entry for firms in markets is associated with less democratic government, greater corruption and larger unofficial economies. Heavy regulation of firm activities may be manifested in a variety of forms: hidden fees for permits and licenses, arbitrary taxation and superfluous statutes (Safavian, Graham and Gonzalez-Vega, 2001). Countries that develop clear guidelines in terms of issuance of permits, fees charged and taxation can expect firms to adhere to the regulatory framework in terms of industrial production and management of industrial by-products. In their work on pertaining to environmental regulation and economic growth, Makdissi and Wodon (2006) have shown that it is theoretically possible that environmental regulation increases economic growth and so regulation is likely to have a beneficial impact.

The *government effectiveness* dimension of governance can also matter in terms of controlling CO_2 emissions. This dimension may include excessive red tape, bureaucratic inefficiency and perceptions of poor governance and financial mismanagement within the public sector and particularly government's environmental regulatory authority (Fischer *et. al*., 2001). In their study, Pushak, Tiongson and Varoudakis (2007) found that there could be a higher growth payoff from macroeconomic stability and public expenditure in countries characterized by relatively better public sector governance. Thus, countries that maintain effective governments (minimal bureaucracy, efficient public service, and with an eye for financial integrity and better management of public resources) can gain confidence from producers and equally enforce governmental rules and regulations relating to CO_2 emissions with greater strength.

Control of corruption usually affecting revenues and expenditure side of government budget, (Mauro, 1998; Tanzi and Davoodi, 2001). A recent study by Wihardja (2010) on corruption in public procurement auctions showed that corruption in public procurement auction could hurt national welfare. Corruption can have implications on the pace and extent to which environmental degradation matters. For example, public servants can be bribed on aspects of regulations or distorting regulations relating to CO_2 emission control that may favor certain groups. Hwang (2002) argued that corrupt governments may distort policies because a corrupt politician (or corrupt public office) may be expected to use his or her authority on those activities on which it is easier to collect bribes. In their study on corruption, the resource curse and genuine saving, Dietz, Neumayer and De Soysa's (2007) findings revealed that governance (corruption) did matter for genuine savings. These authors found that reducing corruption had a positive impact on genuine savings in interaction with resource abundance. Further evidence of the link between environment and corruption is shown by Welsch (2004) whose study revealed that a number of indicators of environment are monotonically increasing with corruption and the relationship is found to be strong at low income levels.

Political stability reflects the extent to which various other dimensions of governance such as the rule of law are observed. Political instability may mean that the governing régime is vulnerable and this may prevent the emergence of strong governing institutions, for example, the judiciary. The rule of law can be influenced by political instability through its impact on state institutions becoming weak leading to ineffective government's, weakening of rule of law and regulatory quality and emergence of bribery and corruption. All these combined can constrain efforts to curb CO_2 emissions.

3. MODEL, HYPOTHESES AND DATA

At this time there is a developing body of empirically established associations between various measures of governance or institutional quality and economic growth as well as environmental sustainability. However, empirical associations between variables are not the same as tests of hypotheses, which can only be developed from within a theoretical framework. Thus, on the basis of the theoretical conceptualization discussed in section 2, the analysis of the relationship between governance and CO_2 emissions can be expressed in a reduced form equation as follows:

$$co_{2it} = \alpha_0 +_1 \alpha_1 pcgdp_{it} + \alpha_2 pcgdp_{it}^{\ 2} + \alpha_3 trd_{it} + \alpha_4 ag_{it} + \alpha_5 ind_{it} + \alpha_6 dm_{it} + \alpha_7 ps_{it} + \alpha_8 ge_{it} + \alpha_9 rq_{it} + \alpha_{10} rl_{it} + \alpha_{11} cc_{it} + f_i + \gamma_t + \mu_{it}, \quad (1)$$

where,

co_2 =carbon dioxide emissions;
$pcgdp$ =per capita income;
$pcgdp^2$ =per capita income squared;
trd =trade openness;
ag =size of the agricultural sector;
ind =size of the industrial sector;
dm =democracy;
ps =political stability;
ge =government effectiveness;
rq =regulatory quality;
rl =rule of law;
cc =control of corruption;
f =country effect
γ =year effect
μ =all unobservable variables;
t =time;
i =country; and

α =coefficients to be estimated.

The a priori expectations are $pcgdp\,(+)$; $pcgdp^2\,(-)$; $trd\,(+)$; $ag\,(+)$; $ind\,(+)$; $dm\,(?)$; $ps\,(-)$; $ge\,(-)$; $rq\,(-)$; $rl\,(-)$; and $cc\,(-)$. The hypotheses relating to the right-hand-side variables are discussed below while the variable measures are described in Table 1. It should be noted that the above equation utilizes two measures of the dependent variable. The first measure is CO_2 emissions in kilograms per 2000 US dollars of gross domestic product (GDP). The second measure is CO_2 emissions in metric tons per capita.

Table 1. Variable Measures and Data Source

Variable	Measure	Source
co_2-int	CO_2 emissions in kilograms per 2000 US dollars of GDP	World Bank (2010a)
co_2-pc	CO_2 emissions in metric tons per capita	World Bank (2010a)
pcgdp	Per capita gross domestic product (PPP constant 2005 US dollars)	World Bank (2010a)
trd	The percentage of trade share in gross domestic product	World Bank (2010a)
ag	Agricultural value added as a percentage of gross domestic product	World Bank (2010a)
ind	Industrial value added as a percentage of gross domestic product	World Bank (2010a)
dm	Political rights rating measured on a one-to-seven scale, with one representing the highest degree of freedom and seven the lowest.	Freedom House (http://www.freedomhouse.org)
ps	The perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including domestic violence and terrorism (Kaufmann *et al*., 2007)	World Bank (2010b)
ge	The quality of public services, the quality of civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of government's commitment to such policies (Kaufmann *et al*., 2007)	World Bank (2010b)
rq	The ability of government to formulate and implement sound policies and regulations and promote private sector development	World Bank (2010b)
rl	The extent to which agents have confidence in an abide by the rules of society, and in particular the quality of contract enforcement, the police, the courts, as well as the likelihood of crime and violence (Kaufmann *et al*., 2007)	World Bank (2010b)
cc	The extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as capture of the state by elites and private interests (Kaufmann *et al*., 2007)	World Bank (2010b)

*Per capita income (pcgdp).*The relationship between income and pollution is summarized by the much-investigated Environmental Kuznets Curve (EKC), for example, Grossman and Krueger (1991); Seldon and Song (1994); Holtz-Eakin and

Selden (1995). According to the hypothesis relating to the EKC, pollution increases in the early stage of industrialization and then decreases in an inverted U-shaped pattern in more matured and industrialized countries (Seldon and Song, 1994; Rosser, 2006). That is to say, pollution first rises as countries advance from low to middle level incomes, and then it begins to fall as countries attain high level of incomes. This happens for at least two reasons. Firstly, there is an argument to be made that people begin to look at environment as a luxury good and demand for superior environmental quality in high-income countries (Torras, 2005). Secondly, the level of pollution decreases because of use of pollution control technology and phasing out of high pollutant industries in economically prosperous countries (Komen, Gerking and Folmer, 1997). Thus, pollution begins to decrease after a certain threshold level of incomes. Even though the EKC is the most well-known articulation of the income-environment link (Torras, 2005), the empirical evidence for this hypothesis is less robust due to variations in the choice of econometric models, the choice of control variables and the measure of pollution itself (Harbaugh, Levinson and Wilson, 2002). For example, Ekins (1997) and Shafik (1994) found that some environmental variables improve (access to water quality and sanitation) while others worsen CO_2 emissions with incomes growth.

Trade openness (trd). Openness, amongst other variables, is found to have a positive impact on economic growth (for example, Behbudi, Mamipour and Karami, 2010). Existing literature suggests that open countries use looser standards of environmental regulation because of the fear of losing international competitiveness, the so called the race-to-the-bottom hypothesis (Frankel and Rose, 2005). The pollution haven hypothesis also becomes relevant which maintains that dirty industries would migrate from developed countries to developing economies (Akbostanci, Tunc and Turut-Asik, 2007). This hypothesis stipulates that free trade will induce the developing countries to relax environmental regulations to attract foreign direct investment by multinational corporations (MNCs) and can be an outlet by MNCs to export dirty industries. In his study on FDI, growth and the environment in India, Acharyya (2009) found that the long-run growth impact of FDI inflow on CO_2 emissions to be quite large. Thus, it can be hypothesized that the greater the extent of openness of an economy, the higher will be the level of CO_2 emissions.

Size of the industrial (ind) and the agricultural (ag) sectors. Existing literature reveals that many of the pollutants emanate from the processes used in the manufacturing sector that are inefficient. Production of waste and hazardous substances is thus a result of the size of agricultural and industrial sector of an economy. However, the level of production of waste and hazardous substances depends, to some extent, on the type of technology used. Technological innovation together with firms adopting pollution reducing technologies in their production process can bring down the pollution levels. This may be the case, particularly for industrial sector in some of the more developed countries. Still, a large industrial sector will produce more CO_2 gases. It is hypothesized that the greater the size of the agricultural and industrial sectors, the higher will be the level of pollution.

Democracy (dm) can also influence the extent to which CO_2 emissions can take place. Freedom is an important component of democracy and an essential aspect of human welfare. The freedom to make choices and the freedom to choose production methods, technology, and use of resources can have direct long term bearing on environment and its sustainability.

Effect of governance (ps, ge, rq, rl and cc). Perhaps the most widely quoted governance indicators are those developed for 212 countries (for the years 1996, 1998, 2000, 2002, 2003, 2004, 2005, 2006, 2007, 2008 and 2009) by Kaufmann *et al.* (2007) of the World Bank. These authors provide numerical measures of six dimensions of governance: political stability *(ps)*; government effectiveness *(ge)*, regulatory quality *(rq)*, the rule of law *(rl)* and control of corruption *(cc)*. It is these aspects of governance that can have direct as well as indirect effects on CO_2 emissions. The theoretical justification of the various dimensions of governance has been addressed in the previous section.

The sample of the countries used in the analysis are Albania; Algeria; Argentina; Armenia; Bangladesh; Belize; Bolivia; Bosnia and Herzegovina; Botswana; Brazil; Bulgaria; Burkina Faso; Cambodia; Cameroon; Central African Republic; Chad; Chile; China; Colombia; Congo, Dem. Rep.; Costa Rica; Dominica; Dominican Republic; Egypt, Arab Rep.; El Salvador; Eritrea; Ethiopia; Fiji; Gabon; Gambia, The; Georgia; Ghana; Grenada; Guatemala; Guinea; Guyana; India; Indonesia; Iran, Islamic Rep.; Jordan; Kazakhstan; Kenya; Kiribati; Kyrgyz Republic; Lao PDR; Latvia; Lebanon; Liberia; Lithuania; Macedonia, FYR; Madagascar; Malawi; Malaysia; Mali; Mauritania; Mauritius; Mexico; Moldova; Mongolia; Morocco; Mozambique; Namibia; Nepal; Nigeria; Pakistan; Panama; Paraguay; Peru; Philippines; Romania; Russian Federation; Rwanda; Samoa; Senegal; Seychelles; Sierra Leone; South Africa; Sri Lanka; St. Kitts and Nevis; St. Lucia; St. Vincent and the Grenadines; Sudan; Suriname; Swaziland; Syrian Arab Republic; Tajikistan; Tanzania; Thailand; Tonga; Tunisia; Turkey; Uganda; Ukraine; Uruguay; Uzbekistan; Vanuatu; Venezuela, RB; Vietnam; and Zambia.

4. FINDINGS

The effects of governance are tested using five dimensions of governance together with control variables in a reduced form as stipulated in section 3.0. The regression equation includes data for 99 developing countries for years 1998, 2000, 2002, 2003, 2004, 2005, 2006 and 2007. It is worthy to note that while data on various dimensions of governance are available for a number of years between 1996 and 2009 for the sample of the developing economies listed in section 3.0; this is not the case for the two dependent variables (Table 1). For the two measures of CO_2 emissions, consistent set of data were available for 1998, 2000, 2002, 2003, 2004, 2005, 2006 and 2007 for the countries listed in section 3.0. The descriptive statistics of the chosen variables are presented in Table 2.

Table 2. Descriptive Statistics

Variable	Number of Observations	Mean	Standard Deviation	Variance	Minimum	Maximum
co_2-int	99	001.4	001.555	002.417	-0.081	010.6
co_2-pc	99	002.2	002.393	005.727	-0.015	015.3
trd	99	082.2	038.239	1462.20	15.900	226.3
ag	99	019.3	013.572	184.210	01.800	078.6
ind	99	028.8	010.231	104.670	06.900	062.3
pcgdp	99	118.5	275.060	75660	01.000	980.3
dm	99	403.2	316.740	0.100E-06	00.700	998.0
rq	99	002.9	002.424	5.575	-2.116	007.0
rl	99	-00.3	000.655	0.424	-2.527	001.5
cc	99	-00.4	000.637	0.408	-2.262	001.3
ge	99	-00.4	000.619	0.384	-1.901	001.6
ps	99	-00.4	000.646	0.418	-2.369	001.4

Given the use of cross country data, ordinary least squares estimation would lead to biased estimates as this estimation assumes a single set of slope coefficients and one intercept. As such, the regression equation is estimated using the panel data estimation technique. Based on the Hausman (1978) test, the results of the fixed effects model are chosen for discussion in this section.

This study utilizes five dimensions of governance: *ps*, *ge*, *rq*, *rl* and *cc* and it is quite possible that there may be some overlapping effects amongst each other. Statistically this means that the five measures of governance could be correlated. Prior to estimating the effects of governance on CO_2 emissions, an attempt is made to gauge the magnitude of the correlations. Table 3 presents that correlation matrix of the governance variables used in empirical analysis and confirms the presence of correlations amongst the five indicators. Hence, the model is estimated by regressing each of the governance indicators separately from the other, thus, avoiding any overlapping effects.

Table 3. Correlation Matrix of Governance Variables

Variables	*ps*	*Ge*	*rq*	*rl*	*cc*
ps	1.000				
ge	0.803	1.000			
rq	-0.123	-0.178	1.000		
rl	0.806	0.786	-0.149	1.000	
cc	0.764	0.864	-0.224	0.739	1.000

The regression results relating governance to CO_2 emissions in kilograms per 2000 US dollars of GDP are presented in Table 4. In Table 4, several of the coefficients of governance dimensions (*ps*, *ge*, *rl* and *cc*) are consistent with the a priori expectations as they have the expected negative signs on their coefficients and are statistically significant at the 5 percent levels. With regard to the question of whether good governance matters for CO_2 emissions in the sample of developing countries, the empirical evidence presented in Table 4 suggests that it certainly does.

Table 4. Regression results (Dependent variable is CO_2-int)

Variables	Effect of Control Variables	Effect of Political Stability	Effect of Government Effectiveness	Effect of Regulatory Quality	Effect of Rule of Law	Effect of Corruption
pcgdp	0.0003	0.0003	0.0002	0.003	-0.0002	-0.0003
	(0.426)	(0.779)	(0.269)	(4.120)*	(0.328)	(0.409)
$pcgdp^2$	-0.104E-05	-0.138E05	0.994E-06	-0.306E-05	-0766E-06	-0.508E-06
	(1.356)	(1.876)***	(1.364)	(4.185)*	(1.123)	(0.699)
trd	0.002	0.003	0.004	0.003	0.003	0.004
	(2.075)**	(3.327)*	(3.954)*	(3.378)*	(3.091)*	(3.913)*
ag	0.014	0.002	-0.001	0.003	-0.002	0.004
	(4.787)*	(0.425)	(0.420)	(1.064)	(0.569)	(1.184)
ind	0.029	0.026	0.023	0.021	0.022	0.022
	(9.329)*	(7.849)*	(6.826)*	(6.328)*	(6.336)*	(6.787)*
dm	0.0002	0.985E-04	0.0001	0.0001	0.442E-04	0.748E-04
	(1.742)***	(0.874)	(1.255)	(1.310)	(0.402)	(0.665)
ps	-	-0.347	-	-	-	-
		(5.219)*				
ge	-	-	-0.451	-	-	-
			(6.753)*			
rq	-	-	-	0.128	-	-
				(7.021)*		
rl	-	-	-	-	-0.484	-
					(7.557)*	
cc	-	-	-	-	-	-0.382
						(6.378)*
F	271.1	248.1	257.5	296.8	266.0	257.2
N	99	99	99	99	99	99
Buse R^2	0.29	0.29	0.39	0.34	0.32	0.30

Notes: *t*-statistics are in parentheses.*, **, and *** indicate statistical significance at the 1, 5 and 10 percent levels respectively. "- " indicates variables not tested.

It is to be noted that most existing studies have adopted CO_2 emissions per capita as an appropriate measure as opposed to the intensity of GDP as used for the equations in Table 4. For example, Selden and Song (1994), Holtz-Eakin and Seldon, (1992), and Cole, Rayner and Bates, (1997) used emissions per capita in their analysis. Some authors (for example, Grossman and Krueger, 1995; Shafik, 1994) adopted the measure of emissions as concentrations of emissions as per capita income of certain air and water pollutants. This study also adopts a second measure of emissions (CO_2 emissions as metric tons per capita) so as to complement the results in Table 4. The use of the second dependent variable: CO_2 emissions as metric tons per capita, also allows for a robustness check on the results presented in Table 4 and provides comparisons of the findings here with those in the EKC literature examining the relationship between per capita income and environmental indicators. Grossman and Krueger (1991) and Seldon and Song (1994) and Holtz-Eakin and Selden (1995) find an "inverted-U" shape for the relationship between per capita GDP and several air pollutants.

Table 5 presents the results of the effect of governance on CO_2 emissions as metric tons per capita. The results in Table 5 are more robust as opposed to those in Table 4. The Buse R-square ranges from 0.53 to 0.55 as opposed to 0.29 to 0.34 in Table 4. Several of the coefficients have the expected signs and with improvements in their statistical significance. More importantly, the results presented in Table 5 provide strong support for the EKC hypothesis, consistent with the EKC findings of studies mentioned above.

The findings in Table 5 show that after controlling for the non-governance influences on CO_2 emissions, some dimensions of good governance have the expected effect. The coefficients of *ps*, *rl* and *cc* carry the expected negative sign, thus, confirming that these variables are inversely correlated with CO_2 emissions. The coefficient of government effectiveness is negative but statistically insignificant. However, the coefficients *ps*, *rl* and *cc* are statistically significant at the 1 percent level. The findings of variables *ps*, *rl* and *cc* indicate that improvements in political stability, the rule of law and control of corruption aspects of governance at the national level can have mitigating effects on CO_2 emissions.

Turning to the control variables, the results are dominated by income (*pcgdp*), income squared ($pcgdp^2$); trade (*trd*), and the size of industrial value added (*ind*). The sign on the coefficients of these variables are as expected and they are statistically significant at the 1 percent level across all the specifications, except *pcgdp* which is statistically significant at the 5 and 10 percent levels. The signs on their coefficients and statistical significance do not change as each governance indicator is tested separately.

Table 5. Regression Results (Dependent variable is CO_2-pc)

Variables	Effect of Control Variables	Effect of Political Stability	Effect of Government Effectiveness	Effect of Regulatory Quality	Effect of Rule of Law	Effect of Corruption
pcgdp	0.002	0.002	0.002	0.003	0.002	0.002
	(1.734)***	(2.116)**	(1.723)***	(2.026)**	(1.835)***	(1.805)*
$pcgdp^2$	-0.323E-05	-0.362E-05	0.320E-05	-0.366E-05	-0.349E-05	-0.333E-05
	(2.740)*	(3.185)*	(2.791)*	(3.021)*	(2.957)*	(2.838)*
trd	0.005	0.005	0.005	0.005	0.005	0.005
	(3.399)*	(3.886)*	(3.608)*	(3.440)*	(3.617)*	(3.608)*
ag	-0.006	-0.069	0.064	-0.060	0.076	0.067
	(12.990)*	(12.460)*	(12.140)*	(12.660)*	(13.130)*	(13.180)*
ind	0.048	0.042	0.044	0.043	0.042	0.044
	(7.301)*	(7.517)*	(7.587)*	(7.204)*	(7.277)*	(7.487)*
dm	-0.0001	-0.0002	-0.0002	-0.0002	-0.0002	-0.0003
	(0.760)	(1.283)	(1.298)	(0.905)	(1.070)	(1.403)
ps	-	-0.287	-	-	-	-
		(2.894)*				
ge	-	-	-0.139	-	-	-
			(1.402)			
rq	-	-	-	0.022	-	-
				(0.765)		
rl	-	-	-	-	-0.414	-
					(4.130)*	
cc	-	-	-	-	-	-0.192
						(2.133)**
F	369.9	369.4	364.2	367.5	368.4	366.3
N	99	99	99	99	99	99
Buse R^2	0.53	0.54	0.53	0.53	0.55	0.54

Notes: *t*-statistics are in parentheses. *, **, and *** indicate statistical significance at the 1, 5 and 10 percent levels respectively. "-" indicates variables not tested.

The positive correlation of income (*pcgdp*) with CO_2 emissions as metric tons per capita provides strong evidence that as incomes increase, CO_2 emissions also increase. It is to be noted that the income effect tested here is assumed to have a short-run effect and not the EKC effect. The EKC effect however is tested with squared income ($pcgdp^2$) and the finding is as expected with a negative coefficient that is statistically significant at the 1 percent level across all the specifications. The results indicate that estimated emissions initially rise with per capita incomes but eventually fall. Based on the empirical estimates, the estimated turning point occurs at very high levels of per capita incomes and is out of the range of observations in the sample considered for the empirical work. Previous studies also find turning points occurring at very high levels of per capita income. For example, Holtz-Eakin and Seldon (1995) showed that turning point of

$35,428 resulted from quadratic levels functional form whilst the turning point of over $8 million was estimated by quadratic logs function. In another study, Cole, Rayner and Bates (1997) found the turning point of per capita income relating to CO_2 emissions to be $62,700 in quadratic log functional form and $25,100 in quadratic levels functional form. The findings of the squared income variable suggest that the EKC effect is plausible. The findings do suggest that increases in incomes are associated with increasing demand for superior quality goods as well as superior quality environment. Therefore, firms are likely to adopt improved technology or tend to phase out high pollutant producing plants as income rise.

The effect of trade (*trd*) is as expected, positively and statistically significantly correlated with CO_2 emissions. The findings provide evidence that greater openness leads to higher CO_2 emissions.

The effect of the size of the industrial sector (*ind*) is as expected. The coefficient *ind* is positive and statistically significant at the 1 percent level across all of the specifications. Given the strong positive correlation of the size of the industrial sector with CO_2 emissions, the results clearly suggest that the larger the industrial sector, the higher the CO_2 emissions. Some of the large developing countries in Asia and Latin America and the Caribbean regions have experienced strong growth rates in recent times with the expansion of their industrial sectors. It is most likely that the industrial sectors in several developing countries will continue to expand and expanding industrial sectors will continue to emit more and more CO_2.

The coefficient of the democracy, variable *dm* is positive and statistically insignificant across several specifications. This finding provides very weak evidence that higher levels of freedom are associated with higher levels of CO_2 emissions.

5. SUMMARY AND CONCLUSION

The central purpose of this paper was to empirically investigate the links between several dimensions of governance and CO_2 emissions in a sample of developing economies. CO_2 emissions measured by metric tons per capita is found to more robustly support the EKC hypothesis as well as strongly correlated with governance and other control variables. The regressions results provide strong evidence that political stability, the rule of law and control of corruption to be strongly and negatively correlated with CO_2 emissions per capita, thus, providing support that good governance matters in terms of controlling CO_2 emissions. Other than confirming the EKC hypothesis as established by past researchers, the results also provide strong evidence that trade openness and the size of the industrial sector as other non-governance dominant variables and these are strong determinants of CO_2 emissions. The results of the governance variables leads to the conclusion that the developing countries perhaps need to focus on various aspects of governance. In particular, maintaining a stable political environment, strengthening the rule of law, and controlling corruption; are all vital in terms of minimizing the

detrimental effects on environment through the rising levels of CO_2 emissions.

CO_2 emissions from the developing countries are likely to increase in years to come as a result of economic reforms instituted in several countries and greater global trade. A common aspect of this reform is the liberalization of trade sector and as a result foreign manufacturing industries largely from high-income countries as well as multinational firms are locating their manufacturing operations in the developing countries. To many manufacturers, opening up of trade by the developing countries gives them an opportunity to relocate their dirty industries (the pollution haven hypothesis). Further, the recent high growth rates recorded by large developing countries such as China, India, Brazil and Argentina signals future increases in CO_2 emissions, thus, contributing to a rise in average per capita CO_2 emission levels for the developing world. Other developing countries are in the same race: to increase industrial production and to expand trade. Hence, the issue relating to the governance of CO_2 emissions will become more relevant. The developing countries can start now to continue to develop sound and coherent policies not only to bring about improvements in various dimensions of governance but to foster environmental sustainability at the national as well as industry level. This is where the regulatory aspects of governance become important as governments can regulate industrial production through developing a framework where firms are required to use cleaner forms of energy as well as adopting technology that minimizes environmental destruction.

The developing countries will have to bear responsibilities in years to come as production in the developing world increases. They could mitigate the extent of CO_2 emissions by partnering with international institutions such as the United Nations Environmental Programmes and World Trade Organization in adopting guidelines and measures designed for sustainable production. International and regional organizations that advocate on environmental sustainability may play a more aggressive role in the developing countries through policy advice and diffusing best practices in production that leads to minimal environmental damage. Environmental groups and societies can also play an active role in the developing countries by creating more awareness on CO_2 emissions through workshops, seminars and conferences for policy makers as well as industry groups. Such forms of combined efforts by all stakeholders are likely to benefit the developing countries and the environment at large.

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