Environmental Quality and Economic Development in the Libyan Arab Jamahiriya

Sami Shibani*

Concern has been growing about global warming and climate change phenomenon caused by greenhouse gas (GHG) emissions. Many experts have discussed and warned against the risk of global climate change deriving from the increase of GHG emissions in the atmosphere. The well-defined emissions reduction policies and environmental regulations are one of the major elements that can positively treat the problem of climate change. A number of previous contributions to the literature state that only when income grows can the effective environmental policies be implemented (Coondoo & Dinda 2002; Dinda 2004). In addition, clearly before adopting a policy, it is important to understand the nature of any causal relationship between economic growth and environmental quality. As a developing nation, the economic development of Libya is proceeding quickly as the country moves towards the development of its infrastructure. Environmental pressure is increasing with the economic development. In this regard, by utilizing an environmental Kuznets curve (EKC) approach, this paper examines the relationship between one of the environmental indicators, carbon dioxide (CO_2) emissions, and economic growth (income per capita GDP) in Libya. This research can help policy makers in Libya to define their environmental policies more clearly and effectively. The outcomes of the research presented in this paper clearly show that, income growth is significantly related to the emissions of CO_2. However, in a developing country such as Libya, policy makers should not assume that economic development will automatically solve the problem of air pollution. Environmental regulations and emissions reduction policies must be take a place.

Keywords: CO_2 emissions; Economic development; Environmental quality; Inverted-U shape relationship; Environmental regulations; Emissions reduction policies.

1. The Research Problem and Its Setting

1.1 Background

CO_2 emissions and other gases affect the environment[1]. Over the last few decades, there has been growing concern about global warming and climate change caused by GHG emissions which derive from human activities that involve fossil fuel combustion (Baumert et al. 2005). The Intergovernmental Panel on Climate Change

*Sami Shibani, PhD Student, Student No: 0050076437, *University of Southern Queensland*, *Faculty of Business*, *School of Accounting, Economics and Finance*
shibani@usq.edu.au

[1] CO_2 emissions are now believed to be primary greenhouse gas responsible for the problem of global warming (IPCC, 2007).

(IPCC) in its assessment on climate change concludes that at least 90 per cent of the global warming observed over the past 50 years is attributable to human activities (IPCC 2007). Also, the assessment of IPCC (2007) provides stronger evidence than prior assessment that human activities are the major cause of recent climate change. The report has found that emission of heat-trapping gases from human activities have caused most of the observed increase in globally averaged temperatures since the mid-20th century. Many experts have discussed and warned against the risk of global climate change deriving from the increase of GHG emissions in the atmosphere (Annicchiarico et al. 2009).

Since the industrial revolution, economic growth has become one of the major aspects that contribute to environmental degradation. This is due to the intensive exploitation of natural resources (Kageson 1997). In this period of depletion of natural resources, policy makers and households are more interested in higher material output, income rates and employment rates rather than environmental conservation (Gürlük 2009). In the later stages of industrialisation, advanced industrialized countries in particular, as economic growth and consequently income increases, give more attention to the environment. In these stages, governments and some other organisations work to mitigate environmental damage by implementing polices and, consequently, environmental quality starts to improve (Enevoldsen et al. 2007).

As has discussed above, Environmental Kuznets Curve (EKC) analysis illustrates a well-defined relationship between the development and environmental degradation (Dasgupta et al. 2002). In developed nations, a turning point could be observed if there is an inverse U-shaped relationship between environmental degradation and development. Thus, the EKC analyses indicate that economic development could be compatible with the environment by implementing efficient environmental policies (de Bruyn & Heintz 1999; Ezzati et al. 2001; O'Neill et al. 1996; Suri & Chapman 1998). This makes it very important to define the relationship between the environmental quality and the economic development.

Developing countries in their rapid movement towards growth are more likely to affect the environmental quality, particularly in the absence of sound environmental policy. In this regard, during the past three decades, there has been rapid development in some developing nations such as Libya that are located in the Mediterranean region. This classification has given by both the United Nation Development Programme (UNDP) and the International Monetary Fund (IMF) (UNDP 2007). This study examines the relationship between environmental quality and economic development in the Libyan Arab Jamahiriya[2]. This investigation may help local policy makers to define their environmental policies more clearly and effectively.

1.2 The Purpose of the Research

The purpose of this study is to investigate the relationship between environmental quality and economic development in Libya which is located in the African-

[2] Libyan Arab Jamahiriya is the official name for Libya (see the U.S Department of State, Diplomacy in Action, 2007, http://www.state.gov/r/pa/ei/bgn/5425.htm).

Mediterranean region. The study is based on prior researches which have been conducted in a number of developed countries (AkbostancI et al. 2009; AnnicchiaricoI et al. 2009; Atici 2009; de Bruyn et al. 1998; Dinda 2004; Grossman & Krueger 1995; Koop 1998; Shafik 1994; Shafik & Bandyopadhyay 1992) that investigate the relationship between environmental quality, represented in CO_2 emissions, and economic development represented in income per capita GDP. This relationship focuses on so-called the EKC approach.

The majority of EKC studies undertaken in many developed countries using cross-section and panel data studies. However, single country studies including developing countries are fewer in comparison. This is one of the justifications of the focus on a developing nation such as Libya in order to understand its environmental and economic growth relationship by employing the EKC framework.

According to Gürlük (2009), economic development would not have a negative impact on environmental quality if such a perspective is adopted. Consequently, as it has been mentioned in the previous section, there is consensus between a number of researchers that the results of the EKC analyses show that development could be compatible with the environmental quality if efficient environmental policies are implemented (de Bruyn & Heintz 1999; Ezzati et al. 2001; O'Neill et al. 1996; Suri & Chapman 1998). This investigation may help local policy makers to define their environmental policies more clearly and effectively.

2. Review of the Related Literature

Several of contributions to the existing literature on the relationship between environmental quality and economic development concentrate on the EKC approach, according to which environmental damage starts to decrease as the country prospers (AkbostancI et al. 2009). It is hypothesized that the environment-income relationship might be similar to that suggested by Kuznets for income inequality in relation to economic development, namely of an inverted-U shape in 1950s. The EKC hypothesis states that pollution levels increase as the country develops, but begin to decrease as rising income pass beyond a turning point Grossman and Krueger (1995). This is reflected in an inverted-U curve, expressing the relationship between pollution levels and income per capita GDP. This hypothesis first proposed by Grossman and Krueger (1991), and restated by them again in 1995.

Grossman and Krueger (1991) were the first to articulate the concept of the environmental degradation and economic growth relationship which became popular by the name of the EKC. Many authors have undertaken empirical studies on a large scale sample. For instance, Shafik and Bandyopadhyay (1992), examined the relationship between the environmental degradation and economic growth using cross section time series data. Their findings were consistent with Grossman and Krueger (1991) at approximately $5000 per capita income to indicate the turning point.

Tucker (1995) selected the period 1971-1991 and looked at changes in CO_2 emissions versus income in a yearly cross-sectional analysis. The findings of this

study show that there is a positive relationship between CO_2 emissions and income per capita GDP. The results also indicate that the changes in CO_2 emissions are clearly related to changes in oil prices, but do not incorporate them into the analysis. A study by Agras and Chapman (1999) the price of energy and highlighted the importance of it, and included it in the EKC framework.

Previous work on the EKC perspective has been done by Grossman and Krueger (1995) provide a systematic explanation for the relation between environment and economic growth. In this regard, and according to the EKC literature (AkbostancI et al. 2009; Grossman & Krueger 1995; Selden & Song 1994) and others argue that income growth has three effects on the existing amount of the pollution emissions. These effects are: scale effect, composition effect and technique effect.

Firstly, scale effect asserts that even if the structure of the economy and technology does not change, an increase in production will result in increased pollution and environmental degradation. This means that greater economic activities raises demand for all inputs, increasing emissions. Secondly, composition effect may have a positive impact on the environment. Income growth increases demand for relatively cleaner goods. This causes the share of pollution-intensive goods in output to fall, reducing emissions. This means that in the earlier stages of development, pollution increases as the economic structure changes from agriculture to more resources intensive heavy manufacturing industries; while in the later stages of development, pollution decreases as the structure moves towards services and light manufacturing industries. Therefore, composition effect could lower the harmful effects of growth on the environment through this change in the production structure. Finally, technique effect captures improvements in productivity and adaptation of cleaner technologies, which will lead to increase in environmental quality. Therefore, a turning point is considered to be important factor to emphasize the positive relationship between environmental quality, particularly CO_2 emissions and economic development.

There is a vast literature of cross-section and panel data EKC studies. However, single country studies are fewer in comparison. As an example, Carson et al.(1997) find a negative relationship between emissions of seven air pollutants (CO_2, air toxic, CO, NO_X, SO_2, VOC, PM_{10}) and income per capita GDP for the US states between 1988 and 1994. Although, the income level in US is higher than any income of the EKC turning points found in cross country studies, the findings are in harmony with the EKC hypothesis. Another study was undertaken by Vincent (1997) in Malaysia for the period 1970-1990. The researcher states that the relationship between one air and five water pollution indicators and income per capita GDP does not fit the EKC form for Malaysian states. In this model, population density, per capita GDP, its square, cube, and their interaction with population density are used as independent variables in the regression. While income cannot be related significantly to emissions of some pollutants in any way, a positive relationship is found between these two variables for some other pollutants.

In relation to GHG emissions, particularly CO_2 emissions integrating with economic growth patterns, there have been a number of prior studies conducted that examine the relationship between CO_2 emissions and economic growth. According to (Andreoni & Levinson 2001; Annicchiarico et al. 2009; Atici 2009; de Bruyn et al. 1998; Dinda 2004; Galeotti et al. 2006; Grossman & Krueger 1995; Sobhee 2004) as

long as economic growth increases, there will be detrimental environmental effects. Achieving the objective of GHG emissions reduction will protect environmental quality. As one economic and environmental point of view, Dinda (2004, p. 431) argued that 'environmental pressure increases faster than income at early stages of development and slows down relative to GDP growth at higher income levels'. This relation will be examined in the case of Libyan Arab Jamahiriya.

3. Related Theory and Conceptual Fram Work

3.1 Related Theory

This research verifies the relationship between environmental quality and economic growth which is based upon so-called EKC. In this regard, many authors consider that, the analysis of EKC is one of the most controversial theories of the interactions between economic growth 'income per capita GDP' and environmental degradation 'air pollution' (AkbostancI et al. 2009; Annicchiarico et al. 2009; de Bruyn & Heintz 1999; Dinda 2004; Grossman & Krueger 1995; Panayotou 1993; Selden & Song 1994; Shafik 1994).

Many researches in the early 1990s indicated that there is a similar relationship to what Kuznets has found between income per capita GDP 'economic growth' and environmental degradation 'air pollution' (Grossman & Krueger 1995; Panayotou 1993; Selden & Song 1994; Shafik 1994; Shafik & Bandyopadhyay 1992). The common point of all EKC studies is that environmental quality deteriorates at the early stages of economic development/growth but eventually as income level increases this degradation in the environment will decrease at later stages (Dinda 2004). This is because of the implementation of clean production approach and effective environmental policies will take a place in societies.

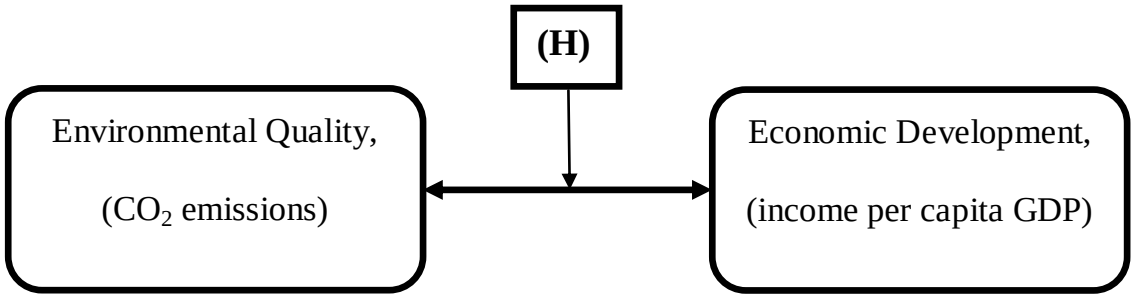
There are several elements that can lead to economic growth. Modern growth theory (endogenous growth theory) accepts that human development, technological progress and natural resource are considered as the forces behind economic growth. In this context, (Van den Bergh 2002) has argued that recent economic studies deal with optimality of the growth, how economic growth and environmental conservation are compatible in the long term, sustainable development, consequences of environmental policy for growth. Thus, as previously mentioned and identified by several authors, the results of the EKC approach show that economic growth could be made consistent with improving environmental by implementing efficient environmental policies. Therefore, the EKC approach may assist the Libyan policy makers to take action towards the problem of climate change.

3.2 The Conceptual Framework

The existence of strong policies and appropriate institutional structures are fundamental to the development of nations (Sharp 2002). This puts Libya in a critical

position regarding to the degradation of the environment resulting from its strong intention to move towards economic prosperity, especially over the last decade.
As can be seen from Figure (1), this study assumes that there is a link which illustrated by two directions between the environmental quality represented in CO_2 emissions and economic development represented in income per capita GDP. The idea is that economic development affects environmental quality. As income per capita GDP increases the environmental degradation thus will decrease. Hence, confirming the EKC hypothesis.

Figure 1: The conceptual framework.



Following Dinda (2004) and other EKC specialists, this study hypothesises that there is a positive relationship between environmental quality (measured by CO_2 emissions) and economic development (measured by income per capita GDP) in the case of Libyan Arab Jamahiriya.

4. The Methodology

This study employed secondary data for a span of 35 years, between 1975 and 2009. These data include 35 observations which were collected from world development indicators (WDI) 'the World Bank' (2008) and some other Libyan institutions such as the Central Bank of Libya (CBL 2009) and the General Information Authority (GIA 2008) in Libya.

A regression analysis was conducted to test the related hypothesis. The hypothesis studies the relationship between environmental quality and economic development, which based upon the EKC hypothesis. In this general format the hypothesis can be formulated as follows:

$$E = f(Y, Y^2, Y^3, Z) \quad \ldots\ldots(1)$$

Where E is the dependent variable which denotes on one of environmental indicators that is CO_2 emissions, Y is the income (per capita GDP) and Z could be other explanatory variables such as population density that are supposed to influence environmental degradation. Conventional EKC studies employ functional forms where results can be evaluated with respect to presence or absence of a turning point and the significance of the parameters computed. The empirical evidence for

the existence of an EKC has been found in various studies. These studies share some common characteristics with respect to data and methods employed. Most of the data used in these studies are cross-sectional panel data and time-series analysis. The following reduced form models are used to test the various possible between environmental pressures 'pollution levels' and income per capita GDP. In this study the researcher investigates the existence of EKC at two different models showing the used of time-series model as it is formulated following de Bruyn et al.(1998), Dinda (2004) and AkbostancI et al.(2009) is given below:

$$E_t = \alpha + \beta_1 Y_t + \beta_2 \ Y_t^2 + \beta_3 Y_t^3 + \varepsilon_t \quad \text{.....(2)}$$

Here, for the environmental indicators (*E*), we use CO_2 emissions per metric tonnes in Libya. The income variable (*Y*) is the income per capita GDP in constant 2000 US Dollars. The subscripts *t* is time, α is constant, β is the coefficient of the explanatory variable and ε is the error term.

The second model that is estimated in this study indicating the population density measured (*Z*) as an explanatory variable that supposed to influence environmental degradation. This model is formulated as follows:

$$E_t = \beta_0 \ + \beta_1 Z + \varepsilon_t \quad \text{..... (3)}$$

5. Results of the Model and Discussion

Regarding to the equation (2), the regression results of this model are given in Tables 1, 2 and 3 respectively. Social scientists use a cut of point of 0.05 as their criterion for statistical significance. Hence, because the observed significance value is less than 0.05 we can say that there was a significant effect of the income per capita GDP on the environmental pressure, this value is equal 0.03 shown in the ANOVA table. This means that the relationship between CO_2 emissions and the income per capita GDP is to some extent positive which asserts the hypothesis drawn. In addition to this, it indicates that, as long as GDP per capita increases the CO_2 emissions thus will increase, this emphasis the theoretical view of the EKC. The following two tables show the descriptive results of the Model Summary and the ANOVA table of the equation (2).

Table 1: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.597	.357	.294	1.022

The independent variable is Income per capita GDP.

Table 2: ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	17.937	3	5.979	5.725	.003
Residual	32.377	31	1.044		
Total	50.314	34			

The independent variable is Income per capita GDP.

Notes: The table shows the ANOVA statistics for the regression model of the equation 2. The F statistic and the associated significance value show that the regression model explains a significant amount of the variation in the environmental quality.

Although the data in table 3 do not reveal a significant relationship, the coefficients have drawn in table 3 telling that to some extent how the independent variable is associated with the dependent variable. Accordingly, it is shown that CO_2 emission increases by 0.001 unit (ton metric) of GDP per capita. This means that CO_2 emission is positively associated with GDP per capita.

Table 3: Coefficients

	Un-standardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Income per capita GDP	.001	.001	1.372	.776	.444
Income per capita GDP ** 2	-1.652E-8	.000	-.544	-.134	.894
Income per capita GDP ** 3	-8.972E-13	.000	-.429	.	.
(Constant)	5.863	1.715		3.419	.002

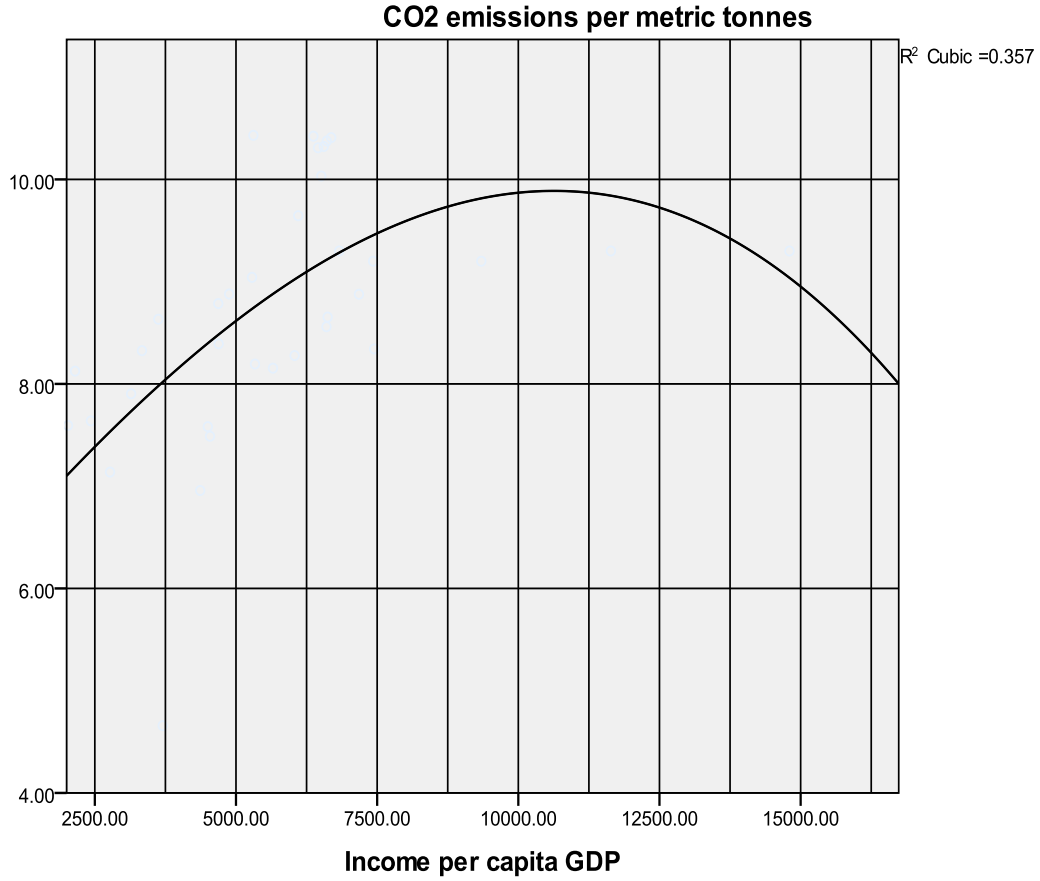
Notes: This table reports the value of the coefficients for the variables and their significance. Although the relationship between the variables is insignificant, still the value of the coefficients is to some extent explains that the independent variable is associated with the dependent variable.

The increase in air pollution'CO_2 emissions' reflects the view that pollution costs are not high in the related country. That is because of the increase in oil production and non-clean productions such as cement and iron productions. Moreover, the abundance of primary sources used in cement and iron manufacturing in addition to

the main source of crude oil are fundamental reasons for increasing the environmental pressure in the case of Libya.

The results of the drawn hypothesis in Figure (2) illustrate that there is a slight significant nonlinear functional relationship between air pollution and income growth in Libya. Although the theoretical view of the EKC in many developed countries reflects that there is a turning point which indicates a decrease in environmental degradation, in the case of developing countries such as Libya, the analysis illustrates that despite the increase in economic development, there is no such turning point even though the previous figure indicated that there is a slight decrease in the emissions. To assert this point, Figure (3) clearly shows the increase in air pollution 'CO_2 emissions' caused by the raise in income per capita GDP in the country. This is due to the lack of environmental regulations as well as the absence of technological innovations.

Figure 2: The relationship between CO_2 emissions and income per capita GDP.



The results reveal that the turning point occurs when the income per capita GDP reaches more than \$6000 starting from the year 2004 until the year 2009 where the income reaches approximately \$14000. In this regard, the analysis shows that, the range of income per capita GDP from \$3000-\$6000 fall into the increased part of the inverted-U shape of the estimated pollution-income relationship 'the scale effect'. This means that, the scale effect dominates the period of 1975-2003 that aggravates the risk of environmental pressure.

The period of 2004-2009 seems to be the beginning of the composition effect. Although it has witnessed a slight improvement in the environmental quality, there is a need to move towards the technique effect, so that the change will move to the use of cleaner technologies and adopting appropriate emissions reduction policies. This is solely to justify that Libya has a substantial amount of CO_2 emissions, therefore, there is a need to regulate those polluters in order to protect the environment.

As described above that, Figure 3 also indicates that, there is a relatively slight decrease in pollution levels for the last five years of 2004-2009, this is resulting from the movement towards the change of the economic structure from the heavily manufacturing industries to light manufacturing industries. That means the last five years, the Libyan economy considers in the part of the composition effect which could lower the harmful effects of growth on the environment through this change in the production structure.

As can be seen from tables 4, 5 and 6 the results of the equation (3) illustrate that the independent variable 'the population density' is also strongly associated with the dependent variable 'CO_2 emissions'. The relationship between these variables is highly significant. This means that the air pollution is positively connected with the population density, so that as long as the population is growing, the CO_2 emissions are increasing as well. This also can be seen in the Figure (4). The following tables show the descriptive results of the equation (3), this including the model summary, ANOVA table and the coefficients table.

Table 4: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.741	.549	.535	.829

The independent variable is The total population density.

Table 5: ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	27.626	1	27.626	40.182	.000
Residual	22.688	33	.688		
Total	50.314	34			

The independent variable is The total population density.
Notes: The table shows the ANOVA statistics for the regression model of the equation 2. The F statistic and the associated significance value show that the relationship between the variables is highly significant.

Table 6: Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
The total population density	7.820E-7	.000	.741	6.339	.000
(Constant)	5.186	.572		9.072	.000

Notes: This table reports the value of the coefficients for the variables and their significance. It explains the significant relationship between population density and environmental pressure.

Figure 4: The relationship between CO_2 emissions and population density.

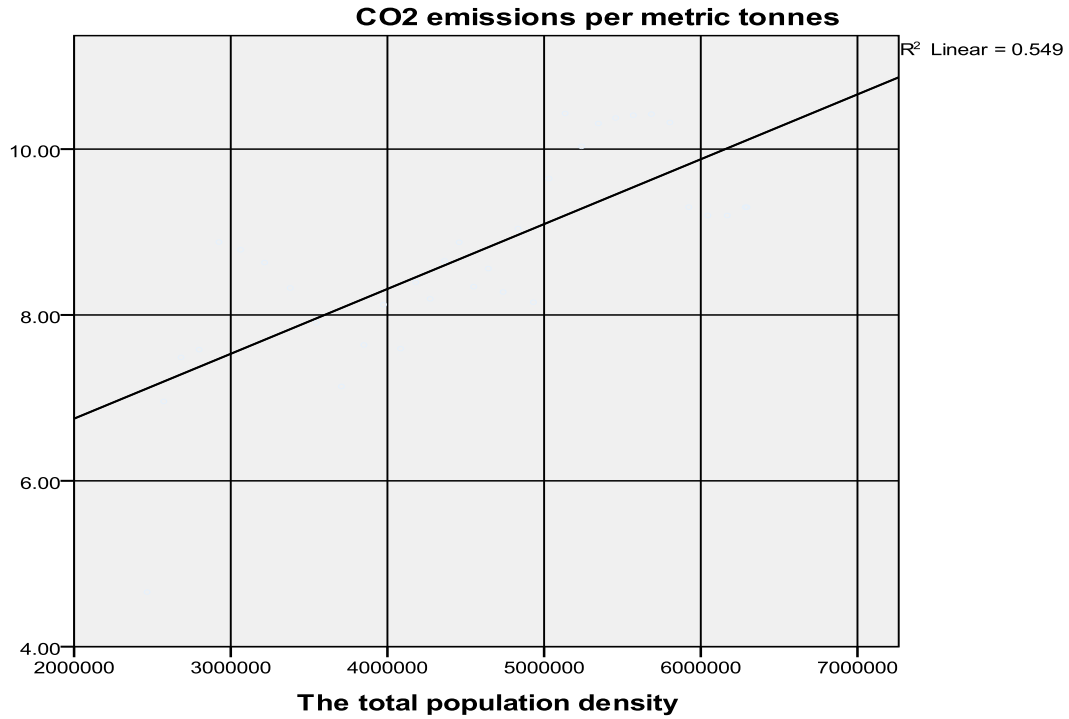
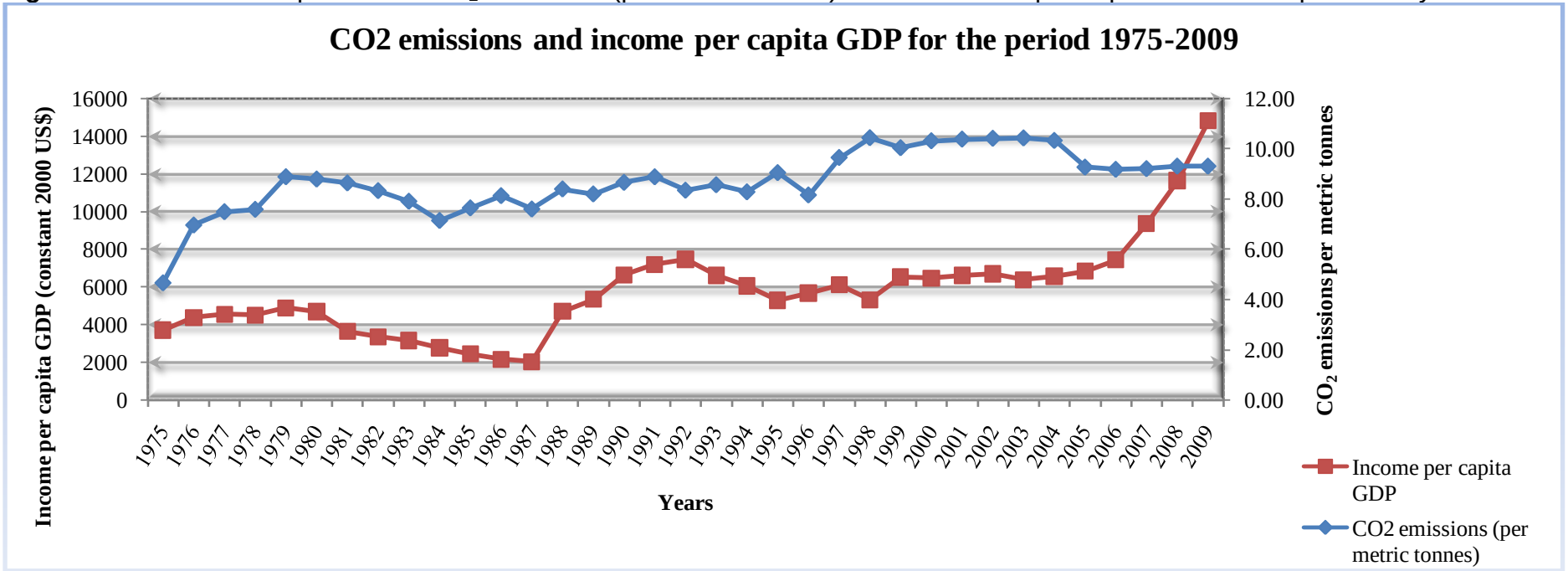


Figure 3: The relationship between CO_2 emissions (per metric tonnes) and the income per capita GDP for a span of 35 years.



Data source: The World Bank, World Development Indicators, CD-ROM provided by the USQ Library.
The World Bank, World Development Indicators, CD-ROM 2008. This includes data for the period 1975-2004.
The World Bank, World Development indicators, CD-ROM 2010. This includes data for the period 2005-2009.
Reports from the Central Bank of Libya, different years. Central Bank of Libya, Research and statistics Department, Economic Bulletin for the period 2003-2009.

6. Policy Recommendations And Conclusion

6.1 Policy Recommendations

According to the current situation, environmental quality will improve for the next five to fifteen years, if such emissions reduction policies are implemented. Poor countries with weak regulatory institutions can reduce pollution significantly by following a few basic principles.

The first is focus. In many areas, relatively few sources are responsible for most of the pollution. Therefore, emissions can be significantly reduced by targeting regulatory monitoring and enforcement on those dominant sources. Another principle is that, countries whose economic policies induce a rapid expansion of income and employment may experience severe environmental degradation unless appropriate environmental regulations are enacted and enforced. Furthermore, should enact and enforce and enforce environmental regulations in order to reduce environmental damage. In this case, economic analysis can be employed to justify environmental regulatory policies that result in a flatter and lower environmental Kuznets curve.

6.2 Conclusion

This study has examined the relationship between environmental quality and economic development in the case of Libyan Arab Jamahiriya, particularly the relationship between CO_2 emissions and income growth 'per capita GDP'. The study has also used the period of 1975-2009, including 35 data observations which have collected from various sources such as the World Bank, world development indicators, CD-ROM and some Libyan governmental institutions, for instance, the Central Bank of Libya 'reports and economic bulletin' and the General Information Authority. In addition, this research has provided an insight of the environmental circumstances which is directly related to the economic development situation in Libya. The consequences of this study indicate that, there is a significant relationship between CO_2 emissions and economic growth 'income per capita GDP' in Libya. The key meaning of this relation shows that as long as economic development increases CO_2 emissions thus will increase. The results drawn are to some extent indicates a nonlinear relationship and as can be noticed from figure (3) that, both CO_2 emissions and GDP per capita curves are close to each other. Moreover, the figure shows that the fluctuated decline of CO_2 emissions for the latest of the 1970s until the latest of the 1980s is due to the financial crisis in the related period with the extreme low of the energy prices that affects the productivity during that period.

Due to the lack of implementing such environmental regulations and the use of technological innovations, the analysis does not clearly reflect the existence of the turning point in Libya. Therefore, the implementation of environmental regulations in Libya will improve the environmental quality in the long-run and in this regard developed nations can play a fundamental role by transferring their technologies in order to protect the environment.

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