INVESTIGATING THE RELATIONSHIP BETWEEN CORRUPTION AND CLIMATE CHANGE: IS CORRUPTION BAD FOR CLIMATE CHANGE?

AN UNDERGRADUATE THESIS

BY

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SUBMITTED IN FULFILLMENT OF POLITICAL SCIENCE DEPARTMENTAL HONORS REQUIREMENTS

2019

Acknowledgements

Special thanks to Professors Ronald B. Mitchell and Craig M. Kauffman for their support and guidance throughout the writing of this paper.

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Abstract

Climate change is one of the most pressing global concerns. It is widely known that corruption adversely effects the economy and causes political and social issues, however, research on the impact of corruption on the environment, especially climate change, is still new. This paper investigates the relationship between corruption and climate by researching the question, *do more corrupt countries emit more CO2 emissions than otherwise similar but less corrupt countries?* Initial findings in Figures 2 and 3 of this paper show a relationship exists between corruption and climate change, when emissions are measured as grams per 2010 US$ of GDP i.e. when GDP is taken into account. Further conditions are applied to the data including: level of development, energy use, energy type, trade, institutions and governance, and type of economy, to examine whether these initial findings are as a result of correlation or causation. A majority of the findings show that, irrespective of these conditions being applied to the data, as corruption increases, CO2 emissions increase. While more research needs to be conducted with a larger number of cases, this paper suggests corruption *is* bad for climate change. Therefore, in order to *effectively* address climate change on a global scale, efforts need to be made in addressing corruption too.

1. Introduction

Corruption adversely effects many things, however, is climate change one of them? This paper answers this question by investigating whether *more corrupt countries emit more CO2 emissions than otherwise similar but less corrupt countries?* "In contrast to the income-pollution and corruption-income linkages, systematic analysis of corruption-environment interactions has only just started" (Welsch, 2004, p. 664). However, this research has proven to be important as it has shown the ways in which corruption can impact the environment including: the direct and indirect effects, significance of political instability, impacts to the stringency of regulations and effects of historical experience of corruption. Moreover, this research has implications for policy formation, environmental regulations and international agreements.

Further investigation into the influences on climate change emissions is important as climate change itself is one of the most pressing environmental problems the world faces. As Mardani et al. (2019, p. 44) states:

> "A study about greenhouse gases is very important lately as a result of their contribution to climate change and its consequences on human life, biodiversity, the environment and vegetation. Moreover, the study of carbon dioxide and factors that contribute to its emissions is much more important since it's the largest GHG emitted hence the largest contributor to climate change."

Scholars have theorized about corruption's impacts on various other environmental concerns, but this paper investigates corruption's impact on climate change, looking at this relationship on a global scale. By having a better understanding of the relationship between corruption and climate change, this research can be help inform more effective international environmental policies aimed at combating climate change.

We can start our analysis with a basic assessment of the cross-national correlation between levels of corruption and total CO2 emissions. Figures 1-3 show this relationship for both 1995 and 2014. These years are the earliest and the most recent years for which both Transparency International Corruption Perception Index (CPI) scores and CO2 emissions data[1] are available. Examining the relationship twenty years apart documents the relationship between corruption and CO2 emissions and how that relationship has changed over time.

Figure 1: The Relationship between Corruption and Average Total CO2 Emissions for 1995 and 2014

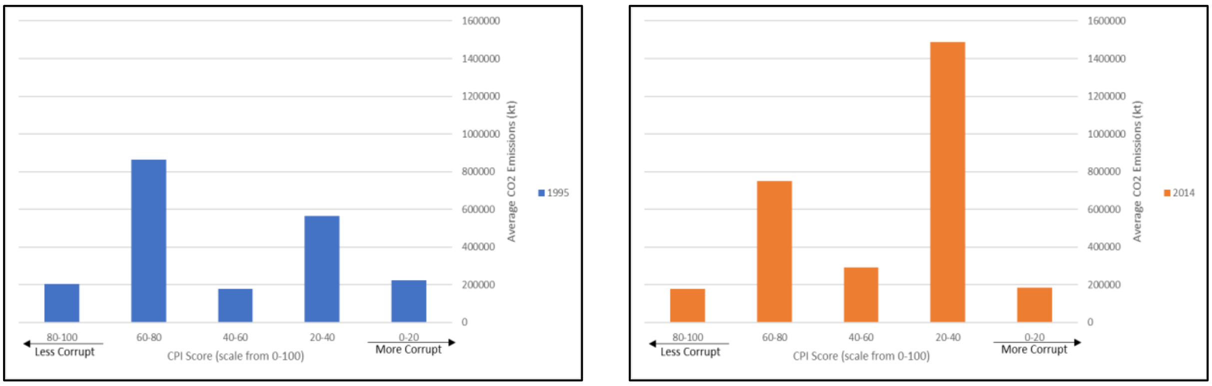


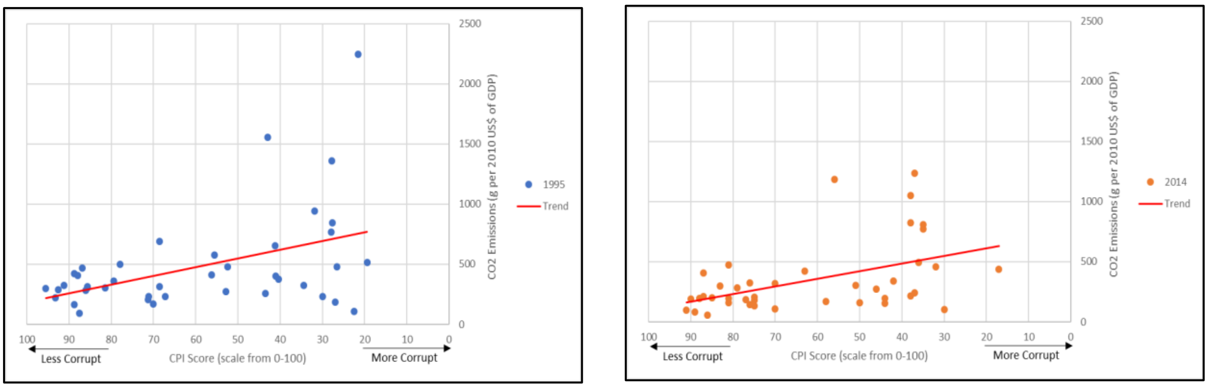
Figure 1 examines if there is a correlation between specific corruption score ranges and *total* emissions over time, by grouping the sample countries according to their corruption scores in 20-point ranges, and calculating the average total emissions for those groups. This is done in order to see a) which CPI score range emits the most emissions, and b) does that range change over time i.e. is there a range of corruption scores that are more likely to emit more emissions, and therefore, countries that are fall within that range are more likely to emit greater emissions.

[1] CO2 Emission data taken from the World Bank, World Development Indicators.

It is observed, in Figure 1, that no clear relationship exists between corruption and CO_2 emissions, and that there are varying results for the groups of CPI scores and emissions over time. For 1995, average total CO_2 emissions are greatest for countries with CPI scores between 60-80, countries with CPI scores between 20-40 having the second greatest average total CO_2 emissions, and countries with CPI scores between 80-100, 40-60, and 0-20, having lower, and almost equal, CO_2 emissions. Similarly, in 2014, corruption and average total CO_2 emissions and countries do not exhibit a strong relationship, with no obvious tend in emissions as CPI scores increase. These figures demonstrate that no consistent relationship exists between corruption and average total CO_2 emissions in 1995 or 2014, when countries are grouped according to corruption scores.

Moreover, where all other groups of countries have similar emissions to those in 1995, emissions in the group of CPI scores between 20-40 have more than doubled in the years from 1995 to 2014. This could be as a result of a) the countries in this group increasing their emissions over this time period, b) a country that emits large amounts of emissions' CPI score changing to that of between 20-40, or c) both of these scenarios occurred. It is important to note all these possibilities for the results shown in Figure 1, as it proves that the issue of increased emissions and climate change is inherently interconnected and complicated. In turn, both the causes and the solutions to this issue are complicated and have to be thoroughly researched and understood in order to create effective and sustainable solutions.

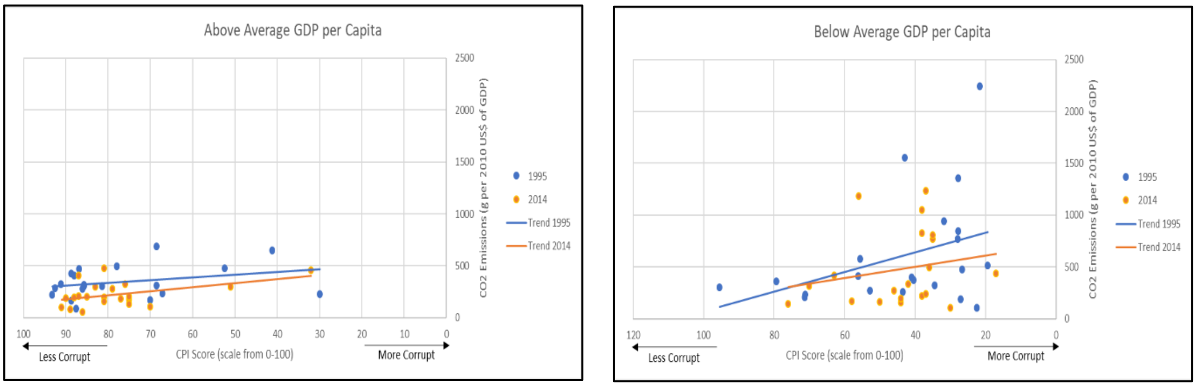
Figure 2: The Relationship between Corruption and CO2 Emissions per US$ for 1995 and 2014



As Figure 1 shows no obvious relationship between countries grouped according to their CPI scores and their average *total* emissions, Figure 2 begins to address the question: does a relationship exist between corruption and emissions on an individual level i.e. when countries are not grouped according to CPI scores?

Furthermore, it is widely known that corruption effects the economic situation of a country, and the economic situation of a country i.e. GDP, is known to be one of the primary indicators of emissions, therefore, we may ask if the relationship between corruption and emissions is instead a relationship between GDP and emissions? In other words, is the correlation between corruption and emissions the same when GDP is taken into account? Figure 2 begins to address this question by measuring emissions as kilograms per 2010 US$ of GDP, instead of total emissions as used in Figure 1. This figure shows the trend of emissions increasing as corruption increases, and overall, CO2 emissions per 2010 US$ have decreased from 1995 to 2014.

Figure 3: The Relationship between Corruption and CO2 Emissions per US$ Depending on GDP per Capita



As Figure 2 begins to show that there may be a correlation between corruption and emissions when GDP is taken into account, Figure 3 goes a step further in incorporating GDP, by grouping countries according to income levels, measured as GDP per capita[2], while at the same time, emissions continue to be measured as kilograms per 2010 US$ of GDP, rather than total emissions.

This figure, like Figure 2, shows that emissions increase as corruption increases. However, this correlation is much more significant among poorer countries than it is among richer countries. Moreover, most countries with above average GDP are less corrupt, and countries with below average GDP are more corrupt. As a result, countries with below average GDPs, and in turn more corrupt countries, emit far more emissions than countries with above average GDPs. This is further examined in the fact that emissions in below average GDP countries exceed 1000 in 2014, compared to all above average GDP countries' emissions falling below 500 in the same year.

Additionally, the relationship between emissions and corruption was stronger in 1995 than in 2014. This reflects that emissions have decreased overall between 1995 and 2014, which is true for all the countries in Figure 3. The outlier countries in Figure 3 show

[2] Averages are calculated from the 41 countries studied in this paper.

that a) countries with above average GDPs have become less corrupt over time, with fewer outliers with lower CPI scores in 2014 than in 1995 and b) countries with below average GDPs have become more corrupt over time, with fewer outliers with higher CPI scores in 2014 than in 1995.

Figures 2 and 3 show that there is a correlation between increased corruption and increased CO_2 emissions, even after accounting for GDP as a major determinant of CO_2 emissions and corruption levels. As correlation need not mean causation, this paper goes on to examine whether corruption is in fact a *cause* of climate change.

When the following conditions: level of development, energy use, energy type, trade, institutions and governance, and type of economy, are applied to the data measuring the relationship between corruption and emissions, there are multiple findings. A majority of the findings show that when emissions are measured as grams per 2010 US$ of GDP, irrespective of other conditions being applied to the data, as corruption increases, CO_2 emissions increase. While more research needs to be done on the impact of corruption on climate change, the initial findings in this paper suggests that in order to *effectively* address climate change on a global scale, efforts need to be made in addressing corruption too.

2. Theory

CO_2 emissions vary significantly across countries. Various scholars have sought to explain this variation with reference to drivers of these emissions such as, level of development, energy consumption, and trade. My research seeks to evaluate whether, after taking those other factors into account, we still observe that more corrupt countries tend to emit more CO_2 emissions than otherwise-similar countries that are considered less corrupt.

Impacts of Corruption

Menocal and Taxell (2015, p. 50) note that, "corruption is perceived as a problem not only in the developing world but also in developed countries". It is therefore a global issue, making it a necessity to better understand and address. Scholars have previously shown that corruption produces various harms including: economic, social/political, and environmental. I describe these here in order to better understand whether corruption produces a particular harm, namely, climate change.

Economic Impacts

The significant body of evidence that assesses the impact of corruption on firm profitability, commercial behavior, and the choices of individuals and businesses, "overwhelmingly suggests corruption has negative impacts on productivity, on investment and, overall, on profitability and growth" (Menocal & Taxell, 2015, p. 45). Corruption is also shown in general to have a hampering effect on trade (de Jong & Bogmans, 2011, p. 45; Menocal & Taxell, 2015). An explanation for this effect is, "the additional costs that importers and exporters face" (Menocal & Taxell, 2015, p. 45). Furthermore, several studies show corruption to have a detrimental effect on Foreign Direct Investment. However, "corruption seems to have a negative effect on FDI flows in OECD countries, and not in non-OECD countries" (Menocal & Taxell, 2015, p. 46).

However, some scholars believe that the effect of corruption on the economy is more complicated. "A substantial body of research suggests corruption levels do not directly determine economic development rates" (Menocal & Taxell, 2015, p. 38). Even though corruption may not *directly* determine economic development rates, it was found that, "the effect of corruption is regime specific" (Aidt, 2009, p. 277; Menocal & Taxell, 2015) and, "conditional on the quality of their political institutions" (Aidt, 2009, p. 277). As a result, "in countries with good governance, the effect of corruption on growth is negative, while in countries with poor governance, the effect is positive (or less negative)" (Aidt, Dutta, & Senna, 2008; Aidt, 2009; Mendez & Sepulveda, 2006, p. 277).

In other words, domestic institutional arrangements can moderate the effect of corruption: "countries with high-quality regulatory systems increase their productivity where corruption is reduced. However, countries with low-quality regulatory systems…would, all things being equal, reduce their productivity when reducing corruption" (Menocal & Taxell, 2015; Méon & Weill, 2010, p. 40). This suggest that a) corruption is more likely to be found in countries that have poor governance, and b) that corruption is less likely to be damaging in these environments (Menocal & Taxell, 2015, p. 40).

Lastly, in terms of total macroeconomic effects of corruption, Menocal and Taxell (2015, p. 41) state that best estimates show corruption to have a negative effect on economic growth overall. Table 1 further outlines the results of various studies on the economic costs of corruption.

Table 1: Literature on Economic Costs of Corruption (Menocal and Taxell 2015)

Author	Research type, design, method	Claimed nature and size of effect
Dreher and Herzfeld (2005)	Primary, observational, cross-country, cross-sectional data with regression analysis.	A 1-point increase in their selected corruption index reduces growth by 0.13 percentage points. The estimate includes indirect effects through government expenditures, investment, foreign aid and inflation as well as the direct effect of corruption on growth.
Gyimah-Brempong and Munoz de Camacho (2006)	Primary, observational, panel survey data.	An increase of corruption by 1 standard deviation reduces growth per capita by 0.4 percentage points in OECD and Asian countries. In Latin America, it reduces growth per capita by 0.64 percentage points; in African countries, it decreases it by 0.75 percentage points.
Rahman et al. (2000)	Primary, observational, cross-country study using ICRG risk of corruption measure for 79 countries, 1990-1997.	An increase in corruption by 1 standard deviation reduces economic growth by 0.79 percentage points. On this basis, had Bangladesh's levels of corruption been comparable with those of Poland at the beginning of the time series, its growth rate would have increased by 2.1 percentage points. This higher growth rate would have resulted in an absolute income level 18% higher than was recorded.
Andvig and Attila (2009)	Primary, observational, cross-country panel study using victimisation data with an instrumental variables approach. 74 countries.	A 1% increase in police corruption causes a decrease in GDP per capita of approximately 0.6%. This suggests that if Nigeria's levels of police corruption were reduced to those of the Czech Republic, for example, real income per capita could be 2.9 percentage points higher.
Mo (2001)	Primary, observational, cross-country panel data with regression analysis, 1975-1985.	Mo's results show a 1-unit increase on the corruption index leads to a reduction of the growth rate by 0.54 percentage points. Of this effect, 53% is explained by the effect of corruption on political instability, and, in turn, the effect of political instability on growth.
Haque and Kneller (2008)	Primary, observational, cross-country panel data with regression analysis for 66 countries, 1970-2000.	An increase by 1 standard deviation of corruption reduces economic growth by about 5 percentage points.
Swaleheen (2011)	Primary, observational, cross-country panel data with regression analysis.	A 1-standard deviation increase in corruption reduces growth rates by 0.12 percentage points.

Social and Political Impacts

"There is a large body of evidence demonstrating a correlation between higher levels of corruption and increased inequality, and, in turn, higher levels of poverty" (Menocal & Taxell, 2015, p. 47). However, there are some indications that particular economic configurations, such as the presence of large informal economies, may be somewhat dependent on particular forms of corruption to operate in the way they do (Menocal & Taxell, 2015, p. 47). As a result, the removal/elimination of these particular forms of corruption could lead to unintended effects on income inequality (Menocal & Taxell, 2015, p. 47).

"There is a large body of evidence showing corruption negatively affects both the volume and the quality of public service delivery. The effect occurs both directly through distortions of resource allocation and indirectly through reductions in revenue" (Menocal & Taxell, 2015, p. 50). Table 2 outlines the results of various studies on the effect of corruption on service delivery. Furthermore, it is also shown that within its effects on public service, corruption disproportionately impacts the lives of women and the poor (Menocal & Taxell, 2015, p. 50).

Table 2: Literature on Effect of Corruption on Service Delivery (Menocal & Taxell, 2015)

Author	Research type, design, method	Claimed nature and size of effect
Bird et al. (2008)	Primary, observational, cross-country regression.	Increase on a corruption index of 1 unit reduces tax revenue as a share of GDP by 0.24-0.38%.
Dreher and Herzfeld (2005)	Primary, observational, cross-country regression.	Increase of corruption by 1 point (on a 6-point scale) is linked to 1.3-3% reductions in government spending.
Lambsdorff (1999)	Secondary, other review.	Higher levels of corruption lower expenditure on education and health care.
Gupta et al. (2000)	Primary, observational, cross-country survey.	Higher levels of corruption lower expenditure on education and health care.
Mauro (1996)	Primary, observational, cross-country regression.	An increase on the corruption index of 1 standard deviation results in a reduction in education spending as a share of GDP by around 0.5%.
Delavallade (2006)	Primary, observational, cross-country regression.	Education, health care and social protection spending is significantly reduced in corrupt states while spending on law and order, culture, fuel and energy and defence increases.
De la Croix and Delavallade (2009)	Primary, observational, cross-country statistical analysis.	In poor countries, corruption results in social spending relative to capital spending being reduced.
Shrestha (2007)	Primary, observational, case study (Nepal).	Corrupt practices at state utility companies reduce collection of revenues: this in turn prevents expansion of utility provision to poor areas. Additional corrupt payments by some Nepalese households to get preferential access to water resulted in water shortages elsewhere.
Widoyoko (2007)	Primary, observational, case study (Indonesia).	Corruption in a government-funded public housing programme resulted in too few houses being built for low-income people, led to growth in the informal housing market and raised the cost of housing.

When examining how corruption effects human emotions, "there is a large and statistically significant negative correlation between corruption and levels of confidence in public institutions" (Menocal & Taxell, 2015, p. 50). Furthermore, studies have found that, "corruption has a negative impact on political participation, undermines belief in the political system and the legitimacy of democracies and may also raise tolerance for the use of violent means to achieve political ends" (Anderson & Tverdova, 2003, p. 51; Clausen, Kraay, & Nyiri, 2011; Menocal & Taxell, 2015; Seligson, 2002).

Although some forms of corruption, specifically with regards to economic rents, create a system of income redistribution, and serve to defuse (or at least not inflame) conflict dynamics in the short term; highly corrupt states are more likely to be fragile states, and in the long term, perceptions of high levels of corruption are likely to exacerbate conflict dynamics (Menocal & Taxell, 2015, p. 52). This results in the use of corruption for conflict resolution to not be a worthwhile or sustainable solution.

Environmental Impacts

While corruption's effects on economic, political, and social situations is important, my research focuses on corruption's effect on climate change as part of research on corruption and the environment more generally. While there is research focused on corruption's impact on the environment, research in this field is still new and is not yet as comprehensive as that on economic, political and social impacts. Even so, this section aims to summarize the relevant research that has been conducted on the relationship between corruption and the environment.

Research has found corruption to have multiple impacts on the environment, "corruption leads to worsened environmental outcomes, such as increased polluting emissions, higher rates of deforestation, increased depletion of natural resources and trafficking in illegal or highly regulated environmental products" (Cole, 2007, p. 52; Management Systems International, 2002; Menocal & Taxell, 2015; Welsch, 2004). Furthermore, "corruption's environmental impact includes effects on stocks and flows of resources" this is particularly concerning for non-renewable resources, "and on income and economic growth, as well as on policy-making and implementation" (Menocal & Taxell, 2015, p. 53).

There is a significant body of literature that examines the environmental impacts of corruption in terms of how it effects income, and the Environmental Kuznets Curve (EKC)[3]. Increase in the demand for environmental policy (following the turning point of the EKC) is conditional on the level of corruption (Damania, Fredriksson, & List, 2003). The EKC works in bettering the environment when wealthier voters who have bypassed the turning point of the EKC, demand environmental protection through environmental policies.

The level of corruption influences this by a) determining the response of government institutions to the demand for environmental protection, and b) determining the number of voters that have bypassed the turning point of the EKC and therefore demand environmental protection. Moreover, if developing countries with rapid economic growth do not couple it with reduction in corruption, pollution levels will be much higher in developing countries than developed countries at the same per capita income. Therefore, the income and pollution levels at which the turning point of the EKC is experienced will also be much higher (López and & Mitra, 2000).

This is consistent with Welsch who notes the importance to developing countries as, "corruption enhancing pollution" is strong at low-income levels, therefore, developing

[3] The Environmental Kuznets Curve (EKC) examines the relationship between per capita income and environmental degradation reflected as CO_2 emissions (Waslekar 2014). The inverted U-shape of the EKC portrays the notion of CO_2 emissions at first worsening, however, income per capita increases to a turning point, after which, CO_2 emissions and the environment improve (Leitão 2010). An explanation as to why this occurs: "In poor countries people value more material well-being over environmental amenities, but once a country reaches a sufficiently high per capita income, people give greater attention to the environment. This causes the political structure to respond through the implementation of environmental legislation, appropriate tax subsidy policies, and other measures that lead to a better environment" (López and Mitra 2000). Moreover, the transition in industry type (from agricultural to industrial to service dominated) of a country, further contributes to the inverted U-shape of the EKC.

countries can improve both their economic and environmental conditions through reducing corruption (Welsch, 2004).

Most high-income countries have already bypassed the turning point of the EKC so an increase in income from reduction in corruption will simply accelerate the reduction of pollution levels, whereas, developing countries are generally still located on the upward slope of the EKC, therefore, an increase in income due to reduction in corruption, in turn speeds up the increase in pollution levels. This is consistent with Cole (2007), who finds that, from a business standpoint, an increase in income through reduction in corruption can end up increasing environmental degradation to a greater amount than the reductions in emissions resulting from the direct effect[4] (Cole, 2007). "Corruption should therefore be tackled alongside appropriate environmental legislation" (Cole, 2007, p. 644). Furthermore, this suggests that the biggest gains from focusing on reduction of corruption would occur in high income countries (Cole, 2007).

Alternatively, Morse (2006), who employed a quantitative approach to examine corruption's impact on the environment, by using the CPI and ESI (Environmental Sustainability Index), found the impact to be significantly related to income, as GDP per capita. Findings showed environmental sustainability to decline as income declined while corruption worsened (Morse, 2006).

[4] The direct and indirect effects of corruption on the EKC are explained as: "On the one hand, corruption may reduce the stringency of environmental regulation…or the effectiveness with which environmental regulation is enforced…thus leading to higher pollution. On the other hand, corruption has been found to reduce prosperity…which, according to another strand of literature…may lead to lower pollution at some income levels and to higher pollution at others" (Welsch, 2004, p. 664).

Corruption can also affect the turning point of the EKC, the higher the degree of corruption in a country, the higher the per capita income at the turning point of the EKC, therefore delaying the point at which pollution starts to decline. However, findings remain the same, even when taking into account differences in richer and poorer countries. Findings further support the notion that country-specific characteristics, are important in explaining the EKC (Leitão, 2010).

Looking at actual pollution and emission levels as dependent variables the results show that the direct effect of corruption on pollution is clearly positive (Welsch, 2004). The indirect effect reinforces the direct effect, “corruption reduces income, and lower income goes along with higher pollution levels” (Welsch, 2004, p. 681).

Looking further at the relationship between corruption and pollution, Cole (2007) *quantifies* the direct and indirect impacts of corruption on air pollution. Where Welsch (2004), having studied data from 1 year, finds the absolute value of the direct effect of corruption on pollution to outweigh the absolute value of the indirect effect, Cole (2007, p. 644), examining a period of 13 years, notes, “although the direct effect of corruption on pollution is positive, the net effect for most countries is actually negative.”

An area of concern when looking at corruption’s effect on the environment, is that of environmental policy. Fredriksson and Svensson (2003, p. 1383) offer insight into the importance of accounting for political instability when forming environmental policies, “Corruption reduces the stringency of environmental regulations, but the effect disappears as political instability increases”. It is noted that, “An increase in political instability has two opposing partial effects. First, bribery becomes less attractive for the producer lobby because the likelihood that the government remains in office throughout the policy implementation stage is reduced, and thus the bribe becomes less likely to pay off" (Fredriksson & Svensson, 2003, pp. 1385-1386). This effect is noticeable when the level of corruption in a country is high. Alternatively, the government can now see bribes as more favorable as they are likely not to be in office during policy implementations and will not affected by their policy choices. This effect is more noticeable when corruption levels are low (Fredriksson & Svensson, 2003).

Morse (2006) explains that, even though corruption is not generally considered to be environmentally destructive, it leads to poor governance which in turn leads to bad policy formation, management and enforcement, the effects of which can be seen as environmentally destructive and are noticeable through issues in environmental sustainability. This is examined further in the various pieces of literature that focus on stringency and enforcement of environmental regulations.

Welsch (2004) notes the inverse relationship between corruption, and the stringency and enforcement of environmental regulations, and the effect on actual pollution and emission levels. "Less corruption is associated with an increase in the stringency of environmental policy" (Damania et al., 2003, p. 507).

Damania (2002) takes a slightly different approach when looking at corruption's effect on environmental regulations by analyzing the interactions between prosecution rate, monitoring rate and fines. With an increasing number of global environmental agreements, many governments have had to incorporate new and more stringent environmental regulations, this in turn results in more areas for corrupt officials to extract bribes (Damania, 2002). The emerging literature on environmental performance indicates that corruption is one of the main sources of environmental damage in several countries.

Furthermore, "Corruption and inadequate penalties for violations are identified as the main factors contributing to non-compliance" (Damania, 2002, p. 408). Damania (2002, p. 409) notes that it is important to analyze corruption and its effect on the environment as:

> "Environmental issues are representative of a larger class of problems where the government delegates powers to self-interested bureaucrats…many of the more acute problems of pollution and bio-diversity preservation are encountered in developing countries with high levels of corruption…the interaction between environmental controls and corruption is of some relevance for environmental policy purposes."

On an international level, environmental issues are a major source of debate, therefore, an understanding of what promotes and inhibits corruption associated with environmental regulations has a practical importance too (Damania, 2002). New policy implications revealed through this paper is that optimal policy depends on the efficiency of the judiciary system (Damania, 2002). In countries where there is an inefficient judiciary and low prosecution rate, the enactment of harsher penalties for corruption showed an increase in pollution. By contrast, in countries where the judiciary is efficient and effective at prosecuting, the best response involves forming policies that combine the reduction of corruption as well as emissions (Damania, 2002).

Examining the effect of free trade on the environment, along with corruption, in order to try resolve the ongoing debate between "free traders" and environmentalists, empirical evidence suggests that, "countries with more open trade policies tend to have stricter environmental regulations, in particular where the level of corruption is high" (Damania et al., 2003, p. 493). Environmental regulations required to participate in certain open trade policies are usually more stringent than regulations that are already present in highly corrupt countries. “Alternatively, where the level of corruption is low this effect may be reversed” (Damania et al., 2003, p. 493), this case occurs in countries with low levels of corruption that have had more stringent environmental regulations than the ones required to participate in certain open trade agreements.

Another factor to consider when looking at corruption’s impact on environmental policy, is the historical experience of corruption. Fredriksson and Neumayer (2016) ask the question, “do the bad old days matter?” They create the “Corruption-control capital stock” which is the accumulated stock of a country’s historical experience free of corruption (Fredriksson & Neumayer, 2016). They find that:

> “The environmental policies and pollution levels existing today are to a great extent the result of numerous historical policies, monitoring and enforcement choices, all influenced by the level of corruption at the time. Differences in current policy outcomes are therefore likely due to different historical experiences with corrupt activities, as previous policy and enforcement decisions set the stage for the next round of policy choices” (Fredriksson & Neumayer, 2016, p. 454).

This offers two reasons as to why corruption reform programmes do not always have immediate effect. Firstly, if corruption is expected to remain high in the future, political actors that want stricter environmental policies do not have the incentive to further their efforts and resources because the chances of these policies lasting are not very high. Secondly, stricter environmental policies may not be considered a priority, they are instead considered to be “secondary policy” (Fredriksson & Neumayer, 2016).

Corruption and CO_2 Emissions

While the previous section outlined the analysis of various authors on the impact of corruption on specific environmental concerns, and show that corruption is an important source of environmental degradation, particularly in terms of the stringency and enforcement of environmental regulations (Damania et al., 2003; Fredriksson, Vollebergh, & Dijkgraaf, 2004; López and & Mitra, 2000); this paper examines corruption's effect on climate change, measured as CO_2 emissions.

As a result, it is important to note that research on corruption's impact on CO_2 emissions is limited, "the quantitative assessments of the environmental effects of corruption are very rare, which increase the uncertainty regarding the magnitude and significance of any such impact" (Sekrafi & Sghaier, 2018; Welsch, 2004, p. 82). However, this research is vital to determine the effect of corruption on climate change. Like Mardani et al. (2019, p. 44) states:

> "A study about greenhouse gases is very important lately as a result of their contribution to climate change and its consequences on human life, biodiversity, the environment and vegetation. Moreover, the study of carbon dioxide and factors that contribute to its emissions is much more important since it's the largest GHG emitted hence the largest contributor to climate change."

Furthermore, research in this subject remains inconsistent, Sekrafi and Sghaier (2018, p. 81) find, "a negative and significant relationship between control of corruption and environmental quality (CO_2)" for their research in Tunisia, whereas, Zhang et al. (2016) find the effect of corruption on CO_2 emissions in APEC countries to have diverse results. They find, "The total effect appears positive, which indicates corruption may worsen environmental quality overall in APEC countries" (Zhang et al., 2016, p. 220). As a result of the small amounts of research on the subject of corruption's impact on climate change and the inconsistent findings of this research, it leads to the notion that more research needs to be done to answer the question, *is corruption bad for climate change?*

Dependent Variable: CO2 Emissions

CO2 emissions, the dependent variable in this paper, is used as the indicator of climate change. Emissions are used as unlike concentrations; they are directly linked to human behavior. While there is a large amount of literature that discusses the economic and political/social impacts of corruption, and various literature that discusses the impact of corruption on specific environmental issues; I want to investigate whether or not corruption has a causal relationship with climate change specifically, or if it is simply an unfavorable behavior for other reasons discussed previously.

These reasons include: its negative economic impacts through decreased profitability, growth (Menocal & Taxell, 2015), and trade (de Jong & Bogmans, 2011); its adverse social and political impacts including, increased inequality and poverty (Menocal & Taxell, 2015) and decreased volume and quality of public service (Menocal & Taxell, 2015), leading to decreased political participation, belief in the political systems, and increased violence (Anderson & Tverdova, 2003, p. 51; Clausen et al., 2011; Menocal & Taxell, 2015; Seligson, 2002). As well as the environmental impacts of corruption that have been researched, including: decreased stringency and enforcement of environmental policies (Damania, 2002; Damania et al., 2003; Welsch, 2004), decreased sustainability (Morse, 2006), and its effect on the Environmental Kuznets Curve[5] (Damania, 2002; Damania et al., 2003; Leitão, 2010; López and & Mitra, 2000; Welsch, 2004).

Independent Variable: Corruption

Corruption for the analysis of this paper is defined as, "the misuse of resources or power for private gain" (2015, p. 12). The three main aspects that cause corruption include: opportunity, motive and the probability of being caught and punished (Morse, 2006). There are challenges to objectively measuring corruption because of, "the clandestine nature of corruption and the reliance of corruption measures on perception-based data, which themselves are determined by understandings of corruption that vary across countries and societies" (Menocal & Taxell, 2015, p. 13). Refer to Table 3 below for further descriptions of corruption.

Table 3: Categories of Corruption (Menocal & Taxell, 2015)

Categories of corruption	Description
Bribery	The act of dishonestly persuading someone to act in one's favour by a payment or other inducement. Inducements can take the form of gifts, loans, fees, rewards or other advantages (taxes, services, donations, etc.). The use of bribes can lead to collusion (e.g. inspectors under-reporting offences in exchange for bribes) and/or extortion (e.g. bribes extracted against the threat of over-reporting).
Embezzlement	To steal, misdirect or misappropriate funds or assets placed in one's trust or under one's control. From a legal point of view, embezzlement need not necessarily be or involve corruption.
Facilitation payment	A small payment, also called a "speed" or "grease" payment, made to secure or expedite the performance of a routine or necessary action to which the payer has legal or other entitlement.
Fraud	The act of intentionally and dishonestly deceiving someone in order to gain an unfair or illegal advantage (financial, political or otherwise).
Collusion	An arrangement between two or more parties designed to achieve an improper purpose, including influencing improperly the actions of another party.
Extortion	The act of impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party.
Patronage, clientelism and nepotism	Patronage at its core means the support given by a patron. In government, it refers to the practice of appointing people directly

Alternate Explanations of CO2 Emissions

Initial findings in the introduction of this paper that looks at the relationship between corruption (the independent variable) and CO2 emissions (the dependent variable)

[5] Environmental Kuznets Curve also referred to as EKC throughout paper.

show that there is no clear relationship between these two variables when total CO2 emissions are used, measured as kt. However, there is a correlation between increased corruption and increased CO2 emissions, when emissions are measured as grams per 2010 US$ of GDP.

As correlation does not indicate causation, this section on Alternate Explanations of CO2 Emission, identifies and applies the major factors scholars claim influence CO2 emissions on the dependent and independent variables. By controlling for these effects, we can determine if there is solely a *correlation* between increased corruption and increased CO2 emissions, or if increased corruption is also a *cause* of increased CO2 emissions, and therefore climate change.

Condition 1: Level of Development

Just as the literature on corruption and the environment includes research on the EKC, so too does literature on Level of Development. Kaika and Zervas (2013b, p. 1403) note that, “The EKC literature is quite large and the results are at best mixed.” One explanation for these mixed results is that, “Since all countries approach economic development and environmental regulation differently, many studies have produced a wide variety of results that tend to conflict with each other. While some agree that an EKC will exist for CO2 emissions, other studies question whether the CO2 EKC actually exists or if it is an artificial construct of econometrics” (Beck & Joshi, 2015, p. 42). For example, they find, “an EKC based on economic growth only exists for the non-OECD regions of Asia and Africa, while the region of Latin America shows no evidence for it at all and the OECD countries have bypassed it into the N-shaped pattern” (Beck & Joshi, 2015, p. 43). Whereas Ertugrul et al. (2016) find the downward trend of gas emissions in developed countries to be consistent the EKC. As the OECD is primarily made up of developed countries, these results directly contradict those of Beck and Joshi (2015).

Another explanation is, “if income inequality worsens when income rises, then the environment will keep deteriorating, and vice versa, because those who suffer from pollution will not be in (economic) position to impose environmental regulations on those who benefit from pollution” (Kaika & Zervas, 2013c, p. 1395). Kaika and Zervas (2013b, p. 1410) further acknowledge these differences by stating, “critiques do not suggest that the EKC-concept is useless or misleading. Rather, the emphasis is given to the acknowledgement that the EKC-concept may apply to certain types of pollutants and to certain countries but cannot be adopted as an appropriate policy for every country or every pollutant.”

Research unrelated to the EKC finds that, “GDP per capita and urbanization are two of the main determinants of CO_2 emissions in the global panel” (Sharma, 2011, p. 381). As GDP per capita and urbanization can be seen as functions of level of development, in other words, level of development is one of the main determinants of global CO2 emissions. Furthermore, Mardani et al. (2019, p. 32) states, “The majority of previous studies for the past two decades has been intensively focused and confirmed the nexus among economic growth and energy use have a significant effect on the CO_2 emissions.”

However, results on the nexus between economic growth and pollution is mixed, “Extensive empirical studies exist on the pollution-economic growth nexus with inconsistent finding” (Acheampong, 2018, p. 678). Some findings state, “Economic development is closely related to CO2 emissions since more economic development causes more energy consumption, leading to more pollution” yet the next sentence reads, “However, a more developed economy might also be more efficient in energy terms, leading to less CO2 emissions" (Balogh & Jambor, 2017, p. 218). Other research suggests, "economic growth negatively causes carbon emissions while carbon emissions positively cause economic growth" (Acheampong, 2018, p. 677). Whereas Lopez and Mitra (2000, p. 137) state, "for any level of per capita income, pollution levels are always above the socially optimal level." This can be as a result of environmental deterioration being a "by-product of economic activity" (Kaika & Zervas, 2013c, p. 1392).

These differences in findings can possibly best be summarized by Mardani et al. (2019, p. 45) who says:

> "Economic growth can prove to be both the friend and foe of the environment. On one hand, there is hope. Environmental quality can improve when income per capita grows and reach a certain level. On the other hand, the environmental degradation that will come about due to poor countries of today reaching a high-income level per capita can possibly bring about such great costs that the accumulated environmental damage can far exceed the present value of higher future growth."

Hypothesis 1: The more developed a country is, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less developed a country is, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.

Conditions 2 and 3: Energy Use and Energy Type

There are various ways energy can impact emissions; through consumption, production, and intensity. There are also different types of energy, which further enables its ability to impact emissions. Balogh and Jambor (2017) find major contributors of pollution to come from energy use and production. Moreover, they found, "A positive role of nuclear energy and renewable energy production…while energy from coal increased environmental pollution as expected" (Balogh & Jambor, 2017, p. 223). Whereas other author's results showed that, "population has some influence on CO_2 emissions overall, trade openness and urbanization tends to increase CO_2 discharges, and expanded energy use often leads to decreased emissions for most of the countries in the study" (Beck & Joshi, 2015, p. 43).

Different results are also found in terms of energy consumption. Iwata et al. (2012, p. 3518) find, "Energy consumption is positive and significant in most selected countries, providing evidence that energy consumption is a main factor in increasing CO2 emissions." However, other studies show that, "energy consumption positively causes carbon emissions in MENA but causes carbon emissions negatively in sub-Saharan Africa and Caribbean-Latin America" (Acheampong, 2018, p. 677). Another factor that can affect the impact of energy, is the price. Kaika and Zervas (2013c, p. 1396) find, "energy prices as a significant factor affecting both CO2 emissions and energy consumption."

Hypothesis 2: The more energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.

Hypothesis 3: The more non-renewable energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less non-renewable energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.

Condition 4: Trade

With the increase and expansion in international trade, many authors have sought to research its impacts. Of those impacts, the pollution-haven hypothesis is well known, “This hypothesis implies that demand for a cleaner environment increases as per capita income raises, and thus dirty industries in developed countries are looking for other places with less environmental standards” (Ertugrul et al., 2016; Kukla-Gryz, 2009, p. 544). Moreover, “free trade reveals the impact of race to bottom…environmental standards in countries decline as long as less environmental standards yield comparative advantages and attract multinational enterprises” (Ertugrul et al., 2016; Olney, 2013, p. 544). Studies have found that, “the amount of carbon emissions increased by 75% between 1980 and 2012 according to the U.S. Energy Information Administration…and the total value of international trade increased by 450% in the same period according to the World Development Indicators” (Ertugrul et al., 2016, p. 543). Also, “trade openness negatively causes energy consumption and carbon emissions at the global level” (Acheampong, 2018, p. 687). Furthermore, “behind fossil energy production, trade and agriculture can be considered as major contributors to world CO2 emission” (Balogh & Jambor, 2017, p. 224). However, Iwata et al. (2012) found the impact of trade to not be statistically significant.

This can be explained as a result of unrestricted regulations leading to, “an increase in the number of firms producing pollution-intensive export goods and an increase in the volume of dirty-goods related foreign direct investment” (Ertugrul et al., 2016; Scrieciu, 2008, pp. 544-545). Leading to the contribution of foreign direct investment (FDI) to emissions, “FDI incur a high significant negative impact on CO2 emissions” (Balogh & Jambor, 2017, p. 219). Moreover, “(FDI)...can also influence level of global warming and climate change through CO2 emission” (Balogh & Jambor, 2017, p. 218).

Literature has also focused on trade's role in the EKC, "the increase of trade openness affects the CO_2 emission positively in short term, then the increase of trade openness will decrease the CO_2 emission after a threshold level…similar to EKC. Hence, beyond a threshold level of trade openness may actually reduce emissions" (Akin, 2014, p. 472). However, the, "inclusion of trade variables raises substantially the turning point of an EKC" (Kaika & Zervas, 2013a, p. 1395). Furthermore, "the net emissions transfers from developing to developed countries have increased...which implies that the transfer of emissions through international trade often exceeds the reduction of emissions at a single developed-country level" (Kaika & Zervas, 2013a, p. 1395).

Hypothesis 4: The more trade a country engages in, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less trade a country engages in, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.

Condition 5: Institutions and Governance

Governance play an important role in reducing emissions and improving environmental quality, "A government's willingness to impose environmental regulations is cited as a crucial factor affecting environmental degradation" (Kaika & Zervas, 2013a, p. 1397). Even though, "institutional development is a time-consuming process…stronger regulation is one of the keys to reduce pollution" (Kaika & Zervas, 2013a, p. 1397).

However, the types of policies and development that is pursued can adversely affect other important features in the world, a primary example being that of the global economy, "environmental and energy conservation policies, which aim at reducing carbon emissions, will hurt global economic growth," (Acheampong, 2018, p. 685) this is not to say that all policies have the same outcome, the same author notes, “however, structural policies, which also aim at increasing global economic growth, will improve the quality of the environment” (2018, p. 685). As a result, Acheampong (2018, p. 687) states that, “since economic growth…to some extent ensures environmental sustainability (reducing carbon emissions), structural policies should pursue at both the global and regional levels to achieve robust economic growth.”

Nevertheless, it is more complicated than this and more factors have to be considered than purely achieving economic growth, “the growth of an economy is an essential condition to overcome pollution but it is not an adequate condition alone: whether environmental quality improvements (or reduced degradation) will materialize or not, when, and how, depends critically on government policies, social institutions and the completeness and functioning of markets” (Kaika & Zervas, 2013a, p. 1397).

Hypothesis 5: The weaker the institutions and governance of a country, the greater the effect of corruption on their CO2 emissions, leading to increased emissions; the stronger the institutions and governance of a country, the lesser the effect of corruption their CO2 emissions, leading to decreased emissions.

Condition 6: Type of Economy

It is said that, “Environmental deterioration is a by-product of economic activity” (Kaika & Zervas, 2013a, p. 1392). It is widely known that the industrial sector contributes significantly to emissions, “According to many authors, industrial structure is an important determinant of carbon dioxide emissions” (Balogh & Jambor, 2017; Kofi Adom, Bekoe, Amuakwa-Mensah, Mensah, & Botchway, 2012, p. 218; Mi, Pan, Yu, & Wei, 2015; Zhu, Shi, & Wang, 2014). This also creates a divide among countries in the world based on level of development, “Usually, the industrialization process in developing countries is based upon polluting industries and at the same time, developing countries account for a steadily increasing proportion in world output in many of the most highly polluting industries” (Kaika & Zervas, 2013a, p. 1395).

Where emissions and environmental degradation can be expected when a country’s primary economy is in the industrial stage, it is also important to consider the effects of other types of economy, especially agriculture:

> “(Henders, Persson, & Kastner, 2015) investigated relationships between carbon emission and land use change and found that in the period 2000-2011, the production of beef, soybeans, palm oil, and wood products in the seven countries was responsible for 40% of total tropical deforestation and resulting carbon losses. Similar results were reached by (Baccini et al., 2012)…(Foley et al., 2011) goes even further and suggest that agriculture not only uses resources such as petroleum and water but it is reported to contribute 30-35% of global greenhouse gas emissions” (Balogh & Jambor, 2017, pp. 218-219).

Moreover, “behind fossil energy production, trade and agriculture can be considered as major contributors to world CO2 emission” (Balogh & Jambor, 2017, p. 224). As well as, “estimates showed that while agricultural development reduces, the impact of agricultural land productivity rather stimulates environmental pollution at a global level” (Balogh & Jambor, 2017, p. 217).

Furthermore, As the world becomes more globalized and reliant on international relations, tourism becomes an important economic factor to consider, in terms of its effect on CO2 emissions and climate change. This is especially true for international tourism. Like

Balogh and Jambor (2017, p. 218) state, "the intensity of tourism industry can also influence level of global warming and climate change through CO2 emission."

Hypothesis 6: The more reliant a country is on agricultural and industrial economies, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The more reliant a country is on service-based economies, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a county is.

Summary of Hypotheses

In conclusion, the following hypotheses were formed from the literature on Alternate Explanations for CO2 Emissions. By controlling for these factors in the Analysis section of this paper, we can assess whether corruption truly makes emissions worse or whether it is in fact a spurious correlation:

1. The more developed a country is, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less developed a country is, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.
2. The more energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.
3. The more non-renewable energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less non-renewable energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.

4. The more trade a country engages in, the greater their CO_2 emissions; and the greater their CO_2 emissions, the more corrupt a country is. The less trade a country engages in, the lesser their CO_2 emissions; and the lesser their CO_2 emissions, the less corrupt a country is.
5. The weaker the institutions and governance of a country, the greater the effect of corruption on their CO_2 emissions, leading to increased emissions; the stronger the institutions and governance of a country, the lesser the effect of corruption their CO_2 emissions, leading to decreased emissions.
6. The more reliant a country is on agricultural and industrial economies, the greater their CO_2 emissions; and the greater their CO_2 emissions, the more corrupt a country is. The more reliant a country is on service-based economies, the lesser their CO_2 emissions; and the lesser their CO_2 emissions, the less corrupt a county is.

3. Methodology

Research Question

This paper examines whether or not corruption contributes to climate change by researching the question, *do more corrupt countries emit more CO_2 emissions than otherwise similar but less corrupt countries?*

Case Selection

This paper uses the following 41 countries in the analysis: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Italy, Japan, Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Norway, Pakistan, Philippines, Portugal, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, Turkey, UK, USA, and Venezuela. These countries are used as a) they were the first set of countries that Transparency International researched and assigned a CPI score to in 1995, allowing an analysis to be made across time, and b) they have data available needed to test the hypotheses formed in the previous section, allowing the five conditions to be analyzed.

Through these analyses, I can conclude if the correlations between increased corruption and increased CO2 emissions (measured as g per 2010 US$) identified in Figures 2 and 3, are as a result of increased corruption *causing* increased CO2 emissions. In doing so, I can answer the question, *Is Corruption Bad for Climate Change?*

Methods of Analysis

Six hypotheses were formed from the literature addressing Alternate Explanations for CO2 Emissions. Data was collected in order to graph the relationship of corruption to CO2 emissions, controlling for the conditions outlined in the section on Alternate Explanations for CO2 Emissions. Conclusions were drawn by comparing the graphs for each condition, to assess the strengthen of the relationship between corruption and CO2 emissions, i.e. are increased emissions as a result of corruption, or as a result of the "alternative explanation" variable being evaluated. Through comparing the graphs of each condition, the hypotheses are tested. Moreover, the graphs include data from two years, 1995 and 2014, in order to identify if, a) if there is a relationship in that year, and b) if this relationship has changed over time.

Data Collection

Dependent Variable: CO2 Emissions

The dependent variable of this research is CO2 emissions (grams per 2010 US$ of GDP). I use this measurement as it controls for the fact that GDP is a major factor in determining both corruption levels and CO2 emissions, therefore, ensuring a more accurate depiction of the relationship between corruption and climate change. Furthermore, this measurement has already shown a correlation between corruption and climate change in Figures 2 and 3.

Independent Variable: Corruption

The major independent variable of interest is corruption, measured as CPI scores. This measurement is used as Transparency International created the Corruption Perception Index and it is considered to be the leading measurement of corruption, "Since its inception in 1995, the Corruption Perceptions Index, Transparency International's flagship research product, has become the leading global indicator of public sector corruption" (Transparency International, 1995 and 2015). The 1995 and 2014 CPI scores are used for graphing as 1995 is the first year these scores were published, and the year 2014 is the most recent year for which data was available for all the conditions. Moreover, this provides (just short of) a 20-year period to examine and compare the data across time.

Condition 1: Level of Development

Level of Development is determined by whether or not the sample countries are members of the Organization for Economic Cooperation and Development (OECD). Most countries that are members of this organization, are also considered more developed countries, therefore, making it a useful measurement for this condition. Furthermore, as a result of the sample countries varying across multiple factors (level of development, and therefore membership in the OECD, being one of them), it is useful for drawing comparisons across the sample countries using this condition. Membership in the OECD is indicated in the second table of the Appendix in this paper, where GDP per capita data is color-coded according to membership - red indicates non-membership and green indicates membership.

Conditions 2 and 3: Energy Use and Energy Type

Energy use is measured as: kg of oil equivalent per capita. Energy type is measured as: fossil fuel energy consumption, measured as the percentage of total energy consumption of a country. These are the measurements used by the World Development Indicators[6], where the data for these conditions was collected from.

Energy can affect CO2 emissions in various ways, through production, type, use, and intensity. I believe energy use to be one of the best forms of energy to incorporate, as it is less reliant on other factors such as level of development or resource availability, in the way energy production or intensity is. Furthermore, the measurement used by the World Development Indicators is per capita, allowing a more accurate depiction of energy use across the sample countries, and therefore, a more accurate comparison and analysis to be draw across this condition. While energy type is more susceptible to factors such as level of development and resource availability, it is directly related to emissions, and is therefore necessary to include in this paper in order to fully appreciate, and account for the effect of energy on emissions.

[6] The World Development Indicators are published by the World Bank (Bank, 1995, 2013 and 2014).

This data is included in the second table in the Appendix of this paper, where the data is color-coded according to averages. For energy use - red indicates below average use and green indicates above average use. For energy type – red indicates below average fossil fuel consumption and green indicates above average fossil fuel consumption.

Condition 4: Trade

Trade is assessed as total trade measured as exports plus imports as a percentage of a country's GDP. Total trade is used as all trade contributes to emissions, both international and domestic, as well as, incoming and outgoing trade. The data used for this condition was taken from the World Development Indicators. It is included in the second table in the Appendix of this paper where the data is color-coded according to average total trade amounts of the sample countries – red indicates below average trade and green indicates above average trade.

Condition 5: Institutions and Governance

Institutions and governance are measured using the Environmental Performance Index (EPI) scores[7]. This condition constitutes a large category, therefore, focus is placed on institutions and governance in relation to their environmental performance, as this paper is focused on corruption's effect on climate change, an environmental concern above all else. EPI scores are used as these scores are based on comprehensive studies, for example, "The 2018 Environmental Performance Index (EPI) ranks 180 countries on 24 performance indicators across ten issue categories covering environmental health and ecosystem vitality. These metrics provide a gauge at a national scale of how close countries are to established

[7] EPI scores are published in the Environmental Performance Index reports by the Yale Center for Environmental Law and Policy (Esty, 2008; Yale University & Columbia University, 2018).

environmental policy goals" (Yale University & Columbia University, 2018). This data is included in the second table in the Appendix of this paper, where it is color-coded according to the average scores of the sample countries – red indicates below average scores, and green indicates above average scores. Scores are based on a scale from 0-100 where, the closer to 0, the worse the performance, and the closer to 100, the better the performance of a country.

Condition 6: Type of Economy

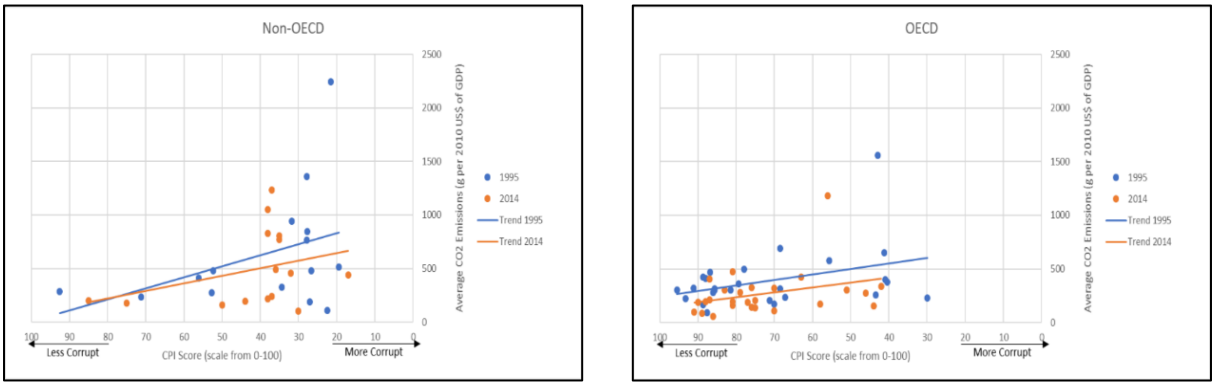
Type of economy is divided according to: agriculture, industry, and service. These are the three main economy types of the world today, and therefore, the best indicators of this condition. Data for economy types was taken from the World Development Indicators and is measured as: value added in terms of percentage of the GDP. This data is included in the third table in the Appendix of this paper, where above average values are color-coded green to show which of the sample countries rely more on each type of economy.

4. Analysis

Level of Development

Figure 3 began to show the impact of level of development on corruption and emissions by grouping countries according to GDP. Figure 4 looks further at this relationship, by grouping countries according to membership in the OECD, while continuing to measure emissions as grams per 2010 US$ of GDP.

Figure 4: The Relationship between Corruption and Climate Change with Different Levels of Development



In general, this figure shows that more corrupt countries are not members of the OECD, and are therefore less developed. Alternatively, less corrupt countries are mainly found in the OECD membership graph, and are therefore more developed.

Secondly, the trendlines show that regardless of time or membership in the OECD, as corruption increases, average CO2 emissions increases. However, the trendlines of non-OECD countries are steeper, showing a stronger and faster trend between increased corruption and increased emissions. Furthermore, countries with CPI scores between 20-40 have the greatest amount of CO2 emissions, and non-OECD countries as a whole emit more CO2 emissions than OECD countries

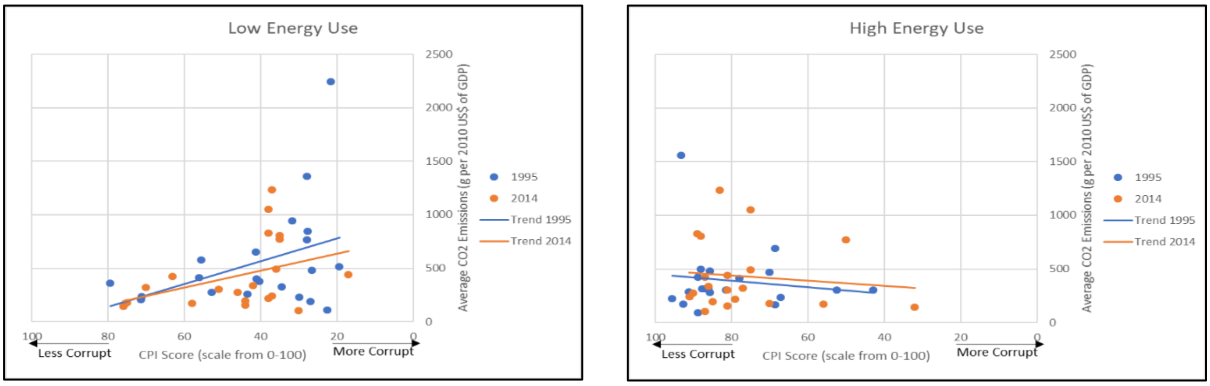
Additionally, both graphs show that a majority of countries' emissions have decreased over time from 1995 to 2014. However, the non-OECD graph shows that these countries have shifted to becoming more corrupt over time, with five countries having a CPI score between 50-100 in 1995, but only two countries in 2014. The same cannot be said for the graph of OECD countries, here, the amount of "outlier" countries that are more corrupt is almost equal for both 1995 and 2014.

Figure 4 *disproves* my first hypothesis that, *the more developed a country is, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less developed a country is, the lesser their CO2 emissions; and the lesser their CO2* *emissions, the less corrupt a country is.* As, Figure 4 shows that non-OECD/less developed countries emit more CO2 emissions than OECD/more developed countries. Furthermore, the trendlines, as well as individual country points on both graphs in Figure 4, show that as corruption increases, emissions increase.

Energy Use

Energy is an important condition to consider when looking at emissions, and energy use is measured in Figure 5, as it is one of the best forms of energy to incorporate, being less susceptible to factors such as level of development and resource availability. The measurement of energy use is: kilogram of oil equivalent per capita.

Figure 5: The Relationship between Corruption and Climate Change for Countries with Different Energy Use



The trendlines of this figure are intriguing. If we look at the graph showing countries with high energy use, it shows a general trend of emissions decreasing as corruption increases. The graph of low energy use countries, looks similar to the graphs in Figure 4, where, as corruption increases, emissions increase. However, the trendline showing emissions increasing as corruption increases is steeper, indicating a stronger correlation between increased corruption and increased emissions. Moreover, countries with CPI scores between 20-40 emit the most CO2 emissions.

Although there is a trend in the high energy use graph of emissions decreasing as corruption increases, most of the less corrupt countries emit equal to or below 500 emissions[8]. Moreover, where in 1995, only two of the high energy use countries reached above 500 emissions, that number more than doubled in 2014. On the contrary, while low energy use countries had a lot more countries emit above 500 emissions in 1995, they have an equal amount of countries emitting over 500 emissions in 2014 as the high energy use countries have in 2014. This shows that overtime the outliers of the low energy use countries have decreased their emissions overall.

This could be due to the fact that, generally speaking, increased energy use causes increased emissions. Though both Figures 4 and 5 primarily show increased corruption to cause increased emissions, Figure 5 also shows that most of the more corrupt countries are all low energy use countries.

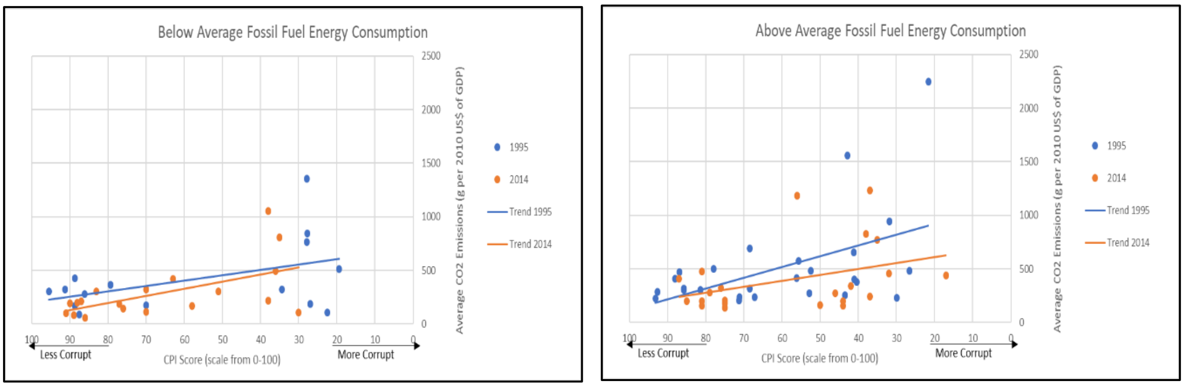
In terms of my second hypothesis, *the more energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is*, Figure 5 shows that that this relationship is not as simple and straightforward. It is shown that both high energy use and low energy use countries emit similar emissions, however, the trend in low energy use countries is that as corruption increases, emissions increase, whereas, the trend in high energy use countries is that as corruption increases emissions decrease. This shows that corruption levels directly influence energy use, in terms of whether or not countries fall into the "low energy use" or "high energy use" bracket, however, energy use on its own does not necessarily determine emissions.

[8] Emissions is equal to "Average CO2 Emissions (g per 2010 US$ of GDP)." This measurement is taken from Figure 5, where g stands for grams.

Energy Type

With the mixed results of the effect of energy use on the relationship between corruption and emissions observed in Figure 5, another form of energy that is important to analyze, is that of energy type. As type of energy directly relates to both emissions and use, through analyzing energy type, a better understanding of energy use is formed. Energy type is measured as: fossil fuel consumption as the percentage of total energy consumption. Furthermore, only fossil fuel consumption is analyzed, as this type of energy is the most pressing concern for a countries' emissions.

Figure 6: The Relationship between Corruption and Climate Change for Countries with Different Fossil Fuel Consumption



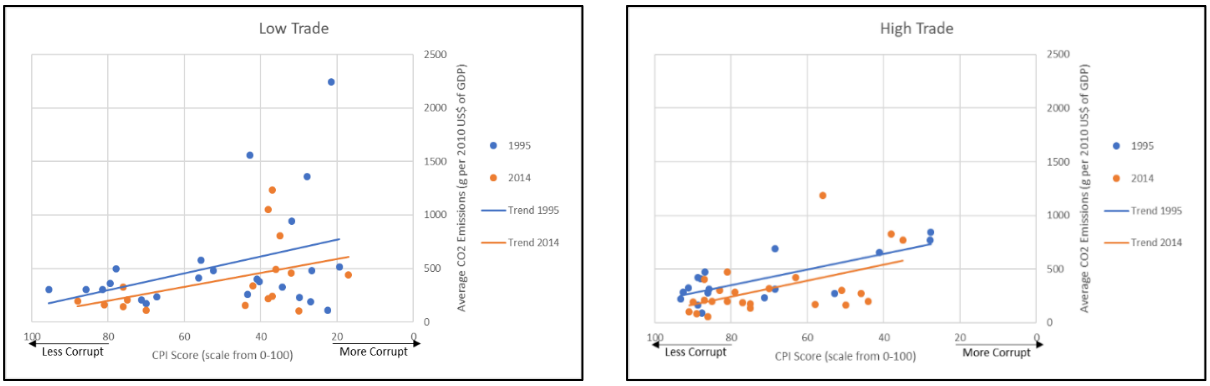
This figure shows that as corruption increases, emissions increase and that this occurs for both 1995 and 2014. This is true for countries with below average fossil fuel consumption and above average fossil fuel consumption. Yet, this relationship is stronger for countries with above average fossil fuel consumption as evident in the steeper trendline.

This figure *proves* the hypothesis that, *the more non-renewable energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less non-renewable energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.* Figure 6 shows that the more non-renewable energy a country uses, the greater their CO2 emissions, as expected. However, while there are more corrupt countries and less corrupt countries in both graphs in Figure 6, there are far more corrupt countries that consume above average amounts of fossil fuels, than those that consume below average amounts of fossil fuels, therefore, the more corrupt a country is, the more likely they have greater emissions as a result of above average fossil fuel consumption.

Trade

Like level of development and energy, trade is another condition found to be a major indicator of emissions and is therefore necessary to analyze in relation to corruption and climate change. Moreover, emissions from trade is especially significant in terms international trade. As this paper is focused on the relationship between corruption and climate change on a global scale, factors that influence emissions on a global scale, such as trade, are important to consider. Figure 7 shows the relationship between corruption and climate change for countries that differ according to trade. The type of trade used to differentiate countries is measured as: percentage of GDP of total trade.

Figure 7: The Relationship between Corruption and Climate Change for Countries with Different Trade Amounts



This figure shows that regardless the amount of trade, be it low or high, as countries become more corrupt, emissions increase. This trend is true for both 1995 and 2014, furthermore, the steepness of the trendline is similar for both graphs, which further proves that level of trade does not influence the relationship between corruption and climate change, in terms of CO_2 emissions.

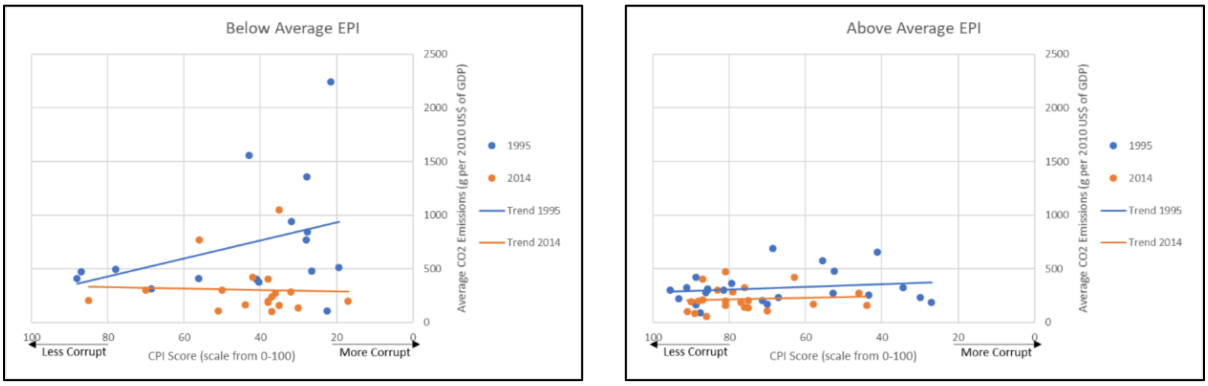
It is also shown that countries are more scattered along the x axis, i.e. there is a larger range of CPI scores across countries for both low and high amounts of trade. However, there are a lot of more corrupt countries, primarily in the CPI score range of 20-40, that also have low trade. Moreover, the low trade graph has a number of countries considered less corrupt, whereas, most countries in the high trade graph are considered less corrupt, and there are only two countries with a CPI score below 40 for both 1995 and 2014.

Figure 7, *disproves* my hypothesis, *the more trade a country engages in, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less trade a country engages in, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.* Figure 7 in turn shows that countries that have low trade amounts reach higher emissions than those that have high trade. However, emissions are similar for both groups of countries, with most countries' emissions falling below 500, and almost all countries' emissions falling below 1000.

Institutions and Governance

Through the various impacts of corruption on social and political factors, as well as on the environment, its impact on institutions and governance is the area that one would most expect to see corruption's impact. As this paper is focused on corruption's impact on climate change, and therefore looking at its impact through an environmental lens, Figure 8 employs the Environmental Performance Index (EPI) to measure this condition. The EPI scores a countries' environmental performance on a scale of 0-100, where the higher the score, the better the performance.

Figure 8: The Relationship between Corruption and Climate Change for Countries with Different Environmental Performance



This figure shows some countries with below average EPI scores emit more emissions than countries with above average EPI scores. However, this relationship has changed over time, with less differences in emissions according to EPI scores in 2014 than in 1995, and less emissions in general in 2014 than in 1995. In 2014, emissions in multiple countries with below average EPI scores exceed 500, whereas, in 2014, only 2 countries exceed 500. Emissions in countries with above average EPI scores have remained relatively similar over time, with 3 countries falling between 500-1000 in 1995, but no countries exceeding 500 in 2014.

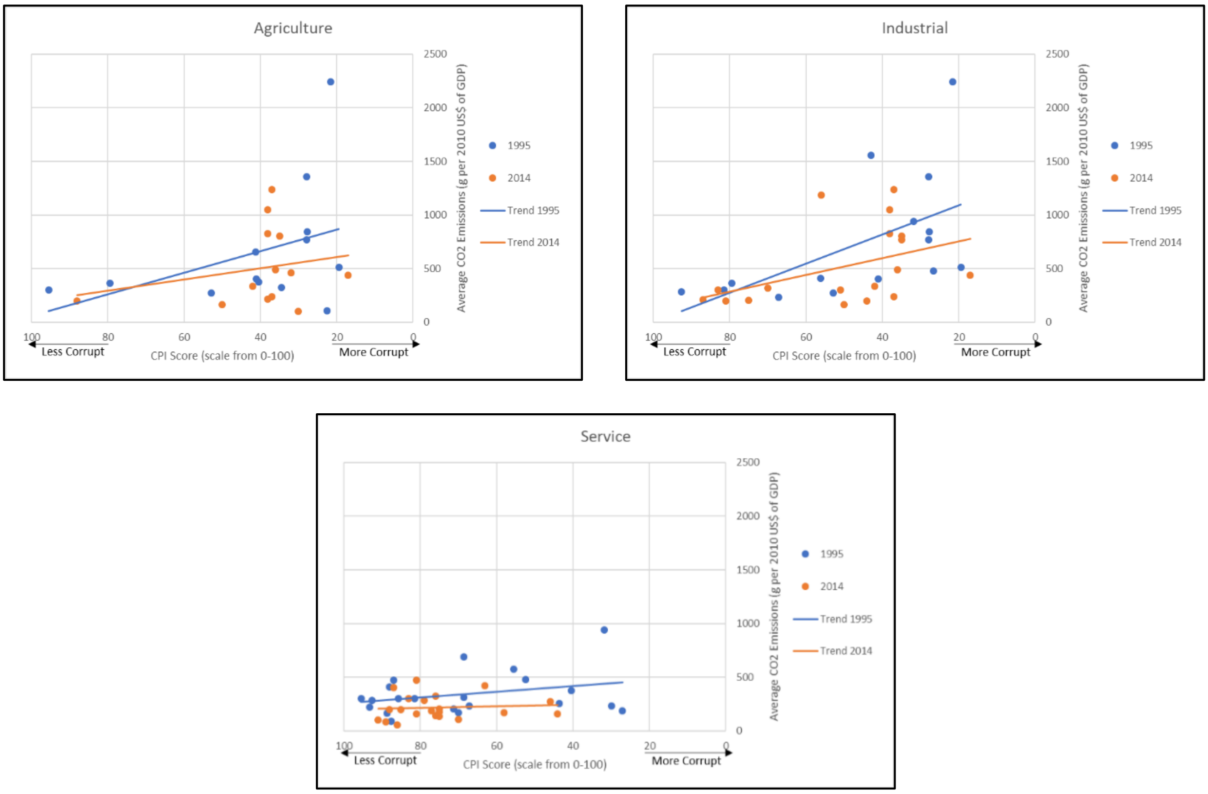
Overall, the trendlines in both graphs in Figure 8 show that a relationship between increased corruption and increased emissions only exists in 1995 for countries with below average EPI scores. All other trendlines show no relationship between corruption and emissions, when countries are grouped according to EPI scores, with similar emissions emitted across a range of CPI scores. Therefore, Figure 8 *disproves* my hypothesis that, *the weaker the institutions and governance of a country, the greater the effect of corruption on their CO2 emissions, leading to increased emissions; the stronger the institutions and governance of a country, the lesser the effect of corruption their CO2 emissions, leading to decreased emissions.*

However, it is shown that there has been a change over time in CPI scores for all countries in Figure 8. There are half the number of outlier countries with higher CPI scores (more than 60) in 2014 than in 1995 in the graph of below average EPI scores, and there are less than half the number of outlier countries with lower CPI scores (less than 60) in 2014 than in 1995. In other words, countries with below average EPI scores have changed over time, and increases in corruption does not lead to as much of an increase in emissions in 2014 as it did in 1995.

Type of Economy

Corruption is known to impact a countries economy, and economy is known to impact emissions; therefore, Figure 9 further examines this through the relationship between corruption and climate change, by grouping countries according to their dominant economy type. The types of economy used to differentiate countries include: agricultural, industrial, and service dominated economies.

Figure 9: The Relationship between Corruption and Climate Change for Countries with Different Dominant Economies



This figure shows that economies more reliant on agriculture and industry emit more emissions than those more reliant on service. Therefore, *proving* the hypothesis that, *the more reliant a country is on agricultural and industrial economies, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The more reliant a country is on service-based economies, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a county is.* Furthermore, the trend lines for the agriculture and industry graphs show the relationship of emissions increasing as corruption increases. However, all the graphs show that overall emissions have decreased over time, across all economies.

Most countries reliant on agriculture as the dominant economy are more corrupt, with majority of the CPI scores between 20-40, and only one country with a CPI score above 80. CPI scores vary for countries with an industry dominant economy; however, emissions do increase as these countries become more corrupt. In countries with service dominant economies, most are considered less corrupt, with only three countries with scores below 60 in 2014, and the number of more corrupt countries having decreased over time. Moreover, emissions of these countries don't exceed 500 in 2014.

5. Conclusion

This paper investigates the relationship between corruption and climate change to answer the question, *do more corrupt countries emit more CO2 emissions than otherwise similar but less corrupt countries?* And ultimately, *is corruption bad for climate change?* While there is a significant body of research examining corruption's impact on economic and social/political variables, research on corruption's impact on the environment is still new. Furthermore, prior research is focused on specific, individualized environmental factors, whereas this paper examines corruption's effect on climate change as a *whole*, incorporating multiple environmental factors.

The examination was conducted by analyzing the relationship between corruption and CO2 emissions for 1995 and 2014, while applying and comparing various conditions that constitute the major alternate explanations for global CO2 emissions. The measurement of grams per 2010 US$ of GDP was used as the measurement for emissions instead of total emissions, measured as kt. This measurement was used as it accounts for the influence of GDP and level of development on corruption and emissions, making it a more accurate measurement of emissions for the purpose of this paper. Furthermore, this relationship was examined across time. In turn, this paper has reached a number of findings.

Summary and Interpretation of Findings

Figure 1 shows that no consistent relationship exists between corruption and average total CO2 emissions, measured as kt. However, countries with CPI scores between 20-40 emit significantly larger emissions than all other CPI groups in 2014.

Figures 2 and 3 both show a correlation exists between increased corruption and increased CO2 emissions, when emissions are measured as grams per 2010 US$ of GDP. Therefore, this relationship continues to exist when GDP is accounted for. However, Figure 3 shows that this relationship is a lot stronger in countries with below average GDP per capita, that countries with below average GDP per capita emit far more emissions than those with above average GDP per capita, and that countries with below average GDP per capita are generally more corrupt, whereas countries with above average GDP per capita are generally less corrupt.

Figure 4 shows that, even when level of development is considered, as corruption increases, CO2 emissions increase. However, the trendlines of non-OECD countries are steeper, showing a stronger and faster trend between increased corruption and increased emissions for developing countries. Additionally, these countries emit more emissions than OECD countries overall. This figure *disproves* the hypothesis that, *the more developed a country is, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less developed a country is, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is.*

Furthermore, the following tentative conclusions can be drawn: a) the more developed a country is, the less corrupt it is; the less developed a country is, the more corrupt it is, b) the more corrupt a country becomes, the faster their CO2 emissions increase; the less corrupt a country becomes, the slower their CO_2 emissions increase, c) less developed countries have become more corrupt over time, or, membership in the OECD reduces the likelihood of countries becoming more corrupt over time, or both. Figures 2,3, and 4 are consistent with Welsch (2004) and his theories on "corruption enhancing pollution" at low income levels as well as the positive direct effect of corruption on pollution levels.

Figure 5 has mixed findings of the relationship between corruption and climate change in terms of the impact of energy use. The graph of countries with high energy use is consistent with Beck and Joshi (2015) who found that expanded energy use leads to decreased emissions. Whereas, the graph of low energy use countries, has a trend of emissions increasing as corruption increases. However, this trend is steeper, indicating a stronger correlation between increased corruption and increased emissions.

Moreover, Figure 5 shows that most low energy use countries are more corrupt. Overall, this figure shows the hypothesis, *the more energy a country uses, the greater their CO_2 emissions; and the greater their CO_2 emissions, the more corrupt a country is. The less energy a country uses, the lesser their CO_2 emissions; and the lesser their CO_2 emissions, the less corrupt a country is*, is not as simple and straightforward. Findings show that corruption levels directly influence energy use of a country, however, energy use does not necessarily determine emissions. An explanation for this includes: low energy use countries are comprised of primarily developing countries that are more reliant on traditional, older, dirtier forms of energy, that emit more, even though they use less energy overall. On the contrary, high energy use countries are more developed and have more access to more modern, renewable and innovative forms of energy, that do not emit as much, even though they may use a lot more energy.

This is demonstrated in Figure 6, as here, there are far more corrupt countries that use above average amounts of fossil fuels than corrupt countries that use below average amounts of fossil fuels. Furthermore, less corrupt countries have fewer emissions. In turn, Figure 6 *proves* the hypothesis that, *the more non-renewable energy a country uses, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less non-renewable energy a country uses, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is*.

Figure 7 shows that regardless of the differences in trade, as countries become more corrupt, emissions increase. This trend remains the same across time, and the steepness of the trendline is similar for both graphs, further proving the fact that trade does not influence the relationship between corruption and climate change. However, it is shown that corruption has an adverse effect on the amount of trade a country is involved in when a country is more corrupt.

This figure *disproves* the hypothesis, *the more trade a country engages in, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The less trade a country engages in, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a country is,* as countries that have low trade amounts reach higher emissions than those that have high trade, however, overall, emissions are similar for both groups of countries. These findings are consistent with Iwata et al. (2012) who found the impact of trade to not be statistically significant.

Figure 8 shows that a relationship between increased corruption and increased emissions only exists in 1995 for countries with below average EPI scores. All other trendlines show no clear relationship between corruption and emissions, with similar emissions emitted across a range of CPI scores. Therefore, this figure *disproves* the hypothesis, *the weaker the institutions and governance of a country, the greater the effect of corruption on their CO2 emissions, leading to increased emissions; the stronger the institutions and governance of a country, the lesser the effect of corruption their CO2 emissions, leading to decreased emissions.*

However, there has been a change over time in CPI scores within each graph in Figure 8, with CPI scores increasing over time in the graph of above average EPI scores, and CPI scores decreasing over time in the graph of below average EPI scores. This could be as a result of: a) countries with below average EPI scores have become more corrupt over time, and countries with above average EPI scores have become less corrupt over time, b) countries that are more corrupt have reduced their environmental performance over time and countries that are less corrupt have improved their environmental performance overtime, or c) both of these scenarios occurred.

These findings are inconsistent with a majority of the research that has been conducted on the importance of governance and institutions in reducing emissions and bettering the environment (Morse 2006; Welsch 2004; Damnia et al. 2003; Damnia 2002). As multiple changes in CPI scores of countries are found in this figure, a possible explanation for these inconsistent findings could be that of political instability causing the effect of corruption reducing the stringency of environmental regulations to disappear, as noted by Fredriksson and Svensson (2003).

An alternate explanation is that the Environmental Performance Index has only been used since 2008, therefore, with time, more accurate results can be formed and ultimately, more research has to be done on this relationship.

Figure 9 shows that economies more reliant on agriculture and industry emit more emissions than those more reliant on service. This is consistent with various authors (Balogh & Jambor, 2017; Kofi Adom, Bekoe, Amuakwa-Mensah, Mensah, & Botchway, 2012; Mi, Pan, Yu, & Wei, 2015; Zhu, Shi, & Wang, 2014; Henders, Persson, & Kastner, 2015; Baccini et al., 2012; Foley et al., 2011). Therefore, *proving* the hypothesis that*, the more reliant a country is on agricultural and industrial economies, the greater their CO2 emissions; and the greater their CO2 emissions, the more corrupt a country is. The more reliant a country is on service-based economies, the lesser their CO2 emissions; and the lesser their CO2 emissions, the less corrupt a county is.*

Furthermore, the trend lines for the agriculture and industry graphs show the relationship of emissions increasing as corruption increases, therefore, most countries reliant on agriculture/industry as the dominant economy are more corrupt. In contrast, countries with service dominant economies are considered less corrupt. As a result, more polluting economies have more corrupt governments and emit more emissions. Furthermore, on an individual level, more corrupt governments emit more than less corrupt governments within the same economy type.

Implications

A majority of the findings in this paper show that when level of development is taken into account, by measuring emissions as grams per 2010 US$ of GDP, regardless of other conditions being applied to the data, as corruption increases, CO2 emissions increase.

Therefore, more corrupt countries emit more CO_2 emissions than otherwise similar but less corrupt countries, and overall, corruption is bad for climate change.

However, more research needs to be conducted with a larger number of cases in order to see if these results continue to be consistent. As it stands with the current results in this paper, it suggests that efforts to combat corruption are not only vital for the economic and political/social circumstances of the world, but also for the environment, and more specifically, for climate change. Therefore, in order to effectively address climate change on a global scale, more research should be done into policy formation and implementation, environmental regulation, and international agreements, that include efforts to address corruption too.

Appendix

The following tables outline the indicator results used in the analysis section of this paper. The CPI scores are color-coded according to the 5 groups of corruption used for Figures 1.

Country	CPI Scores			CO2 emissions (kg per 2010 US$ of GDP)		CO2 emissions (g per 2010 US$ of GDP)		CO2 emissions (kt)	
	1995/10	1995/100	2015	1995	2014	1995	2014	1995	2014
Argentina	5.24	52	32	0.479	0.460	479	460	127964	204025
Australia	8.8	88	79	0.409	0.282	409	282	281860	361262
Austria	7.13	71	76	0.206	0.143	206	143	59783	58712
Belgium	6.85	69	77	0.315	0.186	315	186	112328	93351
Brazil	2.7	27	38	0.186	0.219	186	219	258347	529808
Canada	8.87	89	83	0.424	0.301	424	301	467638	537193
Chile	7.94	79	70	0.363	0.319	363	319	41745	82563
China	2.16	22	37	2.245	1.235	2245	1235	3320285	10291927
Colombia	3.44	34	37	0.324	0.241	324	241	59614	84092
Denmark	9.32	93	91	0.222	0.100	222	100	57172	33498
Finland	9.12	91	90	0.323	0.191	323	191	52713	47301
France	7	70	70	0.172	0.111	172	111	349161	303276
Germany	8.14	81	81	0.304	0.197	304	197	864110	719883
Greece	4.04	40	46	0.375	0.274	375	274	78782	67319
Hong Kong	7.12	71	75	0.233	0.179	233	179	31470	46223
Hungary	4.12	41	51	0.653	0.302	653	302	60370	42086
India	2.78	28	38	1.358	1.051	1358	1051	811562	2238377
Indonesia	1.94	19	36	0.514	0.493	514	493	224941	464176
Ireland	8.57	86	75	0.315	0.135	315	135	32970	34066
Italy	2.99	30	44	0.231	0.157	231	157	430484	320411
Japan	6.72	67	75	0.234	0.205	234	205	1183447	1214048
Luxembourg	6.85	69	81	0.689	0.476	689	476	8317	9659
Malaysia	5.28	53	50	0.272	0.162	272	162	121132	242821
Mexico	3.18	32	35	0.942	0.773	942	773	332817	480271
Netherlands	8.69	87	87	0.470	0.406	470	406	178634	167303
New Zealand	9.55	96	88	0.301	0.196	301	196	27132	34664
Norway	8.61	86	87	0.281	0.213	281	213	33439	47627
Pakistan	2.25	23	30	0.109	0.104	109	104	84484	166298
Philippines	2.77	28	35	0.844	0.807	844	807	60711	105654
Portugal	5.56	56	63	0.577	0.421	577	421	51870	45053
Singapore	9.26	93	85	0.286	0.201	286	201	42174	56373
South Africa	5.62	56	44	0.412	0.197	412	197	362259	489772
South Korea	4.29	43	56	1.557	1.184	1557	1184	374771	587156
Spain	4.35	44	58	0.257	0.171	257	171	241611	233977
Sweden	8.87	89	89	0.166	0.084	166	84	55155	43421
Switzerland	8.76	88	86	0.090	0.056	90	56	39226	35306
Thailand	2.79	28	38	0.767	0.827	767	827	161154	316213
Turkey	4.1	41	42	0.402	0.337	402	337	171975	345981
UK	8.57	86	81	0.302	0.159	302	159	538118	419820
USA	7.79	78	76	0.498	0.324	498	324	5132920	5254279
Venezuela	2.66	27	17	0.479	0.440	479	440	133350	185220

The GDP per capita data is color-coded according to membership in the OECD, where red indicates non-membership and green indicates membership. Energy use, fossil fuel consumption, trade, and EPI score data is color-coded according to averages for the sample countries, where red indicates below average and green indicates above average values.

Country	GDP Per Capita (current US$)		Energy use (kg of oil equivalent per capita)		Fossil Fuel Energy Consumption (% of total)		Trade (% of GDP)		EPI Scores	
	1995	2014	1995	2013	1995	2013	1995	2014	2008	2018
Argentina	20320	62328	5129	5464	87	89	38	43	82	59
Australia	30326	51705	3374	3919	94	94	68	104	80	74
Austria	7373	12245	1544	1951	78	66	20	28	89	79
Belgium	28566	47352	5268	4987	77	71	116	165	78	77
Brazil	4740	12027	993	1451	55	58	17	25	83	61
Canada	20577	50633	7966	7728	73	73	69	64	87	72
Chile	5137	14794	1283	2216	70	69	55	65	83	57
China	2471	7974	737	711	78	88	35	37	65	51
Colombia	610	7684	867	2214	70	77	34	45	88	65
Denmark	35351	62549	3706	3125	92	70	69	102	84	82
Finland	26273	49915	5662	6116	53	43	64	75	91	79
France	26890	43009	3981	3834	54	49	44	60	88	84
Germany	31730	48043	4120	3940	86	81	44	84	86	78
Greece	12959	21761	2147	2128	94	88	37	67	80	74
Hong Kong	4494	40315	2503	2272	95	94	78	169		
Hungary	23497	40315	1720	1944	82	70	257	426	84	65
India	1026	3492	664	863	60	72	54	48	60	31
Indonesia	370	1576	386	607	61	65	23	49	66	47
Ireland	19181	55413	2952	2815	88	86	136	208	83	79
Italy	20596	35397	2799	2579	93	80	46	56	84	77
Japan	43440	38109	3936	3568	81	95	17	38	85	75
Luxembourg	52831	119225	7705	7312	85	85	185	382	83	79
Malaysia	4328	11184	1687	2956	93	97	192	138	84	59
Mexico	3829	10582	1401	1568	86	91	46	65	80	60
Netherlands	28885	52157	4780	4600	95	92	108	154	79	75
New Zealand	17400	44561	4054	4360	68	61	57	55	89	76
Norway	34875	97200	5391	6416	53	62	68	69	93	77
Pakistan	494	1317	436	488	56	59	36	31	59	38
Philippines	1061	2843	481	455	55	61	81	61	78	58
Portugal	11783	22078	2014	2058	83	73	60	80	86	72
Singapore	24937	56957	5347	4880	99	94	346	359		64
South Africa	3694	6429	2460	2599	86	87	44	64	69	45
South Korea	12333	27811	3210	5232	87	84	53	95	79	62
Spain	15430	29623	2537	2512	80	73	45	63	83	78
Sweden	48662	86606	3422	3304	37	30	77	117	93	81
Switzerland	29914	59180	5702	5147	56	52	70	86	96	87
Thailand	2845	5954	1041	1992	76	81	90	132	79	50
Turkey	2898	12127	1053	1543	83	88	44	51	76	53
UK	23013	46783	3729	2988	88	84	50	58	86	80
USA	28782	54697	7764	6902	85	83	22	30	81	71
Venezuela	3489	15692	2111	2268	89	88	47	48	80	64

Lastly, type of economy data is also color-coded according to average values; however, only above average values are color-coded in green and were used in the analysis section of this paper.

Country	Type of Economy, value added (% of GDP) 1995			Type of Economy, value added (% of GDP) 2014		
	Agricultural	Industrial	Service	Agricultural	Industrial	Service
Argentina	5	26	62	7	24	53
Australia	3	27	62	2	25	66
Austria	2	29	59	1	25	63
Belgium	1	26	63	1	20	69
Brazil	5	23	58	4	20	61
Canada				1	28	65
Chile	7	38	48	4	31	57
China	20	47		9	43	48
Colombia	14	29	54	5	31	55
Denmark	3	22	62	1	20	66
Finland	4	29	54	2	23	61
France	2	22	65	2	18	70
Germany	1	30	60	1	27	62
Greece	7	20	64	3	14	71
Hong Kong				0	7	90
Hungary	7	26	52	4	26	55
India	25	30	36	17	28	48
Indonesia	17	42	41	13	42	42
Ireland	6	29	55	1	25	65
Italy	3	26	61	2	21	67
Japan	2	34	63	1	28	70
Luxembourg	1	19	70	0	11	78
Malaysia	13	41	48	9	40	50
Mexico	4	33	59	3	31	60
Netherlands	3	24	63	2	18	70
New Zealand	8	25	60	6	20	65
Norway	3	29	55	1	34	54
Pakistan	23	21	45	24	20	52
Philippines	22	32	46	11	31	57
Portugal	5	25	59	2	19	66
Singapore	0	31	62	0	24	70
South Africa	4	32	56	2	27	61
South Korea	5	36	49	2	35	54
Spain	4	28	60	2	21	67
Sweden	2	27	58	1	23	65
Switzerland	1	29	66	1	25	71
Thailand	9	38	53	10	37	53
Turkey	16	32	49	7	28	54
UK	1	25	64	1	18	71
USA				1	20	75
Venezuela	5	38	49	5	37	52

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