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The Role of Institutions on the Global Economy-Emissions Nexus

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The role of institutions on the global economy - emissions nexus

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Abstract

In 2015, the COP21 countries made pledges to reduce CO2 emissions, focusing on decreasing emissions in the energy sector. A challenge most of these countries experience is reducing CO2 emissions while sustaining economic growth; a possible solution to this challenge might be to account for the effect of institutional quality. This study examines potential pairwise relationships between economic growth and CO2 emissions while considering the institutional quality. The study uses a panel dataset of 106 countries from 2003 to 2018, divided into four income groups. The findings at a disaggregated level confirm no causal relationship is found for low-income countries; however, causal relationships start to form as results are shown for middle-income to high-income countries. At an aggregate level, the results indicate economic growth granger causes CO_2 emissions, while granger causation was also found between economic growth and institutional quality.

Keywords: Energy, Institutions, Emissions, Institutional quality, Economic growth

1. Introduction

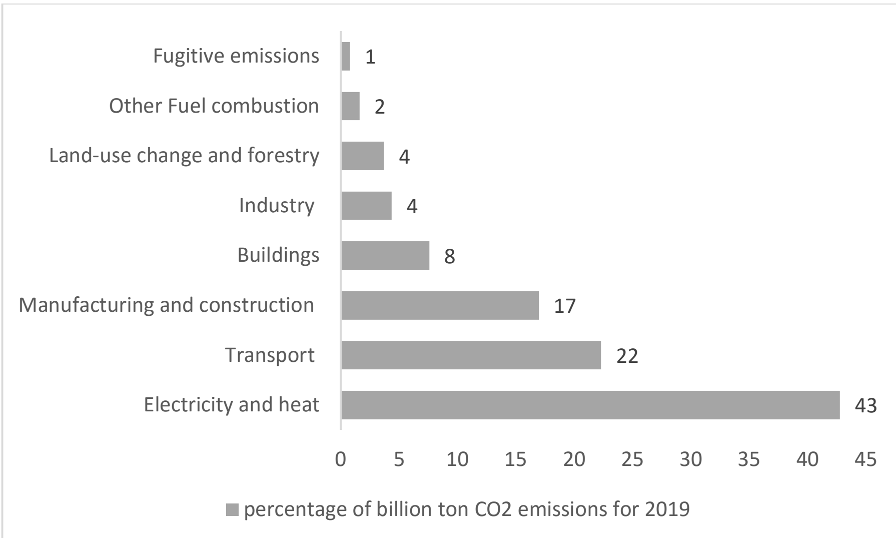
On December 12 2015, COP21 was implemented, and 196 parties came together with one goal: to limit global warming. As COP21 states, one way to limit global warming is to reach a global peak of greenhouse gas emissions as soon as possible (Unfccc, 2015). A significant contributor to greenhouse gas emissions is CO_2 emissions. To reduce CO_2 emissions, most countries focus on decreasing emissions in the energy sector – particularly in the electricity and heat sectors which contributed 43% of total CO_2 emissions in 2019 (Data Explorer | Climate Watch, 2022; Ritchie & Roser, 2020). A challenge most of these countries experience is reducing CO_2 emissions while sustaining economic growth; a possible solution to this challenge might be to account for the effect of institutional quality.

It has been established that CO_2 emissions increase along with economic growth leading to environmental degradation(Al-Mulali, 2012; Bengochea-Morancho et al., 2001; Bhattacharyya & Ghoshal, 2010; Mitić et al., 2017; Narayan & Narayan, 2010). The Environmental Kuznets Curve (EKC) literature explains this relationship, which indicates an inverse relationship between environmental degradation and income. The curve hypothesis explains that within the first stages of economic growth, countries will experience environmental degradation up to a certain point. After the threshold, income levels increase, leading to improvements in the quality of the environment (Ozgur & Yilanci, 2019).

The challenge many countries face is decreasing CO_2 emissions while sustaining economic growth. However, institutions play a role in this challenge as institutions implement policies affecting both economic growth and CO_2 emissions; therefore, institutions might be a tool that can be used to solve this challenge. Good quality institutions can lead to increases in economic growth which can indirectly add to environmental degradation. Significant linkages in literature (Chong & Calderón, 2000; Knack & Keefer, 1995; Mauro, 1995a) have been found between institutions or proxies of institutions, and economic growth has shown that efficient institutions significantly affect economic performance (North, 1990). Institutions play an essential role in the efficient allocation of resources. Societies would experience enhanced efficiency in allocating resources from higher-quality institutions, affecting returns on investments and profits. Acemoglu et al. (2005) indicate that economies will strive where institutions encourage factor accumulation, innovation and efficient allocation of resources. Institutions open to innovation can lead to large-scale research and development.

Institutions can also directly influence efficient policies and their implementation, one of the main determinants that could be used to discourage environmental degradation (Ali et al., 2019; Lau et al., 2014). The latter can assist in the mitigation of climate change. As Ali et al. (2019) indicate, these effective institutions can accelerate a country on the EKC to reach a GHG emissions peak as COP21 states as soon as possible, emitting fewer emissions while achieving sustainable growth in their economies. Institutional quality should be considered when implementing new environmental legislation and policies. Fundamental foundations, such as exemplary quality institutions, are needed to decrease emissions and sustain economic growth.

Figure 1: Global CO_2 emissions per sector for 2019



(Source: Climate watch(2022);Ritchie and Roser (2020))

This study examines the impact of institutional quality in the relationship between CO_2 emissions and economic growth within a Rostow growth theory framework. Given the diverse nature of economic growth, CO_2 emissions and institutional quality within the 106 countries covered in the study, these countries will be subdivided into four income groups according to the World Bank per capita income classification (*World Bank Country and Lending Groups – World Bank Data Help Desk*, n.d.). A panel analysis is done using the Granger causality method to estimate the causality between economic growth, CO_2 emissions and institutional quality from 2003 to 2018. The difficulty most countries experience, which is also mentioned by Stewart (2015), is that "the social, economic and environmental goals are not integrated", which can be problematic when institutions impact policies. In some instances, economic growth is decoupled from environmental degradation, and one is given priority. Understanding the connection between emissions, economic output, and institutional quality is essential. This study indicates the causal relationship between economic growth, CO_2 emissions, and institutional quality in different income groups to clarify how integrating these variables can assist combat against climate change.

2. Literature review

Literature in recent years has indicated that emissions and economic growth have a relationship and can be seen in the pollution growth nexus or EKC literature. A vast amount of literature does not mean the relationship between emission and institutional quality (Ali et al., 2019). Therefore, this study will review studies demonstrating the relationship between institutional quality and its effect on economic growth and environmental degradation. This study will use a different perspective by introducing Rostow's growth stages and literature on how institutions and economic growth exist along with CO_2 emissions.

Literature has indicated that institutional quality plays a significant role in environmental degradation in developed and developing economies(Tauseef Hassan et al., 2019). They have an important role in environmental quality, if they are effective, they decrease costs of economic growth while improving environmental quality. Strong institutions such as the Rule of Law can assist countries in controlling CO_2 emissions, thereby ultimately reducing environmental pollution and creating sustainability for the environment (Asongu & Odhiambo, 2019; Tauseef Hassan et al., 2019).

The effect of corruption is significant to understand as it affects a wide range of economic variables and can also cause environmental degradation. Corruption can decrease the stringency of environmental laws and regulations (Damania et al., 2003; Fredriksson & Svensson, 2003; Welsch, 2004; Zafar et al., 2013) or to what degree of effectiveness is environmental regulation implemented in countries (Welsch, 2004). The total effect of corruption on the environment cannot be determined prior to it occurring. This is because corruption can reduce the prosperity in a country, at some levels of income, pollution maybe be lower than its counterpart where other levels of income may have higher environmental degradations (Grossman & Krueger, 1995; Kraay et al., 1999; Mauro, 1995a; Welsch, 2004)

Ganda (2020) examine corruption's impact on environmental sustainability through two proxies. The dataset consists of 16 Southern African countries from 2010 to 2017 using Granger causality tests and a GMM model. The causality test indicated a bidirectional relationship between corruption and the existing state within these countries. While utilising both corruption proxies in separate models, they suggest that in the short run, corruption within the countries worsens environmental sustainability. Welsch (2004) examines two effects in their study. The first examines "how corruption affects pollution at given levels of income, and the second effect the author examines "the influence of corruption on pollution via corruption's impact on income (indirect effect) and adds the indirect effect to the direct effect to obtain the total effect". The paper uses cross-sectional data with multiple indicators for pollution. The study found that decreasing corruption is key in improving environmental quality as their results indicated that the "effect of corruption on pollution is powerful in low-income countries" and conclude that from a policy point of view it is of importance to decrease corruption in developing regions, should regions succeed in doing this then both the economic and environmental conditions would improve. The latter is also mainly due to the increases in income in these regions as it would be desired for the social wealth of the community and would also be affordable. At the same time, environmental laws have become stricter and more efficient, as mentioned in the previous literature. These studies all indicate that corruption-free culture assists with solid environmental policies, given the Rule of law assists effectively. A strict rule of law institution also stimulates economic growth and GHG emissions, as literature has just indicated (Muhammad & Long, 2021; Welsch, 2004).

These studies indicate that adequate governance, controlling corruption and Rule of Law, can significantly impact environmental degradation. In developing countries, the Rule of Law or conditions for environmental protection are fragile (Zafar et al., 2013). The emissions-institutional literature part that focuses on the Rule of Law indicates that it is measured in a country by the perception "of how well a society is abiding the law" (Muhammad & Long, 2021) in this case, focusing on the areas of policy and regulation enforcement on environmental matters. Efficient and effective Rule of Law institutions in a country can force firms to follow environmental policies, which can assist in mitigating environmental degradation (Muhammad & Long, 2021; Welsch, 2004). A good rule of Law institution also helps with accountability in the markets; if firms do not comply with the Rule of Law, they will be held accountable and made examples of. Muhammad et al. (2021) examined the relationship between institutions and carbon emissions while political stability, the Rule of Law and corruption control represented institutions. A panel data set is used with a combination of 65 belt and road countries from 2000 to 2016. An IV- GMM model was used in the paper. The results indicated that institutional proxies (political stability, corruption control and the Rule of Law) have an important role in decreasing carbon emissions. It was found that political stability might alone not be strong enough to reduce pollution; however, with the assistance of the other two variables, it might be strong enough as both variables indicate they decrease emissions.

As economies go through stages of development along with their respective institutions, future environmental sustainability needs to see how economic growth, institutions and CO_2 emissions impact each other. Some literature does exist on specific relationships between these variables. Extensive research has been done between environmental degradation and macroeconomic variables (Ansuategi & Escapa, 2002; Baloch et al., 2021; Lyeonov et al., 2019; Tucker, 1995). Since the 1980's environmental degradation has become an essential topic in academic literature (Al-Mulali, 2012; Bengochea-Morancho et al., 2001; Bhattacharyya & Ghoshal, 2010; Mitić et al., 2017; Narayan & Narayan, 2010). Grossman and Krueger (1995) explain in their study that an inverse relationship occurs between environmental degradation and economic growth. The hypothesis of the EKC states there are three stages within the EKC. The first stage is where countries start to experience economic growth, and then environmental degradation will increase up to a certain point, after which land enters the second stage. In contrast, income increases, social welfare and the environment become more priorities, and environmental degradation decreases.

Rostow (1959) divided economic development into five stages of economic growth. His theory is differentiated from other theories by accounting for detail on the "composition of investment and development within particular sectors of the economy" and considering the elasticity of demand. It is important to consider the demand for resources as it is determined by society's private demand and social decisions taken by countries' governments. Due to the latter, Rostow indicates welfare functions should be included in developmental research.

The first stage of this theory is known as the traditional society. This stage usually involves agricultural-prone countries with little to no trade presence globally. In this stage, the output is generally consumed by its producers. Economies are also found to be labour intensive while an unavoidable absence of scientific and technological perspectives exists. The second stage of the theory is known as the pre-condition for take-off. This stage is associated with the commercialisation of the agricultural sector and the widening of markets. Technological and scientific perspectives are now developing and at a stage where implementation is beginning. The manufacturing industry is also starting to develop. Hence industrialisation is starting to occur, which causes a build-up in the transport sector. Furthermore, natural resources should be productively exploited to "permit the national government effectively to rule" (Rostow, 1959). This is where institutions start to develop; however, as pointed out by (Acemoglu, 2006; Barro, 1996; North, 1990; Rostow, 1959), institutions are not always effective.

When economic growth, industrialisation, and advancement within the manufacturing sector and institutions occur, the economies move to the third stage of Rostow's theory – the take-off. These countries are moving away from the agricultural sector to the manufacturing sector, with modern industrial techniques assisting self-sustaining. New political and social institutions are gaining momentum while leading sectors attract investment. Stage four- The drive to maturity occurs when countries can now apply new technologies effectively within their economy to increase their resources. New leading sectors are now "gathering momentum to supplant older leading sectors" (Rostow, 1959). In this stage leading sector drive to maturity will be determined by technology, adequate resource endowment and policies of the governments. As these economies mature, they move to stage five, the High mass consumption stage. Within this stage, countries ": achieve both technological maturity and a certain level of real income per head" (Rostow, 1959). These countries are now classified as fully developed, with problems shifting from production to consumption and migrating from rural to urban areas.

Rostow (1959) indicates that development institutions start to play a role and should be considered along with a welfare function – in this study's case, GDP, which will represent economic growth. The dynamic relationships between GDP and institutions have also been vastly researched. Institutions are responsible for incentivising human exchange. However, for this study, they should be differentiated from organisations accountable for providing the structures in society for humans to interact. While having economic freedom, institutions exist in free markets to assist with market failures (Barro, 1996; North, 1990). Literature has shown that institutions can also experience inefficiency within themselves, affecting the economy directly and indirectly. The most common reasons for weak political institutions are ineffective constraints and the implementation of constraints on politicians and leaders. Due to shocks, contracts are becoming more susceptible to failure in the future. Because of the possible failure of contracts, politicians may be prone to implement more distortionary (Acemoglu et al., 2003; Aron, 2000) policies, which weaken or make institutions more vulnerable.

Literature has reviewed the relationships between CO_2 emissions, economic growth and institutions but in pairs of two, leaving the third variable decoupled from the relationship, as Stewart (2015) indicates. This study seeks to include all three variables in one study and examine their impact on one another, as shown in the methodology.

3. Data and Methodology

3.1 Empirical Methodology

Vector autoregressive (VAR) frameworks have been widely used in the past across multiple fields and are often used to test for Granger causality between two or more variables. Given that this study includes 106 countries, a Panel VAR (PVAR) will be used. This will assist with the 16 years as PVARs are effective for short periods due to the efficiency the model gains from the cross-sectional dimensions used (Antonakakis et al., 2017). VARs are also equipped to deal with the endogeneity between GDP and institutional proxies. GDP and CO_2 emissions natural logarithms will be used, while the institutional variable will be recalculated[1] to be between 0 and 1. To ensure that outcomes are not inconsistent, first, a unit root test will be done to determine whether the variables are stationary if long-run relationships are present.

[1] Recalculated value for index = $(value - \text{minimum}\ value) / (maximum\ value - minimum\ value)$

Table 1: Variable description

Variable	Description	Source
CO_2 emissions	This variable is measured in thousand metric tons of CO_2, and it should be noted that the variable data excludes land-use change and forestry data. The definition for this variable is "Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring"(World Development Indicators, 2021).	WDI (World Development Indicators, 2021)
Economic growth - GDP	Real Gross Domestic Product in 2010 US$ terms for each country.	WDI (World Development Indicators, 2021)
Institutions	The World Bank defines control of corruption as the perception the public has of how" 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." (World Governance Indicators, 2021).	WGI (World Governance Indicators, 2021)
	The second variable representing institutions is the Rule of Law which indicates how much citizens respect the Rule of Law and contracts in their country	WGI (World Governance Indicators, 2021)

Correlation Matrix

	CO2 emissions	GDP	Rule of Law	Control of corruption	Institutional Index
CO2 emissions	1				
GDP	0.9350*	1			
Rule of Law	0.2887*	0.4466*	1		
Control of corruption	-0.0130	0.1239*	0.5618*	1	
Institutional Index	0.1560*	0.3228*	0.8837*	0.8837*	1

Descriptive summary

Variable	Observations	Mean	Std. Dev	Minimum	Maximum
CO2 emissions	1696	10.476	1.8939	5.7038	16.1490
GDP	1696	25.2980	1.7885	20.7725	30.6041
Rule of Law	1696	0.4976	0.2533	0	1
Control of Corruption	1696	0.5178	0.2339	0	1
Institutional Index	1696	1.72E-10	1.2497	-2.9549	2.7682

The Levin, Lin and Chu (2002) (LCC), Im, Pesaran and Shin (2003) (IPS), and Phillips-Perron (1988) (PP) unit root tests will be used to determine whether variables are stationary.

With corruption and the Rule of Law as proxies for institutional quality literature, Gwartney et al. (2006) have shown that institutions are endogenous and that correlation between institutional proxies is of concern. Highly correlated institutional factors can create a significant risk for multicollinearity (Moers, 1999; Siddiqui & Ahmed, 2013). This contributes to why literature such as Méon et al. (2005) and Acemoglu et al. (2001) use each institutional indicator in their study in separate equations to avoid the latter problem. Other literature (Alcalá & Ciccone, 2004; Hall & Jones, 1998; Mauro, 1995b) uses sample averages of institutional indicators because this method cancels out the source-specific measurement error. Another option is to construct an index of the institutional indicators. This study's method of constructing an index is known as Principal Component Analysis (PCA). Bittencourt (2012) produced a composite political index based on the PCA method. The study benefited from this method as the PCA allowed the "extraction of unobserved common factors of different political regime variables" (Bittencourt, 2012). With this method, the proxy for political regime characteristics gained a higher explanatory power. "PCA forms factors that are uncorrelated linear combinations of the observed variables" (Siddiqui & Ahmed, 2013). The PCA[2] method explains that the maximum variance is present for the first factor, and the factor leading after this factor's variance becomes progressively smaller but uncorrelated. Concerning eigenvalues, Kaiser (1974)and Siddiqui et al. (2013) suggest dropping elements with a numerical value of less than one. This study runs the regressions of two institutional variables separately as well as runs another separate regression with a PCA index of the institutional variables.

This study will use a traditional panel VAR model that will treat the variables within the system as endogenous (Antonakakis et al., 2017). This PVAR model uses the Generalised Method of Moments (GMM)(Abrigo & Love, 2016). The PVAR model is specified in Equation 1.

$$Y_{it} = A_1 Y_{it-1} + A_2 Y_{it-2} + \cdots + A_n Y_{it-n} + BX_{it} + \mu_i + \varepsilon_{it} \qquad (1)$$

Where Y_{it} is a $(1x\kappa)$ vector of the dependent variables while X_{it} represents a vector of $(1x\ell)$ vector of exogenous covariates.

The dependent variable-specific panels' fixed effects and idiosyncratic errors are represented by μ_I and $\varepsilon_{it,}$ respectively(Abrigo & Love, 2016). After estimating the PVAR models, the Granger causality is then estimated respectively to indicate if causal relationships exist between CO2 emissions, GDP and institutional quality.

To test granger causality, the following three equations will be used. For Equation 2, the study will test if GDP, the two institutional proxies and the institutional index Granger cause CO_2 emissions.

$$CO2emissions_{it} = \alpha_i + \sum_{k=1}^{p} \gamma_i^k CO2emissions_{i,t-k} + \sum_{k=0}^{p} \theta_i^k GDP_{i,t-k} + \sum_{k=0}^{p} \beta_i^k Institutions_{i,t-k} + \varepsilon_{i,t} \qquad (2)$$

[2] Total number of factors in PCA = Number of Observations - this ensures that all variations in the study's' data set is included (Siddiqui & Ahmed, 2013).

Likewise, to Equation 2, CO_2 emissions and two institutional proxies along with the institutional index will now be used to see if they Granger-cause GDP, respectively.

$$GDP_{it} = \alpha_i + \sum_{k=1}^{p} \gamma_i^k GDP_{i,t-k} + \sum_{k=0}^{p} \theta_i^k CO2emissions_{i,t-k} + \sum_{k=0}^{p} \beta_i^k Institutions_{i,t-k} + \varepsilon_{i,t} \tag{3}$$

For the last Granger causality test, we will test whether GDP and CO_2 emissions granger cause the two institutional proxies and the institutional index, respectively.

$$Institutions_{it} = \alpha_i + \sum_{k=1}^{p} \gamma_i^k Institutions_{i,t-k} + \sum_{k=0}^{p} \theta_i^k GDP_{i,t-k} + \sum_{k=0}^{p} \beta_i^k CO2emissions_{i,t-k} + \varepsilon_{i,t} \tag{4}$$

3.2 Data

This study considers an annual balanced panel dataset for 106 countries covering 2003 to 2018. The most significant sample of countries was selected to allow for a broad spectrum of economies. Aggregated data was used for results; however, to gain more detailed results, the sample countries were divided into four income groups per the World Bank divisions (*World Bank Country and Lending Groups – World Bank Data Help Desk*, n.d.) shown in Table 1. Low-income countries' income per capita should be less or equal to $1045[3]. All countries earning an income per capita between $1046 to $4095 will fall within the lower-middle income group. Countries will fall within the upper-middle income group when the income per capita falls between $4096 and $12695. The countries in the high-income group will need to earn an income per capita of $12696 or more.

The data for the empirical study will include CO_2 Emissions, Economic growth, which will be proxied by Gross Domestic Product (GDP) and the two proxies used for institutional quality: Corruption and the Rule of Law. The two institutional variables have been selected from Venter and Inglesi-Lotz (2021); the latter study examines the impact that various institutional factors have on electricity supply and found that the majority of the institutional factors used do affect the electricity supply of countries, whether it be an increase in electricity supply or an efficiency gain occurring in the markets. The study indicates that improved institutional quality can lead to market stabilisation and higher electricity supply efficiency. The description of each variable is discussed in Table 2.

When considering the expectation for CO_2 emissions, it is important to account for the calculation of CO_2 emissions, which is the consumption of a source multiplied by the emissions factor of the source. From the latter, if such sources' consumption increases, the emissions of those sources will increase. Increases in economic activity usually accompany increases in consumption. Economic growth is expected to increase as emissions increase depending on the level of development the country finds

[3] Current US$ is used for calculations (*The World Bank Atlas Method - Detailed Methodology – World Bank Data Help Desk*, n.d.)

itself in (Grossman & Krueger, 1995; Rostow, 1959). Increases in emissions will also have varying impacts on institutions, depending on the stages of development the countries are in.

Given the quality of institutions, an increase in GDP production usually coincides with an expected increase in CO2 emissions (Grossman & Krueger, 1995). It is scheduled for low-income countries where GDP increases, institutional progress can occur, along with manufacturing, and CO_2 emissions can increase. The opposite may be true for higher-income countries as they are usually more service orientated, with higher quality institutions; therefore, even with an increase in GDP, they may emit fewer emissions.

The expectation is that as institutional progress occurs, GDP will increase due to the stabilisation of markets and attract more investors, leading to efficiency gains. This can stimulate GDP. As institutional progress occurs, corruption decreases and environmental laws become more strict; as the literature indicates, therefore, it is expected that CO_2 emissions will decrease at a particular stage.

4. Empirical Results

The LLC, IPS and PP unit root tests presented in Table 3 indicates that CO_2 emissions, GDP and the two institutional proxies are stationary I(0), with CO_2 emissions and GDP being in their natural logarithms and institutional proxies having a value between 0 and 1[4].

Table 2: Unit root test results[5]

Type of unit root test	Specification	CO2 emissions	GDP	Corruption Control	Rule of Law
		Statistic	Statistic	Statistic	Statistic
	No trend	-7.8526***	-7.3196***	-6.8754***	-6.4418***
	Include time trend	-9.0056***	-11.1846***	-9.4766***	-10.1463***
	Suppress panel-specific mean	3.1276	16.2805	-2.5633***	0.6785
LLC	Subtract cross-sectional mean	-6.5549***	-9.2536***	-6.8687***	-6.5990***
	No trend	2.2574	0.7380	-0.5834	-1.7351**
	Include time trend	-5.9505***	-1.2311	-6.4506***	-8.0939***
IPS	Subtract cross-sectional mean	3.7220	4.8206	-0.3838	-1.8245**
	No trend	246.1006*	441.5917***	230.7061	279.7425***
	Include time trend	250.9375**	150.7969	255.4371**	323.6318***
PP	Subtract cross-sectional mean	201,9055	265.8293***	222.5071	292.2649***

[4] If all regressors are of order integration I(0) -then the regressors cannot be cointegrated (Philips, 2018), after which one can proceed to regressions.
[5] *, ** and *** indicates significance at 10%, 5% and 1% respectively.

Rostow's (1959) framework of the five stages of economic growth assists in describing the study's results. Low-income countries can be linked with the first stage – the traditional society. No causal relationships were found for these countries. Still, it is due to the agricultural-driven economies that these countries' societies do not necessarily have a scientific and technological perspective. Middle-income countries can be linked to the second, third and fourth stages – the preconditions to take-off, the take-off stage and the drive to maturity stage. Granger causation occurs within these two country groups as they usually experience significant short-term growth at the initial stages of industrialisation and institutional development. The study found that high-income countries can be linked to Rostow's (1959) fifth stage, where high levels of consumption and production are experienced, with the results indicating economic growth granger causes CO_2 emissions.

For the aggregate country group, economic growth was found to granger cause CO_2 emissions while considering corruption control and the institutional quality index. The latter is in line with theory, with most of the countries in the aggregated group having a manufacturing sector emitting emissions. CO_2 emissions are granger causing corruption control, while economic growth was found to granger cause corruption control. Acemoglu et al. (2005) explained that economic growth would increase institutional quality.

4.1. Low-income country group

No causal relationship was found for lower-income countries. This is expected with Rostow's (1959) first stage – the traditional society, which indicates institutions have not developed yet and that these countries have agricultural-driven economies which are not necessarily commercialised yet. These countries have low economic growth at this stage, and since their most significant sectors do not include the production of goods, their emissions are low as their energy demand is low.

4.2. Low-middle-income country group

Some granger causality is found between the three variables for the lower middle-income group. The latter income group is linked to the second stage of Rostow's (1959) theory – the preconditions to the take-off stage. This group of countries are now starting to experience economic growth as the manufacturing sector is established; this will increase energy consumption and CO_2 emissions. For this country group, the results are in line with the explanation where institutions are Granger caused by economic growth and CO_2 emissions. Corruption and the institutional index were found to granger cause CO_2 emissions. While these institutions assist with the development, it may affect energy consumption, affecting CO_2 emissions. As the country is experiencing development with higher consumption, this economic advancement and increased CO_2 emissions affect the quality of institutions – CO_2 emissions are also found to granger cause control of corruption

4.3. Upper-middle-income country group

Countries in the upper-middle-income group fall under stage 3 or 4 – the take-off stage or the drive to maturity stage. These economies are experiencing economic growth as they advance from agricultural to manufacturing-driven economies. In these stages, as increased manufacturing production occurs, CO_2 emissions increase due to higher demand for energy from the manufacturing sector and others Dong et al. (2020). These economies are usually not in a financial position yet to move entirely from fossil-fuelled points to renewable energy, leaving them with high emissions from energy production. The above explains that economic growth granger causes CO_2 emissions for two of the three institutional quality proxies. At this stage, as already explained, economic growth can lead to better institutional quality, which is in line with the results indicating economic growth is Granger causing control of corruption and the institutional index. Lastly, all three institutional factors granger cause economic growth. As institutional quality improves, it stabilises markets leading to improved economic performance

With development occurring in industrial economies, institutions would generally encourage innovation and stabilise the market with the efficient allocation of resources (Acemoglu et al., 2005; Koeniger & Silberberger, 2015). As institutions become more efficient, it significantly affects and even enhances economic performance (North, 1990). Policies are created by institutions and influenced by the quality of these institutions that implements the policies. As institutions become more effective, policies will become more effective, resulting in social welfare responsibilities (Dong et al., 2020) and environmental policies targeting emissions, thereby reducing pollution. The latter explains why the Rule of Law and the institutional index are found to Granger cause economic growth.

4.4. High-income country group

High mass consumption – Rostow's (1959) fifth stage can be linked to high-income countries. These countries are mostly seen as developed countries that are manufacturing to service orientated with high consumption levels. With manufacturing industries still existing in most sectors of the economies and high levels of consumption, energy demand may still be high as their countries are still partaking in a cleaner energy transition. The latter explains how economic growth granger causes CO_2 emissions. No granger causation was found between CO_2 emissions and institutional variables and institutional variables and economic growth. Other studies have also found this to be the case as Lee et al. (2009) indicate institutions' role within high-income countries diminishes while Law et al. (2008) found institutions' effect to be less significant in high-income countries to middle and low-income countries groups (Hook Law et al., 2013).

Table 3: Granger Causality Results[6]

	Hypothesis	Aggregate Countries		Low-Income Countries		Lower Middle Income Countries		Upper Middle Income Countries		High-Income Countries	
		Chi2	Conclusion	Chi2	Conclusion	Chi2	Conclusion	Chi2	Conclusion	Chi2	Conclusion
Corruption Control	CO2→GDP	0.339	No Causality	0.227	No Causality	0.079	No Causality	2.753	Causality	0.031	No Causality
	GDP→CO2	4.157	Causality	0.623	No Causality	0.138	No Causality	2.472	No Causality	1.221	No Causality
	CO2→CC	3.277	Causality	0.076	No Causality	3.120	Causality	4.117	Causality	0.028	No Causality
	CC→CO2	0.000	No Causality	0.358	No Causality	4.309	Causality	1.049	No Causality	0.015	No Causality
	GDP→CC	4.813	Causality	0.045	No Causality	3.858	Causality	6.479	Causality	0.008	No Causality
	CC→GDP	5.101	Causality	2.061	No Causality	0.766	No Causality	1.658	No Causality	0.031	No Causality
Rule of Law	CO2→GDP	0.109	No Causality	0.650	No Causality	0.001	No Causality	2.283	No Causality	0.185	No Causality
	GDP→CO2	2.416	No Causality	0.784	No Causality	0.381	No Causality	3.691	Causality	0.907	No Causality
	CO2→RL	0.318	No Causality	0.629	No Causality	2.281	No Causality	0.000	No Causality	1.191	No Causality
	RL→CO2	0.605	No Causality	0.472	No Causality	3.637	Causality	0.140	No Causality	0.031	No Causality
	GDP→RL	0.372	No Causality	0.649	No Causality	3.235	Causality	0.052	No Causality	0.046	No Causality
	RL→GDP	9.089	Causality	0.534	No Causality	1.688	No Causality	8.960	Causality	0.355	No Causality
Institutional index. of Corruption Control and Rule of Law	CO2→GDP	0.015	No Causality	0.746	No Causality	0.037	No Causality	2.983	Causality	0.023	No Causality
	GDP→CO2	4.227	Causality	1.180	No Causality	0.000	No Causality	3.719	Causality	3.041	Causality
	CO2→PCA	1.122	No Causality	0.273	No Causality	4.294	Causality	2.541	No Causality	0.057	No Causality
	PCA→CO2	0.210	No Causality	0.695	No Causality	4.089	Causality	0.832	No Causality	0.037	No Causality
	GDP→PCA	1.850	No Causality	0.377	No Causality	5.484	Causality	4.096	Causality	0.497	No Causality
	PCA→GDP	10.07	Causality	1.320	No Causality	1.362	No Causality	4.776	Causality	0.352	No Causality

5. Conclusion and discussion

With the rising threat of climate change, countries from all over the world came together during COP21 to take measures to combat climate change. One of their goals is to decrease GHG emissions. With the latter in mind, these countries look at their energy sectors, more specifically the electricity and heat sector, as this sector contributes the largest portion of CO_2 emissions, which in turn contributes to GHG emissions. Institutions may be the solution for countries that struggle to decrease emissions while sustaining economic growth. This study examines if pairwise causal relationships exist between CO_2 emissions, economic growth and institutional quality.

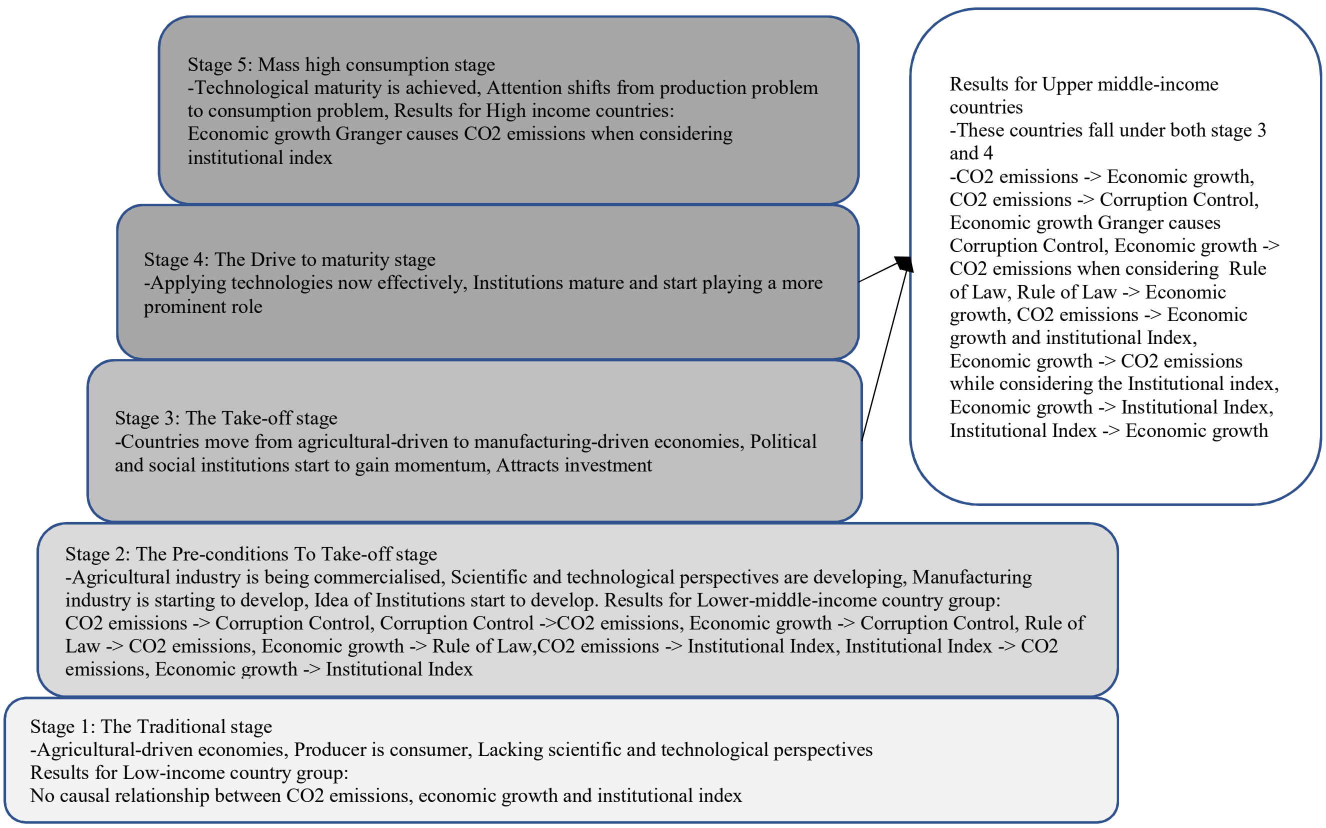
The overall results indicate that as economic developmental changes start, causal relationships begin to form. While no causal relationship was found for the low-income countries, it is explained due to the countries being agricultural-driven economies and lacking scientific and technological perspectives (Rostow, 1959). As Countries develop into more industrialised driven economies, institutions start to

[6] *, ** and *** indicates significance at 10%, 5% and 1% respectively.

have an impact. At the same time, consumption increases with increased energy demands explaining the causal relationships found for middle and high-income country groups.

The difficulty most countries experience, as mentioned by Stewart (2015), is that "the social, economic and environmental goals are not integrated" within countries' policy frameworks, which can be problematic. This study aims to assist institutions on when to account for integrating CO_2 emissions, economic growth, and institutional quality within the policy framework. Institutions impact policies that affect economic growth and CO_2 emissions; therefore, less developed countries can gain an advantage with good quality institutions influencing these policies.

Figure 2: Summary of Rostow's growth stages and study's results



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7. Appendix

Table 4: Countries per Income Group

Low-Income Countries - Less or Equal to $1045						
Ethiopia	Mozambique					
Gambia	Sierra Leone					
Madagascar	Sudan					
Malawi	Uganda					
Mali	Yemen					
Lower Middle-Income Countries – $1046 to $4095						
Algeria	Egypt	Honduras	Morocco	Pakistan	Sri Lanka	Vietnam
Bangladesh	El Salvador	India	Myanmar	Papua New Guinea	Tanzania	Zambia
Bolivia	Ghana	Indonesia	Nicaragua	Philippines	Tunisia	
Cameroon	Haiti	Kenya	Nigeria	Senegal	Ukraine	
Upper Middle Income Countries - $4096 to $12 695						
Albania	Botswana	Cuba	Jamaica	Mauritius	Peru	Turkey
Argentina	Bulgaria	Dominican Republic	Jordan	Moldova	Romania	
Armenia	China	Ecuador	Kazakhstan	Namibia	Russia	
Azerbaijan	Colombia	Georgia	Lebanon	Panama	South Africa	
Belarus	Costa Rica	Guatemala	Malaysia	Paraguay	Thailand	
High-Income Countries - Equal to or More than $12 696						
Australia	Cyprus	Greece	Lithuania	Portugal	UAE	
Austria	Czech Republic	Hungary	Luxembourg	Saudi Arabia	UK	
Bahrain	Denmark	Iceland	Netherland	Singapore	US	
Belgium	Estonia	Ireland	New Zealand	Slovenia	Uruguay	
Canada	Finland	Israel	Norway	Spain		
Chile	France	Italy	Oman	Sweden		
Croatia	Germany	Japan	Poland	Switzerland		