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Effects of Free Trade on CO2 Emissions: The Case of High and Low Income Countries

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The study determines the effects of free trade on CO2 emissions of selected five high income countries; Australia, Canada, Japan, Norway, United Kingdom and five low income countries; Benin, Liberia, Nepal, Sudan and Zimbabwe. Moreover, the study empirically analyzes the effects of trade openness on CO2 emissions in high and low income countries and examine the Environmental Kuznets Curve for GDP per capita and CO2 emissions in metric tons per capita of mentioned high and low income countries by using World Bank data for 51 years from 1960-2011.The findings of this study suggests that high income countries are not gained much in the respect of free trade in case of reducing CO2 emissions as CO2 is a global pollutant and Environmental Kuznets Curve for GDP per capita and CO2 emissions in metric tons per capita of selected high and low income countries does not hold as CO2 emissions rises with GDP per capita.

Field of Research: Environment and National Economy

1. Introduction

The increasing threat of global warming and subsequent climate change has been the major on-going concern for all societies from developing countries to developed countries. Trade, Economic Growth and environment are mutually interdependent as trade contributes to economic growth and economic growth leads to environmental degradation like Carbon dioxide (CO2) emissions.CO2 is regarded as the main source of greenhouse effect and increasing global warming where most of the CO2 emissions come from fossil fuels consumption, electricity generation, manufacturing activities, transport and consumption of goods and services that are associated with trade and leads economic growth. Trade is the major source of economic growth that enhances production intensively by utilizing domestic resources efficiently. Trade openness or free trade provides a way for mobilizing factors of production freely between the countries. Trade exists due to the specialization and division of labor, in which most people concentrate on a small aspect of production, trading for other products. Trade exists between regions because different regions may have a comparative advantage (perceived or real) in the production of some trade-able commodity, or because different regions' size may encourage mass production. As such, trade at market prices between locations can benefit both locations. The main reason is international trade will shift the production of pollution-intensive goods from developing countries to the developed nations and hence declines CO2 emissions of the world. So trade openness could lead to greater

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trade which further lead to economic growth has led to a rising CO2 emissions. Proponents of trade liberalization claim that, income growth induced by trade can lead individuals to increase their demand for environmental quality; to increasingly enforce environmental regulations, thus encouraging firms to shift towards cleaner production techniques. This can in fact positively impact the environment and income growth. On the other hand opponents of trade liberalization, argue that if production techniques do not change, then globalization could aggravate environmental damage through more protracted economic activity, rapid growth of pollution-intensive industries, thereby having a detrimental effect on the environment. Thus it is having an important effect to examine the effect of trade on CO2 emissions.

Many well-informed people believed that more developed economic systems produce more goods and services for people and consequently more economic development means more stress on the natural environment. The Environmental Kuznets Curve challenges the often advanced argument that increases in income lead certainly to more pollution because more income implies more consumption, which in turn implies more pollution. Theoretically, an Environmental Kuznets Curve declares the possibility that there may be factors having the opposite effect of decreasing, rather than increasing pollution. The combination of the two effects can thereby lead to pollution first increasing and then decreasing with increases in income. The set of factors leading pollution to fall with income can be classified into two groups.

The first is that the richer countries tend to use efficient and later vintage technology to produce goods that is less polluting respect to energy consumption. The second is that as they become wealthier, consumers will demand better environmental quality by shifting their consumption toward less polluting products, moving to cleaner areas, or demanding that their government agencies more strictly regulate the output of various types of pollution. So they argue that carbon emissions appear to increase with low-income countries and decrease with high-income countries. Famous is the quotation from Beckerman (1992): ‘‘The strong correlation between incomes and the extent to which environmental protection measures are adopted demonstrate that in the longer run the surest way to improve your environment is to become rich’’ (p. 495). The paper takes in to account the debate within high and low income countries.

The growth of Gross Domestic Product (GDP) is specially a good indication of economic growth. GDP is the monetary value of all final goods and services produced within a country in a given time period, though GDP is usually calculated on an annual basis. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Trade openness as a share of GDP is the sum of merchandise exports and imports divided by the value of GDP, all in current U.S. dollars. So the study is examining the EKC relationship between CO2 emissions and GDP per capita in high and low income countries. The study chose five high income countries - Australia, Canada, Japan, Norway and United Kingdom moreover five low income countries which are Benin, Liberia, Nepal, Sudan and Zimbabwe.

The main objective of the study is to analyze the effects of free trade on CO2 emissions of selected high and low income countries to justify the argument that carbon emissions appear

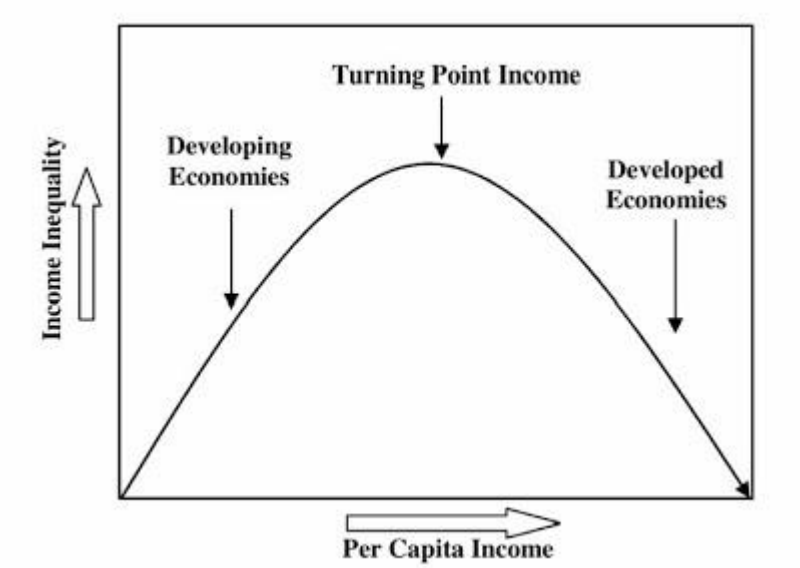
to increase with low-income countries and decrease with high-income countries that is the motivation of this study. In addition to examine the Environmental Kuznets Curve for GDP per capita and CO2 emissions metric tons per capita for mentioned high and low income countries from the year of 1960 to 2011.

The rest of the paper is organized as follows namely section 2 reviews the theoretical background, section 3 discusses literature review, section 4 lays out the methodology, section 5 discusses the results from the analysis and section 6 concludes, section 7 provide references; Lastly, section 8 provide Appendix where tables and graphs are used for this research are presented.

2. Theoretical Background

It has been argued that EKC is an inverted-U-shaped relationship between economic growth (per capita income) and measured pollution indicators (indicators of environmental quality). In fact EKC hypothesis is projected a long term relationship between environmental impact and economic growth; as income of an economy grows over time, emission level grows first, reaches a peak and then starts declining after a threshold level of income has been achieved.

Figure 1: Environmental Kuznets Curve



The EKC has another term “stages of economic growth” as economies pass through a transition from agriculture based economies to industrial economies as mass production and consumption grow in the economy by extraction and greater use of natural resources results in increasing environmental degradation and then post-industrial or service intensive economies therefore start on to show decreases in pollution and environmental degradation due to increased environmental awareness, higher environmental expenditures, efficient technologies and increased demand for environmental quality. It is assumed that as income moves away from the EKC turning point, transition to improving environmental quality starts.

3. Literature Review

Trade openness or movement of factors of production may also move dirty industries from home countries to developing economies where laws and regulations about environment is just formality.

3.1 Literature Support to Trade Openness on Reduction of CO2 Emissions

Copeland and Taylor (2005) supported that international trade is beneficial to environmental quality through environmental regulations and capital-labor channels. The authors documented that free trade declines CO2 emissions. The main reason is international trade will shift the production of pollution-intensive goods from developing countriesto the developed nations and hence declines CO2 emissions of the world.

McCarney and Adamowicz (2006) suggested that trade openness improves environmental quality depending on government policies. The local government can reduce CO2 emissions through the environmental policies.

3.2 Literature Support to Trade Openness on CO2 Emissions

Feridun et al. (2006) documented that trade openness harms the environmental quality in less developed economies like Nigeria.

Chen (2009) explored this issue to Chinese provinces and documented industrial sector's development is linked with increase of CO2 emissions due to energy consumption.

Halicioglu (2009) added trade openness to explore the relationship between economic growth, CO2 emissions and energy consumption for Turkey. The result showed that trade openness is one of main contributor to economic growth while income raises the levels of CO2 emissions.

Much has been written on the growth–environment relationship and on the Environmental Kuznets Curve (EKC). Several literature supports to inverted U shape curve and some literature rejecting inverting U shape.

3.3 Literature Support to Inverted U Shape Curve for CO2 Emissions

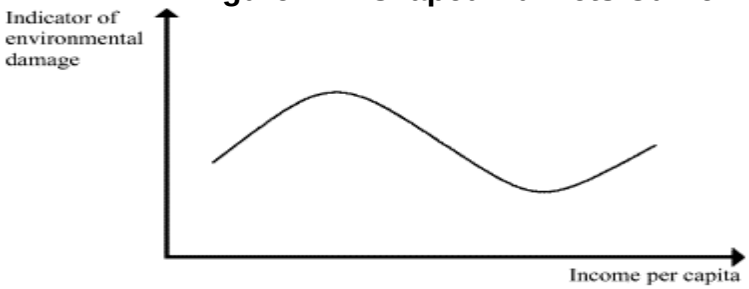
Lucena (2005) confirmed EKC of CO2 emissions in case of Brazil.

Song et al. (2008), Dhakal (2009), Jalil and Mahmud (2009) and, Zhang and Cheng (2009) supported the existence of EKC in China.

3.4 Literature Rejecting Inverting U Shape for CO2 Emissions

The inverted U relationship has often been rejected otherwise or in favour of an N-shaped curve which indicates that pollution increases as a country grows, after reaching its threshold level then decreases and then begins increasing as economy grows further.

Figure 2: N-shaped Kuznets Curve



Maddison and Rehdanz (2008) find strong evidence for bidirectional causal relationship between per capita GDP and per capita CO2 emissions except for Asia. In case of Asia, there is no evidence of CO2 per capita caused by GDP per capita.

Akbostanci et al. (2009) did not support the existence of EKC in Turkey. They argued that CO2 emissions are automatically reduced due to the rapid pace of economic growth.

Eunho Choi et al., (2010) find N-shaped curve describing the relationship between pollution and GDP in case of China. Though it is not a fine N-shaped curve but the curve hints to follow such relationship in the long run.

The findings of Fodha and Zaghdoud (2010) revealed the existence of EKC between the SO2 emissions and economic growth but not for the CO2 emissions in Tunisia.

Miah et al., (2010) show that EKC for CO2 in Bangladesh follows a monotonous straight line in most cases.

4. Methodology

The study covers 10 countries from high income countries (5) and low income countries (5) from 1960 to 2011. Data has been collected from the secondary source known as World Development Indicators (WDI), World Bank Database. Alot of factors associating with CO2 emissions, but there are basically four variables included in the model with CO2 emissions that are represented in a table.

Table 1: Data Definitions and sources

Code	Name	Source
CO2	CO2 emissions (metric tons per capita)	WDI
GDP	GDP per capita (current US$)	WDI
TR	Exports + Imports of goods and services/GDP	WDI
X	Exports of goods and services (% of GDP)	WDI
M	Imports of goods and services (% of GDP)	WDI
GDP^2	Squared of GDP	WDI
GDP^3	Cubic of GDP	WDI

Table 2 displays summary statistics for sample. Table 3 (in Appendix section) reports pair wise correlation for our variables of interest. We observe a strong positive correlation between CO2 emissions per capita and GDP per capita and trade in selected high and low income countries. Estimation results of regression of high and low income countries are presented in table 4(Appendix section).

The relationship between CO2 emissions and economic growth and trade openness is specified as follow:

CO2 = f(GDP,GDP^2, GDP^3,TR)……..model 1

TR= (X+M as share of *GDP)……model 2*

Now we consider model 2 to analyse the effects of trade openness on CO2 emissions,

CO2 = f(GDP ,GDP^2, GDP^3, X, M)……...model 3

Hence, the estimable equation is re-written as follow:

$$LCO2=\beta_1+\beta_{TR}LTR+\beta_{GDP}LGDP+\beta_{GDP^2}LGDP^2+\beta_{GDP^3}LGDP^3+\mu$$

μ is stand for residual or error term.

It is expected that economic growth is stimulated with an increase in trade that in resulting increase of CO2 emissions. The expected sign of trade openness is negative, *TR* < 0 if production of pollutant intensive items is reduced due to the environment protection laws and imports such items from the other countries where environmental laws are flexible. However, Grossman and Krueger (1995) and Halicioglu (2009) argued that sign of *TR* is positive if dirty industries of developing economies are busy to produce heavy share of CO2 emissions with production. The environmental hypothesis reveals that *GDP*> 0 while sign of GDP^2 should be negative or *GDP*^{2}< 0 and *GDP*^{3}>0 an N-shaped pattern is obtained, i.e. there is a second turning point, after which the environmental degradation rises again with increasing income.

5. Empirical Results

In this section, the study examines the effects of trade openness as a determinant of economic growth. GDP per capita is major determinant of economic growth. In case of mean or average GDP per capita, there are greater disparities among high and low income countries as high income countries held higher GDP per capita than low income countries naturally. In this study, Norway ($27,347) and Zimbabwe ($578.68)captured top GDP per capita in selected high and low income countries that is shown in table 2 which displays summary statistics for sample (in Appendix section). Trade is the major mover of economic growth where trade plays more or less than 50% role in total GDP contribution. Trade openness has positive significant contribution on GDP growth in both high and low income countries which are shown in first regression of regression results (table 4, row 1 in Appendix section).The role of trade in GDP contribution is greater in high income countries compare to low income countries where trade

has considerable part in Norway ($3,216.04 GDP achieved for $1of trade) in selected high income countries anywhere Benin has substantial effect of trade ($10.648 GDP achieved for $1of trade)in selected low income countries in this study.

As far as the first regression is concerned, now the study observes the effects of trade openness as a determinant of CO2 emissions. Trade openness has positive almost strong correlation (approximately 70%) with CO2 emissions that is shown in pair wise correlation of variables of interest (in table 3 of Appendix section). The coefficient of trade openness has significant effects at 0.01% in high and low income countries that are CO2 emissions raises with an increase of trade. But trade plays noteworthy role forCO2 emissions in high income countries where Australia (.484 metric tons per capita of CO2 emissions occurs due to $1 of trade). Conversely, Zimbabwe (.012 metric tons per capita of CO2 emissions occurs due to $1 of trade) emits greatest CO2 in selected low income countries in the study which is minor in terms of measurement of CO2 emissions relative to high income countries. In case of effects of Export and Import for CO2 emissions, the amount of export and import plays major significant role in high income countries comparatively low income countries (in table 4 of Appendix section).

According to the regression results, positive and significant relationship is found between trade openness and CO2 emissions. Furthermore GDP per capita accelerates CO2 emissions which are also higher in high income countries than low income countries. Japan (7.98 metric tons per capita of CO2 emissions occurs due to $1of GDP) shows highest emissions because of GDP growth and Sudan (7.91 metric tons per capita of CO2 emissions occurs due to $1of GDP)shows highest CO2 emissions because of GDP growth in selected high and low income countries in the study.

In addition to this study shows that CO2 emissions continue to rise as GDP per capita goes up. For CO2 emissions, it may be that, the downward portion of the Environmental Kuznets Curve (EKC) would be reached at some income level in long run but no society has achieved the EKC shape yet (graphs are in Appendix section).

6. Conclusion

Previous studies investigate the causality relation between trade openness and CO2 emissions in short run and long run terms; the vector error correction model, the panel cointegration, panel unit root test, granger causality was used widely. Many researchers also introduced compositional, scale and technological effects by decomposing the trade model. This paper tries to give explanation for the favour of argument thatCO2 emissions ofhigh income countries arehigher than low income countries and strongly disagree that carbon emissions appear to increase with low-income countries and decrease with high-income countries. Besides trade openness of high income countries emit more CO2 emissions relative to low income countries.

High income countries (and regions) are the most powerful and influential on both policies and developments in the international issue of coping climate change and related negotiations. Staying rich economy is not the only way to reduce CO2 emissions. So, without global

cooperation only high income countries are not capable to reducing CO2 emissions because CO2 is not local pollutant. So high income countries (regions) also reveals rising CO2 emissions which is the original findings of this study. The implication of the study is that free trade will not be responsible of CO2 emissions if different country groups apply environmental law and policy, environment friendly technology in production process simultaneously because CO2 is global pollutant not local pollutant and its effects are not restricted by country borders.

There are certain limitations of the study which be taken into account for further studies in the future, like there are taken few high and low income countries and sample size are also small. Besides this study do not include all associating factors of CO2 emissions. However, this paper mainly investigates the consequences of free trade on CO2 emissions in some selected high and low income countries.

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Appendix

Table 2: Descriptive Statistics of Study Variables

GDP per capita (current US$)										
Descriptive Statistics	***High Income Countries***					***Low Income Countries***				
	Australia	**Canada**	**Japan**	**Norway**	**U.K**	**Benin**	**Liberia**	**Nepal**	**Sudan**	**Zimbabwe**
Obs.	52	52	52	52	52	52	52	52	52	52
Mean	16173.11	17190.52	18980.23	27347	15998.58	314.62	249.49	192.46	456.29	578.68
Min	1807.46	2231.29	479	1441.76	1380.31	93.02	64.81	48.41	107.45	278.96
Max	62133.61	52086.53	46203.71	100575.12	48319.93	745.39	478.39	696.47	1617.60	1084.16
Std. Dev.	14127.54	13330.72	15532.30	27068.62	14046.83	178.32	118.24	137.44	346.60	211.25
CO2 emissions (metric tons per capita)										
	Australia	**Canada**	**Japan**	**Norway**	**U.K**	**Benin**	**Liberia**	**Nepal**	**Sudan**	**Zimbabwe**
Obs.	52	52	52	52	52	52	52	52	52	48
Mean	14.36	15.74	7.77	7.68	10.00	.18	.43	.06	.22	1.23
Min	8.58	10.63	2.52	3.66	7.09	.04	.14	.01	.10	.60
Max	17.70	18.21	9.86	11.62	11.82	.54	1.09	.16	.36	1.71
Std. Dev.	2.71	1.90	2.04	1.86	1.14	.14	.34	.05	.07	.29
Trade (% of GDP)										
	Australia	**Canada**	**Japan**	**Norway**	**U.K**	**Benin**	**Liberia**	**Nepal**	**Sudan**	**Zimbabwe**
Obs.	52	52	52	52	52	52	52	49	52	52
Mean	28.38	46.48	19.87	49.48	37.41	36.96	174.03	27.08	24.86	50.85
Min	22.12	28.94	13.68	43.44	29.04	14.50	60.58	13.14	6.66	30.14
Max	37.04	70.51	31.83	56.73	45.67	55.95	986.65	43.26	43.66	116.63
Std. Dev.	4.23	11.28	4.29	3.38	4.54	11.61	179.99	9.58	9.09	17.34
Exports of goods and services (% of GDP)										
	Australia	**Canada**	**Japan**	**Norway**	**U.K**	**Benin**	**Liberia**	**Nepal**	**Sudan**	**Zimbabwe**
Obs.	52	52	52	52	52	52	42	47	52	37
Mean	15.98	27.82	11.67	38.54	24.20	16.80	52.39	12.90	11.83	28.95
Min	11.96	16.97	9.00	31.76	18.48	3.52	8.79	4.90	3.34	16.44
Max	22.53	44.41	17.75	45.95	30.87	29.06	91.51	26.33	24.10	43.39
Std. Dev.	2.92	7.42	2.26	3.46	3.17	6.63	24.35	5.70	5.28	7.46
Imports of goods and services (% of GDP)										
	Australia	**Canada**	**Japan**	**Norway**	**U.K**	**Benin**	**Liberia**	**Nepal**	**Sudan**	**Zimbabwe**
Obs.	52	52	52	52	52	52	42	47	52	37
Mean	16.97	26.45	10.56	33.82	24.99	27.99	63.44	22.47	16.25	34.81
Min	11.09	17.45	6.87	26.94	18.90	9.53	26.87	6.95	7.07	19.47
Max	22.43	38.77	17.52	44.33	32.35	43.96	144.73	37.71	28.40	78.46
Std. Dev.	3.10	6.30	2.55	4.27	3.55	7.87	25.65	9.45	4.82	15.70

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Table 3: Pair wise correlation of variables of interest

	CO2 per capita	GDP per capita	Trade	Export	Import
CO2 per capita	1				
GDP per capita	**High Income Countries** .762**(Australia) .317*(Canada) .765**(Japan) .717**(Norway) .897**(U.K) **Low Income Countries** .925**(Benin) .485**(Liberia) .833**(Nepal) .362**(Sudan) .213(Zimbabwe)	1			
Trade	**High Income Countries** .753**(Australia) .600*(Canada) .206 (Japan) .564**(Norway) .533**(U.K) **Low Income Countries** .652**(Benin) .251(Liberia) .905**(Nepal) .428**(Sudan) .717**(Zimbabwe)	**High Income Countries** .872**(Australia) .673*(Canada) .115 (Japan) .402**(Norway) .390**(U.K) **Low Income Countries** .693**(Benin) .505**(Liberia) .682**(Nepal) .060(Sudan) .248(Zimbabwe)	1		
Export	**High Income Countries** .802**(Australia) .551**(Canada) .363**(Japan) .509**(Norway) .679**(U.K) **Low Income Countries** .420**(Benin) .766**(Liberia) .672**(Nepal) .634**(Sudan) .501**(Zimbabwe)	**High Income Countries** .828**(Australia) .678**(Canada) .220 (Japan) .589**(Norway) .574**(U.K) **Low Income Countries** .489**(Benin) .350*(Liberia) .247(Nepal) .230(Sudan) .728**(Zimbabwe)	**High Income Countries** .920**(Australia) .992**(Canada) .957**(Japan) .771**(Norway) .938**(U.K) **Low Income Countries** .784**(Benin) .246(Liberia) .806**(Nepal) .912**(Sudan) .842**(Zimbabwe)	1	
Import	**High Income Countries** .839**(Australia) .522**(Canada) .190(Japan) .498**(Norway) .746**(U.K) **Low Income Countries** .191(Benin) .039(Liberia) .903**(Nepal) .418**(Sudan) .770**(Zimbabwe)	**High Income Countries** .817**(Australia) .751**(Canada) .104(Japan) .763**(Norway) .726**(U.K) **Low Income Countries** .363**(Benin) .170(Liberia) .752**(Nepal) .138(Sudan) .399*(Zimbabwe)	**High Income Countries** .896**(Australia) .984**(Canada) .976**(Japan) .078(Norway) .863**(U.K) **Low Income Countries** .687**(Benin) .020(Liberia) .962**(Nepal) .679**(Sudan) .815**(Zimbabwe)	**High Income Countries** .910**(Australia) .976**(Canada) .894**(Japan) .537**(Norway) .894**(U.K) **Low Income Countries** .750**(Benin) .192(Liberia) .794**(Nepal) .613**(Sudan) .655**(Zimbabwe)	1

*. Correlation is significant at the 0.05 level (2-tailed), **. Correlation is significant at the 0.01 level (2-tailed).

Table 4: Regression results

High Income Countries					
	Australia	**Canada**	**Japan**	**Norway**	**U.K**
GDP/Trade	2914.92 (.000)	795.43 (.000)	414.81 (.000)	3216.04 (.003)	1204.88 (.004)
CO2/Trade	.484 (.000)	.101 (.000)	.098 (.000)	.311 (.000)	.134 (.000)
CO2/GDP	4.562E-005 (.000)	4.531E-005 (.022)	7.986E-005 (.000)	4.935E-005 (.000)	7.286E-005 (.000)
CO2/Export	.747 (.000)	.141 (.000)	1.756 (.000)	.358 (.000)	.244 (.000)
CO2/Import	.733 (.000)	.158 (.000)	1.17 (.000)	.22 (.000)	.24 (.000)
Low Income Countries					
	Benin	**Liberia**	**Nepal**	**Sudan**	**Zimbabwe**
GDP/Trade	10.648 (.000)	.332 (.000)	9.76 (.000)	2.28 (.000)	3.021 (.000)
CO2/Trade	.008 (.000)	.003 (.000)	.004 (.000)	.004 (.000)	.012 (.000)
CO2/GDP	.001 (.000)	.001 (.000)	.001 (.000)	7.914E-005 (.000)	.006 (.000)
CO2/Export	.009 (.000)	.011 (.000)	.005 (.000)	.009 (.000)	.021 (.002)
CO2/Import	.006 (.000)	.001 (.000)	.004 (.000)	.007 (.000)	.015 (.000)

Figure 3: CO2 emissions and GDP per capita in Australia, 1960-2011

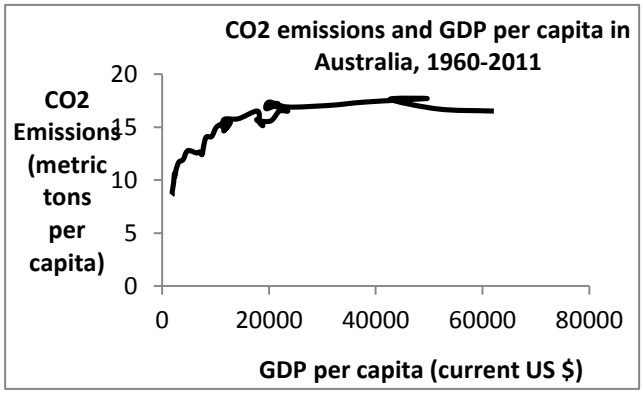

Figure 4: CO2 emissions and GDP per capita in Canada 1960-2011

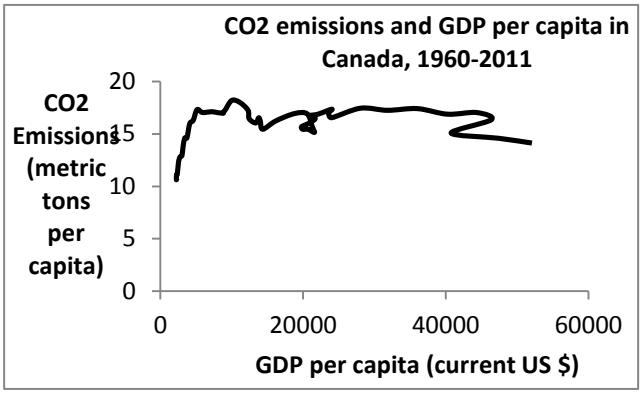

Figure 5: CO2 emissions and GDP per capita in Japan, 1960-2011

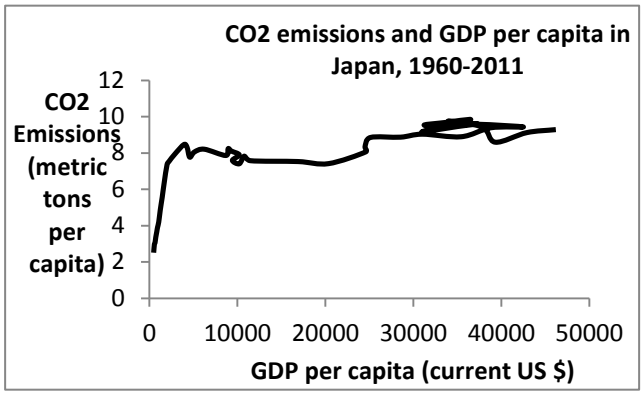

Figure 6: CO2 emissions and GDP per capita in Norway 1963-2014

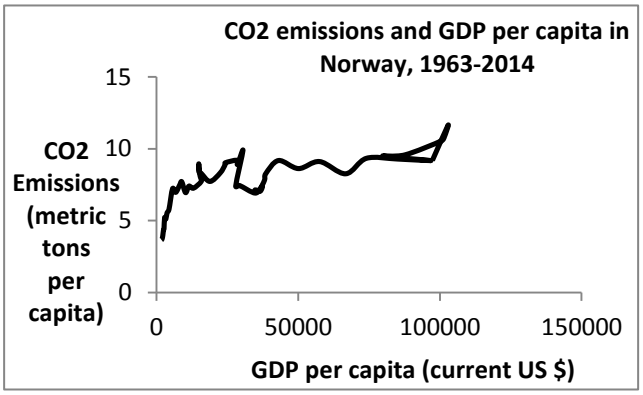

Figure 7: CO2 emissions and GDP per capita in UK, 1960-2011

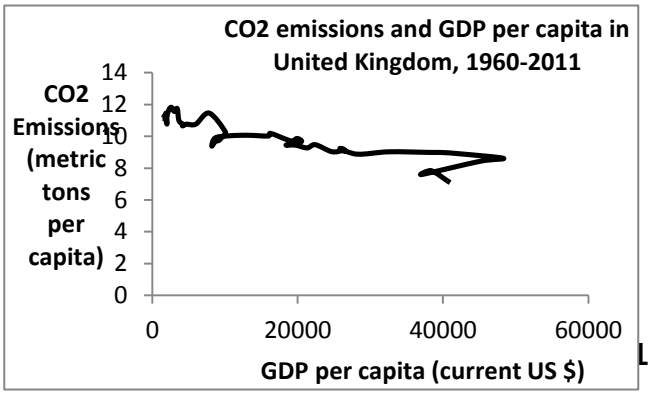

Figure 8: CO2 emissions and GDP per capita in Benin, 1960-2011

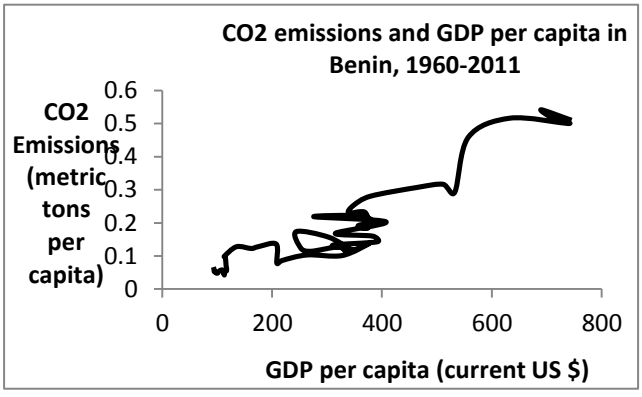

Figure 9: CO2 emissions and GDP per capita in Liberia, 1960-2011

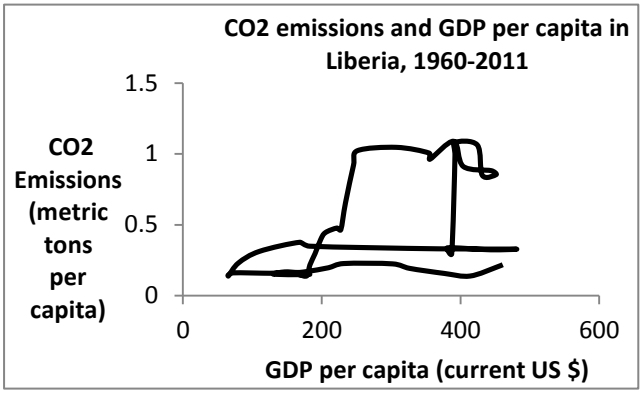

Figure 10: CO2 emissions and GDP per capita in Nepal, 1960-2011

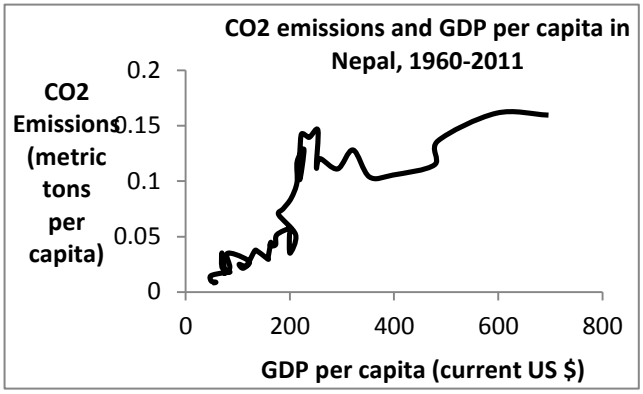

Figure 11: CO2 emissions and GDP per capita in Sudan, 1960-2011

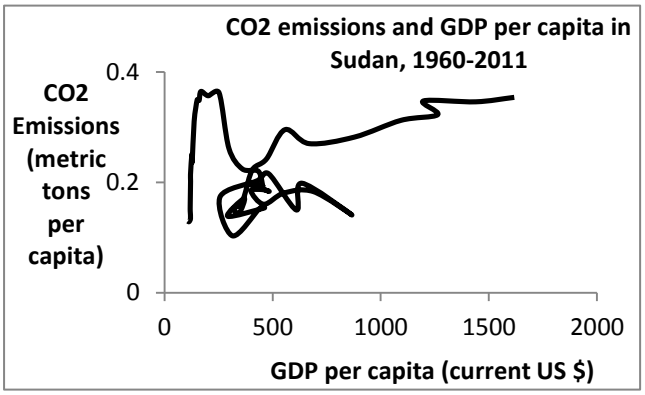

Figure 12: CO2 emissions and GDP per capita in Zimbabwe 1964-2011