The Moderating Role of Natural Resources Between Institutional Quality and CO2 Emissions: Evidence From Developing Countries

Bashir Muhammad (bashirbtni123@gmail.com)
Henan University https://orcid.org/0000-0001-5616-8169

Research Article

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Abstract

The recent study aim is to scrutinize the moderating role of natural resources between institutional quality and carbon dioxide (CO2) emissions in 106 developing countries from 1996 to 2017 by using dynamic fixed effect, generalized method of moments (GMM) and system generalized method of moments (system GMM) estimators as well as apply the instrumental fixed effect, the instrumental time fixed effect and instrumental system GMM estimators as robustness. We make use of dynamic models and instrumental system GMM to reduce the result of autocorrelation increasing from misspecification of a model as well as clear the biases from unnecessary data and solve the possible endogeneity issues. The empirical results indicate that financial development, trade, and institutional factors: corruption perception control, government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability play a vital role in CO2 emissions reduction but natural resources along with economic growth are the core factors that cause CO2 emission in developing countries. On the opposing, natural resources boost the indirect impact of institutional quality on CO2 emissions in developing countries.

1 Introduction

The environment is the key anxiety for both developing and developed countries because high-level CO2 emissions affect both developing and developed countries crosswise the World. The environment catches temperature and creates the earth warm. Over more than 50 years, the human movements are liable for approximately the entire rise in CO2 emissions. The major cause of CO2 emission from human moments is from transportation, heat, and burning fuels for electrical energy. CO2 emission is reasoned by flood in different Countries; fire in forest is the key essentials that cause the CO2 emission. The above measures reasons to bother the agricultural land, the highly important survival of human beings, natural resources, and infrastructure. These measures are the core anxiety for experts in economics as well as the environment. CO2 emission is a worldwide issue and the entire world is affected by the threats increasing from the decline of the quality of the environment, this is the core anxiety of circumstances that releases greenhouse gases (GHGs).

Developing countries play a vital role in global CO2 emission. According to the World Economic Forum (2019) developed countries have more contribution to global CO2 emission but in the rent year, developing countries contribute a high-level growth of CO2 emissions to the global CO2 emissions. Figure 1 shows that developing countries contribute 60% to the global CO2 emissions and also indicate that China and India have the uppermost 45.33% and 11.33% contributions in developing countries CO2 emission and 27.2% and 6.8% in global CO2 emissions in 2017 (Joint Research Centre, 2019). In addition, since dissimilarities in both China and India growth, these both counties set CO2 emissions reduction assurances. China with somewhat high-level urbanization and industrial growth has created an official assurance to climax its emission of CO2 by 2030 and struggle to get to the climax as soon as possible (National Development and Reform Commission of China, 2015). India with low per capita emission of CO2 and lack of electricity has no apparent aims for control of CO2 emission but has committed to severing per capita emission of GDP by around 33% by 2030 (Ministry of Environment, Forest, and Climate Change of India, 2015). Regards as the huge level of CO2 emissions and the emissions reduction assurance, China and India has a vital suggestion for achieving an enhanced grab of the development and the climax of CO2 emission in developing countries.

Developing countries have CO2 emissions issues since the 1990s, mostly the Asian countries, as the developed countries have transferred their industries to developing countries that produce a large number of CO2 emissions Acquaye et al. (2017). Asian countries have the environmental pollution issues cause of the flows of industries abuse into the river that reasons to pollutants of water which indirectly affects the citizen’s health He et al. (2012).

Development of some countries of Asia is increasing from the previous few years Bajpai (2018) and revealed that these countries of Asia have scheduled the prevalent economy of the globe such as China, as well as India and Singapore, are respectively scheduled in biggest the economy of the globe. Development directly affects economic growth but growth badly affects environmental pollutants which are the core cause of citizen's health, deforestation, and environmental pollutant Saboori and Sulaiman (2013). The link between energy use and environmental pollutants assessed by Huang et al. (2008) and demonstrated that use of energy resources boost GHGs and badly affects the environment pollutant.

The recent study aims to scrutinize the association between natural resources, institutional quality, and CO_2 emissions in developing countries due to large quantity of natural resources and bad quality institutional indicators in developing countries. Figure 2 shows the average natural resources rents in developing countries which are 8.02% in 2017 (World Bank, WDI, 2019). Figure 3 shows the average corruption perception index in developing countries which indicates 36.72% in 2017 (Corruption Perception Index, 2019). Figure 4 shows the average of institutional factors in developing countries which indicate the bad quality of institutions such as; -0.34% government effectiveness, -0.24% political stability, -0.33% regulatory quality, -0.35% rule of law and – 0.26% voice and accountability in developing countries in 2017 (World Bank, WDI, 2019).

Based on the above details, an inspection into the moderating role of the natural resource between institutional quality and CO_2 emission in developing countries are reasonable because a few studies have explored association between natural resources and CO_2 emissions for example; in BRICS countries Dong et al. (2017) examined link of natural gas with CO_2 emissions as well as association between CO_2 emissions and natural resources explored in BRICS countries by Baloch et al. (2019), Balsalobre et al. (2018) applied in 5 countries of European Union while institutional factors link with CO_2 emissions inspected MENA and European Union countries Abid, M, (2017) and explored by Abid, M, (2016) in Africa countries of Sub Sahara but our contribution the literature to explores the moderating role of natural resource between institutional quality and CO_2 emissions that no study has scrutinized so fulfill this gap to the literatures as Wegenast (2013); Eregha and Mesagan (2016) and Aleksynska and Havrylchyk (2013) indicated that natural resources have a vital role in institutions. So this is the first study to scrutinize the moderating role of natural resource between institutional quality and CO_2 emissions in developing countries.

To fulfill this gap in the literature, the recent study aims to inspect the moderating role of natural resource between institutional quality and CO_2 emission in 106 developing countries from 1996 to 2017. Firstly, this is the new work to explore the relationship between natural resources, institutional quality, and CO_2 emissions in developing countries. Secondly, we add the moderating role of natural resources between institutional quality and CO_2 emissions which no study has examined in the previous literature. Thirdly, we are taking lagged of all independent variables as instruments and use instrumental fixed effect and time fixed effect and system GMM estimators as robustness to deal with the endogeneity issue which no study has considered in the literature. This study will help the policymakers and government to use advanced equipment for exploitation of natural resources and invent suitable exploitation during agriculture, as well as mining will upgrading quality of the CO_2 emissions and also will reduce the indirect impact of institutional quality on CO_2 emissions.

The residual parts of the current paper are ordered as follows. Section 2 gives an analysis of the correlated literature but Sect. 3 provides data and econometric methods while Sect. 4 outlines the observed results and discussions and Sect. 5 provides conclusion and policy recommendations.

2 Literature Review

The quality of Institutions and bureaucratic systems, corruption, and the rule of law contribute vita role to the quality of the environment in institutional theories. The provide freedom of information and political rights that improve awareness of the public about the optimal utilization of the natural resource (Bernauer et al. 2012; Barbier 2015). Government and regulatory authorities play enthusiastic attention in the decision-making of natural resources to maintain the economic system. However, natural resources, particularly minerals and fossil fuels, are essential to economic development as they have an essential contribution to goods and services production. Yet, the costs of natural resources by the burning of fossil fuels, boost CO2 emissions into the environment, gases that absorb and emit thermal emission and are a most essential provider to the 'greenhouse effect'. Natural resources play a very important role in institutions (Wegenast 2013; Eregha and Mesagan 2016) and Aleksynska and Havrylchyk (2013). Natural resources directly affect economic growth Sachs and Warner (1995) and indicated that this impact is more significant than the indirect impact through institutions. Boschini et al. (2007) and Isham et al. (2005) indicated that the indirect impact of natural resources through institutions is more influential. The natural resources association with institutions is argued in the studies (Knack and Keefer, 1995).

Some of the literature such as North (1990) highlighted the importance of institutional factors for under developing and developing countries after emphasizing the less support to institutions for productive movements. Neumayer (2002) suggested that democracy play important role in the quality of the environment. The political institutions direct through an appropriate governance structure that affects the quality of the environment (Barret and Graddy 2000). Moreover, Gallagher and Thacker (2008) found a negative impact of democratic quality on the quality of the environment. Dasgupta and Mäler (2006) found a positive impact of law and order on environmental quality through the way of supporting enhanced abatement policies. Moreover, Panayotou (1997) confirmed that institutional factors have a vital role in enhancing the quality of the environment, even if a country has a low level of economic growth, means that the institutional factors can assist to reduce the environmental cost of augmented economic development, therefore, enable countries to alleviate the pollution of environment. In addition, Gagliardi (2008) indicated that better quality of institutions can assist to depress exploitation, an advance joint association among the agents, therefore, support agents to incorporate the externalities. As a result, the better quality of institutions can provide inclusive resolution to be executed for the betterment of environmental quality and improvement of economic development (Subramanian, 2007). Moreover, institutional quality and CO2 emissions assessed in the European Union and the Middle East and Africa Abid, M, (2017) and found a reduction in CO2 emission due to control of corruption, Government effectiveness, political stability, and regulatory quality and indicated that control of corruption, Government effectiveness, political stability, and regulatory quality are important factors to reduce CO2 emissions. Abid, M, (2016) found that Control of corruption, government effectiveness, political stability and democracy play a vital role in CO2 emissions reduction but the rule of law and regulatory quality boost CO2 emissions and also indicated that get better the quality of corruption, government effectiveness, political stability and democracy lead to improve the quality of CO2 emissions in Sub Saharan countries of Africa. Rules on a firm's entrance into the market are linked with better informal economies, high corruption, and less democratic governments. Government efficiency may possibly play a vital role in CO2 emission reduction Djankov and Hoekman (2002). Pushak et al., (2007) indicated that Countries that continue efficiently governments can get assurance from producers and more successfully implement rules as regards to CO2 emission. Corruption boosts CO2 emission Cole (2007) and indicated that corruption better the quality of CO2 emission through the negative effect of corruption on economic growth.

The natural resources along with use of renewable energy and economic growth impact on CO2 emissions in BRICS countries examined by Baloch et al. (2019) and indicated that natural resources in huge quantity reduce CO2 emissions in Russia but augment CO2 emissions in South Africa and Dong, et al. (2017) also found reduction in CO2

emissions due to natural gas and use of renewable energy but in 16 countries of European Union, Bekun et al. (2019) indicated improvement in the CO_2 emissions due to natural resources. Muhammad, B, et al. (2021) indicated that CO_2 emissions increase due to massive quantity of natural resources exploitation during mining, agriculture, and deforestation.

The role of economic growth is totally reverse to both change in climate and CO_2 emissions. Industrial ventures in the improvement of economic growth augment natural resources that increase the hurriedness of natural resource tiredness; with quantity growing along with hazardous misuse manufactured Sarkodie, S. A. (2018). Financial development and CO_2 emission scrutinized in Malaysia Shahbaz, M., et al. (2013) and found that financial development plays an important role in CO_2 emission mitigation and indicated that financial sectors might offer the loan that is associated with CO_2 emission mitigation. Financial sectors might also insert CO_2 emission associated circumstances or allocate CO_2 linked charges in their financial merchandise. Financial development encourages foreign firm’s which can better the quality of CO_2 emission (Frankel and Romer, 1999). Second, most well-organized financial organizations offer opportunities to the citizens to grip liquid assets and invest in gainful corporations that make use of cleaner equipment and environmentally pleasant methods of production. These types of equipment better the quality of CO_2 emissions (Birdsall and Wheeler, 1993).

3 Data And Econometric Methods

3.1 Data

This study uses 106 developing countries panel data from over the period 1996 to 2017 to evaluate the moderating role of natural resources between institutions and CO_2 emission in developing countries. CO_2 emissions is proxied by per capita CO_2 emissions metric tons, natural resources proxied by natural resources rents such as mineral, oil, coal and natural gas rents, Economic growth proxied by Per capita GDP as the previous literature Lorente, and Álvarez-Herranz, (2016), Song, M. L., et al. (2013), Muhammad, B, (2019) and Muhammad, B, et al. (2021) used GDP per capita as a proxy for economic growth, percentage of trade for trade openness (TO), private sector from domestic credit percentage of GDP for financial development (FD). We use six variables as institutions such as; corruption perception index (CPI), government effectiveness (GE), political stability and absence of violence (PS), regulatory quality (RQ), rule of law (RL) and voice and accountability (VA). Corruption perception index measures approximately the same issue as control of corruption but, when developing the control of corruption, the World Bank measured a bigger series of sources and applies a more complicated approach than the easy average done for corruption perception index (Rohwer, 2009). Although, corruption perception index has recognized itself as the main variable of corruption in the literature (applied such as in Huang, 2016; Liu, 2016; Barassi and Zhou, 2012; Méon and Weill, 2010). As a result, we consist of it in our study regardless of its likeness and certainly find it to present much powerfully than control of corruption. Moreover, the corruption perception index is calculated on a scale from 0 to 100 where 0 is high corruption but 100 is not corruption. The CO_2 emissions data are composed from the Joint Research Centre (2019) but natural resources, economic growth, trade openness and financial development data are are collected from (World Bank, Worldwide development indicators, 2019) Corruption perception index data is collected from Transparency International's (Corruption Perception Index, 2019) but the other institutions (Government effectiveness, political stability, regulatory quality, rule of law, and voice and accountability) data are collected from the World Bank, World governance indicators (World Bank, Worldwide Governance Indicators, 2019). For variables description and included countries in the study (See; table A1 and table A2 in the appendix).

Figure 5 reports the total annual CO2 emission in the developing countries which shows 10.65 billion metric tons of CO2 emissions in 1996 but increased to 22.05 billion metric tons in 2017 in developing countries and also indicates that China was 3.41 billion metric tons CO2 emissions in 1996 but increased to 9.84 billion metric tons in 2017 and India was 0.88 billion metric tons CO2 emissions in 1996 but increased to 2.47 billion metric tons in 2017 (Joint Research Centre, 2019).

3.2 Dynamic models

We are using the dynamic fixed effect, GMM method that suggested by (Arellano and Bond, 1991) along with System GMM method suggested by (Arellano, and Bover, 1995 and Blundell, and Bond, (1998). We are using GMM and system GMM because these models deal with endogeneity issues and ignore individual particular heterogeneity and estimators such as simple fixed effect as well as OLS estimator are not dependable estimators in such type cases because of huge difference between time periods and countries as suggested by Asongu, and Acha-Anyi, (2017). We exercise system GMM since this model calculates the factors with endogenous to fixed effects estimator with a lagged of dependent variables and lagged of endogenous variables as instruments and compacts with unobserved heterogeneity. The lagged values of the dependent variable are 0.4% in the GMM model and 0.9% in system GMM but decrease to 0.6% in instrumental system GMM estimator System GMM deal with the endogeneity issues through means of instrumentations and controls over-identification and also deal with cross-sectional dependence (Tchamyou, 2019a, and 2019b). The system GMM implements in advance of the difference GMM using more assumptions that no connection is examined between the first differences of appliances. Bond, et al. (2001), Zhuo, et al. (2020) and Muhammad, B, (2019) indicated that the system GMM significantly deals with unobserved heterogeneity of a country, measurement error, absent variable bias, and possible endogeneity issues.

We indicate our dynamic model as follows:

$CO2_{i,t} = B_1 CO2_{i,t-1} + B_2 NR_{i,t} + B_3 logGDPi_{,t} + B_4 TO_{i,t} + B_5 FD_{i,t} + B_6 Institutions_{i,t} + B_7 Institutions{*}NR_{i,t} + \varepsilon_{i,t}$ (1)

The above equation is the dynamic equations, where, i represent the country, t represents time and $\varepsilon_{i,t}$ is the error term. CO2 is CO3 emission, NR is natural resources (Coal, oil, mineral and forest rents), logGDP is the log of GDP per capita, TO is trade openness, FD is financial development, Institutions indicates six variables such as; CPI, GE, PS, RQ, RL and VA. Institutions*NR is an interaction term between institutional factors and natural resources. We take the lag of dependent variable $CO2_{i,t-1}$ because the lag of the dependent variable reduces the result of autocorrelation increasing from misspecification of model.

The study report endogeneity issue between some independent variables so, we are taking lagged of all independent variables to deal with this issue and get the following model.

$CO2_{i,t} = B_1 CO2_{i,t-1} + B_2 NR_{i,t-1} + B_3 logGDPi_{,t-1} + B_4 TO_{i,t-1} + B_5 FD_{i,t-1} + B_6 Institutions_{i,t-1} + B_7 Institutions{*}NR_{i,t-1} + \varepsilon_{i,t}$ (2)

Given the complexity of finding superior instrumental variables, a helpful method to deal with the endogeneity issue is to take the lag of endogenous variables as instruments and use System GMM estimator. This is a suitable procedure to deal with endogeneity issue so, therefore; we are using system GMM estimator and also taking lag of all independent variables as instruments in fixed effect, the time fixed effect, and system GMM estimators as robustness. Wu, and Chen, (2019), Liu, H. Y., et al. (2017) and Tang, and Zhang, (2016) proposed lagged of endogenous variables as an instrument is a better way to deal with the endogeneity issue.

3.3 Multicollinearity test

Table 1 shows the result of the correlation between independent variables. We find less than 0.6 coefficient values for all the independent variables except for institutions. The uses of all the independent variables except institutions in our models do not create any issue of multicollinearity as their coefficient values less than 0.70 (Kennedy, 2008) but the institution variables, we use individually in our models.

Table 1
Pairwise correlation matrix.

	NR	GDPPC	TO	FD	CPI	GE	PS	RQ	RL	VA
NR	1.000									
GDP	0.279**	1.000								
TO	0.067*	0.269*	1.000							
FD	-0.234**	0.275***	0.338*	1.000						
CPI	-0.178***	0.555***	0.304**	0.475***	1.000					
GE	-0.286***	0.506*	0.317*	0.613**	0.839**	1.000				
PS	-0.168***	0.425**	0.382*	0.299*	0.671**	0.625*	1.000			
RQ	-0.314***	0.439***	0.278*	0.520*	0.753*	0.871*	0.585*	1.000		
RL	-0.295*	0.491**	0.328*	0.531*	0.871*	0.899*	0.740*	0.857*	1.000	
VA	-0.481***	0.0131**	0.121*	0.259*	0.535*	0.627*	0.552*	0.665*	0.721*	1.000
Notes: *** = Significance at 0.01, ** = Significance at 0.05 and * = Significance at 0.1.										

Table 2
Descriptive statistic

Variables	Mean	S-Dev.
CO2 emissions	3.635	6.917
Natural resources	10.034	12.629
GDP	5753.199	9079.629
Trade openness	78.852	37.502
Financial development	32.761	28.319
Corruption perception	33.869	12.813
Government effectiveness	-0.385	0.691
Political stability	-0.376	0.868
Regulatory quality	-0.332	718
Rule of law	-0.460	0.685
Voice and accountability	-0.415	0.760
Sources: World development indicators (WB; 2019) and European Union (JRC, 2019).		

Table 2 reports the descriptive statistic. We find the bad quality of institutional quality in developing countries and large quantities of natural resources and high economic growth which badly affects CO2 emission.

4 Results And Discussions

We use dynamic fixed effect, GMM and system GMM estimators as well as apply an instrumental fixed effect, instrumental the time fixed effect, and instrumental system GMM estimators as robustness to deal with the endogeneity issue between some independent variables and use lagged independent variables as instruments as the previous literature Wu, and Chen, (2019), Liu, H. Y., et al. (2017) and Tang, and Zhang, (2016) suggested that given the complexity in finding superior instrumental variables, a helpful method to deal with the endogeneity issue is to take the lag of endogenous variables as instruments.

Table 3 shows the result of a dynamic fixed effect but Table 4 demonstrates the result of the GMM estimator while Table 5 shows the result of the system GMM estimator as well as Table 6 shows the result of instrumental system GMM estimator as robustness where we use lagged independent variables as instruments. The lagged level values of CO2 emission show that previous year CO2 emission effects of current CO2 emissions around 0.6%, 0.4% and 0.9% in Tables 3, 4 and 5 but 0.6% in instrumental system GMM estimator. The sargan test, Arellano and Bond test confirm a better-quality act in all models, as well as Hansen test, also perform well in Table 6.

We also run the models for the association of natural resources and institutions factors with CO2 emission without interaction term and the details results are reported in tables A3 to A5 where, table A3 shows the result of dynamic fixed effect model without interaction term while table A4 indicates the result of GMM estimator without interaction term but table A5 demonstrates the result of system GMM estimator without interaction term (For more details see tables A3 to A5 in Appendix). The instrumental fixed effect and the instrumental time fixed effect results are reported in tables A6 and A7 where, table A6 shows the result of instrumental fixed effect model but table A7 indicates the result of instrumental time fixed effect (For more details see tables A6 to A7 in Appendix).

Natural resources influence CO2 emission significantly and positively in all models. The results confirm that natural resources are the core cause that augments CO2 emissions in developing countries and the results indicate in both system GMM and dynamic fixed effect that a 1% increase in natural resources increases 0.2% in CO2 emissions of developing countries. The large development of the available natural resources manipulate a country abilities to repeat resources but such alteration from common equipments that abuses more resources to advanced equipments that consists of value-addition, recycling, innovation and utilize again and again, that alteration in natural resources will augment economic growth but as a results badly affects environment. Economic evolution impels industrial ventures that advance natural resources but augment the hurriedness of natural resources tiredness; with quantity growing, along with insecure misuse produced Muhammad, B., et al. (2021). Moreover, most natural resources countries misuse during agriculture, deforestation, and mining affect CO2 emissions.

Table 3
Dynamic fixed effect model

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.601***	0.623***	0.616***	0.621***	0.616***	0.623***
	(0.025)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
NR	0.018***	0.021***	0.012	0.019**	0.020***	0.014**
	(0.013)	(0.008)	(0.007)	(0.007)	(0.008)	(0.006)
logGDP	0.664***	0.575***	0.608***	0.570***	0.670***	0.576***
	(0.125)	(0.140)	(0.140)	(0.140)	(0.125)	(0.139)
TO	-0.003**	-0.003**	-0.003**	-0.003*	-0.003**	-0.002*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
FD	-0.005***	-0.005**	-0.005**	-0.005**	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CPI	-0.013***					
	(0.004)					
CPI*NR	-0.002***					
	(0.001)					
GE		-0.207*				
		(0.101)				
GE*NR		0.009*				
		(0.005)				
PS			-0.023**			
			(0.083)			
PS*NR			-0.012**			
			(0.006)			
RQ				-0.235***		
				(0.087)		
RQ*NR				0.013**		
				(0.004)		
RL					-0.161**	
					(0.112)	
RL*NR					0.016***	

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

D. Variables: CO2	1	2	3	4	5	6
					(0.005)	
VA						-0.096**
						(0.119)
VA*NR						0.010**
						(0.005)
Constant	-5.165***	-2.435***	-2.648***	-2.690***	-2.513***	-2.689***
	(0.858)	(0.930)	(0.938)	(0.942)	(0.934)	(0.922)
Observations	1,646	1,919	1,910	1,919	1,919	1,919
R^2	0.624	0.684	0.680	0.683	0.684	0.680
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

Table 4
GMM estimator

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.401***	0.463***	0.452***	0.455***	0.428***	0.452***
	(0.035)	(0.031)	(0.031)	(0.031)	(0.031)	(0.032)
NR	0.089***	0.034***	0.023**	0.041***	0.060***	0.034***
	(0.017)	(0.012)	(0.011)	(0.012)	(0.013)	(0.010)
logGDP	0.606***	0.690***	0.644***	0.572***	0.428***	0.603***
	(0.206)	(0.313)	(0.309)	(0.314)	(0.297)	(0.311)
TO	-0.002**	-0.002*	-0.003*	-0.005	-0.003*	-0.002*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
FD	-0.004***	-0.007***	-0.006***	-0.005***	-0.007***	-0.007***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
CPI	-0.029***					
	(0.007)					
CPI*NR	-0.002***					
	(0.001)					
GE		-0.200**				
		(0.180)				
GE*NR		0.014*				
		(0.008)				
PS			-0.137**			
			(0.128)			
PS*NR			-0.017**			
			(0.007)			
RQ				-0.288***		
				(0.161)		
RQ*NR				0.013*		
				(0.007)		
RL					-0.159*	
					(0.206)	
RL*NR					0.022***	

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

D. Variables: CO2	1	2	3	4	5	6
					(0.008)	
VA						-0.094
						(0.263)
VA*NR						0.016**
						(0.008)
AR(1)	0.047	0.049	0.039	0.046	0.047	0.032
AR(2)	0.115	0.121	0.127	0.119	0.117	0.124
Sargan Test	0.627	0.655	0.655	0.620	0.619	0.644
Observations	1500	1549	1546	1549	1549	1549
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

Table 5
System GMM estimator

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.953***	0.909***	0.929***	0.924***	0.916***	0.953***
	(0.012)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
NR	-0.017**	0.021***	0.020***	0.024***	0.022***	0.019***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)
logGDP	0.224***	0.227***	0.217***	0.222***	0.240***	0.196***
	(0.041)	(0.052)	(0.051)	(0.052)	(0.048)	(0.058)
TO	0.002	0.002	0.002	0.002	0.002	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FD	-0.002	-0.001	-0.001	-0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CPI	-0.028**					
	(0.002)					
CPI*NR	-0.002***					
	(0.001)					
GE		-0.209***				
		(0.043)				
GE*NR		0.024***				
		(0.002)				
PS			-0.144***			
			(0.039)			
PS*NR			-0.019***			
			(0.003)			
RQ				-0.248***		
				(0.039)		
RQ*NR				0.018***		
				(0.002)		
RL					-0.126***	
					(0.041)	
RL*NR					0.021***	

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

D. Variables: CO2	1	2	3	4	5	6
					(0.002)	
VA						-0.097*
						(0.056)
VA*NR						0.012***
						(0.002)
Constant	-0.751***	-1.735***	-1.694***	-1.731***	-1.779***	-1.276***
	(0.285)	(0.424)	(0.408)	(0.413)	(0.409)	(0.423)
AR(1)	0.066	0.063	0.063	0.069	0.061	0.064
AR(2)	0.147	0.141	0.145	0.138	0.146	0.144
Sargan Test	0.734	0.720	0.727	0.731	0.735	0.721
Observations	1646	1919	1910	1919	1919	1919
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

Economic growth influences CO2 emission significantly and positively in all models and the results point out that economic growth is the core reason of CO2 emissions in developing countries. The results indicate in dynamic fixed effect and GMM estimators that a 1% increase in economic growth increases in CO2 emission around 0.6% but system GMM estimator results indicate that a 1% increase in economic growth increases in CO2 emission around 0.2%. Most developing countries struggle for development and get high-level economic growth but people start to give less attention to the environment and as a result, increase CO2 emission that affects the citizen's health. CO2 emissions and economic growth boost mutually until a certain rotating circumstances in the growth is accomplished, at the back the CO2 emission reduces but overturns after that. Thus, an overturned U-shaped connection between CO2 emission and growth expects a dynamic process of structural transform linked with growth. The CO2 emissions manipulates through growth with the three most important ways: composition, technology impacts and scale. Therefore, the environment is considered as a process that products from composition, technology impacts and scale. At that stage, as growth enhances, the public will be expected to craving clean approaches intended at protecting the CO2 emission. Climax consequential in the CO2 emissions alteration is apparently to be in motion eventually as of technological transform and improved concerns due to CO2 emissions Lorente, and Álvarez-Herranz, (2016), and Song, M. L., et al. (2013).

Financial development influences CO2 emissions significantly and indirectly and indicated that a 1% increase in financial development reduces 0.005% in CO2 emissions of developing countries because the financial sector invest in the development of renewable energy which causes CO2 emission reduction. Our results are similar to the study Kim, and Park, (2016) indicated that CO2 emission reduces due to financial development.

Trade openness influences CO2 emissions significantly and negatively in developing countries and the results indicate that a 1% increase in trade openness mitigates 0.002% in CO2 emissions of developing countries. The results indicate that international trade might decrease CO2 emissions because the fast growth of trade also

encourages transform production components from industries that exploit high-level CO_2 emission to atmosphere friendly industries so international trade might be helpful for CO_2 emission reduction. Our results are similar to the study Hu, H. et al. (2018) showed a reduction in CO_2 emission due to trade openness. Services such as finance, continuance, retail, and wholesale negatively influence CO_2 emission Alcántara and Padilla (2009).

Corruption perception significantly and negatively affects CO_2 emissions and the results indicate indicated that a 1% increase in corruption perception reduces 0.03% in CO_2 emission of developing countries. Government effectiveness, political stability, regulatory quality, rule of law and voice and accountability also significantly and negatively influences CO_2 emissions in developing countries and the results indicate that a 1% increase in lack of public goods as considered by the government effectiveness, risk of violence as considered by Political stability and absence of violence, both regulatory quality and voice and accountability as explaining how the economic system and government of country pragmatics somewhat whether or not it practical and problems such as crime (as calculated by Rule of law) reduce 0.20%, 0.14%, 0.248%, 0.15% and 0.09% in CO_2 emission. The institution's results confirm that institutions are very important factors that cause CO_2 emissions reduction and the results indicate that good quality of institution may assist to reduce CO_2 emissions in developing countries. The provide freedom of information and political rights that improve awareness of the public about the optimal utilization of the natural resource, as well as Government and regulatory authorities, play an enthusiastic attention in the decision-making of natural resources so good quality of institutions reduce CO_2 emissions of the country. The corruption, political stability and government effectiveness results are supported by Abid, M, (2017) and Abid, M, (2016) but the regulatory quality result is corroborated by Abid, M, (2017).

Natural resources play important role in institutional quality (Wegenast 2013; Eregha and Mesagan 2016) and Aleksynska and Havrylchyk (2013) and recommended that natural resources play an important role in an institution's quality. Sachs and Warner (1995) indicated that natural resources affect economic growth more significantly than indirect affect through institutional quality as well as Boschini et al. (2007) and Isham et al. (2005) indicated that the indirect impact of natural resources through institutions is more influential. The natural resources association with institutions are argued in the studies (Acemoglu et al. 2002 and Knack and Keefer, 1995). The results indicate that only corruption perception and political stability interaction with natural resources continue reduction in CO_2 emissions indicate that corruption, and risk of violence as considered by Political stability plays an important role in natural resources effect on CO_2 emissions and suggested that natural resources may assist to reduce CO_2 emission through corruption perception and political stability. The moderating role of corruption perception and political stability between natural resources and CO_2 emission is essential. Therefore increase in control of corruption and political stability is supportive to decline the influence of natural resources on CO_2 emissions so better the quality of control of corruption and political stability, in the long run, reduce the influence of natural resources on CO_2 emissions in developing countries. While the other institution's factors such as; government effectiveness, regulatory quality, voice and accountability, and rule of law interaction term with natural resources change the coefficient sign to significant and positive which indicates that government effectiveness, regulatory quality, voice and accountability and rule of law badly affect CO_2 emissions due to natural resources. The results indicate natural resources badly affect the quality of government effectiveness, regulatory quality, voice and accountability, and rule of law and as a result, increase CO_2 emissions. The institution's interaction with natural resources, results indicate that good quality of corruption control and Political stability may assist to reduce CO_2 emissions in developing countries and through better, the quality of corruption and political stability can reduce the effect of natural resources on CO_2 emissions in developing countries but other institutions factors increase CO_2 emissions due to natural resources so better the quality of institution indicators is very important to reduce CO_2 emissions in developing countries.

Table 6 indicates the robust results of instrumental system GMM estimator that use lagged all independent variables as instruments to deal with the endogeneity. The results indicate that institutional factors continued reduction in CO_2 emissions while on the other side natural resources not only increase CO_2 emissions but also indirectly increase the impact of institutional quality on CO_2 emissions. The institutional factors affect CO_2 emissions through natural resources results indicate that high-level exploitation of natural resources and huge scale natural resources badly increase the impact of institutional quality on CO_2 emissions as well as the large development of the available natural resources affect talent of a country to reproduce resources while such a alteration from customary equipments that exploit more quantity of resources to advanced equipments that comprises artificial resources, value-addition, recycling, innovation and use again and again that alteration of natural resources will improve their growth but refuse the CO_2 emissions and indirectly increase the impact of institutional quality on CO_2 emissions. Moreover, economic growth directly and significantly affects CO_2 emissions.

Table 6
Instrumental system GMM estimator

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.655***	0.634***	0.658***	0.638***	0.646***	0.677***
	(0.011)	(0.012)	(0.006)	(0.011)	(0.007)	(0.012)
NR_{it-1}	-0.009	0.024***	0.010***	0.022***	0.017***	0.009**
	(0.006)	(0.004)	(0.002)	(0.004)	(0.002)	(0.004)
$logGDP_{it-1}$	0.098**	0.168***	0.109***	0.177***	0.143***	0.075*
	(0.039)	(0.042)	(0.027)	(0.042)	(0.028)	(0.045)
TO_{it-1}	0.001**	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FD_{it-1}	-0.001	-0.001	-0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CPI_{it-1}	-0.002*					
	(0.003)					
$CPI*NR_{it-1}$	0.001					
	(0.001)					
GE_{it-1}		-0.108***				
		(0.066)				
$GE*NR_{it-1}$		0.022***				
		(0.005)				
PS_{it-1}			-0.057*			
			(0.031)			
$PS*NR_{it-1}$			0.007***			
			(0.002)			
RQ_{it-1}				-0.139**		
				(0.067)		
$RQ*NR_{it-1}$				0.019***		
				(0.004)		
RL_{it-1}					-0.077**	

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

D. Variables: CO2	1	2	3	4	5	6
					(0.037)	
$RL*NR_{it-1}$					0.011***	
					(0.002)	
VA_{it-1}						-0.084***
						(0.052)
$VA*NR_{it-1}$						0.002***
						(0.004\)
Constant	-0.530*	-0.805**	-0.689***	-0.876**	-0.941***	-0.610*
	(0.310)	(0.345)	(0.200)	(0.348)	(0.216)	(0.346)
AR(1)	0.003	0.010	0.011	0.009	0.005	0.012
AR(2)	0.109	0.130	0.136	0.133	0.132	0.134
Sargan Test	0.528	0.547	0.539	0.540	0.543	0.546
Hansen test	0.87	0.68	0.64	0.59	0.67	0.65
Observations	1,557	1,894	1,888	1,894	1,901	1,901
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

5 Conclusion And Policy Recommendations

The recent study assesses the moderating role of natural resources between institutional quality and CO2 emissions in developing countries. This is the first study to inspect the moderating role of natural resource between institutional quality and CO2 emission in 106 developing countries from 1996 to 2017 by using GMM, and system GMM as well as dynamic fixed effect estimators as well as use instrumental time fixed effect and instrumental system GMM estimators as robustness to deal with the endogeneity issue.

The empirical results indicate that natural resources and economic growth are the core causes that enhance CO2 emission in developing countries because developing countries are struggling to get a high level of economic growth and try for the exploitation of more natural resources and use of old equipment during the exploitation of natural resources and also misuse during mining as a result, boost CO2 emission. Financial sector investment in renewable energy and International trade plays an important role in CO2 emission mitigation. Moreover, institutional factors; corruption perception control, government effectiveness, political stability, regulatory quality, rule of law and voice, and accountability have the most important role in a CO2 emissions reduction of developing countries and especially corruption perception control and political stability interaction term with natural resources significantly and negatively affect CO2 emission and indicate that corruption perception control and political stability reduce the effect of natural resources on CO2 emission in developing countries. However, the government effectiveness, regulatory quality, rule of law and voice and accountability interaction term with natural resources significantly and directly affect CO2 emission in developing countries and the results indicate that natural resources boost the role of

government effectiveness, political stability, regulatory quality, rule of law and voice, and accountability in CO2 emission in developing countries.

The results of the study suggest that natural resources are not only directly affect CO2 emission but also increase the indirect impact of institutional quality on CO2 emissions so the developing countries should use advanced types of equipment for exploitation of natural resources and build suitable use during agriculture, deforestation and mining will improve the CO2 emissions quality and also will reduce the indirect impact of institutional quality on CO2 emissions. Developing countries must compose suitable policies to augment the make use of renewable energy that will defend their CO2 emissions and boost their economy. The developing countries must award more concentration on the CO2 emissions throughout a great effort for economic augmentation and build suitable policies for use of chemical because the abuse of the chemical into the air and water badly affects the environment. The government should also make such type policies that people start to give more attention to the environment because human activities play important role in the environment. High-level exploitation of CO2 emissions industries should change production components to friendly industries in other countries because trade services eliminate CO2 emission in developing countries. The government should make policies that the financial sector invests more and more in renewable energy projects because financial development reduces CO2 emission in developing countries so more investment in financial sectors will protect their environment. The government should better the quality of institutional factors because institutional factors play an important role in CO2 emission mitigation so developing countries can mitigate CO2 emission due to the good quality of institutional factors. The government should get a better awareness of the public about the best use of natural resources.

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The authors declare that they have no competing interests

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Appendix

Table A1
Description of Variables.

Symbols	Variables	Proxy	Source
CO2	CO2 emission	Metric tons Per capita CO2 emission	(JRC, 2019)
NR	Natural resources	Coal, Oil, natural gas and mineral rents (% of GDP)	(WDI, 2019)
GDP	Economic growth	Per capita GDP (constant 2010 US $)	(WDI, 2019)
TO	Trade openness	Trade (% of GDP)	(WDI, 2019)
FD	Financial development	Domestic credit to private sector (% of GDP)	(WDI, 2019)
CPI	Corruption	Corruption Perception Index determined on a scale from 0 (fully corrupt) to 100 (not corrupt).	(Transparency International's, 2019)
GE	Government effectiveness	Governance effectiveness determines the quality of public good provision and the independence of the civil service from political pressure	(WGI, 2019)
PS	Political stability	Political stability determines the absence of terrorism, external and internal conflict and riots, etc. and the risk of the government being violently overthrown rather than general instability and as a result should be interpreted primarily as indicator of political violence.	(WGI, 2019)
RQ	Regulatory quality	Regulatory quality is an index of low government involvement and economic freedom, aggregating indicators on (the lack of) barriers to trade, entry, and investment, government regulated prices, etc.	(WGI, 2019)
RL	Rule of law	Rule of law summarizes both indicators of crime in general (i.e. the inability of the government to enforce it's law) and the governments' abuse of law in its dealings with citizens.	(WGI, 2019)
VA	Voice and accountability	Voice and accountability aggregates over individual indicators that capture democratic institutions on the one hand and government transparency and arbitrariness on the other side (effectively making this a second “rule of law” indicator).	(WGI, 2019)

Table A2
Countries included in the recent study

No	Country name	No	Country name	No	Country name	No	Country name
1	Albania	28	Costa Rica	55	Lebanon	82	Paraguay
2	Algeria	29	Cote d'Ivoire	56	Lesotho	83	Peru
3	Angola	30	Dominica	57	Liberia	84	Philippines
4	Argentina	31	Dominican Republic	58	Libya	85	Romania
5	Armenia	32	Ecuador	59	Lithuania	86	Russian
6	Azerbaijan	33	Egypt	60	Madagascar	87	Rwanda
7	Bangladesh	34	El Salvador	61	Malawi	88	Senegal
8	Belarus	35	Eritrea	62	Malaysia	89	Serbia
9	Benin	36	Gabon	63	Maldives	90	Seychelles
10	Bhutan	37	Gambia, The	64	Mali	91	Sierra Leone
11	Bolivia	38	Georgia	65	Mauritania	92	South Africa
12	Bosnia and Herzegovina	39	Ghana	66	Mauritius	93	Sri Lanka
13	Botswana	40	Guatemala	67	Mexico	94	Sudan
14	Brazil	41	Guinea	68	Moldova	95	Tajikistan
15	Bulgaria	42	Guinea-Bissau	69	Mongolia	96	Tanzania
16	Burkina Faso	43	Guyana	70	Montenegro	97	Thailand
17	Burundi	44	Haiti	71	Morocco	98	Togo
18	Cambodia	45	Honduras	72	Mozambique	99	Tunisia
19	Cameroon	46	India	73	Myanmar	100	Uganda
20	Central African Republic	47	Indonesia	74	Namibia	101	Ukraine
21	Chad	48	Iran	75	Nepal	102	Uruguay
22	Chile	49	Iraq	76	Nicaragua	103	Venezuela
23	China	50	Jamaica	77	Niger	104	Vietnam
24	Colombia	51	Jordan	78	Nigeria	105	Zambia
25	Comoros	52	Kazakhstan	79	Oman	106	Zimbabwe
26	Congo, Dem.	53	Kenya	80	Pakistan		
27	Congo, Rep.	54	Kyrgyz Republic	81	Panama		

Table A3
Dynamic fixed effect model

D. Variables: CO2	**1**	**2**	**3**	**4**	**5**	**6**
$CO2_{it-1}$	0.503***	0.619***	0.618***	0.619***	0.618***	0.620***
	(0.025)	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
NR	0.007*	0.014**	0.013*	0.013**	0.014**	0.017*
	(0.004)	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)
logGDP	0.632***	0.566***	0.600***	0.576***	0.822***	0.577***
	(0.093)	(0.140)	(0.140)	(0.140)	(0.124)	(0.139)
TO	-0.003**	-0.003*	-0.003**	-0.002*	-0.003*	-0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FD	-0.006***	-0.005**	-0.005**	-0.005**	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CPI	-0.015***					
	(0.004)					
GE		-0.101*				
		(0.094)				
PS			-0.089**			
			(0.073)			
RQ				-0.162**		
				(0.082)		
RL					-0.140*	
					(0.105)	
VA						-0.170**
						(0.107)
Constant	-4.873***	-2.634***	-2.803***	-3.054***	-2.909***	-2.734***
	(0.847)	(0.935)	(0.934)	(0.942)	(0.938)	(0.922)
Observations	1,646	1,919	1,910	1,919	1,919	1,919
R^2	0.623	0.679	0.679	0.680	0.679	0.679
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

Table A4
GMM estimator

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.225***	0.454***	0.453***	0.449***	0.437***	0.460***
	(0.035)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
NR	0.018***	0.024**	0.024**	0.024**	0.024**	0.024***
	(0.005)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
logGDP	1.306***	1.637***	1.644***	1.576***	1.585***	1.600***
	(0.192)	(0.310)	(0.309)	(0.313)	(0.290)	(0.312)
TO	-0.007***	-0.004	-0.005*	-0.003	-0.004	-0.004*
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
FD	-0.014***	-0.017***	-0.016***	-0.016***	-0.017***	-0.017***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
CPI	-0.037***					
	(0.006)					
GE		-0.260**				
		(0.168)				
PS			-0.252**			
			(0.113)			
RQ				-0.399***		
				(0.154)		
RL					-0.167***	
					(0.194)	
VA						-0.250***
						(0.242)
AR(1)	0.035	0.021	0.029	0.025	0.027	0.024
AR(2)	0.147	0.163	0.167	0.169	0.163	0.164
Sargan Test	0.802	0.816	0.815	0.816	0.819	0.814
Observations	1500	1549	1546	1549	1549	1549
No of Countries	106	106	106	106	106	106

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

Table A5
System GMM estimator

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.975***	0.965***	0.965***	0.965***	0.966***	0.952***
	(0.010)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
NR	0.006***	0.012***	0.011***	0.012***	0.012***	0.010***
	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
logGDP	0.129***	0.0810*	0.106**	0.0909*	0.169***	0.186***
	(0.023)	(0.048)	(0.046)	(0.047)	(0.026)	(0.052)
TO	0.001	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
FD	-0.002	-0.002	-0.002	-0.002	-0.002	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
CPI	-0.002**					
	(0.002)					
GE		-0.078**				
		(0.039)				
PS			-0.016***			
			(0.023)			
RQ				-0.038		
				(0.033)		
RL					-0.049	
					(0.036)	
VA						-0.151*
						(0.045)
Constant	-0.529*	-0.582	-0.828**	-0.691*	-0.711*	-1.441***
	(0.285)	(0.399)	(0.372)	(0.377)	(0.379)	(0.410)
AR(1)	0.027	0.017	0.021	0.014	0.009	0.011
AR(2)	0.176	0.147	0.158	0.156	0.149	0.150
Sargan Test	0.837	0.867	0.856	0.863	0.859	0.864
Observations	1646	1919	1910	1919	1919	1919
No of Countries	106	106	106	106	106	106

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

Table A6
Instrumental fixed effect model

D. Variables: CO2	1	2	3	4	5	6
$CO2_{it-1}$	0.577***	0.655***	0.848***	0.846***	0.844***	0.648***
	(0.023)	(0.024)	(0.014)	(0.014)	(0.014)	(0.024)
NR_{it-1}	0.010	0.043***	0.015***	0.022***	0.019***	0.0214***
	(0.011)	(0.008)	(0.004)	(0.005)	(0.006)	(0.008)
$logGDP_{it-1}$	0.887***	0.334***	0.224**	0.199*	0.222**	0.360***
	(0.127)	(0.113)	(0.104)	(0.105)	(0.102)	(0.111)
TO_{it-1}	-0.004***	-0.005***	-0.003**	-0.003*	-0.003**	-0.004***
	(0.001)	(0.001)	(0.002)	(0.00155)	(0.002)	(0.001)
FD_{it-1}	-0.006***	-0.005**	-0.004**	-0.005**	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CPI_{it-1}	-0.004***					
	(0.004)					
$CPI*NR_{it-1}$	-0.001**					
	(0.001)					
GE_{it-1}		-0.0545*				
		(0.130)				
$GE*NR_{it-1}$		0.0280***				
		(0.007)				
PS_{it-1}			-0.116*			
			(0.062)			
$PS*NR_{it-1}$			0.008***			
			(0.003)			
RQ_{it-1}				-0.153*		
				(0.085)		
$RQ*NR_{it-1}$				0.011***		
				(0.004)		
RL_{it-1}					-0.280***	

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

D. Variables: CO2	1	2	3	4	5	6
					(0.102)	
$RL*NR_{it-1}$					0.010*	
					(0.005)	
VA_{it-1}						-0.111***
						(0.116)
$VA*NR_{it-1}$						1.001***
						(0.006)
Constant	-4.718***	-2.608**	-0.732	-0.655	-0.916	-1.468*
	(0.922)	(1.012)	(0.722)	(0.741)	(0.728)	(0.851)
Observations	1,557	1,894	1,888	1,894	1,901	1,901
R^2	0.480	0.527	0.696	0.695	0.696	0.489
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

Table A7

Time Instrumental fixed effect model

D. Variables: CO2	**1**	**2**	**3**	**4**	**5**	**6**
$CO2_{it-1}$	0.767***	0.655***	0.655***	0.844***	0.841***	0.844***
	(0.016)	(0.0237)	(0.024)	(0.014)	(0.014)	(0.012)
NR_{it-1}	0.009***	0.0378***	0.027***	0.021***	0.021***	0.024***
	(0.012)	(0.00880)	(0.007)	(0.006)	(0.006)	(0.006)
$logGDP_{it-1}$	0.479***	0.661***	0.698***	0.614***	0.467***	0.376***
	(0.154)	(0.195)	(0.198)	(0.199)	(0.131)	(0.127)
TO_{it-1}	-0.003*	-0.00242	-0.004***	-0.002	-0.004***	-0.004***
	(0.001)	(0.00163)	(0.002)	(0.002)	(0.001)	(0.001)
FD_{it-1}	-0.005***	-0.005**	-0.004*	-0.004**	-0.004*	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CPI_{it-1}	-0.008*					
	(0.004)					
$CPI*NR_{it-1}$	0.001*					
	(0.001)					
GE_{it-1}		-0.0267				
		(0.140)				
$GE*NR_{it-1}$		0.0272***				
		(0.00958)				
PS_{it-1}			-0.201**			
			(0.078)			
$PS*NR_{it-1}$			0.012**			
			(0.006)			
RQ_{it-1}				-0.199**		
				(0.089)		
$RQ*NR_{it-1}$				0.011***		
				(0.004)		
RL_{it-1}					-0.366***	

Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.

D. Variables: CO2	1	2	3	4	5	6
					(0.107)	
$RL*NR_{it-1}$					0.012**	
					(0.005)	
VA_{it-1}						-0.092
						(0.097)
$VA*NR_{it-1}$						0.013***
						(0.004)
Constant	-3.678***	-2.200*	-2.413*	-2.479*	-3.006**	-2.235*
	(1.276)	(1.233)	(1.237)	(1.272)	(1.248)	(1.206)
Observations	1,557	1,894	1,888	1,894	1,901	1,901
R^2	0.588	0.645	0.645	0.645	0.646	0.645
No of Countries	106	106	106	106	106	106
Notes: *** = Significance results at 0.01, ** = Significance results at 0.05 and * = Significance results at 0.1.						

Figures

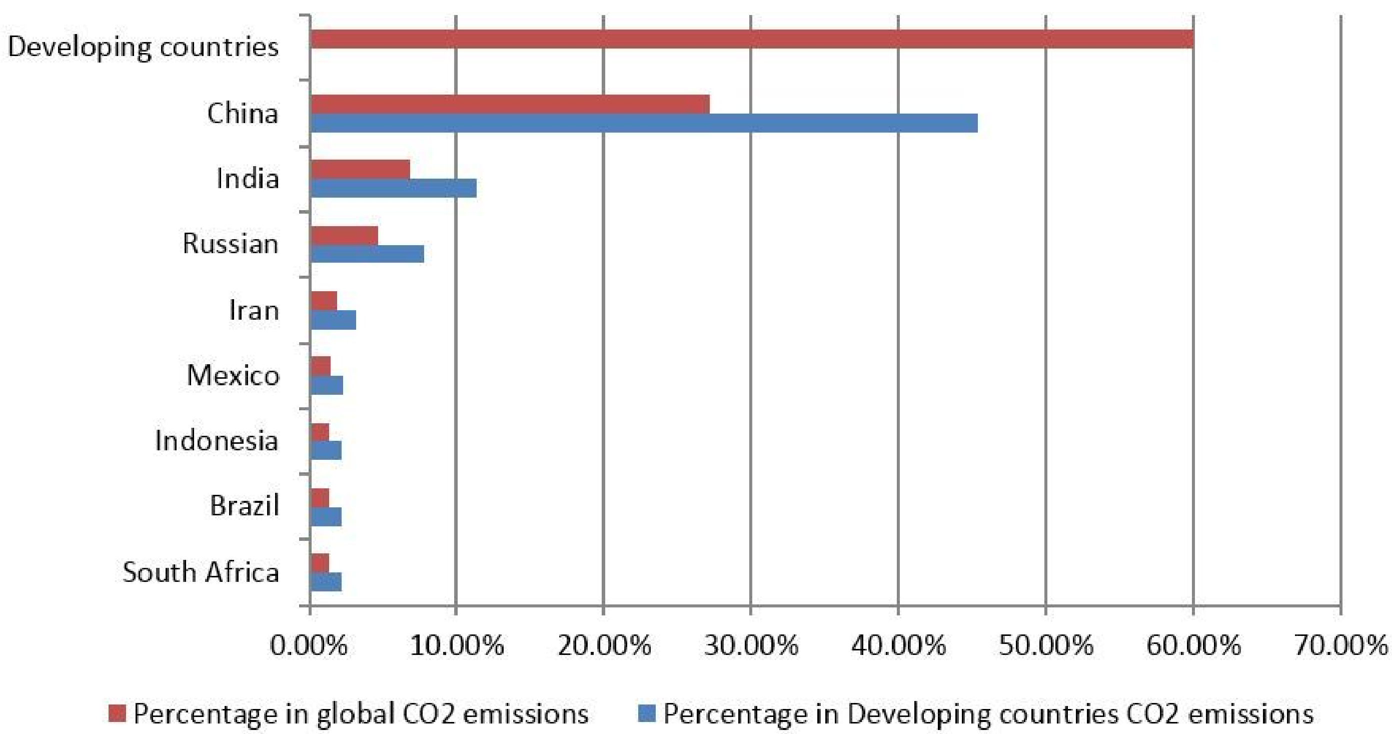

Figure 1

Percentage of developing countries CO2 emissions Source: Joint Research Centre (JRC, 2019)

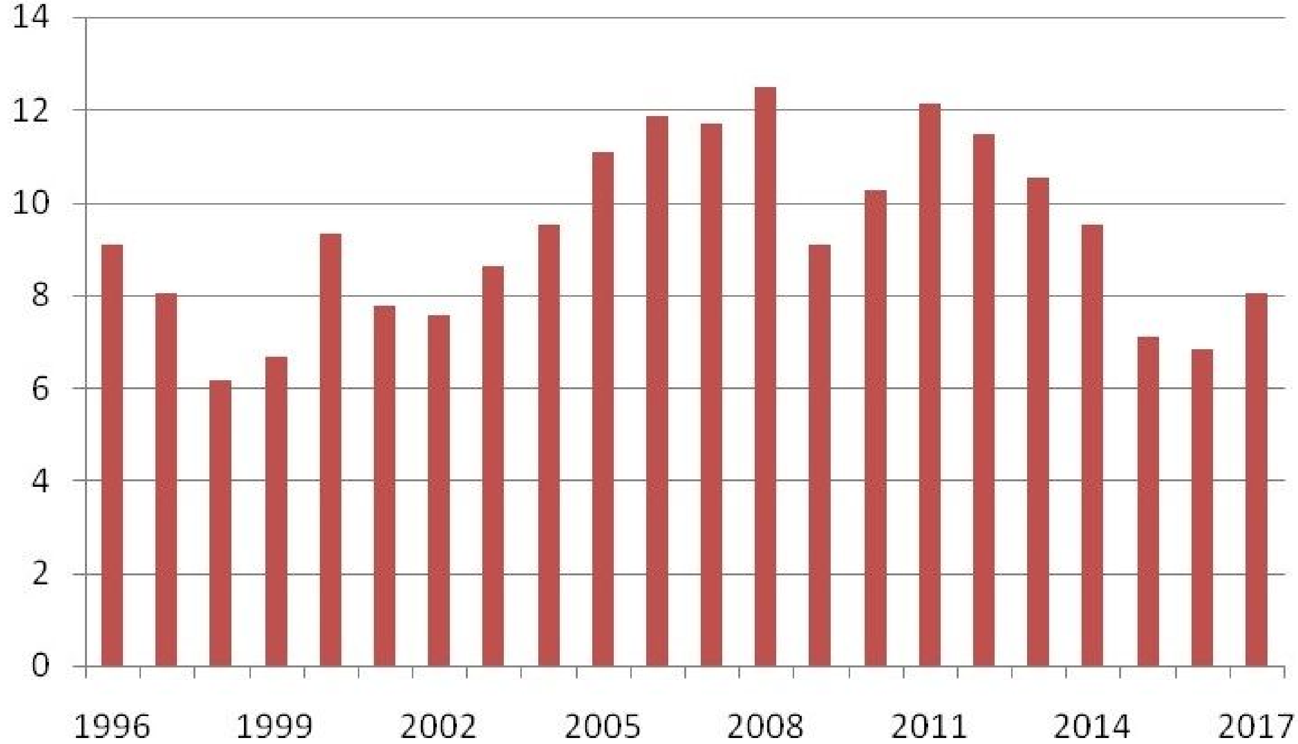

Figure 2

Natural resources rents Source: World development indicators (WB, 2019)

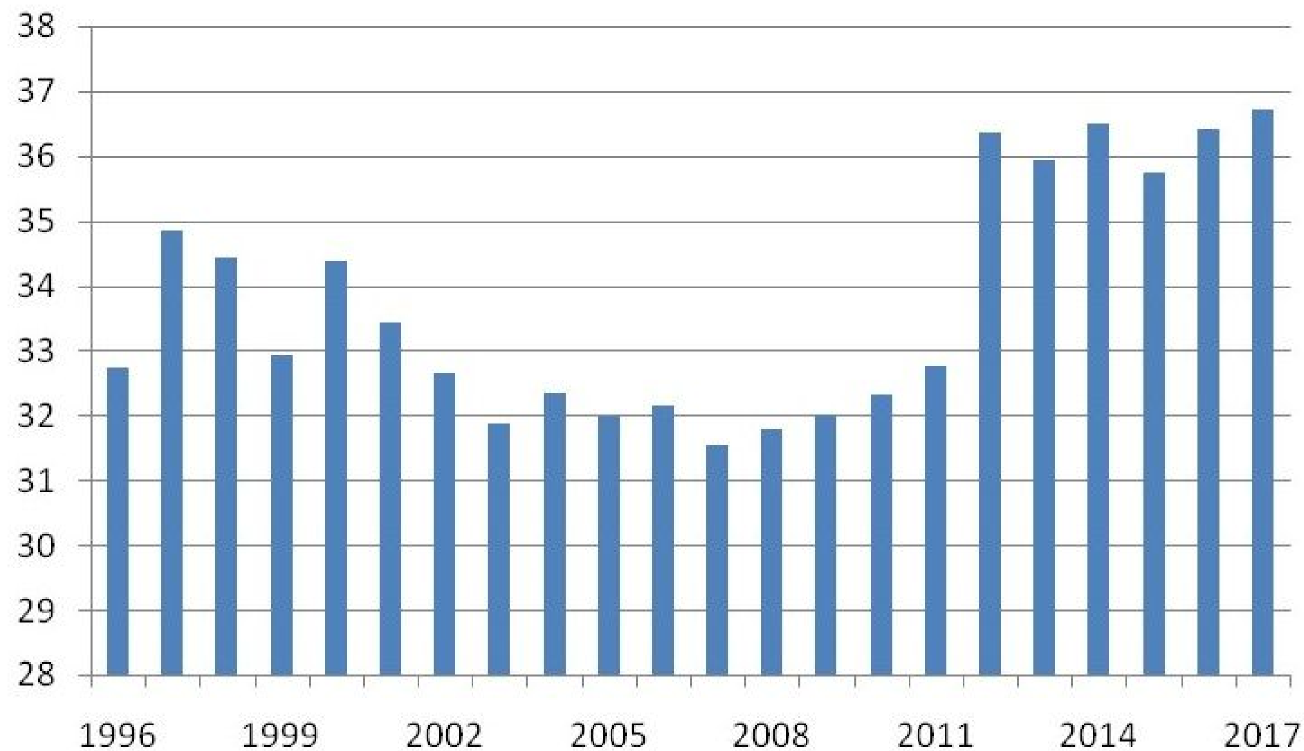

Figure 3

Corruption perception index Source: Transparency International's (Corruption Perception Index, 2019)

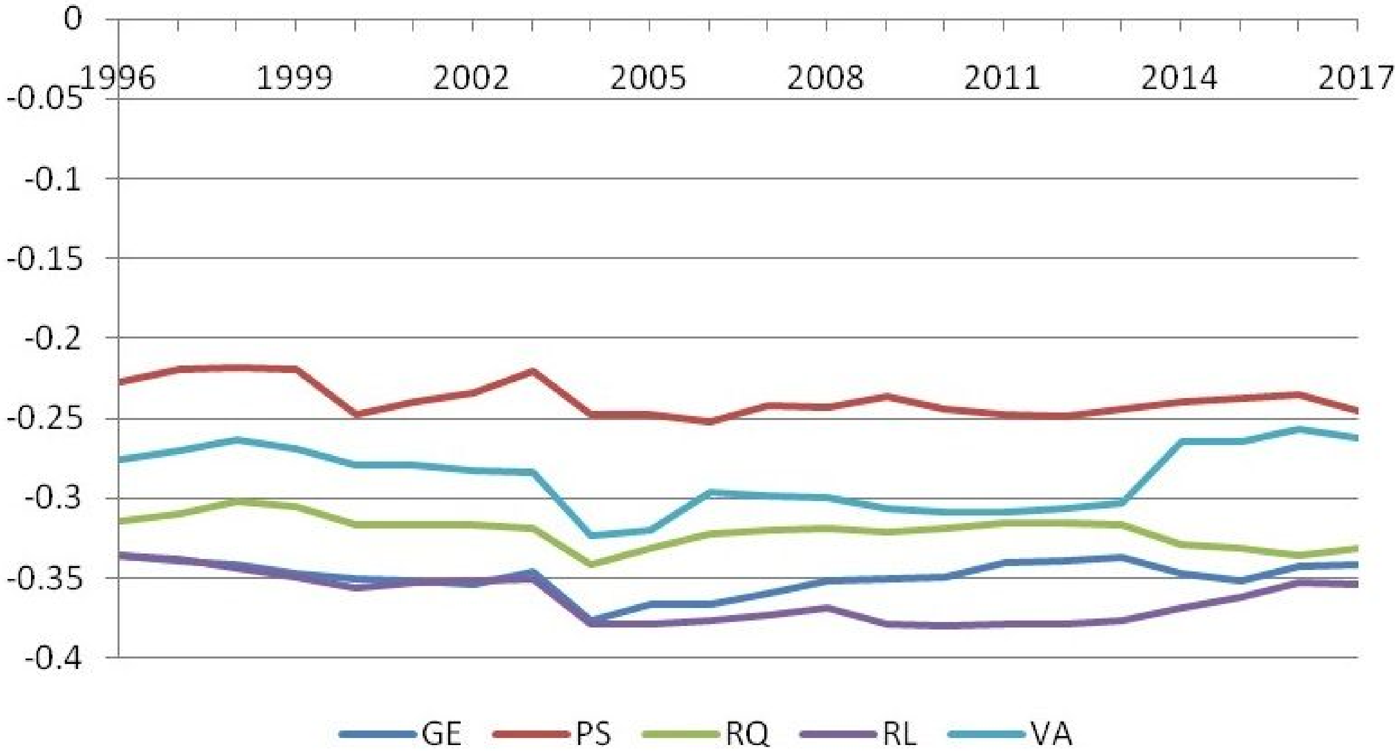

Figure 4

Institutional indicators Source: World governance indicators (WB, 2019)

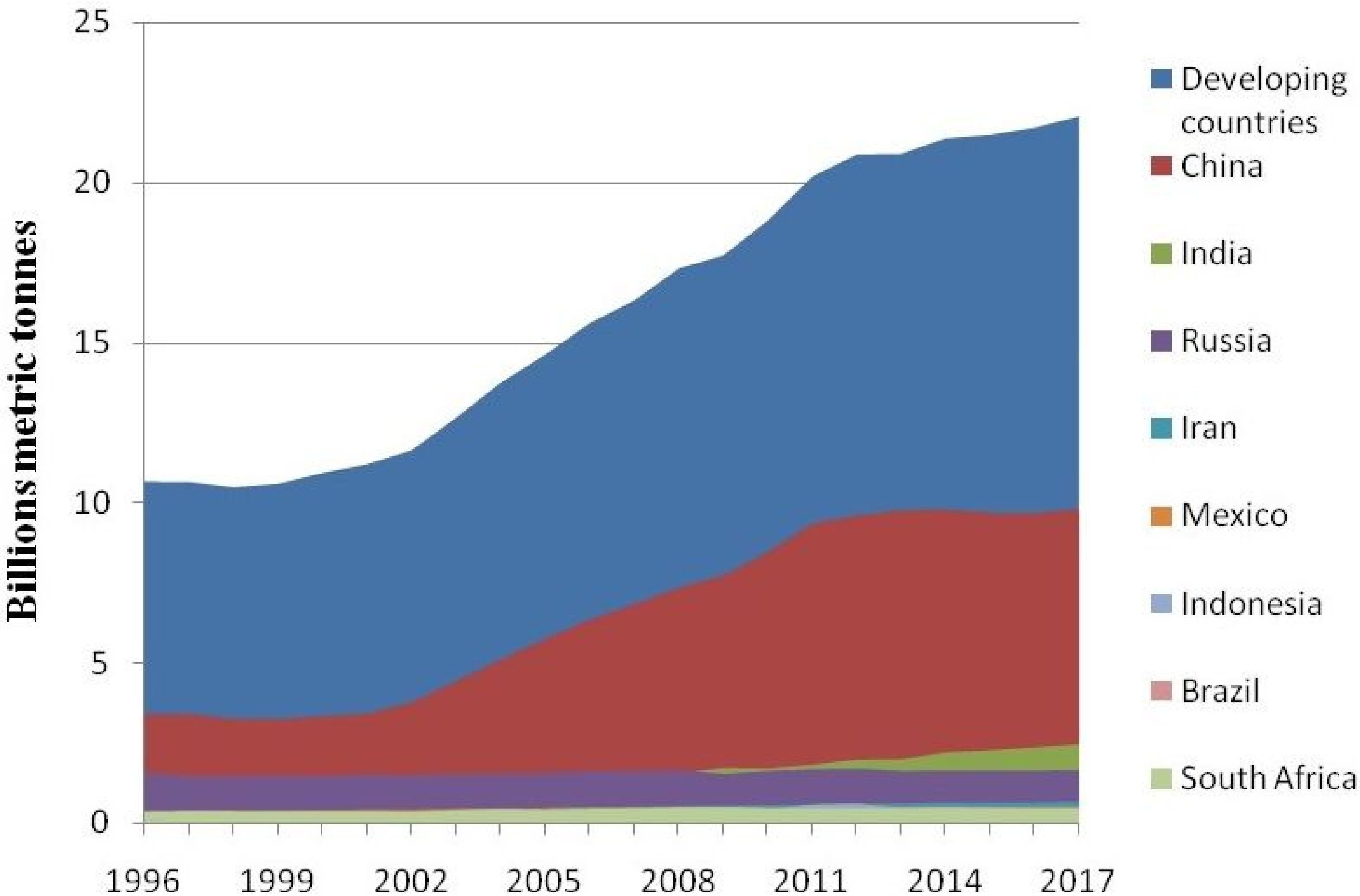

Figure 5

Sum of annual CO_2 emission in developing countries Source: Joint Research Centre (2019)