Corruption and the Environmental Kuznets curve: an empirical analysis of carbon dioxide, methane and dinitrogen monoxide

Rik-Jan Veldhuijzen - 434710

ERASMUS UNIVERSITY ROTTERDAM

Erasmus School of Economics

Bachelor Thesis Economie en Bedrijfeconomie

Supervisor: A.J. Hummel
Second assessor: K.F.J. Spiritus

Date final version: t.b.d.

Abstract

The Environmental Kuznets Curve (EKC) hypothesis postulates an inverted-U shape relationship between per capita income and factors of environmental degradation. In this thesis, I investigated how corruption influences the income level at the turning point of EKC for the three most emitted greenhouse gasses, carbon dioxide (CO_2), methane (CH_4) and dinitrous oxide (N_2O). The study is based on a panel of eighty countries which are observed from 2000 and up to and including 2014. The results support the Environmental Kuznets Curve hypothesis for CO_2 and CH_4 but not for dinitrogen monoxide. I find that the lower the degree of corruption the higher the per capita income at the turning point of CO_2 emissions and the lower the per capita income at the turning point of CH_4 emissions. However, when allowing for different income slopes across richer and poorer countries, the main finds can only be replicated for high-income countries. Contrary to common findings in the literature on climate and corruption, this study suggests that the net effect of corruption is beneficial for the climate, by decreasing the income-level at the turning point of the EKC.

1. Introduction

Since the *Club of Rome* published *Limits to Growth* (1972). The predominant view of environmentalists is that economic growth leads to environmental degradation. However, economists have found empirical evidence of the existence of an inverted U-shaped relationship between some factors of environmental quality and per capita income. This relationship is called the Environmental Kuznets Curve (EKC). The EKC hypothesis posits that during the early stages of a country's economic growth process its pollution increases, but then, after per capita income exceeds a certain threshold level, decreases Grossman and Krueger (1991) were the first to find an inverted U-shape relationship between per capita income and concentrations of several local pollutants such as smoke and chemicals. This kick-started a large body of empirical literature on the EKC. In this literature, the income-pollution pathway is typically considered to homogeneous with the same turning point for each country, regardless differing country-specific characteristics, such as its geographical position, natural resource endowment, quality of institutions and type of governance.

However, this position has been challenged. Several empirical studies, such as Cole 2005, Dijkgraaf and Vollebergh 2005, and Vollebergh et al. 2006 have rejected the homogeneity assumption regarding income-pollutions paths. Several researchers have since identified that social-political factors play a pivotal role in determining the shape of the EKC. Farzin and Bond (2006) have demonstrated the impact of democracy, inequality, age composition and education level on the EKC. Williamson (2017) found that different types of governances, such as constitutional monarchies and a parliamentary government lead to a significant decrease in CO_2 and CH_4 emissions compared to absolute monarchy. Moreover, Tamazian and Rao (2010) stress the importance of both institutional quality and financial development for environmental performance and warn that financial liberalisation without a strong institutional framework may be harmful to environmental quality.

In a recent survey paper on the EKC, Shahbaz and Sinha (2019) stress that further research on the EKC should consider socio-economic and political. This thesis aims to fill this gap by concentrating on the effect of corruption on the EKC. More specifically, by investigating how corruption influences the income-pollution path across countries. The theoretical background is laid by Lopez and Mitra (2000), who argue that corrupt governments can influence the income-pollution relation by postponing environmental regulation. Although pollution is, due to non-optimal government decisions, above the social optimum for any level of income, Lopez and Mitra find that the deviation from the social optimum increases with higher levels of corruption. This results in higher levels of per capita income at the EKC turning point, which postpones the decrease of pollution to later stages of a countries economic development. To the best of my knowledge, only Leitao (2010) has conducted a study to investigate the impact of corruption on the EKC. This study found that corruption significantly increases the turning point of the EKC for sulphur emissions and thus is harmful to the environment. This thesis aims to extend Leitao's research by investigating the impact of corruption on the turning point of the EKC of the three most emitted anthropogenic greenhouses gasses, being CO_2, CH_4 and N_2O.

This thesis finds evidence for the EKC hypothesis for CO_2 and CH_4 and a montonically increasing income-N_2O emission relationship. Corruption significantly affects the EKCs of CO_2 and CH_4 but in opposing direction. Due to corruption, the income level at the turning point increases for CO_2 but decreases for CH_4. When allowing for heterogeneity between poor and rich countries these results can only be replicated in the high-income group. I found no significant impact of corruption on N_2O emissions.

The remainder of the thesis is structured as follows. Section 2 provides a theoretical background on the concept of the EKC and the impact of corruption. Section 3 and Section 4 respectively outline the methodology and used within this study. Section 5 presents the results and Section 6 investigates their robustness to measurement errors of corruption. The conclusions are summarized and discussed in Section 7.

2. Theoretical Background

The concept of the EKC arises in the early 1990s with Grossman and Krueger's ground-breaking study *Environmental Impacts of a North American Free Trade Agreement* (1991). They identify the inverted U-shape income-pollution relationship for some factors of environmental degradation. The concept was further popularized through the 1992 World Bank Development Report (IBRD, 1992) (Stern, 2004). The EKC made way for a new way of thinking in which economic growth and sustainability are compatible. This led some authors, such as Beckerman (1992) to believe that economic growth is ''the best – and probably the only – way to attain a decent environment''. This line of arguing fits in the framework of laissez-faire politics. As such, the idea of the EKC as a political tool has been controversial from its conception as it seems to imply that environmental protection is secondary to economic growth. However, Grossman and Krueger (1996) already warned that the EKC is not an automatic process.

Economic growth is typically considered to increase emissions of pollutants because it implies that the scale of the economic activity increases. However, according to the EKC hypothesis, this initial phase of environmental deterioration is subsequently followed by a phase of environmental improvement after reaching a critical income level. The literature typically considers three underlying factors that determine the downhill portion of the EKC. Firstly, the output mix of an economy changes during its economic development from an industrial-based to a service-based economy. Secondly, the adaption of new technology decreases emissions by (i) increasing the efficiency of the production and (ii) by environmental specific innovations. Thirdly, demand for a clean environment increases in income. In poor countries, people value their material well-being over environmental protection. However, when a sufficiently high level of income is reached, people can afford to care more about the quality of the environment. The last mechanism is widely considered to be the most important factor in causing the decline in environmental degradation (Barrett and Graddy, 2000). Hence, the shape of the EKC depends on a society's demand for environmental protection. In this thesis, I argue that government corruption may affect the process in which the increase in demand for environmental protection is translated into environmental policy.

Corruption has a twofold effect on the environment in opposing directions. The direct effect of corruption can be that the government is reluctant to implement more stringent environmental regulation or to enforce the environmental regulation in place. In a well-functioning country, an increase in demand for environmental protection causes the government to respond appropriately by implementing environmental regulation, taxing pollution or subsidizing sustainable alternatives. However, a corrupt government abuses its public power to gain private benefits. This can manifest itself in two ways, depending on the relation between the political and economic elites. If the political elite is simultaneously the economic elite than the government can create an environment to benefit their own enterprises. When the political elite is not directly involved in economic activity, it may benefit businesses to bribe politicians. Lopez and Mitra (2000) provide a theoretical framework in which it is in the interest of the firm to bribe politicians and in the interest of the politician to accept a bribe despite lowering his chances of re-election. In conclusion, corruption directly harms the environment due to the government's unwillingness to execute environment regulation. Corruption also has an indirect effect on pollution, by reducing economic growth and thus the scale of economic activity (Mauro, 1995). This effect can be either positive or negative for the environment, depending on whether the country has passed the critical income threshold after which the emission of pollutants starts to decline. Due to the opposing directions of these effects, we cannot determine in advance whether the total effect of corruption is negative or positive.

It is beyond scope of this thesis to distinguish the effect of corruption between the difference of implementation or enforcement regulation, or even to distinguish the direct and indirect effects, Instead, this thesis I will investigate the total effect of corruption on the income-emission relation. As mentioned above, the effect of corruption is ambiguous and cannot be determined a priori. However, although the empirical suggest a negative impact of corruption dominate the positive effect. I, therefore, expect to find, similarly to Leitao's (2010) that corruption increases the income level at the turning point of the EKC. It must be noted, however, that these findings concern the EKC of sulphur – a local pollutant – and cannot be extrapolated to greenhouse gasses that have a global effect. From a theoretical point of view, the demand for pollution abatement should be higher for local pollutants – which cause damage near the emissions source – than for global pollutants. Because the impact of global pollutants is shared across the planet there is a strong incentive for free-riding. This makes an EKC for global pollutants less likely. This study is concerned with greenhouse gas emissions, which negative impact only applies on a global scale. Moreover, although there is an extensive body of literature on the EKC of CO_2 with mixed results concerning evidence for an EKC, the literature on both CH_4 and N_2O is very limited. Consequently, it is impossible to accurately predict the income-emission relationship for these pollutants and the effect that corruption has on the shape of the curve.

3. Methodology

This study uses three distinct atmospheric pollutions variables CO_2, CH_4 and N_2O, as dependent variables in separate regression analyses. The gasses respectively made up seventy-six, sixteen and six per cent of the anthropogenic greenhouse gas emissions in 2010 (IPCC, 2014). Combined, these three greenhouse gases make up ninety-eight per cent of all anthropogenic greenhouse gas emissions. Hence, this study will provide an almost complete insight into the income-emission relationship. To carry out my analysis of the effect of corruption on the EKC turning point of greenhouse gas emissions I employ a fixed effect linear model, as is common in the literature. The panel data consists of eighty countries, which combined are residence to approximately eighty per cent of the world population, (a list of countries can be found in Appendix A) and are observed over a time period of fifteen years – from 2000 up to and including 2014 for CO_2 – and twelve years – from 2000 up to and including 2012 for CH_4 and N_2O. Both country- and time fixed effects will be employed to control for differences between countries and over time. The inclusions of these fixed effects prevents us from picking up effects, that would otherwise be contributed to the explanatory variables, but which are in reality driven by differences between countries or changes over time. The country fixed effects will capture specific characteristics of each country that result in higher or lower greenhouse gas emissions. Furthermore, to estimate the income-emissions relation, both linear and squared-income variables will be added to our model. The EKC is determined by the squared income variable because this allows for a non-linear income-emissions relation. Moreover, a corruption variable is added to the regression, to estimate the effect of corruption on greenhouse gas emissions. Of course, due to the possibility of omitted variable bias, this results of the regression analysis cannot be interpreted as definitive. Nevertheless, I tried to minimize the omitted variable bias as much as possible, by adding a set of control variables. The control variables used include the degree of inequality, the openness to trade, the degree of urbanisation and the mean amount of year spent in school. Another time variable is added to represent the increasing state of technology. This all can be summarized in regression Equation 1, which takes the following form:

$$E_{jit} = \alpha_{it} + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Corr_{it} + D_{it} + \delta_i + \gamma_t + \epsilon_{it} \qquad (1)$$

Where E is the per capita emissions of greenhouse gas for country i at time t, α_{it} serves as a constant, Y is the per capita income, $Corr_{it}$ is a corruption variable and D is a set of control variables. δ_i and γ_t represent the respectively the country and time-specific fixed effects. This model will be used for each greenhouse gas studied in this thesis separately and serves to identify their income-emission relation. The model represented in Equation 1 can take the following functional forms, of which each represents a different income-emissions relation.

(a) $\beta_1 = \beta_2 = 0;$ no income-emissions relation.

(b) $\beta_1 > 0,\ \beta_2 = 0;$ linearly increasing income-emissions relation.

(c) $\beta_1 < 0,\ \beta_2 = 0;$ linearly decreasing income-emissions relation.

(d) $\beta_1 > 0,\ \beta_2 < 0;$ inverted U-shaped income-emissions relation.

(e) $\beta_1 < 0,\ \beta_2 > 0;$ U-shaped income-emissions relation.

The EKC is given by specification *(d)*. The income level at the turning point of the EKC from Equation 1 is thus given as:

$$Y^* = -\frac{\beta_1}{2\beta_2} \qquad (2)$$

An assumption of the linear model used is, that the income-emission relation has the same shape in every country. In this thesis, I want to investigate how corruption influences a country's emission by identifying whether corruption influences the shape of the EKC. In that case, every country would have a unique turning point, depending on the level of corruption in the country. To measure the effect of corruption on the shape of the EKC, an interaction effect between income and corruption is needed. This will make the turning point of the EKC dependent on the corruption variable. This model is represented in Equation 2.

$$P_{jit} = \alpha_i + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Corr_{it} + \beta_4 Corr_{it} Y_{it} + \beta_5 Corr_{it} Y_{it}^2 + D_{it} + \epsilon_{it} \qquad (3)$$

The income level at the turning point of Equation 3 thus is a function of corruption and is given as:

$$Y^* = \frac{-\beta_1 - \beta_4 Corr}{2(\beta_2 + \beta_5 Corr)} \qquad (4)$$

4. Data

4.1 Dependent variables

CO_2 emissions are measured in kilotons per capita and cover a timespan from 2000 up to and including 2014. The data are provided by the Carbon Dioxide Information Analysis Center (CDIAC).

Data on CH_4 and N_2O emissions are also measured in kilotons per capita and cover a timespan from 2000 up to and including 2012. Because CH_4 and N_2O are more potent greenhouse gasses than CO_2, both CH_4 and N_2O emissions are measured in standardized units of CO2 equivalents to allow for comparison between the environmental impacts of different greenhouse gasses. This means that one kiloton of CH_4 or N_2O measured in CO_2 equivalents has an equal effect on the greenhouse effect as one kiloton of CO_2. The data on CH_4 and N_2O are provided by European Commission's Emissions Database for Global Atmospheric Research (EDGAR) from the cooperation of Joint Research Centre (JRC) and the Netherlands Environmental Assessment Agency (PBL). The data has been transformed to per capita units.

4.2 Explanatory variables

4.2.1 Income

Per capita income is measured in international dollars with fixed prices from 2011. The data is obtained from the World Bank and adjusted for differences in purchasing power to allow cross country analysis and is based on the international comparison programme (ICP) of 2011. In order to identify a parabolic (inverted U-shape) income-pollution relationship, I will use a squared income variable as well. In the Results section, GDP is presented in millions of international dollars, to keep the size of the income coefficients compact.

4.2.2 Corruption

4.2.2.1 CPI

Corruption is the second explanatory variable. In this thesis, data from the Corruption Perception Index (CPI) from Transparency International, will be used as an estimate for the corruption in a country. It defines corruption as the abuse of public power for private benefit. Because of the illegal nature of corruption, it is not well recorded. This makes it difficult to assess corruption with hard empirical data. For example, comparing the number of bribes in two countries does say little about the prevalence of corruption but instead, it only shows in which country corruption is more thoroughly investigated. Therefore, the corruption measure is based on the perception of corruption rather than empirical data. The CPI estimate is based on survey data, in which the public is asked how they perceive corruption in their own country. This method is considered to be more reliable for cross-country analysis than an empirical analysis because it is based on the experience of those who face corruption in their country first hand. The index uses a scale ranging from zero to one hundred, where zero is highly corrupt and one hundred is very clean. The higher a countries CPI-score the less corrupt a country is. The CPI dates back to 2000 and does not have continuous data for all countries. These constraints greatly diminish our sample size as it limits both the number of years and countries. To standardize the data, the data from 2000 to 2011 have been multiplied by ten to be comparable with data from 2012 and onwards.

4.2.2.2. ICRG

In order to test the robustness of the results, I will use the International Country Risk Guide's (ICRG) corruption estimation, which has been commonly used in the cross-country corruption literature (Cole, 2007; Leitão, 2010; the data is acquired from the risk assessment institution The PRS Group. It focusses on corruption in the form of excessive patronage, nepotism, job reservation, 'favour-for-favours', secret party funding, and suspiciously close ties between politics and business. The ICRG's corruption Index ranges from 0 to 6 where lower values correspond with more corruption.

4.3 Control variables

Inequality has been observed to influence emissions (Torras & Boyce, 1998) and to change the income level at the EKC turning point (Ridzuan, 2019). Therefore, we will control for inequality to avoid contributing its effects to the corruption variable. Similarly to these papers, I use the World Bank's Gini-coefficient to measure of inequality. The Gini index is a standard measure of inequality widely used in economics. The Gini-coefficient ranges from 0 to 1 where 0 represent perfect equality and 1 represent perfect inequality. A limitation of the data is that the Gini-coefficient of a country can be based on either income or consumption inequality and both estimates occur within the same dataset. This diminishes the reliability of the Gini-coefficient in cross-country analysis.

Furthermore, this study controls for trade openness and the degree of urbanisation. Both variables have been demonstrated to significantly affect the course of the EKC since they are correlated to both GDP and greenhouse gas emission (Dogan & Turkekul, 2016; Ridzuan, 2019). Trade openness is measured as the percentage of imports and exports of the total GDP and is provided by the World Bank. The degree of urbanisation is the share of people in a country that lives in urban areas. Data on urbanisation is also provided by the World Bank.

Lastly, I control for the level of education. Torras and Boyce (1998) found that the literacy rate has a significant effect on the course of the EKC in relation to inequality. Because the available data on literacy rates was insufficient for our dataset I have chosen to use mean years of schooling (MYOS) as a proxy of the level of education of the public. An educated public has greater access to information, which is correlated with power and is thus better equipped to oppose corrupt governments. The data has been obtained from the Institute for Health Metrics and Evaluation (IHME).

4.4 Overview

Table 1 shows the descriptive statistics for the independent and explanatory variables. Figure 1 and 2 show the evolution of the combined average GDP per capita and greenhouse gas emissions per capita for the countries in the dataset. During the timespan of this study, GDP has an upward sloping trend, with the exception of the Great Recessions, following the 2008 financial crisis. CO_2 per capita has an upward slope during the early 2000s, which after a short period of stagnation in the mid-2000s is followed by a continuous downward slope from 2008 and onwards. Thus, at first sight, the combined average per capita CO_2 emissions follow an inverted U-shape curve. Both CH_4 an N_2O exhibit a downward sloping trend.

Table 1: Descriptive statistics independent and explanatory variables

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
CO_2 per capita	1200	5.53	4.66	0.49	25.20
CH_4 per capita	1040	1.45	1.28	0.21	7.05
N_2O per capita	1040	0.70	0.61	0.03	4.22
GDP per capita	1200	20266	17021	792	97900
CPI	1199	49.98	23.98	10	100
ICRG	1167	2.97	1.27	0	6

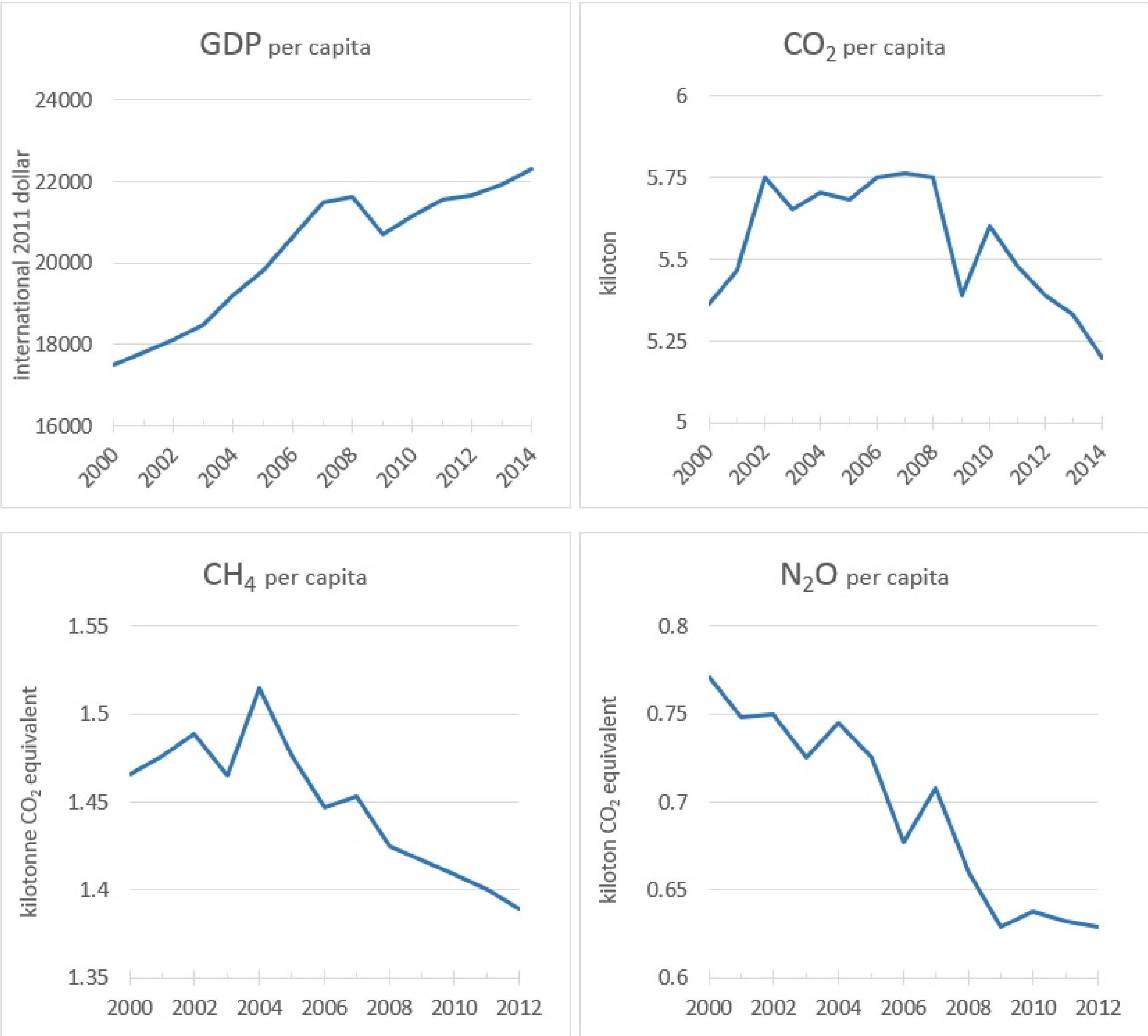

Figure 1: Graphical representation of the trend of GDP and the greenhouse gasses

5. Results

5.1 Introduction to the results

In this section of the thesis, the results will be presented. The first part of this thesis consists of regression analysis with panel data, in which the three greenhouse gasses CO_2, CH_4 and N_2O are the dependent variables. The main explanatory variables are GDP and CPI and interaction between these two variables. All three dependent variables are analysed with identical regression models. The results of the analyses are represented respectively in Tables 3 to 6.

5.2.1 Regression analysis CO_2 emissions

Table 3 shows the results of the analysis of CO_2. The first two models attempt to identify the inverted-U shape relationship and the influence of corruption on CO_2 emissions. Model 1 finds strong evidence for a positive relationship between GDP per capita and per capita CO_2 emissions and weak evidence for an inverted-U shape relationship. The estimated income level at the turning point of the EKC is 70,500 dollar. This is too high in order for the EKC to be a realistic tool in a climate discussion, as in our dataset, only outlier Luxembourg has passed that income level. Corruption is positively correlated with CO_2 emissions. Since a higher CPI score represents low corruption, this means that less corruption corresponds with higher levels of emissions. This contradicts the idea that corruption results in more emissions. However, this effect is most likely due to the fact to less corrupt countries are richer and consequently more CO_2 emissions. In Model 2 several control variables are added to the model. As a result, the significance of the corruption variable increases, while the coefficient remains within the same order of magnitude. However, GDP-squared no longer significantly correlates with GDP which puts doubt on an inverted U-shape income-emission relation. The control variables explain part of the variation that leads to the inverted U-shape income-emission relation. Except for MYOS, the control variables bear a significant relationship with the dependent variable. As a result, the R-square of Model 2 is greatly improved. Albeit that Model 2 does not find significant evidence for an EKC, I still estimate the turning point of the hypothetical EKC to get an intuition of how the control variables influence the income-emission relation. As is shown in Table 2 the estimated turning point of the EKC in Model 2 greatly increases to 97,000, becoming approximately equal in size to the highest measured value of GDP per capita in our dataset (Luxembourg, 2007). At this level, the concept of an EKC is irrelevant in the climate discussion, as no country's per capita income is expected to surpass the turning point. However, it must be noted, that the evidence for an EKC is insignificant and as a result, the estimation the income level at the hypothetical turning point is not definitive.

Model 3 and 4 deal with the main question at hand: how does corruption influence the shape of the EKC. Using Model 3, without further control variables, I find significant evidence for both the existence of the EKC and the influence of corruption on the EKC. However, estimating the turning point of the EKC is difficult. With the use of Equation 4, I find that lower levels of corruption lead to a higher income level at the turning point. However, in the upper range of CPI levels, we find that the income-level rapidly increases with a decrease in corruption. The trend can be observed in Table 3. The CPI values shown are the minimum, mean and maximum value that CPI takes in the dataset and a further estimation for a better intuition of the course of the curve. The rapid increase in income levels is due to the fact that the denominator of Equation 4 takes a value of zero when CPI is 92.8 As such, estimation in the upper spectrum cannot be considered realistic. T Model 4, improves Model 3 with the addition of the set of control variables. This reduces the level of significance that is achieved in Model 3. However, Model 4 still supports the existence of the EKC at a 5 per cent significance level. Furthermore, corruption remains significantly correlated with CO_2 emissions. The interaction effect between the corruption index and CPI is significant at a 10 per cent level, suggesting that corruption does affect the shape of the EKC. The addition of control variables results, similarly as in Model 2, in higher income-levels at the turning point. Unfortunately, Model 4 suffers from the same problem as Model 3 and cannot produce reliable estimation for the upper end of the CPI values.

Table 2: Estimation of the turning point of the EKC for CO_2 corresponding to Table 4

CO_2	Model 1	Model 2	Model 3	Model 4
Fixed TP	70,500	97,000		
TP if CPI = 10			37,600	45,100
TP if CPI = 50			47,700	60,500
TP if CPI = 80			96,400	139,900
TP if CPI = 100			Negative Value	Negative Value

5.2.2 Regression analysis of CH4 emissions

Table 3 shows the results of the analysis for CH_4. This regression is run in the same way as the previous regression for CO_2. Model 1 finds strong evidence for a positive relationship between GDP per capita and per capita CO_2 emissions and weak evidence for an inverted-U shape relationship while controlling for corruption. The turning point of the income-emission relationship amounts to 56,400 dollars. Although the estimated turning point is lower than that of CO_2, it is still relatively high and only four countries – who combined account for less than one per cent of global emissions – have managed to pass this level. However, since the United States have almost reached this critical threshold, it may lead to a significant decrease in the future. Corruption itself does not have a significant effect on the level of emissions. Adding control variables, as done in Model 2, only increases the positive income-emission relation but has no effect on the corruption variable. The control variables are all insignificant. Nevertheless, the inclusion of control variables increases leads to a more precise estimation of the turning point, which is increased by 3,000 dollars. However, I cannot stress enough that these estimates are not reliable due to the high standard error of the coefficients used to calculate the turning point – which are significant at a ten per cent level only. Furthermore, the R-square value of neither model exceeds 0.10, which raises the question whether the model is adequate for the data at hand.

Model 3 allows for interaction effects between income and corruption. Within this model, I find significant evidence for the existence of an EKC. The corruption variable itself is insignificant, hence there is no direct effect of corruption on CH_4 emissions. However, the interaction variables between corruption and GDP are significant, meaning that corruption does change the income-emission relation. Lower levels of corruption slightly decrease the income-level at the turning point. Thus, more corrupt countries reach the turning point for CH_4 emissions later than less corrupt countries. For countries free from corruption, the income level drops to 20,300 dollars. However, due to the aforementioned problems, I believe the estimations on the upper end of the corruption values to be unreliable. Model 4 improves upon Model 3 by adding control variables. We still observe the same decreasing trend in CH_4 emissions for less corrupt countries and the fallibility of the Model for high values of CPI. However, the interaction effect variable between squared-income and corruption, which increases the income-level at the turning point, is no longer significant in Model 4. As can be seen in Equation 4, positive values of its coefficient put upward pressure on the turning point. As a result of its lower significance, the income-level at the turning point is likely overestimated, because the evidence for this upward pressure has decreased.

Table 3: Estimation of the turning point of the EKC for CH_4 corresponding to Table 5

CH_4	Model 1	Model 2	Model 3	Model 4
Fixed TP	56,400	59,400		
TP if CPI = 10			57,600	62,900
TP if CPI = 50			56,800	61,200
TP if CPI = 80			54,500	55,900
TP if CPI = 100			20,300	Negative Value

Table 4: Results CO_2 regression analysis

CO_2 emissions	(1)	(2)	(3)	(4)
GDP	285.2***	269.7***	576.1***	497.9**
	(94.43)	(82.55)	(208.3)	(192.5)
GDP-squared	-2024.0*	-1389.1	-7905.1***	-5741.7**
	(1190.9)	(1084.5)	(2787.1)	(2584.8)
CPI	0.0213*	0.0255**	0.0562**	0.0546**
	(0.0126)	(0.0111)	(0.0235)	(0.0240)
CPI*GDP			-4.563*	-3.621
			(2.507)	(2.369)
CPI* GDP-squared			85.13**	62.47*
			(34.95)	(33.11)
Technology		-0.124***		-0.131***
		(0.0264)		(0.0276)
Gini		-0.0749***		-0.0749***
		(0.0268)		(0.0257)
MYOS		0.0383		0.0524
		(0.139)		(0.143)
Trade		-0.00881*		-0.00620
		(0.00467)		(0.00392)
Urbanisation		0.109***		0.0985***
		(0.0371)		(0.0344)
Constant	0.447	245.0***	-1.363	258.1***
	(1.047)	(50.45)	(1.801)	(52.74)
Controls	No	Yes	No	Yes
Time F.E.	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes
N	1199	1191	1199	1191
R^2	0.24	0.34	0.28	0.36

Standard errors in parentheses
** $p < 0.10$, **$p < 0.05$, *** $p < 0.01$*

Table 5: Results CH_4 regression analysis

CH_4 emissions	(1)	(2)	(3)	(4)
GDP	56.58**	57.19***	110.2***	111.5***
	(22.49)	(20.16)	(29.31)	(26.93)
GDP-squared	-501.8*	-481.3*	-954.3**	-882.8**
	(266.0)	(256.0)	(381.5)	(371.8)
CPI	-0.00481	-0.00498	0.00758	0.00833
	(0.00387)	(0.00369)	(0.00572)	(0.00624)
CPI*GDP			-1.093***	-1.131***
			(0.395)	(0.404)
CPI* GDP-squared			9.321*	8.684
			(5.187)	(5.247)
Technology		0.00108		-0.00738
		(0.00558)		(0.00668)
Gini		-0.00499		-0.00690
		(0.0138)		(0.0144)
MYOS		0.0261		0.0395
		(0.0416)		(0.0377)
Trade		-0.000969		-0.000589
		(0.00122)		(0.00113)
Urbanisation		0.00818		0.00538
		(0.00895)		(0.00772)
Constant	0.996***	-1.630	0.591**	14.97
	(0.269)	(10.64)	(0.294)	(12.95)
Controls	No	Yes	No	Yes
Time F.E.	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes
N	1039	1031	1039	1031
R^2	0.09	0.10	0.13	0.14

Standard errors in parentheses
** $p < 0.10$, **$p < 0.05$, *** $p < 0.01$*

Table 6: Results N_2O regression analysis

N_2O	(1)	(2)	(3)	(4)
GDP	16.23	15.42	29.95**	30.36**
	(11.59)	(12.09)	(12.17)	(12.51)
GDP-squared	-215.9	-210.2	-179.7	-166.4
	(172.8)	(184.8)	(239.6)	(273.2)
CPI	0.0000593	0.000307	0.00453	0.00535**
	(0.00313)	(0.00316)	(0.00571)	(0.00235)
CPI*GDP			-0.334	-0.369**
			(0.303)	(0.178)
CPI* GDP-squared			0.878	0.872
			(3.983)	(3.500)
Technology		-0.0176**		-0.0186***
		(0.00788)		(0.00367)
Gini		-0.00824		-0.00918***
		(0.0136)		(0.00327)
MYOS		0.0268		0.0326*
		(0.0300)		(0.0177)
Trade		0.000129		0.000199
		(0.00104)		(0.000536)
Urbanisation		-0.000945		-0.00175
		(0.00826)		(0.00388)
Constant	0.606***	35.95**	0.484***	37.94***
	(0.116)	(15.59)	(0.156)	(7.114)
Controls	No	Yes	No	Yes
Time F.E.	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes
N	1039	1031	1039	1031
R^2	0.11	0.12	0.12	0.13

Standard errors in parentheses

** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

5.2.3 Regression analysis for N_2O emissions

In contrast to CO_2 and CH_4, there appears to be no significant income-N_2O emissions relationship, in both the model with and without control variables. Moreover, corruption has no effect on the emissions, since the size of the coefficient is both negligible and insignificant. Without evidence for the EKC, any attempt at estimating its turning point would be futile.

Model 3 finds significant evidence for a linearly increase income-emissions relationship. Despite the increase of its coefficient, corruption has no significant effect on the emissions level. This changes in Model 4 after the introduction of control variables. Less corruption results in significantly, albeit slightly, higher emissions. This effect is, however, is nullified, by the significant decrease in the interaction effect of income and corruption. The total effect of corruption on N_2O emissions is thus negative which corrupt countries have higher N_2O emissions. However, most coefficients are not significant which means that the estimations of the coefficients are imprecise. As a result, there is no point in drawing a strong conclusion from this model.

5.3.1 Homogeneity test

The aim of this thesis is to investigate the possibility of different income-emission pathways due to corruption. This eases the homogeneity assumption that typically underlies the empirical literature on the EKC. However, the methodology used in this paper still assumes that apart from the impact of corruption, the EKC is identical for all countries. To test for heterogeneity between poor and rich countries, the analyses will be replicated with for two separate groups based on income. This allows for heterogeneity between low-income and high-income countries. The high-income countries are defined as having a mean income above 25,000 dollars during the time period of this study. Approximately one-third of the countries in the dataset meets this requirement. For this analysis, the most specified model (Model 4, in Table 3 to and including 6) is employed. Table 9 shows the results of the regression analysis for both income categories.

5.3.2 Homogeneity test for CO_2

The income distinction greatly impacts the analysis of CO_2 and CH_4 emissions as most significant findings can only be replicated for the high-income group. There is no significant income-emission relation for CO_2 in the low-income group but significant evidence for an EKC in the high-income group. Moreover, the shape of the EKC is affected by the level of corruption. Less corruption increases the income-level at the turning point. Hence, the previous findings can only be replicated for high-income groups. This suggests heterogeneity in the income-emission relation between rich and poor countries. Since the evidence for an EKC is only replicated for high-income groups, it can be expected that the estimation of the turning points will increase. This is also what we see when we compare the results with Model 4 of Table 3. The income-level at the turning point is much higher, with 85,500 compared to 60,500 for a CPI level of 50. However, I have to emphasize, that this calculation of turning points suffers from the same problems mentioned above, resulting in inaccurate estimations for high levels of CPI. Although evidence for an EKC cannot be replicated in the low-income group, an effect of corruption can still be identified. The corruption variable and the corruption-income interaction variable are significant, albeit at a ten per cent level. The variables have the opposite sign. Therefore, the total effect of corruption in low-income countries is ambiguous and depends on the level of income. When the country becomes richer, the net effect of corruption will be a decrease emissions.

5.3.3 *Homogeneity test for CH_4*

The separation into two separate income groups has a similar effect on the analyses of CH_4 emissions. In the low-income group, I find evidence for a monotonically increasing income emission relation, whereas, the high-income group exhibits an inverted-U shape income-emission relationship suggesting a decrease in emissions after a certain threshold is reached. The interaction variables between income and corruption are significant meaning that this turning point is dependent on corruption. As was previously established in corruption has a negative effect on CH_4 emissions, however, compared with the previous findings (Table 3), the turning point of the EKC is estimated to occur at a lower income level, of 44,900 dollars compared to 61,200 dollars for a CPI level of 50.

Table 7: Estimation of the turning point of the EKC corresponding to Table 8

	Model 2	Model 4
TP if CPI = 34	66,000	46,900
TP if CPI = 50	85,500	44,900
TP if CPI = 80	Negative Value	Negative Value
TP if CPI = 100	6,900	64,100

Table 8: Results regression analysis for separate income groups

	CO_2		CH_4		N_2O	
	(1) Low Income	(2) High Income	(3) Low Income	(4) High Income	(5) Low Income	(6) High Income
GDP	407.5	705.4**	99.41**	143.0**	36.72	93.12
	(290.0)	(311.6)	(44.81)	(56.59)	(30.63)	(77.87)
GDP-squared	-4878.4	-6567.5**	-579.5	-1470.3**	-1190.9	-1116.4
	(9153.6)	(3069.7)	(1673.7)	(604.7)	(1116.4)	(882.4)
CPI	0.0360*	0.156*	0.00155	0.0308*	0.000860	0.0197
	(0.0204)	(0.0874)	(0.00898)	(0.0176)	(0.00863)	(0.0253)
CPI*GDP	-6.523*	-7.418*	-0.695	-1.796*	-0.333	-1.278
	(3.670)	(3.699)	(1.154)	(0.897)	(0.906)	(1.293)
CPI* GDP-squared	152.9	92.24**	-3.255	17.56**	16.33	13.29
	(131.5)	(33.81)	(34.28)	(8.239)	(23.75)	(12.14)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes	Yes	Yes
N	786	405	680	351	680	351
R^2	0.38	0.57	0.12	0.52	0.07	0.46

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

5.3.4 Homogeneity test for N_2O

This analysis with two income groups also finds neither a significant income-N_2O relation nor an effect of corruption on the N_2O emissions. The previous results did identify a monotonically increasing income-emissions relation and a minor positive impact of corruption, but these results cannot be replicated when allowing for heterogeneity between rich and poor countries. This is unsurprising, since the evidence for earlier findings was weak.

5.4 Intermediary conclusions

Before we proceed to test the robustness of these finding, I will sum up the main findings we have reached until now. First and foremost, all three greenhouse gasses have a distinct income-emission relationship which confirms that they have to be analysed separately. The evidence for an EKC for CO_2 emissions is weak in Model 1 and loses its significance when controlled variables are added. Furthermore, the corruption variable is significant and positively correlated to CO_2 emissions, which suggest that, contrary to expectations, corruption is beneficial for the environment. However, when corruption is allowed to interact with income variables, I find significant evidence confirming the EKC hypothesis. Moreover, corruption influences the shape of the EKC in a way that is harmful to the environment by increasing the income-level at the turning point. When we controlled for other variables, the evidence for the EKC remains but the impact of corruption on the EKC becomes less significant. When allowing for possible heterogeneity in the income-emission relation between poor and rich countries, I find that the results can only be replicated for the high-income group

The evidence for an EKC for CH_4 emissions is weak in both when controlled and when not controlled for other variables. Corruption does not have a significant effect on Ch_4 emissions. However, when corruption is allowed to interact with income, we find significant evidence confirming the EKC hypothesis. Corruption does significantly decrease the income level at the turning point which is beneficial for the environment. However, when we control for other variables, one of the corruption-income interaction variables is no longer significant, which makes it impossible to reliably estimate the turning point. However, when the poor and rich countries are analysed separately, I find that this is caused by the fact that no significant income-emission relationship exists for the poor countries. The impact of corruption on the EKC thus increases in significance in the rich countries.

In Models 1 and 2, no significant income-N_2O emission relationship. In Model 3, I find that N_2O significantly increases with income. This monotonically increasing income-emission relationship remains significant when controlling for other variables in Model 4. In the latter model, the total effect of corruption is a slight decrease in N_2O emissions.

5.5 Estimation of emissions level

The EKC literature concerns itself mostly with the income level at the turning point of the EKC. This is, of course, important in our understanding of the income-emission relationship and relevant for determining abatement strategies in developing countries. The contribution of this thesis is to provide an insight into the effects of corruption on the income-emission relation, which tells us whether fighting corruption is an effective strategy for environmental protection. However, it is not only relevant to know how corruption affects the income level but also how it affects the emission level. Therefore, I compare two poor and two rich hypothetical countries which are identical in all factors except corruption. At both income levels, we compare a corrupt country – CPI is 20 – and a non-corrupt country – CPI is 80. To estimate the emissions per capita emissions, the mean value of the control variables are used for all four countries. The estimations are based on Model 4 of Tables 4, 5 and 6. The estimates are in line with our expectations. Corruption increases CO_2 emissions but decreases CH_4 emissions. The impact of corruption on CH_4 emissions is rather big, as the clean rich country emits less CH_4 than a corrupt poor country. The results of N_2O are surprising. The results in Table 6 seems to suggest that N_2O emissions are monotonically increasing with income, but the clean rich country has lower per capita emissions that the clean poor country. However, the estimates of N_2O emissions are the least accurate, as most of the variables are insignificant.

Table 9: Estimation of greenhouse gas emissions

	p.c. CO_2 emissions		p.c. CH_4emissions		p.c. N_2O emissions	
	GDP = 15000	45000	GDP = 15000	GDP = 45000	GDP = 15000	GDP = 45000
CPI = 20	4.310	8.988	1.829	3.219	0.571	0.992
CPI = 80	5.170	10.077	1.429	1.720	0.572	0.423

6. Robustness test

6.1 Measurement error of corruption

As mentioned before, it is difficult to quantify corruption due to its illegal nature. Transparency International's CPI index circumvents this problem and is based on the perception of corruption. Although the CPI index is widely considered reliable, quantification of corruption remains based on estimations and is consequently prone to measurement error. Therefore, I will test whether my previous findings are robust to differences in measurement by using an alternative data set for the corruption variable. In this section the thesis, the regression analysis is reconducted, with the only difference that ICRG data is used instead of CPI data to estimate corruption. The ICRG data gives countries a score on a small scale between zero and six and therefore less unable to specify minor differences in corruption level. Despite that, it is highly correlated with the CPI index – *r* is 0.87 – during the timespan of this study. However, due to the fact that the ICRG does not discriminate between minor fluctuations in corruption as the CPI index does, the results of the robustness test are expected to provide less significant results. If the results nevertheless corroborate previous findings than this increases the probability that the corruption is correctly measured and that the different shapes of the EKC can be contributed to varying levels of corruption.

6.2 Results robustness check

As can be inferred from comparing Table 10 to Model 4 of Tables 4 to 6, some inconsistencies arise with the use of the ICRG index compared to CPI. The regression analysis of CO_2, in Model 1 of Table 10, identifies a linearly increasing income-emission relationship instead of the previous finding of an EKC in Model 4 of Table 4. Moreover, although corruption is positively correlated with CO_2 emissions, corruption does not appear to affect the income-emission relation. Despite the fact the evidence for an EKC for CO_2 is not corroborated in the robustness check, I nevertheless estimated the turning point of the hypothetical EKC to allow for a comparison with the previous test. The income-level at the turning point increase significantly, with 88,900 dollars when ICRG is three compared to 60,500 dollars when CPI is fifty. The observed trend increasing income-levels at the turning point with a decrease in corruption is also observed in the robustness check. The findings regarding CH_4 remain mostly unchanged previous evidence for an EKC for CH_4 emissions remains significant. However, the influence of corruption on the shape of the EKC becomes less clear, as the only significant income-corruption interaction term is only significant at the ten per cent level. Interestingly, the income-levels at the turning point are significantly lower and are decreasing with lower levels of corruption. The robustness check for N_2O confirms the previously found monotonically increasing income-emission relation. However, evidence for the influence of corruption on N_2O emissions cannot be replicated.

6.3 Robustness check of homogeneity test

In Section 5.3, I separated the countries in the dataset into two income groups to test the homogeneity assumption that is implicit in the methodology used in this thesis. Because we find a significant difference in the income-emission relation of poor and rich countries, I will attempt to replicate the findings in this robustness exercise. The results are presented in Table 11. This evidence for the inverted-U shape income-emission relation for CO_2 in the high-income group is confirmed by the robustness check. All previous findings hold at a higher significance level. The previous findings for the low-income group are not corroborated as no significant relationship between the dependent and explanatory variables can be identified. Surprisingly, the evidence for an EKC for CH_4 in the high-income group is not robust. There is no significant income-pollution relation nor any significant effect of corruption on the emissions. The reverse results were found in the regression with the complete dataset, where the findings could only be replicated for CO_2 instead of CH_4. The robustness test confirms the previous finding that there is no relationship between income and N_2O emission in neither the low nor the high-income group.

The R-square values for all robustness models are on par with the R-square level for the same analysis conducted in the Results section. Thus, the model equally fits both measurements of corruption.

Table 10: Results regression analysis with alternative corruption data

	CO_2	CH4	N_2O
	(1)	(2)	(3)
GDP	441.0***	88.23***	30.36**
	(153.4)	(31.40)	(14.19)
GDP-squared	-4697.6	-1233.7**	-484.9
	(2921.7)	(584.2)	(332.1)
ICRG	0.342*	0.0599	0.0145
	(0.187)	(0.0502)	(0.0391)
ICRG*GDP	-33.86	-10.96*	-5.146
	(26.75)	(6.072)	(4.244)
ICRG* GDP-squared	684.3	194.9	75.47
	(594.9)	(125.5)	(77.55)
Gini	-0.0808***	-0.00623	-0.00762
	(0.0276)	(0.0148)	(0.0140)
MYOS	0.0160	0.0135	0.0183
	(0.136)	(0.0392)	(0.0278)
Trade	-0.00752	-0.00123	0.0000984
	(0.00474)	(0.00124)	(0.000997)
Urbanisation	0.115***	0.00564	-0.00198
	(0.0344)	(0.00892)	(0.00806)
Technology	-0.132***	-0.0205***	-0.0170**
	(0.0262)	(0.00776)	(0.00745)
Constant	261.0***	41.65***	34.97**
	(50.13)	(15.25)	(14.80)
Time F.E.	Yes	Yes	Yes
Country F.E	Yes	Yes	Yes
N	1160	1003	1004
R^2	0.357	0.114	0.140

Standard errors in parentheses
** $p < 0.10$, **$p < 0.05$, *** $p < 0.01$*

Table 11: Results regression analysis with alternative corruption data and separate income groups

	CO_2		CH_4		N_2O	
	(1)	(2)	(3)	(4)	(5)	(6)
	Low Income	High Income	Low Income	High Income	Low Income	High Income
GDP	193.7	1439.1***	33.18	70.89	31.45	100.0
	(235.2)	(480.2)	(38.82)	(70.12)	(29.02)	(78.58)
GDP -squared	401.2	-18011.4***	1899.0	-690.5	-866.8	-1312.5 (1185.9)
	(9324.2)	(5677.4)	(1998.6)	(1029.1)	(1325.8)	
ICRG	-0.00783	4.927**	-0.0713	0.279	0.00198	0.469
	(0.194)	(2.034)	(0.0619)	(0.315)	(0.0561)	(0.366)
ICRG*GDP	17.09	-272.1**	22.68	-14.00	-6.158	-24.27
	(61.49)	(100.8)	(13.73)	(17.27)	(10.52)	(20.21)
ICRG*GDP -squared	-819.9	3816.0***	-1375.9*	126.0	215.2	271.7
	(3307.2)	(1220.9)	(750.5)	(219.8)	(418.8)	(254.0)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Country F.E.	Yes	Yes	Yes	Yes	Yes	Yes
N	756	404	653	350	654	350
R^2	0.38	0.60	0.12	0.51	0.07	0.47

Standard errors in parentheses
$* p < 0.10$, $** p < 0.05$, $*** p < 0.01$

Table 12: Estimation of the turning point of the EKC with alternative corruption data corresponding to Table 10

	Model 1	Model 2
TP if ICRG = 0	46,900	35,800
TP if ICRG = 3	64,200	42,600
TP if ICRG = 6	200,900	175.700

Table 13: Estimation of the turning point of the EKC with alternative corruption data for separate income groups corresponding to Table 11

	Model 2	Model 4
TP if ICRG = 2	56,200	48,900
TP if ICRG = 3	88,900	46,200
TP if ICRG = 4.5	690,500	31,100
TP if ICRG = 6	Negative Value	100,100

7. Conclusion and discussion

The literature on EKC typically assumes constant income-pollution pathways with a common turning point across countries. This thesis investigates the possibility of different income-pollution paths for different countries due to corruption. In contrast to previous literature, this thesis studies the influence of corruption on the income level at the turning point of the EKC of greenhouse gasses CO_2, CH_4 and N_2O.

Contrary to the existing literature, I find throughout this thesis that the corruption variable is positively correlated to all three studied greenhouse gas emission, although not always significant. Since the index gives high scores to countries with low corruption, this means that countries with high corruption have lower greenhouse gas emissions than countries with low corruption. This finding is surprising since, in line with both the theoretical and the empirical literature, corruption is expected to have a negative effect on the environment.

The first important finding of this thesis is that the three different greenhouse gasses have different income-pollution pathways. Firstly, I find robust evidence for the existence of an EKC for CO_2. Secondly, I find weak evidence for an EKC for CH_4. Thirdly, I find no evidence of an income-N_2O relation. These differences could be the result of the role CO_2 has taken in our climate discussion. As the most prevalent greenhouse gas, it is considered the main contributor to climate change. As such, it has dominated both the scientific literature and public opinion on climate change. Consequently, CO_2 emissions may have been disproportionally been subjected to governmental regulations. Another possible explanation is that the differences in income-emission relation between the greenhouse gasses is due to the fact that the different production sources of each greenhouse gas. Abatement policy for CO_2 emissions could be easier to implement than those of CH_4 and N_2O. Whereas CO_2 is mainly a by-product of energy production and manufacturing, CH_4 and N_2O emissions originate for a large share in agriculture, as a by-product of animal waste, which is harder to subject to change. This hypothesis is further strengthened by the fact that the control variables have different effects on the different greenhouse gasses. The control variables used in this thesis yield no significant relation with CH_4 emissions, whereas the state of technology and inequality significantly influences both CO_2 and N_2O emissions. The degree of urbanisation and openness to trade only significantly influence CO_2 emissions and education only has an effect on N_2O emissions. It is important for further research to use a unique set of control variables for each individual greenhouse gas.

The second important finding of this thesis is that poor and rich countries have a different income-pollution relation. Given the fact that the EKC turning point occurs at a higher level of income, it is not surprising that no quadratic income effect could be identified in the lower-income groups. However, it is surprising, that no income effect at all could be identified. Greenhouse gas emissions would be expected to increase with higher levels of income for reasons specified above. This suggests that, in earlier phases of a country's development, the emissions are determined by factors other than income, such as geographical position, natural resource endowment and international integration.

The first estimation of the income-level at the turning point of the EKC is too high to be economically salient. The turning point of CO_2 occurs at an income level of 97,000 dollars. It must be noted that this turning point is inaccurate due to a high standard error of the coefficients, but regardless the turning point seems to be on the high end of the spectrum. Although no consensus on the income level at the turning point has been reached in the literature, with estimates ranging from as low as 1,200 (Ibrahim and Rizvi, 2015) to as high as

4,591,065 (Shi, 2003), most turning points are estimated to occur at lower income levels of ten to thirty thousand dollars (Shahbaz and Sinha, 2019). Hence, the results of this study are not in line with the most common findings, albeit that the results do not exceed the higher estimates in the literature. Similarly, the turning point of CH_4 occurs at the relatively high income level of 59,000 dollars. The fact that both the turning point of the EKC of CO_2 and CH_4 are relatively high, and the fact that there is no evidence for the existence of a turning point in the income-N_2O emission relation puts serious doubt on Beckerman's (1992) idea that economic growth is the best way to attain a decent environment.

The main research question of this thesis is: how does corruption influence the shape of the EKC? The thesis demonstrates corruption affects the EKC of CO_2 and CH_4 differently. Per capita CO2 emissions increase when the corruption decreases. The increase in the required income-level at the turning point is significant and can amount to tens of thousands of dollars. This suggests that fighting corruption would be harmful to the environment because low corruption seems to postpone the reduction in per capita CO2 emissions. On the other hand, CH4 emissions are positively correlated with a decrease in corruption. However, the decrease of the income level at the turning point amounts to several thousand dollars, which is a much smaller decrease than the increase of the turning point of CO2. Besides, per capita CO2 emissions are almost four times higher than per capita CH4 emissions. The net effect of corruption on the total greenhouse gas emissions is positive. This thesis did not distinguish between direct and indirect effects of corruption. Whether the effect of corruption on emissions is driven by the impact on the economy or by reluctancy to implement and enforce environmental regulation remains therefore unknown and should be the topic of further research.

All in all, it can be concluded that this thesis provides suggestive evidence for the existence of a world-wide EKC for CO_2 and CH_4. Corruption significantly effects at which income-level the turning point occurs. However, this thesis shows, that contrary to the consensus in the literature that the net effect of corruption is positive for the climate because it results in lower per capita emissions.

Appendix A: Countries

Table A1:: List of countries

Argentina	Egypt	Lithuania	Slovakia
Australia*	El Salvador	Luxembourg*	Slovenia*
Austria*	Estonia	Malawi	South-Africa
Azerbaijan	Finland*	Malaysia	South-Korea*
Belgium*	France*	Mauritius+	Spain*
Bolivia	Germany*	Mexico	Sweden*
Botswana	Ghana	Moldova	Switzerland*
Brazil	Greece*	Morocco	Tanzania
Bulgaria	Hungary	Namibia	Thailand
Cameroon	Iceland*	Netherlands*	Tunisia
Canada*	India	New Zealand*	Turkey
Chile	Indonesia	Nigeria	Uganda
China	Ireland*	Norway*	United Kingdom*
Colombia	Israel*	Peru	Ukraine
Costa Rica	Italy*	Philippines	United States*
Cote d'Ivoire	Japan	Poland	Uzbekistan+
Croatia	Jordan	Portugal*	Venezuela
Czech Republic*	Kazakhstan	Romania	Vietnam
Denmark*	Kenya	Russia	Zambia
Ecuador	Latvia	Senegal	Zimbabwe

* High-income country

\+ No ICRG data available

Table A2: Countries by geographical region

Asia	10	Middle East	5
Africa	18	North America	3
Caribbean	2	Pacific	2
Europe	32	South America	8

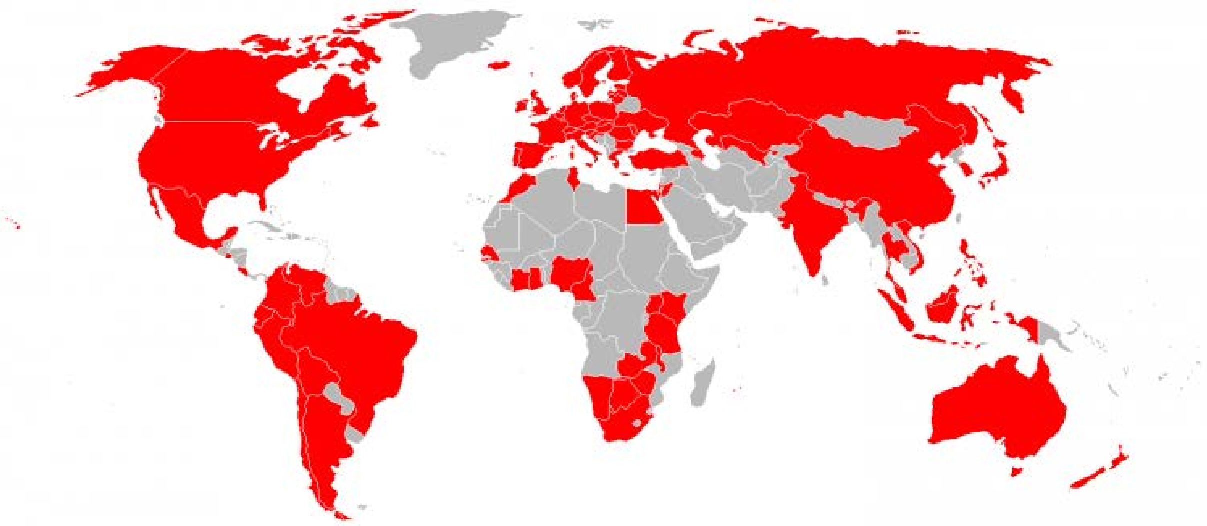

Figure A1: Map of countries

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