LUND UNIVERSITY
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Master programme in Economic History

The Implication of Indonesia's Economic Development for Global Climate Change

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Abstract: Indonesia is a significant global player both in terms of economic performance and Carbon Dioxide (CO_2) emissions. While its total Gross Domestic Product (GDP) and emissions are ranked high in global comparisons, both in terms of per capita measures have a relatively low ranking, suggesting that there is potentially more growth to come. Growth in Indonesia's total emissions is being driven by economic growth and in particular growth in the industry sector and increasing energy use. While emissions intensity is also growing and being driven by technological changes in the industry sector and changes in the energy generation mix to being dominated by the more emissions intensive coal generation. Given that the world is already at dangerous levels for climate change Indonesia needs to address these drivers in order to reduce its relative and absolute impacts on global climate change.

Key words: CO_2 emissions, CO_2 emissions intensity, economic growth, drivers of change, economic sector decomposition, Environmental Kuznets Curve.

EKHM51
Master thesis, (15 credits ECTS)
August 2014
Supervisor: Tobias Axelsson
Examiner: Kerstin Enflo

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1. Introduction

1.1. The Problem of Climate Change

Climate change is a significant issue that is facing the global community, with the impacts affecting everyone across the world. The climate is changing with unequivocal warming of the climate system (atmosphere and oceans), diminishing amounts of snow and ice, sea level rise, and increased occurrence of climate extreme events (storm surges, flooding, droughts). This change is driven by increasing concentrations of greenhouse gases in the atmosphere, predominantly Carbon Dioxide (CO_2), and the human influence on these emissions is clear (IPCC 2013).

The largest contributor to CO_2 emissions is from the burning and consumption of fossil fuels (oil, coal, gas), predominantly for energy generation (electricity, heat and transport fuels). History has shown that as economic growth occurs so does energy use, particularly electricity consumption and transportation in modern economic growth. Understanding how this relationship functions is an important step on the path to discovering potential solutions to begin to abate climate change.

In order to limit climate change it will require substantial and sustained reductions in CO_2 emissions (IPCC 2013). A potential solution to begin to abate climate change and reduce the growth rate of CO_2 emissions is to break or decouple economic growth and energy usage. This could be achieved by finding ways to reduce the energy intensity of an economy. This process could potentially lead to a reduced amount of energy usage, while at least maintaining or increasing economic output, and may lead to a positive impact on economic growth as it improves efficiency of inputs to economic output.

Another potential solution would be to reduce the emissions intensity of economic outputs. This could be achieved through changing the energy generation mix, by for example increasing the use of renewable energy resources for electricity generation as a replacement to fossil fuels. However, in general currently there is a higher cost associated with this form of generation given the sunk costs associated with fossil fuel infrastructure, and therefore this may suppress economic growth.

The Environmental Kuznets Curve, provides a theory that as economic development occurs and a country becomes wealthier environmental degradation (in this case climate change and CO_2 emissions) should peak and then decline as wealth continues to grow. This wealth generation would allow for the capacity to find and fund solutions to environmental problems.

1.2. The Significance of Indonesia

Indonesia is a diverse nation consisting of an archipelago with over 13,000 islands and a population of over 247 million, making it the fourth most populous country in the world. Although Indonesia has a relatively high population density it also has a plentiful supply of natural resources.

Indonesia has significant deposits of oil, gas, coal, mineral ores such as copper, gold, nickel, as well as rich and diverse forest and marine resources. Indonesia's rainforests account for 50 per cent of the tropical forests in the Southeast Asian region and more than 10 per cent of the world's and it has the world's largest remaining mangrove forests. Its marine resources are some of the most productive tropical seas in the world containing the largest area of coral reefs of any country. Indonesia's vast population is reliant on these resources for its livelihood (Resosudarmo 2005).

The economy is ranked 16th in the world in 2012, with an estimated Gross Domestic Product (GDP) of $878 billion (current prices – all currency figures are given in US$). Though when considering GDP per capita it ranks 116th at $3,557. Indonesia has experienced strong long term growth over several decades. Since 1960 it has achieved an average annual growth rate of 5.7 per cent.

This is a strong performance when compared to the global average of 3.5 per cent over the same period. It is also a stronger performance than other large economies: United States of America (USA – 3.2 per cent); India (5.2 per cent); Brazil (4.4 per cent); and European Union (EU – 2.7 per cent); with only China having stronger growth of 8.1 per cent (World Bank 2014).

Indonesia's economic growth experienced steep acceleration from the 1970's as it underwent an industrialisation process. The economy has over the past few decades continued to experience a restructure with a movement of labour from agriculture to industry and services. This movement towards industry generally leads to higher levels of CO_2 emissions as industry tends to be a relatively more energy intensive sector. This is particularly the case in early stages of the industrialisation process as there is a tendency to begin with heavy industries that are coupled with capital intensive construction such as steel, cement, and chemicals.

In 2010 Indonesia ranked 14th for CO_2 emissions with 434 million tons (mt), though in terms of emissions per capita again it slid down the rankings to 116th with 1.8 tons (World Bank 2014). Once again when comparing long term average annual growth rates, this time in emissions, Indonesia has the highest percentage of any of the economies mentioned above with 6.6 per cent. As mentioned it has an abundance of primary energy fossil fuel resources (coal, gas, oil) and in 2011 energy production was dominated by fossil fuels accounting for 87% of generation, which accounts for its high levels of emissions (EIA 2014).

Indonesia is often overlooked in research given the rise of China and India, however given its long term growth trajectory, its sheer size of population, and with a low GDP per capita but high growth rate it suggests there is still much economic growth to come. Indonesia is already a significant global player on the economic and environmental stage, and it potentially has further significant contributions to come particularly in regards to climate change impacts.

1.3. Research Questions

As the current economic paradigm dictates pursuit of economic growth and given its significant implications for and impacts of climate change, its relation to energy usage and CO_2 emissions, coupled with Indonesia's economic situation and current CO_2 emissions, future economic development and growth in Indonesia will have serious implications for global climate change.

Understanding the connection between economic development (changing economic structures) and growth, energy usage and intensity, and ultimately CO_2 emissions and intensity, is important to set a base for developing potential policy solutions. Given the significance of Indonesia's impact on the global stage using its experience is an extremely important area of research. With these issues in mind the research question that this thesis aims to address is:

> *Research Question – "What are the driving forces behind changes in Indonesia's CO_2 emissions?"*

Following this introduction and in order to answer the research question the thesis is structured as follows: section two will discuss the methodological approach employed; section three outlines the theory underpinning the thesis and previous research; section four will provide the data and analysis to address the research question, and discuss the results; and finally section five will provide concluding remarks, policy implications and potential further areas of research.

2. Methodology

A deductive research approach is used, where the broad theory sets the path for defining the research question and the expected findings. To address the research question quantitative methods are utilised.

Quantitative methods are used to analyse the changes in CO_2 emissions and intensity of the Indonesian economy, through use of data to determine the trend over time, drivers of change and the current situation of emissions. The interpretation of data and analysis then provides the ability to place it within the contextual situation and settings, and into potential practical application for the consideration of appropriate policy solutions.

As with any research there are limitations, and in particular when working with developing countries reliability of data is an issue, if indeed data is readily available. The impact of this, on research outcomes, has been mitigated as far as possible by using high level national data (as opposed to disaggregated regional data which is usually prone to more inaccuracies) that is used in national accounts by leading organisations in the field of data, i.e. economic data from World Bank, and climate change data from United Nations Framework Convention on Climate Change (UNFCCC).

However, in cases where data is not directly available then it is reconstructed by using data from a range of different (both primary and secondary) sources and cross referenced as far as possible in order to assess its accuracy and consistency. The research is also focussed on trends over time which helps to smooth out data concerns as inaccuracies from a data source would not likely change from period to period.

A range of sources will also be utilised predominantly previous research on Indonesia's past and potential future economic performance, the theory of Environmental Kuznets Curve and economic growth's relationship with the environment, and studies that focus on analysing energy and emissions intensity.

3. Theory of Growth's Relationship with the Environment

Economic growth typically involves some form of costs. Environmental degradation relating to economic activity, either from production or consumption, is one such externality that is not generally captured adequately in cost structures. So as a country progresses and the economy develops and grows, typically there is a corresponding growth in environmental degradation. In this case the focus is on growth of CO_2 emissions which tends to follow also growth in energy usage.

The emissions intensity of an economy has significant consequences for the environmental degradation linked to increased economic activity. Though as Kander (2002) points out there is a connection between economic performance and environmental degradation, however, it is not simply a linear relationship. The structure of an economy and technical changes impacts upon the growth/degradation relationship through differing productivity levels and efficiency developments. Understanding the drivers of emissions and intensity changes is an important component for developing and implementing successful policies.

Consumption of energy is a key input to economic activity, and this comes with environmental degradation through the production of energy, particularly electricity. The primary degradation of concern for this research is the release of CO_2 emissions. Much research uses the energy intensity of an economy to measure the efficiency of economic outputs and by proxy CO_2 emissions. The more energy intensive an economic activity is the more CO_2 emissions are released (of course the energy generation mix is important to the level of emissions, but all things being equal the more energy efficient an activity is the less emissions would occur). A word of caution, which Kander et al (2013: 351) highlights is that energy intensity is only a relative indicator, and to actually measure total environmental degradation (CO_2 emissions) requires total consumption of energy.

According to Kander et al (2013: 333) economic energy efficiency across Europe has actually improved significantly from the 1970's with the progressive implementation of Information and Communication Technology (ICT). There were three significant components contributing to this improved efficiency with the aid of ICT: move to lighter manufacturing such as electronics and pharmaceuticals; improvements in heavy industry through use of microelectronics; and shift towards more service sectors such as software development and banking. This provides hope that at the very least the rate of (relative) environmental degradation has been slowed or is slowing, though in absolute terms CO_2 emissions continue to grow.

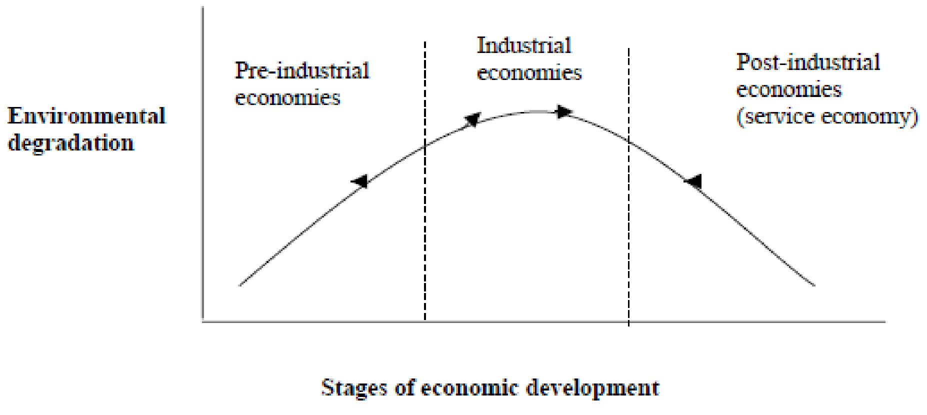
3.1. The Environmental Kuznets Curve

A way to contextualise the theory of economic growth's relationship with environmental degradation (in particular CO_2 emissions) is through the Environmental Kuznets Curve (EKC). This theory came to prominence in the 1980's and is based on Simon Kuznet's work in the 1950's on income inequality and economic development.

The EKC hypothesis is that there exists an inverted U-shape relationship with the wealth of a nation (measured on a per capita GDP basis) and environmental degradation. As nations begin to grow economically and gain wealth, usually in relation to the industrialisation process, it will in the first instance come at the cost of rising environmental degradation as the focus is on jobs and income and environmental regulation is weak. However, this environmental degradation should peak and begin to decrease as wealth continues to accumulate, as more value is placed on the environment, and regulatory institutions are strengthened (Dasgupta et al 2002).

This shift in the economy follows a typical pattern (which is graphically represented below) where at low levels of development a subsistence based economy has correspondingly low levels of resource extraction and waste generation. As development increases with industrialisation resource extraction and waste generation intensifies, but then tapers off and decreases with a higher level of development driven by a shift to less intensive services sector (Panayotou 2003).

Figure 1: Theory of Environmental Kuznets Curve



Source: Taken from Panayotou (2003)

This development shift leading to a structural change in the economy is typically characterised by the movement of labour from agriculture, to industry and to services sector. This progression in theory would then result in the inverted U-shaped EKC as the industrial sector is the most emissions intensive sector, while higher productive services sector (such as finance and ICT) is less emissions intensive and generally produces higher economic value. However, the drivers of changes in emissions intensity may not just be the structural shift but may also be affected by production functions within these sectors through better processes and technological innovations.

Panayotou (2003) suggests that a few different alternative outcomes exist to the EKC depending on a number of factors that can bend the EKC. These factors include structural changes in the economy, policy drivers or changing consumer preferences linked to higher incomes. The author also notes that the EKC outcome is also highly influenced by the type of degradation, for example turning points are more evident when pollutants are noticeable and have a more direct impact on consumers (such as particulates). On the other hand when degradation is less immediate and less evident to the consumer (such as CO_2 emissions) then there may be a higher or no turning point.

An issue with using the EKC to measure environmental degradation is that there exists a weak (relative relationship) and a strong (absolute relationship) hypothesis. In the case of the weak hypothesis although relative environmental improvements may occur absolute degradation may continue. Though in either case the implication is still that economic growth does not need to cause the same level of ongoing environmental degradation and particularly for developing countries opportunities exist to press down the curve or accelerate the turning point (Kander 2002). The implication here is that care must be taken when interpreting results and extending to policy recommendations to ensure that the correct outcomes are being conveyed.

3.2. Findings of Environmental Kuznets Curve Studies

Kander et al (2013: 348) shows that an EKC exists when considering energy intensity at an aggregate European level over a long time period (from the 1800's to 2000) driven largely by coal economies as coal production improved significantly overtime. However, when disaggregated to national levels the results vary greatly as it is influenced by the countries specific conditions such as climate and economic structure. Though a striking feature is that over time energy intensity converges to similar levels for most countries, likely due to technology transfers.

Panayotou (2003) finds that across developed and developing countries a certain degree of decoupling of environmental degradation from economic growth is occurring in relative terms with declining intensity levels. The drivers though are different, with developed countries seeing positive outcomes from a shift to service economies, technological change in production processes, and new economic and environmental policies. On the other hand developing countries have seen changes predominantly due to pricing of inputs to reflect international costs. The author does highlight although relative decoupling appears to be occurring there is still concern as absolute environmental degradation is increasing as increasing consumption patterns continue to drive total CO_2 emissions growth.

Henriques and Kander (2010) though dispute the importance of the service sector transition, as the authors argue that this has minimal effects on real production. Their research showed that service sector transition had minimal impact on overall energy intensity and that gains were generally accrued from improvements in the manufacturing sector.

Studies have utilised econometric approaches to investigate the existence of the EKC with a range different parameters and models. A number of econometric studies have found positive support for the existence of the EKC (Lapinskienė et al 2014, Galeotti & Lanza 2005, Lindmark 2002). These studies though highlight the results are sensitive to individual dynamic conditions and the parameters used.

In further highlighting the sensitivity of results, according to Stern (2004), finding econometric evidence for the existence of the EKC is unlikely and is dependent on what type of environmental degradation is considered. While Panayotou (2003) highlights that without a common theoretical underpinning studies utilise a plethora of different approaches, variables and parameters which lessens the reliability of the results.

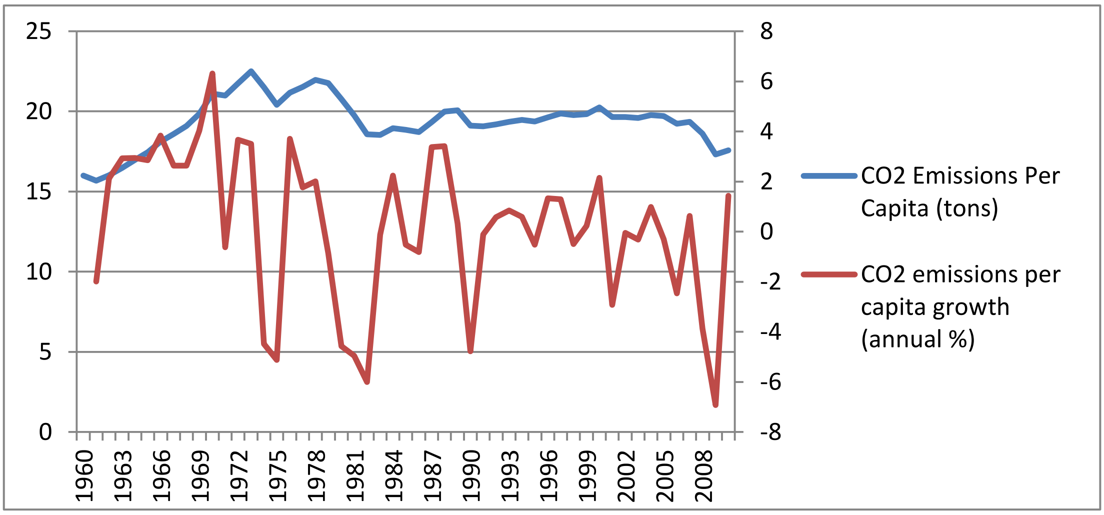
Although there are challenges to finding reliable econometric causal relationship, this does not invalidate the theory. With rising environmental awareness over recent decades there has been a corresponding increase in spending on environmental protection. The issue is whether this spending is sufficient to offset the continued growth and associated environmental degradation. In the case of CO_2 emissions it can be reasonably argued that the ability for countries that have decreased emissions is at the least supported by having access to greater funds accumulated through rising wealth.

Global funding for climate change action has been increasing with more mitigation projects being undertaken and being monitored through the UNFCCC Climate Finance Work (UNFCC 2014).

National funding has also been increasing. In the case of USA climate change expenditure increased from $4.6 billion in 2003 to $8.8 billion in 2010 (GAO 2011).

Along with the trend of increased funding the graphs below shows that USA's CO_2 emissions per capita have been progressively trending downwards since its peak in the early 1970's. This is reflected in the annual growth which has largely been negative growth in the last couple of decades.

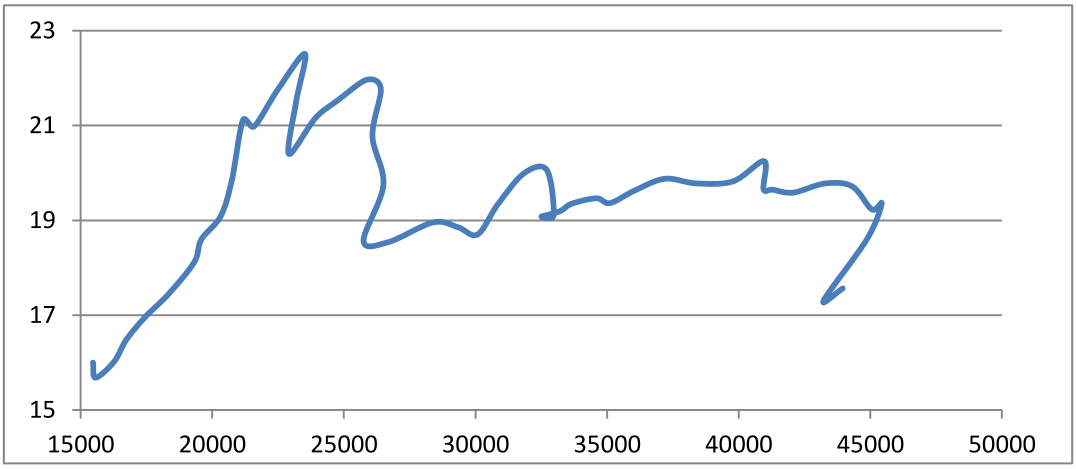
Figure 2: USA CO_2 Emissions Per Capita



Data Source: World Bank (2014)

In addition USA's EKC shows that it generally follows the trend suggested in the theory. The graph shows that as USA has become increasingly wealthier (measured by GDP per capita) in the initial stages of development in the 1960's emissions per capita were increasing but hit a turning point in the early 1970's where wealth continued to increase but CO_2 emissions experienced a drop over a few years, then followed a time of stable emissions. The GDP per capita turning point was at approximately $23,000 in 1973.

Figure 3: USA Environmental Kuznets Curve (1960 – 2010)
CO_2 Emissions Per Capita (Tons) Versus GDP Per Capita (Constant 2005 $)

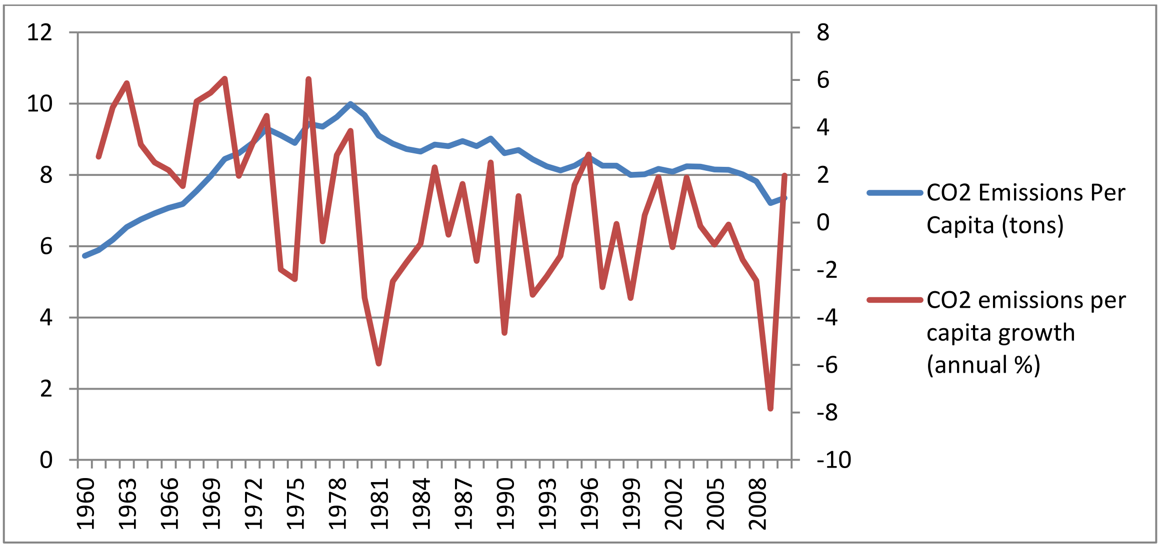


Data Source: World Bank (2014)

In recent years there has been another steep drop though this is likely due to the effects of the Global Financial Crisis (GFC) in 2007 which significantly impacted economic output and corresponding in negative economic growth. The following decade will provide more insight into the future trajectory of emissions in the USA as its economy is recovering and more funding is allocated to address climate change issues.

This trend of increasing climate change funding appears to be set to continue with at least the EU increasing its share of budget spending on climate change related action to 20% for the 2014-2020 period, from a 6-8% share in 2007-2013 period (European Commission 2014). The EU per capita CO_2 emissions also follows a similar trend with a peak in emissions in the late 1970's followed by long period of steady decline and a sharp drop around the GFC. The annual growth also is largely negative since the peak in emissions reflecting the change over time.

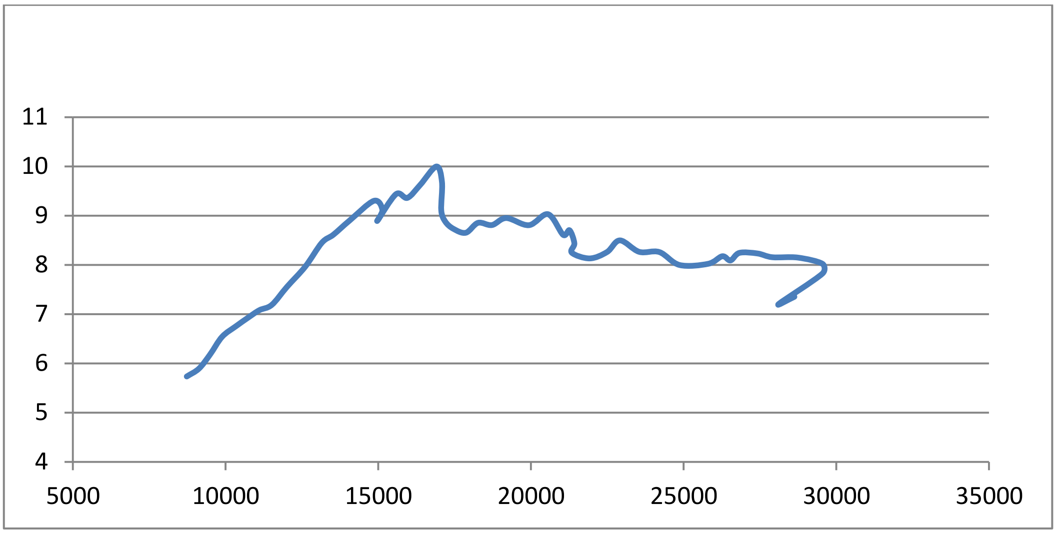
Figure 4: EU CO_2 Emissions Per Capita



Data Source: World Bank (2014)

The EU's EKC follows a smoother pattern which more closely resembles the theory, with an upward swing followed by a turning point where emissions have since steadily declined. The EU's turning point came at a GDP per capita of approximately $17,000 in 1979. Similar to the USA the recent years have seen a steep decline that can be attributed to the effects of the GFC and negative economic performance.

Figure 5: EU Environmental Kuznets Curve (1960 – 2010)
CO_2 Emissions Per Capita (Tons) Versus GDP Per Capita (Constant 2005 $)



Data Source: World Bank (2014)

Although there is ongoing debate about the existence of the EKC and of finding econometric evidence of causal relationships, these two simple examples provide a plausible depiction of the connection between increased spending and resulting (relative) environmental outcomes. Given this and the findings of numerous studies the EKC provides a useful framework to analyse patterns of growth and environmental degradation.

This thesis therefore uses the EKC as the basic theory providing a framework to analyse Indonesia's patterns of CO_2 emissions and their interplay with economic development, and will identify if Indonesia follows the EKC pattern as suggested by the theory.

3.3. Measuring Drivers of CO_2 Emissions Intensity Change

A quantitative component is used to understand the drivers of changes to CO_2 emissions intensity within Indonesia's economy. Decomposition has been commonly used in energy related environmental research, particularly in relation to understanding the drivers of energy intensity changes as economic development progresses. Numerous energy intensity studies have utilised decomposition analysis, through the Logarithmic Mean Divisia Index (LMDI) method (Ang & Zhang 2000).

According to Ang (2004) the LMDI approach is the preferred method for undertaking decomposition analysis. In a further study Ang (2005) highlights the main benefits of the

LMDI method being that interpretation is simplified as it does not leave unexplained residuals, and it allows for aggregation of sub-sectors and multi-level aggregation.

Muller (2006) highlights a number of issues with the LMDI particularly that a zero residual is actually without basis while, a non-zero residual is natural. It also requires detailed data in order to perform which is not often readily available. However, the author concludes that the LMDI remains the favourable method, which has been extensively used in previous research, for performing decomposition analysis as it has exact or good approximation for a wide range of functions under simulation.

In addition to energy intensity, decomposition of CO_2 emissions intensity is also being investigated, with a number of more recent studies being undertaken. The theory of decomposing drivers of energy intensity holds for emissions intensity and the same methodology can be applied. Effectively emissions intensity becomes the extension of energy intensity to measure the actual impact of environmental degradation.

Ang (2005) provides an illustrative case of how the LMDI can be used for CO_2 emissions intensity by decomposing Canadian industries. The author found that industry structural changes are an important factor in reducing the growth of emissions, despite growing industrial output.

O'Mahony (2013) decomposes emissions in Ireland (using the LMDI) and finds that the main drivers of emissions increases is growth in affluence and population, though growth in emissions is limited and offset by reduction in energy intensity and fossil fuel substitution. The author finds that there was a sharp (absolute) increase in emissions due to periods of rapid growth even though a relative reduction in intensity was evident.

While Jiao et al (2013) look at the impact of a number of factors (including industry structure, energy intensity, and energy mix) on future CO_2 emissions in China (also using the LMDI). The authors find that the main contributor to reducing emissions is energy mix with a reduction in fossil fuel generation, though energy intensity and industry structure also has a role in limiting emissions growth.

Given that decomposition has been used in numerous previous studies to decompose intensity changes over time, including across of range of economies from developed to emerging economies, it is an appropriate methodology to apply for this thesis and to the Indonesian economy. The LMDI will be employed to estimate the drivers behind CO_2 emission intensity changes. It will provide insight into the role of economic development and in particular the structure of the economy has on these changes by identifying either within-sector (technological) or between-sector (structural) changes.

3.3.1 Decomposition Formula

The LMDI formula and its elements used for decomposition have been taken from those used in previous research, particularly Henriques (2011). The elements of the decomposition are as follows:

Ei	Emissions from economic sector *i*
Ek	Emissions from non-economic sector
E	Final CO_2 emissions (= ∑*Ei*+∑*Ek*)
Y	Total value added (constant prices)
Yi	Gross value added of sector *i* (constant prices)
Si	Share of sector *i* in total value added *(=Yi/Y)*
I	Final CO_2 emissions intensity (= *E/Y*)
Ii	Emissions intensity of sector *i* (= *Ei/Yi*)
Dtot	Total CO_2 emissions intensity change, from I^T which is the comparison year and I^O the starting year
Dstr	Change of I due to structural effect (between-sector changes)
Dtech	Change of I due to technological effect (within-sector changes)
Dpcons	Change of I due to personal consumption effect

Constant prices are used as it this allows for true representation of real production growth against the base year. Where if current prices are used these are open to fluctuations due to a range of factors and may overestimate production changes as cost increases is not necessarily followed by productivity increases (Henriques and Kander 2010).

The formulas used to decompose emissions intensity are as follows:

- $D_{tot} = D_{str} * D_{tech} * D_{pcons}$ – calculates the total change in emissions intensity of the economy
- $D_{str} = \exp\left[\sum_i w'_i \ln\left(\frac{S_i^T}{S_i^0}\right)\right]$ – calculates the component of change in emissions intensity attributed to structural change of the economy
- $D_{tech} = \exp\left[\sum_i w'_i \ln\left(\frac{I_i^T}{I_i^0}\right)\right]$ – calculates the component of change in emissions intensity attribute to technological change within individual sectors of the economy
- $D_{pcons} = \exp\left[\sum_k w'_k \ln\left(\frac{E_k^T}{Y^T} / \frac{E_k^O}{Y^O}\right)\right]$ – calculates the component change in emissions intensity attributed to personal consumption from a non-economic sector

- $w'_{i(k)} = \frac{L\left(\frac{E^T_{i(k)}}{Y^t}, \frac{E^0_{i\,(k)}}{Y^0}\right)}{L\,(I^T, I^0)}$ – calculates the weights of the economic and non-economic sectors by using the logarithmic mean of sectoral emissions divided by total value added, and dividing again by the logarithmic mean of total emissions intensity
- $L(x,y) = \frac{(x-y)}{\ln(\frac{x}{y})}$ – this gives the the logarithmic mean weight function of two positive numbers

The rationale for variable selection and Indonesian data used to help answer the research question will be detailed in the following section.

This section has argued that there is a link between economic growth and environmental degradation and in order to find solutions to this, understanding the drivers behind the connection is crucial. It has also outlined the theoretical concept of EKC which provide a framework to help understand the drivers behind the connection. The following section will provide data analysis, using methods detailed above, to test against the theoretical concepts.

4. Indonesia's CO_2 Emissions and its Drivers

4.1. Indonesia's Economic Rise and Structural Change

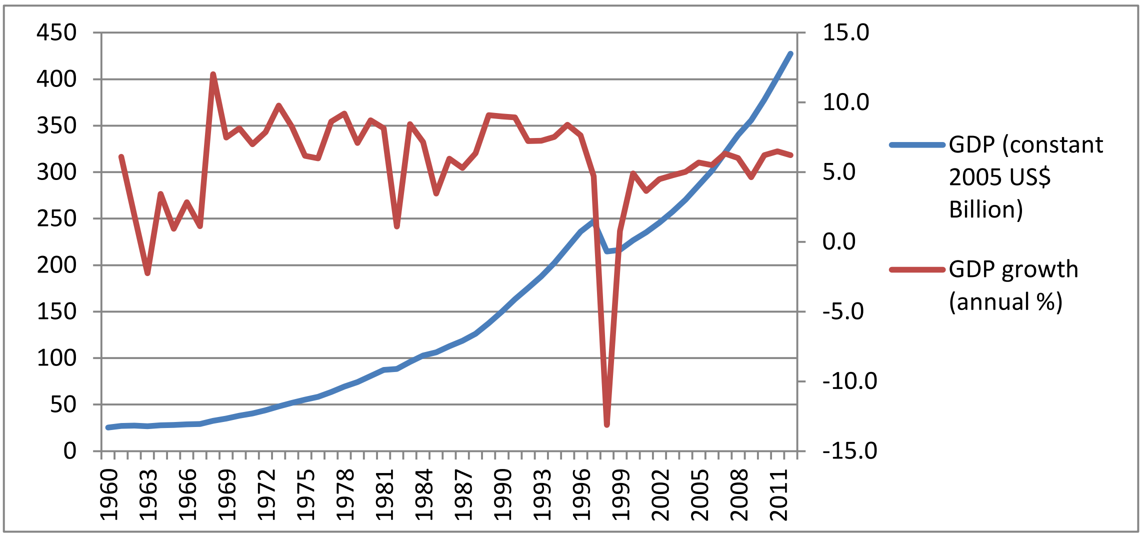
4.1.1. Performance of the Economy

Indonesia is a significant player on the global stage given the size of its economy and its population, coupled with likely future economic growth. In order to interpret the results from decomposition and drivers of change it is important to have a contextual understanding of Indonesia's recent economic development and how it compares to other similar economies around the world.

Indonesia's economy is ranked 16th in the world, with an estimated GDP of $878 billion (current prices) in 2012. Though when considering GDP per capita it only ranks 116th at $3,557. Indonesia has experienced rapid growth over a number of decades and this is depicted below (in constant prices in order to see the relative growth). The graph shows an upward trend with steep acceleration from the early 1970's where sustained periods of rapid growth were achieved with annual growth rates of nearing 10 per cent (World Bank 2014).

The initial growth from the 1970's can be seen as the beginning of the industrialisation process and was predominantly fuelled by increasing oil production and sharp rises in oil prices, however the 1980's was driven by rapid expansion of manufacturing (Hayashi 2005).

Figure 6: Indonesia's GDP and Annual Growth



Data Source: World Bank (2014)

Though there was a significant downward deviation, that resulted from the impacts of the Asian Financial Crisis (AFC) in 1997, where the economy contracted by over 14 per cent. However, since then the economy has recovered with continued strong growth, even during the GFC in 2007, with recent growth rates closer to its long term average annual growth rate of 5.7 per cent. Although income per capita (and most other social indicators) has recovered to pre-AFC levels, the current level of income per capita would have been much higher without the resulting economic contraction (Hill 2007).

It is also important to contextualise Indonesia within a global perspective, in order to understand its impacts significance on the global stage. The table below compares Indonesia's economic statistics with global averages and other large developed and emerging economies, China, India, USA and EU, and Brazil.

The Indonesian economy is the smallest of the grouping below and relatively small compared to the largest economies, approximately 5 per cent of the USA economy, 7 per cent of EU and 10 per cent of the China economy. Though as mentioned previously Indonesia has achieved a GDP average annual growth rate of 5.7 per cent since 1960, which significantly outperforms the global average of 3.5 per cent over the same period and the other large economies with only China having performed better.

Table 1: Economic Performance Comparisons of Large Economies (Current $)

	GDP - 2012	Avg Annual Growth Rate 1960 - 2012	GDP Per Capita -2012	Avg Annual Growth Rate 1960 – 2012	Population (million)- 2012	Avg Annual Growth Rate 1960 - 2012
Indonesia	$878b (16th)	5.7%	$3,557 (116th)	11.3%**	247 (4th)	2.0%
China	$8,227b (2nd)	8.1%	$6,091 (91st)	8.9%	1,351 (1st)	1.3%
India	$1,859b (10th)	5.2%	$1,503 (142nd)	6.1%	1,237 (2nd)	1.9%
Brazil	$2,253b (7th)	4.4%	$11,340 (62nd)	9.0%	199 (5th)	1.9%
USA	$16,245b (1st)	3.2%	$51,749 (11th)	5.8%	314 (3rd)	1.1%
EU	$12,213b (*2nd**)	2.7%	$32,969 (*29th**)	7.6%	506 (*3rd**)	0.4%
World	$72,682b	3.5%	$10,291	6.4%	7,043	1.6%

Data Source: World Bank (2014)

*This is what the EU would be ranked if included as a separate county in the rankings.

**Indonesia's GDP per capita average annual growth is calculated from 1967 due to lack of data availability.

When comparing GDP per capita the table shows that Indonesia performs relatively poorly against most of the other economies, with the exception of India which ranks almost thirty places lower. It performs particularly poorly against developed economies, Indonesia's GDP per capita level is only seven per cent of USA's and 10 per cent of EU's. Though compared to other emerging countries it still does not compare well, only 31 per cent of Brazil's GDP per capita and 58 per cent of China's, or 35 per cent of the global average.

However, when considering GDP per capita average annual growth rates from 1960 – 2012, Indonesia performs significantly stronger with a rate of 11.3 per cent. China (8.9 per cent) and Brazil (9 per cent) are close behind, though it is almost 5 per cent higher than the global average. This growth is impressive, especially when considering that it also has the highest population growth rate from this grouping at almost 25 per cent above the global average.

Given Indonesia's strong past economic performance and coupled with its particularly strong growth rates in GDP, GDP per capita and population, and the fact that it is still on a relatively low base for GDP per capita, it would appear that the economy has capacity for further growth.

4.1.2. Structure of the Economy

With economic development and growth the occurrence of structural change can also be seen with the movement of labour between key sectors and their relative worth, which is highlighted by the tables below. The table below indicates a process of structural change within the economy as there is continuous shift from agriculture to more advanced sectors.

The agriculture sector comprises of cultivation of crops and livestock production, forestry, hunting, and fishing. The industry sector comprises of manufacturing, mining, construction, electricity, water, and gas. While the services sector comprises of wholesale and retail trade (including hotels and restaurants), transport, and government, financial, professional, and personal services such as education, health care, and real estate services.

Table 2: Employment Shares of Indonesian Sectors

Sector	1980	1990	2000	2012
Agriculture	56.4%	55.9%	45.3%	35.9%
Industry	13.1%	13.7%	17.4%	20.6%
Services	30.4%	30.2%	37.3%	43.5%

Data Source: World Bank (2014)

Agriculture is progressively decreasing its share of employment from being the dominant sector in late twentieth century, while industry and services are consistently increasing their shares overtime. Other data shows that this process begun much earlier with estimates of agricultural labour shares at 73 per cent in 1961 and 68 per cent in 1971 (de Vries & Timms 2007).

As is to be expected with a shift of employment the relative worth of these sectors are also changing. The relative value of the agricultural sector has decreased much further over the same time period as compared to employment shares. Indicating lower productivity growth in this sector, where as the industry sector has had significant productivity growth well beyond its growth in employment.

Table 3: Indonesian Sector Value Added Shares and Total (Constant 2005 $)

Sector	1960	1970	1980	1990	2000	2012
Agriculture	37.6%	32.6%	23.2%	17.7%	14.1%	11.2%
	$9.0b	$11.8b	$18.4b	$26.3b	$32.0b	$48.0b
Industry	25.2%	33.1%	40.4%	43.8%	48.4%	42.5%
	$6.0b	$12.0b	$32.0b	$65.0b	$110.0b	$181.4b
Services	37.1%	34.3%	36.4%	38.5%	37.4%	46.3%
	$8.9b	$12.4b	$32.4b	$57.2b	$85.0b	$197.4b

Data Source: World Bank (2014)

While employment share during the early stage of the industrialisation process did not change between 1980 and 1990, the growth in respective value added contributions of each sector reflects the importance of in particular the industry sector. Over this decade the agriculture value add increased by 43 per cent, services sector increased by 77 per cent, while industry increased by 103 per cent.

Although the Industry sector, in 2012, accounts for only 21 per cent of employment it contributes 43 per cent to value add to GDP, while agriculture only contributes 11 per cent from 36 per cent of employment share. The services sector is equally important contributing 46 per cent to value add, though this is achieved from 44 per cent employment share which is more than double the industry employment.

The growth in the industry sector has been largely driven by the rapid expansion of the manufacturing sector, which contributed 29 per cent to the Industry sector value add in 1960 and by 2012 it was contributing 59 per cent.

A new trend is emerging in the last decade (2000 – 2012) with the importance of the services sector growing significantly with an increase of 132 per cent value add compared to industry sector of 65 per cent. This may be reflective of the next stage of the industrialisation process where Indonesia’s economy maybe maturing and developing higher productive and value services such as ICT and finance.

Indonesia’s long term economic performance has outperformed the global average, and this has largely been driven by growth in the industry sector. Yet it still has capacity to grow especially considering its per capita position.

According to Hill (2007) Indonesia has the ability to achieve it past economic performance in the future as it has continued good macroeconomic stability and an open economy. While Oberman et al (2012) are optimistic predicting that growth will continue and by 2030 Indonesia could become the seventh largest economy in the world. According to the authors this based on a macroeconomic stability ranking that has Indonesia on par with more mature economies around the world. In addition the authors point to the likely continued strong domestic demand in Indonesia which will drive continued growth and fuel high levels of infrastructure investment and further production and construction being delivered by heavy industries.

The analysis above suggests that Indonesia has capacity for continued economic growth and If Indonesia is able to continue its strong performance and replicate its past annual growth rates that has been well above the global average, it would have significant implications for global CO_2 emissions.

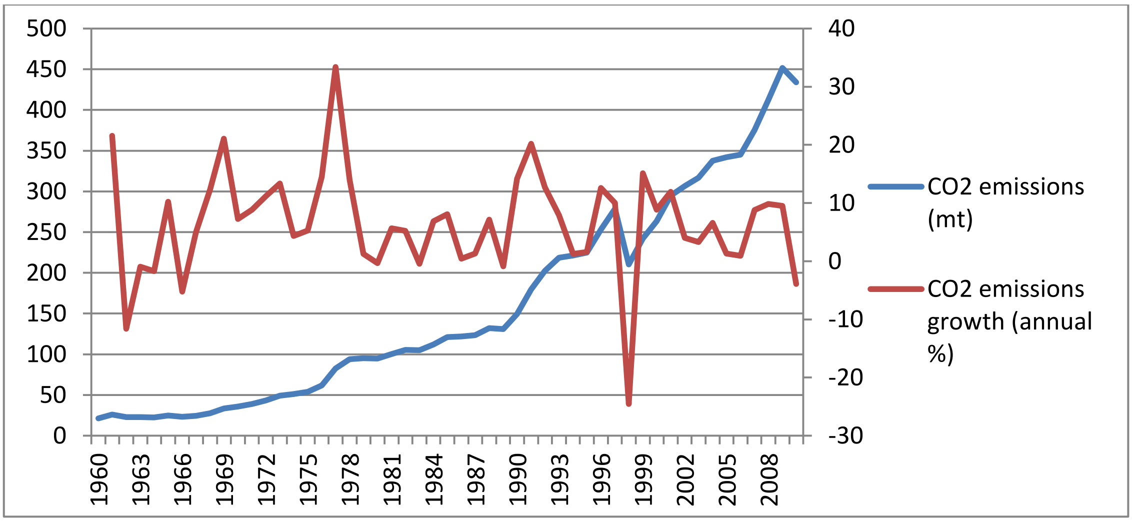
4.2. Indonesia's CO_2 Emissions and Emissions Intensity

4.2.1. Past CO_2 Emissions Trends

Indonesia is a significant player on the global climate change stage. When considering the CO_2 emissions, in 2010, it is ranked 14th with 434 mt. Though in terms of emissions per capita it slides down the rankings to 116th with 1.8 tons (World Bank 2014).

The graph below shows growth in total emissions since 1960 with an average annual growth rate of 6.6 per cent. The growth of emissions is similar to the GDP graph above with a similar steeper increase from the early to mid-1970's though emissions overall have grown faster than GDP. This implies that is has an emission intensive economy as emissions are growing faster than the economy.

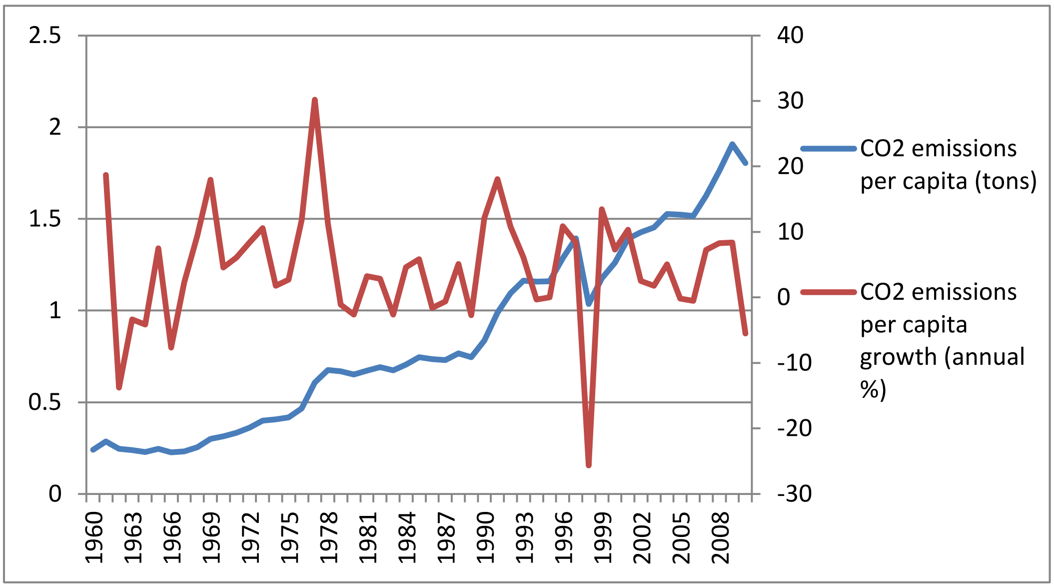
Figure 7: Indonesia's CO_2 Emissions and Annual Growth



Data Source: World Bank (2014)

Similarly the graph below shows per capita growth in emissions with an average annual growth rate of 4.5 per cent and significant growth since 1960 of nearly 700 per cent. Though the growth is not as strong as total emissions and is ranked relatively low by global standards it is still considerable considering rapid population growth, averaging 2 per cent annual growth over this time (compared to a global average of 1.6 per cent).

Figure 8: Indonesia's CO_2 Emissions Per Capita and Annual Growth



Data Source: World Bank (2014)

In a global context, the table below highlights Indonesia's relative position on the global stage. As mentioned it is currently ranked 14th behind the large economies below, with the exception of Brazil. In a similar story to the its economic performance, Indonesia's emissions average annual growth rate is the highest with 6.6 per cent which is more than double the global average, more than five times higher than the developed economies of USA and EU and approximately a percentage point higher than other emerging economies.

Table 4: CO_2 Emissions Comparisons of Large Economies

	CO_2 Emissions - 2010	Avg Annual Growth Rate 1960 - 2010	Per Capita CO_2 Emissions - 2010	Avg Annual Growth Rate 1960 - 2010
Indonesia	434mt (14th)	6.6%	1.8t (116th)	4.5%
China	8,287mt (1st)	5.3%	6.2t (60th)	3.8%
India	2,009mt (3rd)	5.8%	1.7t (119th)	3.8%
Brazil	420mt (15th)	4.6%	2.2t (108th)	2.6%
USA	5,433mt (2nd)	1.3%	17.6t (10th)	0.2%
EU	3,710mt (**3rd***)	1.0%	7.3t (*46th**)	0.5%
World	33,615mt	2.6%	4.9t	0.9%

Data Source: World Bank (2014)

*This is what the EU would be ranked if included as a separate county in the rankings.

When comparing emissions per capita, it is again the lowest ranked economy, yet with the highest average annual growth rate. Again considering the strong population growth and potential future economic performance it appears that Indonesia has the capacity for continued growth both in absolute and relative emissions and therefore confirms the significant potential impact Indonesia's future emissions has on global climate change

In order to provide a more detailed sectoral analysis for a deeper understanding of which sectors of the economy are driving changes in emissions the method of measurement for this thesis is using the data on release of CO_2 emissions only. As mentioned previously this is predominantly through the combustion of fossil fuels for energy generation and consumption. This method is more easily linked to economic activity from different sectors and data is more readily available, particularly sectoral data.

Looking at the sectoral CO_2 emissions the table below clearly highlights that the growth in emissions has been driven by growth in the industry sector (438 per cent from 1990 to 2008). This correlates with the economic data where industry has also had significant growth in terms of value add to the economy. Though it also shows that the industry sector is very emissions intensive as it contributes 43 per cent to value add, yet it accounted for 63 per cent of emissions.

Table 5: Indonesian Sectoral CO_2 Emissions

Sector	1990	2000	2008	% change 1990-2008
Industry	32.2	71.0	173.3	438%
Services	1.6	3.6	5.3	231%
Transport	32.2	62.7	70.3	118%
Agriculture	3.6	6.3	7.0	94%
Households	19.3	27.9	21.9	13%
Total	**88.7**	**171.6**	**277.8**	**213%**

Data Source: World Energy Council (2014)

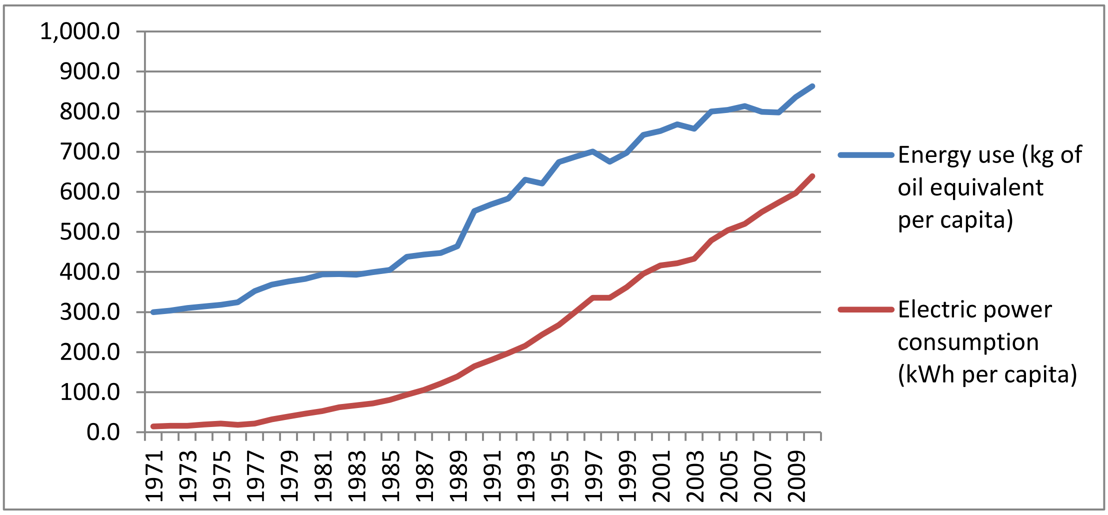
The transport sector is the second largest contributor to emissions (25 per cent), followed by households, agriculture and services, though services has seen the second largest increase in emissions albeit starting from a low base.

4.2.2. Patterns of Energy Consumption and Intensity

A factor contributing to increasing emissions is that overall energy usage and electricity consumption are also increasing. The graph below shows that energy usage (this includes electricity and transport consumption) on a per capita basis has increased by 188 per cent.

While electricity consumption has had a rapid increase of over 4,000 per cent given it started from a very low base. However, Indonesia still has quite low rates of access to electricity with only 65 per cent of households and 85 per cent of villages having access (ABB 2011). As the country further develops so too will access to electricity and therefore leading to increased consumption of electricity and consequently absolute CO_2 emissions.

Figure 9: Indonesia's Energy Usage and Electricity Consumption Per Capita

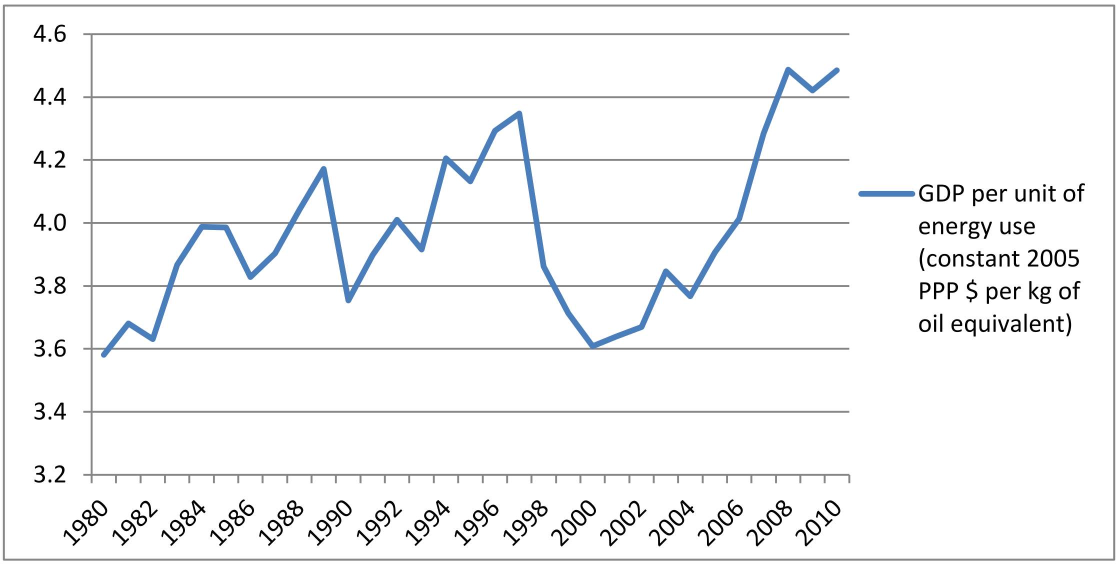


Data Source: World Bank 2014

Indonesia is also increasingly seeing an urbanisation of its population with 51.4 per cent currently living in urban areas and increase of over 20 per cent since 1990 and nearly 40 per cent since 1960 (World Bank 2014). This increasing urbanisation trend will also continue to place demand pressure for electricity consumption.

One area where there has been improvement though is in energy intensity which is consistent with previous research and is likely due to technology transfer. The measure takes GDP output against energy use. Here the data shows that the economy has become more energy efficient, by being able to produce more output with less energy. The graph shows that there has been a steady improvement in energy intensity, though again a significant deviation occurred during the AFC, however overall there was a 25 per cent improvement.

Figure 10: Energy Intensity of Indonesia's Economy



Data Source: World Bank 2014

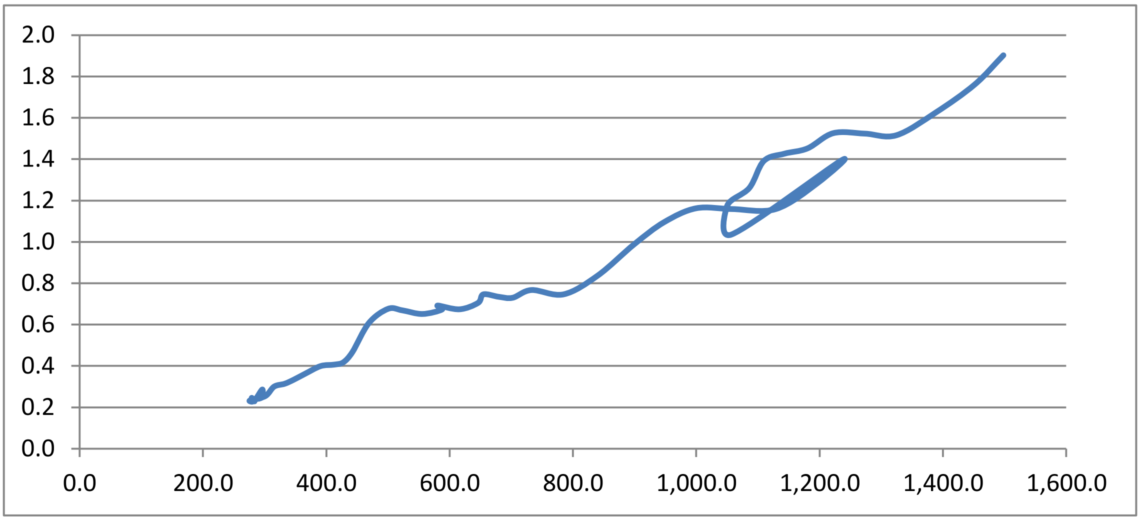
Continued improvement in energy efficiency provides a positive movement towards decoupling of the economy and energy usage. Though again this is only a relative improvement in environmental degradation as the data has shown total emissions continue to grow.

4.2.3. Environmental Kuznets Curve

The previous two sections have shown that overtime Indonesia's economy has been performing well and there has also been significant emissions growth. When considering the interplay between these, Indonesia's EKC provides insights into the current level of development by comparing GDP per capita and emissions per capita at different points in time.

The graph below shows that there is an upwards trend without a turning point, though it did experience a decline following the AFC in 1997, it has recovered and follows the pre-AFC trajectory. This makes intuitive and conceptual sense (when considering the theory) given that Indonesia has relatively only begun in its industrialisation process, where the economic development stage correlates with an economy that is still reliant on the emissions intensive industry sectors. The economic data also confirms this highlighting the strong contribution of the industry sector.

Figure 11: Indonesian Environmental Kuznets Curve (1960 – 2010)
CO2 Emissions Per Capita (Tons) Versus GDP Per Capita (Constant 2005 $)



Source: World Bank 2014

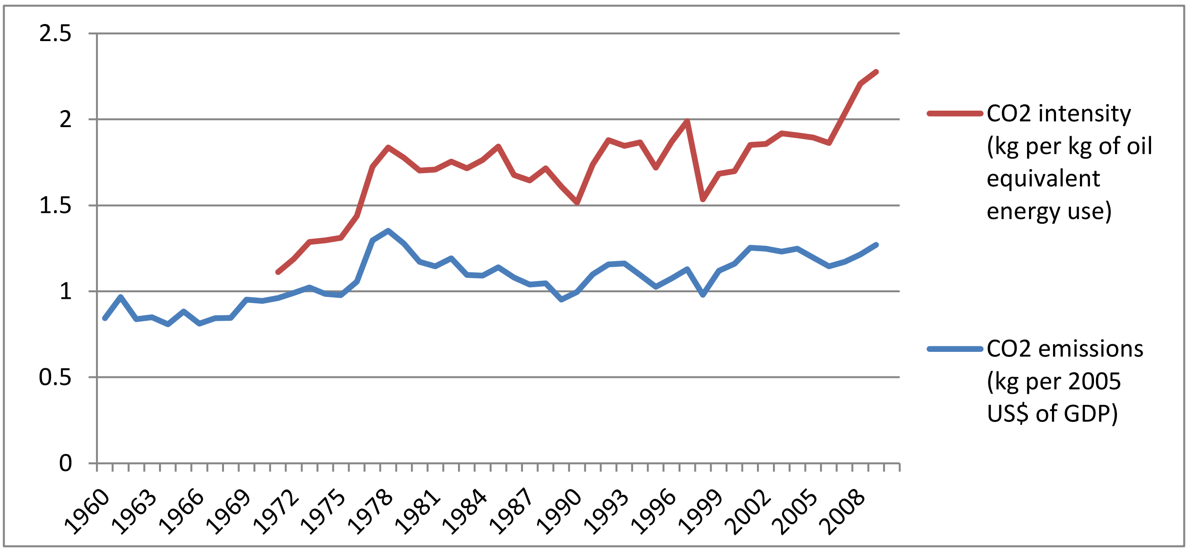
Indonesia is still on a low level path of wealth accumulation on a per capita basis. If we compare these results to the USA and EU EKC, Indonesia it seems has much more upswing to come given it has a current GDP per capita of only $1,500. Especially when considering USA turning point was at $23,000 and EU turning point at $17,000 over three decades ago.

Following the theory and considering how Indonesia's economic performance and context compares to other large economies it would appear that Indonesia's per capita CO_2 emissions will continue to rise. When considering its low GDP per capita ranking it suggest that there may be further significant emissions growth to come.

4.2.4. CO_2 Emissions Intensity

The emissions intensity for Indonesia can be seen in the graphs below. Two different measures are displayed, both resulting in the same outcome showing Indonesia's emissions intensity increasing. Again this makes sense given Indonesia's position along the industrialisation process and the rapid economic growth it has experienced over the past few decades.

Figure 12: Indonesia's CO_2 Emissions' Intensity



Data Source: World Bank 2014

Both of the measures follow a similar trend upwards with a downward deviation caused by the AFC in 1997, but has since continued its upward trend as economic recovery took hold.

The graph indicates that Indonesia's economic activity is increasingly more emissions intensive. Since the 1960's CO_2 emissions intensity, measured against GDP output, has increased by 50 per cent. In 1960 for every $ of GDP 0.8 kilograms (kg) of emissions was produced where as in 2009 it was 1.3 kg. This increase in emissions intensity of the economy would be offset by the decrease in energy intensity of the economy depicted above, though given continued increase of emissions it would appear that the emissions intensity is growing at a faster rate.

Similarly emissions intensity, measured against energy use, has increased by 105 per cent where the emissions from every unit of energy used have more than doubled since 1970. This would indicate that the form of energy generation has been increasingly becoming more emissions intensive.

The data has established that emissions intensity is increasing and the following section will attempt to identify the drives of emissions changes from a sectoral perspective. Understanding what drives these changes is an important component to being able to influence the outcomes.

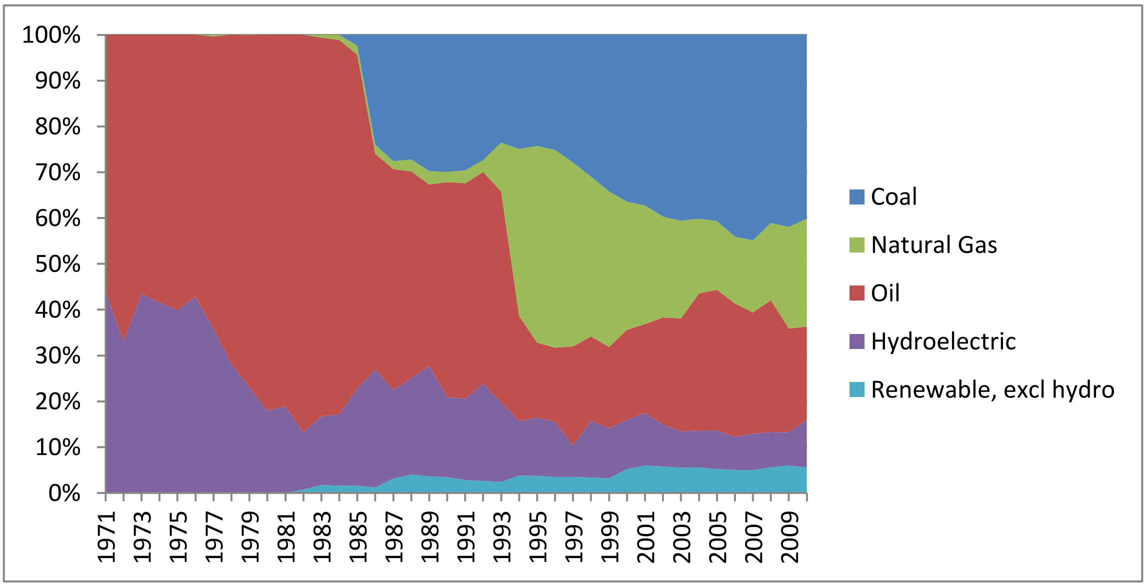
4.2.5. Energy Generation Mix

Indonesia's high emissions can be attributed in part due to an abundance of primary energy fossil fuel resources (coal, gas, oil). In 2011 energy production was dominated by fossil fuels accounting for 87% of generation (EIA 2014).

The table below shows Indonesia's electricity generation mix since 1971. In the early period generation was dominated by oil and hydroelectric, which was actually when Indonesia experienced its largest share of generation from renewable sources accounting for approximately 40 per cent. Renewable energy sources now play a much smaller role accounting for just over 10 per cent. Though since the mid 1980's other sources of renewable energy (geothermal, solar, tides, wind, biomass, and biofuels) has experienced steady growth, albeit on a small scale it is still a positive trend.

Since the early 1980's a significant shift in generation mix occurred with the emergence of coal to become the current dominant source. This is not a positive trend given that amongst fossil fuel electricity generation, typically coal is the most emissions intensive, followed by oil and then natural gas. This shows a primary reason for increasing emissions intensity and confirms that is the energy generation mix remains coal dominated and energy consumption grows so will total CO_2 emissions.

Figure 13: Indonesia's Electricity Generation Mix



Data Source: World Bank 2014

4.2.6. Decomposition of CO_2 Emissions Intensity

As mentioned earlier given the positive critique of the LMDI and its common use in previous research and its application to a range of economies it is therefore the preferred method for this thesis as it can provide further insight into answering the research question.

As with any data there are limitations. The time period under investigation is limited from 1990 (as opposed to other measures that have begun at 1960) due to detailed emissions data not existing prior to this. In addition a deeper decomposition was not possible as energy consumption and fuel mix for each sector was also not available. Although the transport sector is a significant contributor to emissions (as highlighted in Table 5), detailed sectoral data was not available and therefore it has been excluded from the decomposition analysis.

Following the formula detailed above in section 3.3.1., and given the limitations and the desire to identify drivers of change with a sectoral perspective, four sectors have been selected for decomposition: agriculture, industry, services and residential. The commercial sectors identified match those from the structural change analysis.

The residential sector has been included as a measure for changes in personal preferences and consumption n and it also provides insight into the effect of population growth.

The following table and graph shows the impact of Indonesia's key sectors on CO_2 emissions from the period 1980 to 2008. It also identifies the drivers of change in commercial sectors being either structural change (Dstr) which is the impact of between-sector changes in shares of output from the industrialisation process or transition to a service based economy. The other driver is technological change (Dtech) which is the within-sector changes by increased output of a sector with the same amount of emissions or alternatively the same level of output with fewer emissions, potentially achieved through efficiency gains, substitution effect, or technical innovation. The non-commercial household sector identifies changes due to personal consumption (Dpcons) driven by consumer preferences.

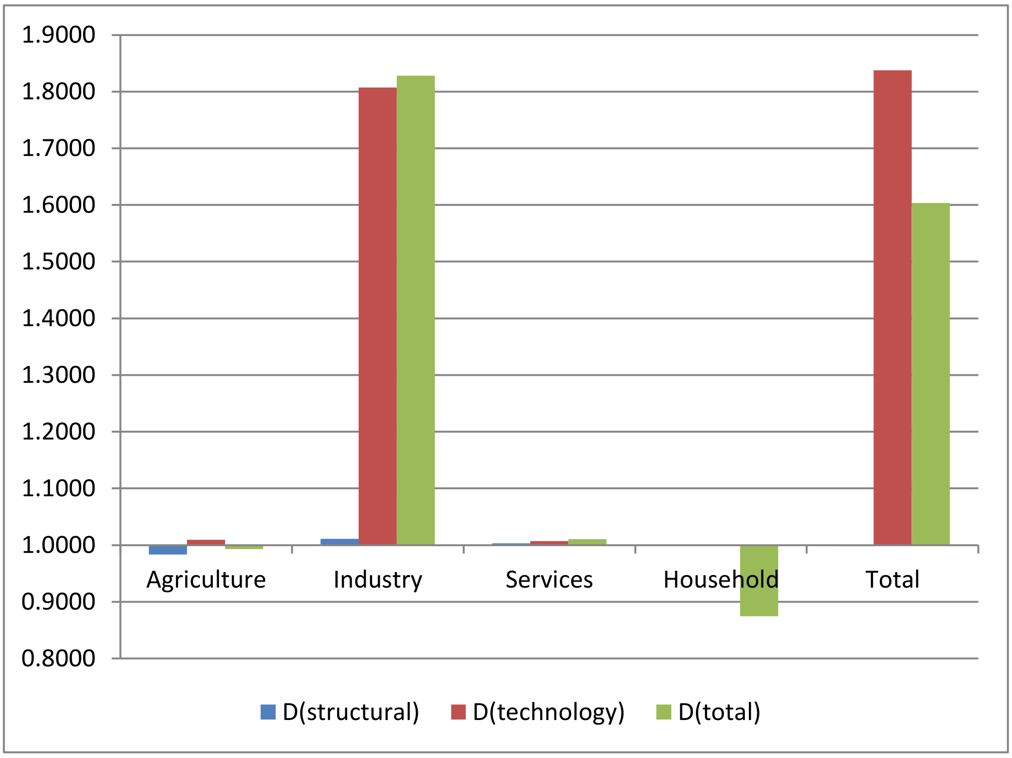
The decomposition output shows that any figure above one correlates with a percentage increase in intensity, while any figure below one a decrease.

Table 6: CO_2 Emissions Intensity Decomposition of Indonesia's Economic Sectors

1990-2008	Agriculture	Industry	Services	Households	Total	% change
D(str)	0.98	1.01	1.00		0.9923	**0.2%**
D(tech)	1.01	1.81	1.01		0.8574	**-83.8%**
D(pcons)	-	-	-	0.87		
D(tot)	0.99	1.83	1.01	0.87	0.8508	
% change	**0.7%**	**-82.2%**	**-1.0%**	**12.6%**	**-60.4%**	

Data Source: World Bank 2014, World Energy Council 2014

Figure 14: CO_2 Emissions Intensity Decomposition of Indonesia's Economic Sectors



Data Source: World Bank 2014, World Energy Council 2014

Overall the figures indicate that Indonesia's emissions intensity has increased by 60 per cent, with nearly all of the impact driven by technological change within the sectors and only a negligible contribution from structural change.

The emissions intensity increase is effectively due to a significant intensity increase in the Industry sector rising by over 80 per cent. The driver of this change has been technological changes (as supposed to structural changes), which if we consider the theory is logical, that as a country develops they move along the industrialisation process and move into more heavy forms of industry which are typically more emissions intensive. These industries include cement, metals, construction, electricity and oil and gas. This also makes intuitive sense as the early stages of economic development usually correlates with a strong period of infrastructure development and construction.

The overall increase is offset slightly by an intensity decrease in the household sector of 13 per cent. Although as noted above total household consumption is rapidly growing more efficient personal consumption driven by new technologies in appliances and housing construction means the rate of emissions growth is lower than it would otherwise have been.

The changes in the agricultural and services sector have a minimal impact on emissions intensity. In the case of the services sector this supports the findings from Henriques & Kander (2010) that the contribution of services sector transition in curbing CO_2 emissions is overstated in other studies and does not play a significant role in improving energy intensity.

Though the results still fits into the EKC theory as Indonesia is still in the middle stage of economic development. This suggests that higher productive service sectors have yet to play a significant role and therefore its impact on CO_2 emissions cannot be fully measured.

4.2.7. CO_2 Emissions in the Future

Indonesia by any definition is a large emitter of greenhouse gases. There are, as always, number of different ways that this can be measured. When considering total greenhouse gas emissions from all sources (measured in million tons of CO_2 equivalent – $MtCO_2e$ – this includes other gases such as methane and nitrous oxide) Indonesia rises significantly to become the third highest emitter in the world (DNPI 2010). This is due to the inclusion of forestry emissions, predominantly from deforestation and peat-land destruction.

Although direct sources of emissions provides different figures to those that have been analysed above, as previously mentioned, the important information is the trend over time, and this data set provides an insight into potential future trends in emissions.

The table below shows estimated source emissions from 2005, with projections to 2020 and 2030 under a Business-As-Usual (BAU) scenario – where no policy interventions are undertaken. The projections show that total emissions will increase significantly (by 59 per cent) predominantly on the back of forecasted economic growth and increasing consumption (DNPI 2010).

Table 7: Projected Sources of Indonesian Emissions ($MtCO_2e$)

Sector	2005	2020	2030
Energy	205	470	915
Agriculture	130	145	150
Transport	60	220	440
Buildings & Cement	50	75	115
Forestry	1,610	1,620	1,640
Total	**2,055**	**2,530**	**3,260**

Source: DNPI (2010)

Over the same period according to the World Population Review (2014) population will grow by 36 per cent – from 225 million in 2005 to 307 million in 2030. On a per capita basis in 2005 CO_2e emissions were 9.1 Mt and projected to be 10.6 Mt in 2030, representing a 16 per cent growth. Therefore with these projected increases it indicates that not only will total emissions increase, but so will emissions intensity on a per capita basis.

The forestry emissions are by far the largest contributors (78 per cent in 2005), however they are projected to remain at a similar level as declining rates of deforestation is offset by increasing rates of peat decomposition (MoF 2008). Although this source contributes a large proportion of emissions, it is acknowledged that there are difficulties with the methodology and accurately measuring Land Use, Land Use-Changes and Forestry emissions due to lack of data, and low reliability and high uncertainty of existing data (UNFCC no date).

In comparison to forestry emissions, the other sectoral sources are currently proportionally small contributors, though from a global perspective these sources of emissions are still significant and are projected to increase significantly.

Agriculture is projected to increase by 15 per cent to 2030 driven by increasing land usage, livestock and rice cultivation. While buildings and cement is projected to increase by 130 per cent due to demand for cement production and energy consumption in residential and commercial buildings.

Emissions from the energy and transport sectors are projected to rapidly increase. The transport sector is projected to grow by over 600 per cent, taking its contribution from 3 per cent in 2005 to 14 per cent by 2030, driven by increasing income and wealth leading to growth in both personal and commercial vehicles.

The energy sector is projected to grow by over 340 per cent to 2030, taking the sectors contribution from approximately 5 per cent in 2005 to 25 per cent by 2030. This increase will be driven by strong demand for electricity from the residential and industrial sector, plus continued electrification of rural areas. The petroleum and gas component is to remain relatively stable due to maturing oil and gas fields closing and being replaced by more efficient fields (DPNI 2010).

These projections supports the analysis and conclusions above where the economic and past emissions trend data suggests that Indonesia's CO_2 emissions will continue to grow and have a significant impact on climate change on a global stage.

4.3. Summary Findings of Drivers of Emissions Changes

In answering the research question it has been established that there are a number of different factors effecting Indonesia's CO_2 emissions and emissions intensity.

The data analysis for total emissions growth in Indonesia has highlighted a main driving factor of change which has a number of mechanisms. The overarching factor has been Indonesia's strong economic performance and increased economic activity.

A mechanism which translates this economic growth into emissions has been the beginning of structural change within the economy and the industrialisation process, which has resulted in growth of the industrial sector. The data has shown that both economic growth and emissions growth has been driven predominantly by the growth in the industry sector.

Another mechanism resulting in emissions growth has been that the increased economic activity has also led to increasing rates of energy usage and consumption. Though the impact on emissions growth has been slightly offset by improvements in energy efficiency, the data indicates that this has not been sufficient enough to curb emissions growth.

In addition to total emissions growth, emissions intensity is also increasing, when measured by energy usage, per capita and GDP, though again this is less steep due to improvements in energy efficiency.

The analysis of emissions intensity changes has highlighted two factors. One driver behind emissions intensity changes has been changes in the energy generation mix with significant increase in emissions intensive forms of generation, namely fossil fuel generation. Another driver has been the technological changes in the industry sector due to Indonesia's stage of economic development and the move towards industrialisation triggering production from more heavy industries.

In addition to the total CO_2 emissions growth and intensity increases, the data suggests that these trends will continue over the coming years with growth in both relative, in terms of per capita emissions, and total emissions. Again this is to be driven by projected economic growth from the combination of good macroeconomic stability, abundant natural resources and a growing population that is fuelling domestic demand.

Based on the analysis above it would indicate that Indonesia's total CO_2 emissions and emissions intensity are likely to grow significantly. In addition the data above clearly highlights that Indonesia is a major player on the global stage for climate change, with potentially large climate impacts if its emissions is to continue to grow.

These climate impacts and environmental degradation from emissions will also affect Indonesia through its natural resource base. There have already been observed changes in extreme events and severe climate anomalies, such as massive droughts, water shortages and forest fires, which clearly also come with an economic cost (Cruz et al 2007). It will also impact on broader Indonesian society as a large proportion of the population is reliant on these natural resources for their livelihood (Resosudarmo 2005). Subsequently the continued environmental degradation is likely to impact on future economic growth, which in itself may actually be a limiting factor to growth and emissions.

However as Panayotou (2003) suggested it is possible to affect the outcome and bend the EKC. One such lever available is through national policy settings, which could be an important mechanism to limit the growth of emissions. The following section will briefly look at Indonesia's climate policy that would aid the effective implementation of change.

4.4. Indonesia's Climate Chance Policies

The World Bank (2014) performs a review and rating (1=low, 6=high) of developing countries policy and institutions for environmental sustainability. The rating assesses the extent to which environmental policies foster the protection and sustainable use of natural resources and the management of pollution.

As outlined in the table below, according to this rating Indonesia in 2006 was 2.5 with an improvement in 2007 to 3. Unfortunately the rating was not undertaken for developed countries in order to benchmark Indonesia against countries with good settings.

However, when compared to the average for developing countries and regions, and other emerging economies, Indonesia compares relatively well and only slightly below the average.

Table 8: Environmental Sustainability Rating of Policy and Institutions

(1=low to 6=high)	2006	2007
Indonesia	2.5	3.0
India	3.5	3.5
Vietnam	3.5	3.5
East Asia & Pacific	2.8	3.0
Europe & Central Asia	3.1	3.2
World	3.1	3.1

Data Source: World Bank (2014)

This implies that potentially Indonesia has some work to do to improve its policy and institutional settings in order to achieve strong environmental outcomes. However it would appear that it has a reasonable base from which to build and develop sound settings.

More specifically Indonesia has been an active participant in climate change negotiations and has a range of climate change policies. Indonesia hosted a UNFCCC conference in 2007 and has since committed to a range of climate change targets and actions. These commitments and an action plan, including institutional arrangements and specific programs across the economy have been legislated through a presidential regulation in 2011. The plan has set a target of greenhouse gas reductions of 26 per cent by 2020 or 41 per cent with additional international aid and sectoral reduction targets across a range of sectors including agriculture, forestry, energy and transportation, and industry (Republic of Indonesia 2011).

Commitment is the first step but it needs to reinforced with effective implementation of a range of climate change policies, and not be offset with other policies that contribute to fuelling emissions. In particular Indonesia’s energy subsidy programs are a well-known policy issue that causes market distortions and contributes to increasing fuel consumption and subsequently emissions. The Government spends an increasing amount of its budget on these subsidies as it controls the domestic price of oil at lower than world prices and electricity at lower than production costs (Hartonoa & Resosudarmo 2008).

If Indonesia is to effectively bend its EKC to achieve a lower turning point it must continue to commit to climate change policies, improve institutional settings to ensure effective implementation of policies and target counter-productive policies such as energy subsidies.

5. Concluding Remarks and Policy Implications

Indonesia is currently a significant player in global economic and environmental outcomes. In both GDP and CO_2 emissions it ranks relatively highly in the world and in terms of average annual growth rates it has been outperforming the global average and a number of other large economies such as USA, EU, Brazil, and India.

Given Indonesia's strong past economic performance and coupled with its particularly strong growth rates in GDP, GDP per capita and population, and the fact that it is still on a relatively low base for GDP per capita, it would suggest that this trend of strong economic performance is likely to continue and see Indonesia become an even more significant player in years to come. In addition the similarly strong growth trends in total CO_2 emissions and emissions intensity appears set to continue and therefore a correlating increase in global environmental degradation through the release of higher levels of total emissions.

The results from the analysis indicate that total CO_2 emissions growth has been driven by economic growth and particularly growth in the industrial sector and overall energy and electricity consumption. While the drivers for growth in emissions intensity has been a significant change in energy generation mix to more intensive forms of generation and technological changes in the industry sector with more intensive forms of industry.

Indonesia's EKC highlights that it is in a relatively early stage of economic development having begun its industrialisation process in the 1970's, suggesting a continued dominant role of industry in the economy. Given this a number of potential solutions exist for Indonesia to reduce emissions growth. Indonesia should focus on emissions intensity in particular targeting energy generation mix in order to decouple economic growth from emissions. The growth of coal as the dominate form of energy generation is a significant contributor to increase in emissions intensity and therefore policies should target increasing cleaner forms of energy generation particularly renewable energy.

Another large driver has been the industry sector and seemingly an increasing proportion of heavy emitting industries, suggesting that a focus on cleaner production methods through technology transfers or the new clean technology industries would also positively impact on CO_2 emissions growth.

While the EKC theory suggests that as economic growth continues there will be a turning point at some stage, Indonesia is already a significant global emitter and yet still at very low point on the EKC in terms of GDP per capita. Therefore given that according to the IPCC (2014) the world is already at dangerous concentrations of greenhouse gases Indonesia needs to intervene now to drastically change its current trend projections in order to avoid further potentially irreversible environmental degradation.

While it was beyond the scope of this thesis an important area of research which would also give insights into potential outcomes would be what impact would a feedback of absolute environmental degradation have on economic performance? While there have been glimpses of the economic impacts of climate change, particularly through the increasing frequency and intensity of climate events, the world has not seen what a tipping point of climate change will have on the climate and subsequently economies and broader society.

Emissions intensity and emissions growth is only part of the solution as generally this is a relative measure, while total emissions continue to grow and accumulate in the atmosphere. So what is the solution to reducing both relative and absolute environmental degradation? Potentially the focus needs to shift towards the idea of economic growth and its role within society. Alternatives are emerging with research into a post growth world, where economic growth is not the paradigm, as it may hold some of the answers to mitigating climate change.

References

1. ABB (2011), Trends in Global Energy Efficiency, Country Reports – Indonesia, ABB Zurich
2. Ang, B.W. (2005), The LMDI Approach to Decomposition Analysis: A Practical Guide, Energy Policy 33, 867-871
3. Ang, B.W. (2004), Decomposition Analysis for Policy Making in Energy: Which is the Preferred Method?, Energy Policy 32, Pg 1131-1139
4. Ang, B.W. & Zhang, F.Q. (2000), A survey of index decomposition analysis in energy and environmental studies, Energy 25: 1149–1176
5. Cruz, R.V., Harasawa, H., Lal, M., Wu, S., Anokhin, Y., Punsalmaa, B., Honda, Y., Jafari, M., Li, C. and Huu Ninh, N. (2007): Asia. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 469-506.
6. Dasgupta, S., Laplante, B., Wang, H. and Wheeler, D. (2002), Confronting the Environmental Kuznets Curve, Journal of Economic Perspectives Vol.16, No.1: 147-168
7. de Vries, G. & Timmer, M. (2007), Groningen Growth and Development Centre 10-sector database, http://www.ggdc.net/ [last accessed 14/08/2014]
8. DNPI – Indonesian National Council on Climate Change – (2010), Indonesia's Greenhouse Gas Abatement Curve, Dewan Nasional Perubahan Iklim
9. EIA – Energy Institute Association – (2014), Indonesian Energy Data, available online: http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm [last accessed 14/08/2014]
10. European Commission (2014), Supporting Climate Change Action Through EU Budget, http://ec.europa.eu/clima/policies/finance/budget/index_en.htm [last accessed XX/XX/2014]
11. Galeotti, M. & Lanza, A. (2005), Desperately Seeking Environmental Kuznets, Environmental Modelling & Software 20, 1379–1388
12. Hartonoa, D. & Resosudarmo, B. (2008), The economy-wide impact of controlling energy consumption in Indonesia: An analysis using a Social Accounting Matrix framework, Energy Policy 36, 1404–1419
13. Hayashi, M. (2005), Structural Changes in Indonesian Industry and Trade: An Input-Ouput Analysis, The Developing Economies, March, 39-71

14. Henriques, S.T. (2011), Energy Transitions, Economic Growth and Structural Change, Portugal in a Long-Run Comparative Perspective, Lund University
15. Henriques S.T. & Kander, A. (2010), The modest environmental relief resulting from the transition to a service economy, Ecological Economics 70: 271-282
16. Hill, H. (2007), The Indonesian Economy: Growth, Crisis and Recovery, The Singapore Economic Review, Vol. 52, No. 2: 137–166
17. IPCC (2014), Climate Change 2013 The Physical Science Basis - Headline Statements from the Summary for Policymakers, IPCC
18. Jiao, J.L., Qi, Y.Y, Cao, Q., Lan-Cui Liu, L.C, and Liang, Q.M (2013), China's targets for reducing the intensity of CO2 emissions by 2020,
19. Kander, A. (2002), Economic growth, energy consumption and CO_2 emissions in Sweden 1800-2000, Lund University
20. Kander, A., Malanima, P. and Warde, P. (2012), Power to the People, Energy In Europe over the Last Five Centuries, Princeton University Press, Princeton and Oxford
21. Lapinskienė, G., Tvaronavičienė, M., & Vaitkus, P. (2014), Greenhouse Gases Emissions and Economic Growth – Evidence Substantiating the Presence of Environmental Kuznets Curve in the EU, Technological and Economic Development of Economy, 20:1, 65-78
22. Lindmark, M. (2002), An EKC-pattern in historical perspective: carbon dioxide emissions, technology, fuel prices and growth in Sweden 1870–1997, Ecological Economics 42: 333–347
23. MoF - Ministry of Finance - (2008), Low Carbon Development Options for Indonesia, Phase 1 Status Report and Findings, World Bank
24. Muller, A. (2006), Putting decomposition of energy use and pollution on a firm footing, Goteborg University
25. Oberman, R., Dobbs, R., Budiman, A., Thompson F., & Rosse, M. (2012), The Archipelago Economy: Unleashing Indonesia's Potential, McKinsey Global Institute, McKinsey & Company
26. O'Mahony, T. (2013), Decomposition of Ireland's carbon emissions from 1990 to 2010: An extended Kaya identity, Energy Policy 59: 571 - 583
27. Panayotou, T. (2003), Economic Growth and The Environment, Harvard University and Cyprus International Institute of Management, Spring Seminar of the United Nations Economic Commission for Europe, Geneva, March 3

28. PEACE (2007), Executive Summary: Indonesia and Climate Change. Working Paper on Current Status and Policies, World Bank, March
29. Republic of Indonesia (2011), Presidential Regulation of The Republic of Indonesia No.61 Year 2011 on The National Action Plan for Greenhouse Gas Emission Reductions, Indonesia
30. Resosudarmo, B.P (2005), Introduction, in Resosudarmo B.P (ed), The Politics and Economics of Indonesia's Natural Resources, Institute of Southeast Asian Studies
31. Stern, D. (2004), The Rise and Fall of the Environmental Kuznets Curve, World Development Vol. 32, No. 8: 1419–1439
32. UNFCC (2014), Climate Finance, http://unfccc.int/focus/climate_finance/items/7001.php [last accessed 14/08/2014]
33. UNFCC (no date), CGE Greenhouse Gas INventorty Hands-on Training Workshop – Land-Use Change and Forestry Sector, UNFCC
34. World Bank (2014), World Development Indicators, IND Country Metadata Excel, http://data.worldbank.org/country/indonesia#cp_wdi [last accessed 14/08/2014]
35. World Energy Council (2014), Indicators by Country/Region – Indonesia, http://www.worldenergy.org/data/efficiency-indicators/ [last accessed 14/08/2014]
36. World Population Review (2014), Indonesian Population 2014, http://worldpopulationreview.com/countries/indonesia-population/ [last accessed 14/08/2014