ENVIRONMENTAL QUALITY, TRADE OPENNESS AND ECONOMIC GROWTH IN KENYA

An Implication of the Environmental Kuznets curve

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DECLARATION

I hereby declare that this research paper titled **Environmental Quality, Trade Openness and Economic Growth in Kenya**, submitted to the School of Economics University of Nairobi, is original work done by me under the guidance of Professor Leopold Mureithi. The paper has not been submitted to any other institution for the award of a degree, diploma or certificate or published any time before.

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APPROVAL

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God bless you all.

LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
ARDL	Autoregressive Distributed Lag model
CO_2	Carbon dioxide
EKC	Environmental Kuznets Curve
FDI	Foreign Direct Investments
GDP	Gross Domestic Product
IMF	International Monetary Fund
IPAT	Impact, Population, Affluence, Technology
IPOC	Intergovernmental Panel on Climate Change
LDC	Least Developed Countries
STIRPAT	Stochastic Impacts by Regression on Population, Affluence and Technology
VAR	Vector Auto Regression
VECM	Vector Error Correction Model

DEFINITION OF TERMS

Biocapacity	Biocapacity is the ability of the ecosystem to produce what humans need and to absorb the wastes generated by humans, given the existing extraction technologies.
Data quality score	It is a score given by researchers after assessing the reliability of the data. The quality of data is affected by the availability of yearly data on different components of biocapacity and ecological footprint, and the number of errors in the data. A score of 6 is the best and it indicates that no component is unreliable or unlikely to be found for any year.
Ecological elasticity	Ecological elasticity is the degree of responsiveness of the environmental impacts to a one percent change in any of the driving factors.
Ecological Footprint	It is the amount of land and water required by an individual, country or region to produce what it consumes and absorb the wastes it generates, given the prevailing environmental management practices and technology.
Income elasticity	Income elasticity is the responsiveness of demand with changes in income

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ABSTRACT

This paper seeks to examine the applicability of the Environmental Kuznets Curve (EKC) in Kenya and the effects of trade openness on the environment for the period 1960-2012. In the study, environmental quality is proxied by ecological footprint. The study is motivated by the harsh realities on the country's poverty status and its vulnerability to the effects of climate change. There has been increasing environmental degradation despite the growing affluence. This is against the postulates of the EKC, hence the need to investigate its applicability. The ARDL model is used in the analysis.

The results reveal that Real GDP per capita has a negative effect on environmental quality in the long run and therefore the EKC hypothesis is not valid for Kenya. The paper therefore recommends that policy makers try to achieve inclusive economic growth and sustainable development simultaneously instead of expecting that growth will automatically lead to a better environment. Trade openness is observed to have a negative effect on the environment in the short run and a positive effect in the long run. Opening up is therefore encouraged as it will facilitate transfer of clean technologies, hence improving environmental quality in Kenya.

CHAPTER ONE: INTRODUCTION

1.0 Background

World GDP per capita has been increasing over time except for the sharp decline between 2006 and 2008, as indicated in figure 1. This decline is majorly because of the global financial crisis (IMF, 2009). The growth can be attributed mainly to the advancement in technology (Martinez-Garcia, 2013). However, in as much as the trend is impressive, some technologies have been a threat to the environment because of the greenhouse gas emissions. This has resulted in increasing global warming and subsequently, rapid climate change. The world is already experiencing the effects of climate change such as prolonged drought and rising water levels. Consequently, the issues of the environment such as the applicability of

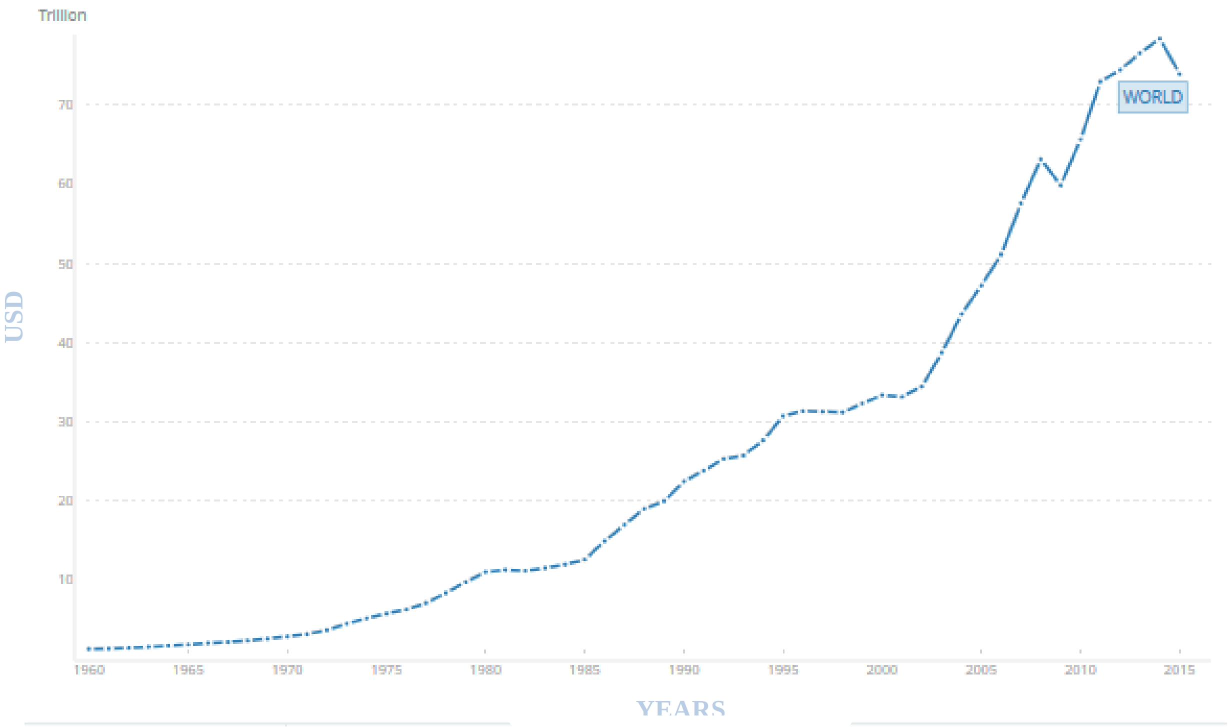

Figure 1.1: Annual global GDP growth

Source: World Bank, 2015

The Environmental Kuznets hypothesis have attracted a lot of attention in environmental economics literature. It is by considering this trend that this study intends to investigate the applicability of the Environmental Kuznets hypothesis in Kenya**.**

The Environmental Kuznets hypothesis asserts that at initial stages of development, pollution increases and this continues up to a certain level of economic growth when pollution starts declining. This implies that rich countries are greener and cleaner than poor countries. However, the trend in world GDP per capita and world ecological footprint presents a situation that puts the validity of this hypothesis in question. It shows that the environmental quality has been worsening despite increasing GDP per capita. According to the Global Footprint Network, we currently need 1.6 earths to support humanity. We needed 0.75 earths in 1960, and if the current rate of environmental degradation continues, we will need two earths to support humanity by 2030. Figure 2 indicates the worsening situation since 1960. There is therefore the need to take necessary measures to bring the figure down as we only have one earth.

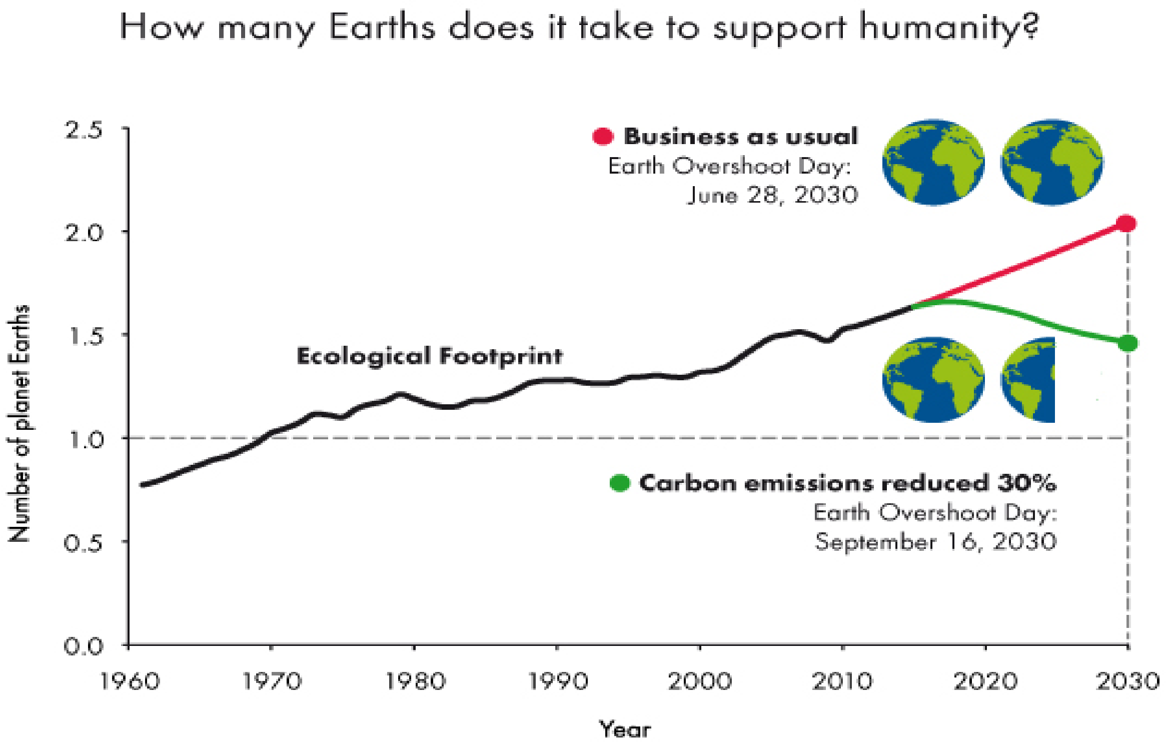

Figure 1.2: Global Ecological footprint trend

Source: Global Footprint Network

The African Economic Outlook (2016) indicates that the Africa continent is urbanizing at a rapid rate. This urbanization and industrialization comes at a time the continent has to deal with the effects of climate change and at the same time adopt technologies that minimize carbon emissions. It is important that African countries focus on environmental conservation because of its vulnerability to climate change effects (I.P.O.C., 2001). The effects of climate change that includes, rising water levels, drought and reduced agricultural output are likely to further strain food security in Africa. There is, therefore, the need to investigate the trends of pollution and economic growth so as to assess the progress of African countries in attaining sustainable development.

Kenya has witnessed significant economic growth in the recent past. The economy has been growing at an average rate of 5%, a trend that can be attributed to infrastructure development, industrialization, increased trade and macroeconomic stability (World Bank, 2016). According to the Economic survey (2016), this growth is also attributed to the expansion of key sectors of the economy, such as agriculture, real estate, construction and financial sector. The World Bank has projected that the economy will grow by 6% and 6.1% in 2017 and 2018 respectively.

The rising affluence has been associated with increasing demand for a quality environment. This together with the mounting global concerns about climate change have necessitated the need to try and conserve energy, use energy more efficiently and promote the use of renewable energy. This could explain why the country's ecological footprint has been declining over time as indicated in figure 3. However, the country's biocapacity has been declining, a trend which is not desirable. These statistics are reliable given the high data quality score.

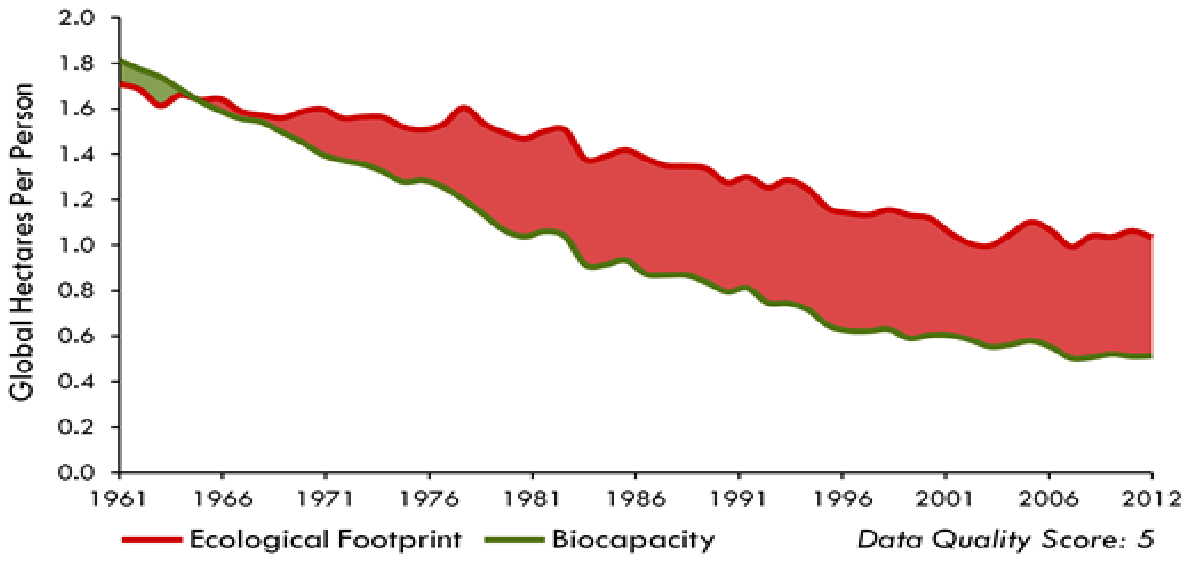

Figure 1.3: Kenya's ecological footprint and biocapacity trend

Source: Global Footprint Network

The trends of carbon dioxide emissions indicate that CO_2 emissions have been rising over time, as indicated in figure 4. This can be attributed to the continued use of fossil fuels.

There is, therefore, the need for the country to adopt more environmentally friendly technologies that would see CO_2 emissions go down. Such technologies are expensive and therefore require that the country has enough income to afford it. The concept of Environmental Kuznets suggests that this is only possible if the country has attained a given level of income per capita. At this level, people are rich and start valuing the environment more hence prompting effectiveness in implementing environmental standards from the regulatory institutions (Dinda, 2004).

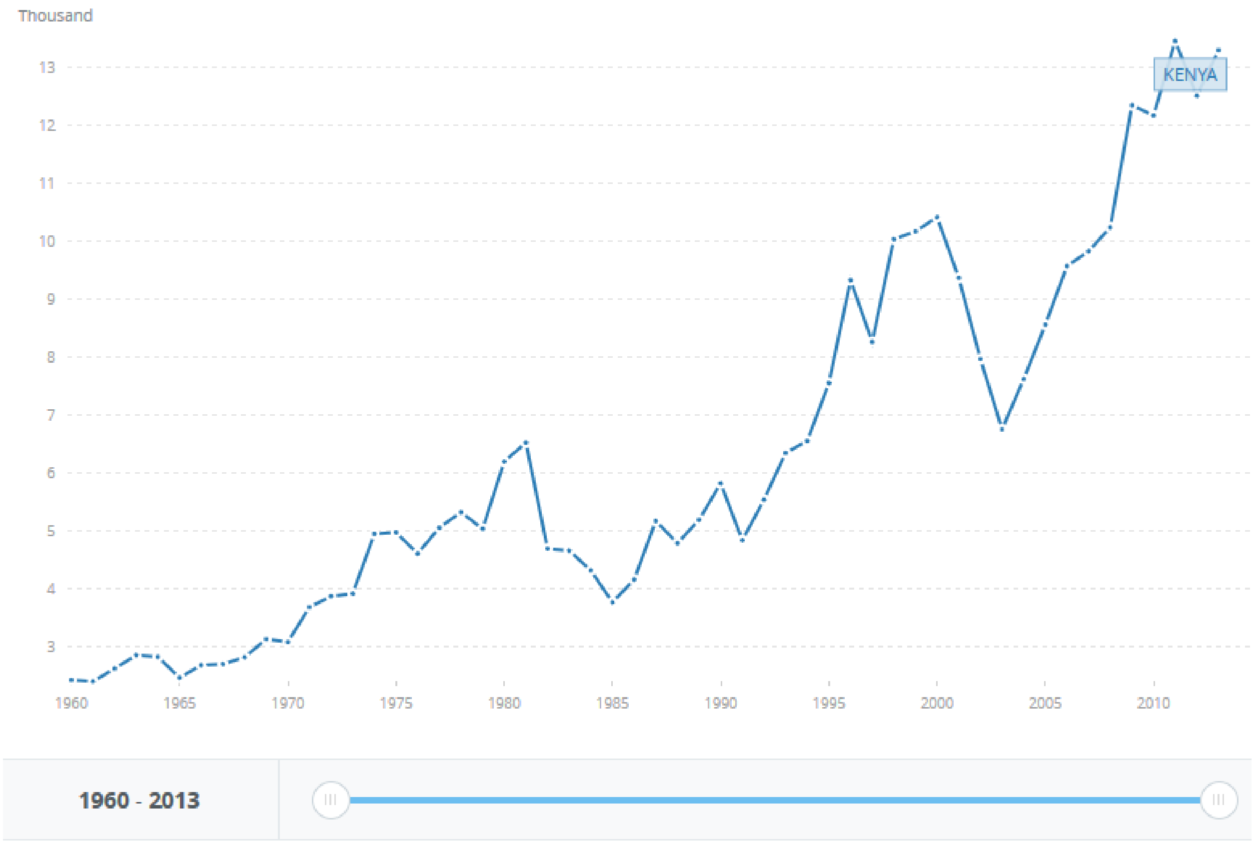

Figure 1.4: Kenya CO_2 emissions trend

Source: World Bank, 2015

1.2 The concept of Environmental Kuznets Curve

The idea was first put forward by Kuznets (1955) when he investigated the relationship between income inequality and income per capita. He observed that the relationship follows an inverted U curve which was then referred to as the Kuznets curve. Studies on pollution and income per capita nexus also observed an inverted U relationship and borrowed from the Kuznets concept and came up with what is now referred to as the Environmental Kuznets Curve (EKC).

The idea of this relationship is that during the initial stages of economic development, pollution increases with an increase in the gross domestic product up to some point when a further increase in income levels reduces pollution (Al-Mulali et al., 2016). Researchers have provided different explanations for this relationship. According to Dasgupta et al. (2002), pollution increases at a faster rate during the initial stages of development because a country gives priority to increasing material output, and the demand for jobs and higher income is more than the demand for clean air and water. A clean environment is considered to be a luxury good.

The rapid economic growth results in the use of natural resources and emission of pollutants. More so, people are too poor to pay for pollution abatement (Charles K, 2000). In the later stages of economic development, people become more cautious and value the environment more prompting effectiveness from regulatory institutions hence reducing pollution (Dinda, 2004).

1.3 Trade openness and environmental quality

Trade openness can affect the environment either positively or negatively. Most countries are keen to encourage international trade especially the growth of exports. However, trade openness has encouraged multinationals to relocate from developed countries to low-income countries with less stringent environmental policies (Hubbard and O’Brien, 2013). These companies not only pay fewer wages but also pollute more than they would pollute in their mother countries. A country should, therefore, be committed to putting up policies that will mitigate pollution. This can be done by using part of the income earned from the trade to abate pollution. International trade generally increases pollution in one country and reduces in another. This can be explained by the pollution haven hypothesis and the displacement hypothesis.

The displacement hypothesis indicates that there is displacement of dirty industries to less developed countries (Dinda, 2004). The poor countries tend to produce dirty and material-intensive goods. The richer countries on the other hand focus on clean and service intensive production which is friendlier to the environment.

The pollution haven hypothesis postulates that pollution- intensive industries move to developing countries so as to take advantage of lower environmental standards (Cole, 2004). More so, some countries purposely lower their environmental standards so as to attract foreign direct investments. A study conducted by Mabey N. & McNally R. (1998) indicates that indeed highly polluting industries do have a preference for economies with less stringent regulations and also have an influence in creating lower standards. The debate on FDI has been skewed to its role in promoting economic growth, at the expense of environmental quality. This paper tries to examine the effect of trade openness on environmental quality in Kenya.

1.4 Statement of the problem

Kenya has experienced an average economic growth of approximately 5% for the past decade. Despite this impressive trend, poverty has remained pervasive in the country. According to World Bank (2016), 46% of Kenyans live below the poverty line and food security is also under threat. Given these harsh realities, the country still lags behind in terms of development indicators and the looming effects of climate change are likely to further cause stern economic and development constraints on the country (Lin et al., 2016). Reduced agricultural output, increasing drought and floods, worsening food security, rising risk of conflict over threatened resources such as water and land will cause more strain to the country's effort to achieve economic development.

The EKC suggests that at the initial stages of economic development, a country engages in economic activities that lead to environmental degradation. The question that arises is: Can Kenya manage the environmental challenges that come with these activities? Part of the solution can be borrowed from the Environmental Kuznets hypothesis. It suggests that we wait until we reach the turning point of the curve then environmental degradation will start declining. This study intends to find out the applicability of this hypothesis in Kenya and therefore if it can be used as a basis for environmental policy.

Several studies have been conducted on the relevance of EKC in Africa (See for example; Lin et al. (2015); Al-Mulali et al. (2015) and Shahbaz et al. (2015)). For Kenya, Ozturk et al. (2016) used the ARDL model to investigate this hypothesis. They found out that it is not applicable in Kenya since GDP increases air pollution both in the short-run and long-run. Similar findings have been observed by Weng-Wai et al. (2015) for lower middle income and low-income countries. Lin et al. (2016) also found out that the EKC is not applicable in Africa and therefore it's not a sound basis for environmental policy in the region. The hypothesis is, however, applicable in other countries as indicated by some studies. (Weng-Wai et al. (2015) for high and higher middle income countries, Shahbaz et al. (2012) in Pakistan, Al-Mulali et al. (2015) for seven developed countries and Gokmenoglu and Taspinar (2015) in Turkey.)

The variance in findings by researchers in the same region can be attributed to the different econometric approaches used and the different ways of measuring environmental quality. Most studies have used CO_2 emissions as a measure of environmental quality and a few have made use of ecological footprints. The only study conducted in Kenya used CO_2 emissions as a proxy for environmental quality. This study uses ecological footprint which is a broader measure of environmental quality.

1.5 Research questions

i. Is the environmental Kuznets curve applicable in Kenya?

ii. How does trade openness affect environmental quality?

iii. What policy recommendation can be drawn from the findings of the study?

1.6 Research objectives

i. To investigate the applicability of the Environmental Kuznets Curve hypothesis in Kenya and establish whether it is a sound basis for environmental policy in Kenya.

ii. To analyze the effect of trade openness on pollution in Kenya.

iii. To draw policy implications from study findings.

1.7 Justification of the study

Environmental degradation is one of the major concerns most countries are currently facing. Policy makers are faced with the challenge of simultaneously achieving economic development and environmental sustainability. Stakeholders have come to appreciate the reality of climate change and therefore have been committed to reducing greenhouse gas emissions. Researchers have joined hands in trying to find out the solution to environment degradation. Bekerman (1992) argued that the surest way of attaining quality environment is by becoming rich. However, some researchers have questioned this hypothesis, arguing that if this was the case, then developed countries would be greener and cleaner.

This study joins in the debate by examining the hypothesis in Kenya. To the best of authors' knowledge, only one study has focused on Kenya exclusively. This paper will add to the existing stock of knowledge by using ecological footprint as a measure of environmental quality.

The findings of the study will also be important to policy makers. They will provide guidance on whether Environmental Kuznets curve can be used as a basis for sound policy in Kenya and whether we should focus on sustainable development or wait until we reach the turning point of the EKC. Trade experts will also benefit from this study since we will be able to find out whether more revenue earned from international trade should be channeled towards pollution control.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The Environmental Kuznets curve has been tested by many researchers who have considered different regions and used different econometric approaches. Given that this study is focusing on Kenya, the empirical literature will focus on studies that have been done in Kenya, Africa and those that have included Africa in their panel. More so, the existing literature in this category has used different indicators of environmental quality including, carbon and Sulphur dioxide emissions, deforestation and ecological footprint. Most studies have used carbon dioxide emissions because it is the main source of pollution in most countries. The first part of this section presents the theoretical explanations of the EKC, followed by the empirical literature and lastly, the overview of the literature.

2.1 Theoretical Literature Review

There are various justifications for worsening environmental quality at initial level stages of development and improving quality once a country attains a given level of income.

First, environmental quality is regarded as a normal good or a luxury good (Charles K., 2000). This means that its income elasticity is more than zero and even more than one. When a country is at the initial levels of development, and poverty levels are high, environmental quality is considered to be a luxury good. People are more concerned about how they will get basic needs and environmental conservation is not a priority. More so, poor people engage in economic activities that are harmful to the environment, such as charcoal burning. When the country attains a certain income level, the quality environment becomes a priority and the government is in a better position to meet the increasing demand for environment protection because of improved institutional capacity (Charles K, 2000).

The second argument, in theory, is that rich countries can afford modern and less polluting technology and capital (Gallagher, 2010). Such technology is most desirable especially now that there is a lot of emphasis on sustainable development. However, it is quite expensive for poor economies. This, therefore, explains the inverted-U shaped EKC.

The third explanation concerns the sector composition of the economy. Agriculture is the most dominant economic activity in poor countries. When their incomes start growing, the share of agriculture decreases while that of industry increases (Gallagher, 2010). These changes lead to environmental degradation hence the positive slope. When an economy attains a given threshold of income, that is, the turning point, the share of industry starts declining as the service sector dominates. Therefore, pollution starts declining.

Lastly, the pollution haven hypothesis also explains the inverted U shape of the EKC. Rich countries export highly polluting industries to poor countries (Dinda, 2004). They do this partly because LDCs have less stringent environmental policies. The poor countries, therefore, experience rising pollution levels while the rich countries become cleaner. Some countries lower their environment regulations intentionally so as to attract foreign direct investments. This increases pollution as more industries are set up. The rich countries import pollution-intensive goods and therefore appear to be cleaner and greener.

2.2 Empirical Literature Review

Using the Autoregressive Distributed Lag model, Ozturk et al. (2016) analyzed the applicability of the Environmental Kuznets Curve in Kenya. They used the Narayan and Narayan 2010 approach, citing high multicollinearity in the standard EKC equation, which assumes that environmental quality depends on GDP and GDP squared. The results of the study indicated that the EKC is not present in Kenya and that fossil fuel energy, urbanization, opening up to trade and GDP enhance pollution both in the short-run and long-run.

Lin et al. (2015) investigated the factors that affect CO_2 emissions in Africa with a special focus on the applicability of the environmental Kuznets curve. They intended to establish whether the environmental Kuznets is an appropriate basis for environmental policy in Africa. The study used the stochastic impacts by regression on population, affluence and technology (STIRPAT) empirical model, highlighting that it is more reliable than the IPAT model which assumes elasticity to be one. They distinguished between agriculture driven and industrial driven development and used panel data regression. The countries included in the sample are Kenya, Nigeria, Egypt, South Africa and DR Congo, representing all the regions in the continent.

The findings of the study by Lin et al. (2015) indicate that the hypothesis is not applicable in Africa and therefore it is not an appropriate basis for environmental policy. They find that energy structure and energy intensity drives CO_2 emissions. The study, therefore, recommends that African countries need to pursue inclusive and sustainable economic growth and development by advocating for pro-poor policies and technologies that are less polluting.

With a special focus on the effect of globalization, Shahbaz et al. (2015) investigated the EKC in 19 African countries including Kenya for period, 1971 to 2012. They argue that the existing literature has neglected the effects of globalization yet it has allowed highly polluting international companies to relocate to developing countries which have less stringent environmental standards. The ARDL methodology is used in the study and the findings indicate that globalization reduces CO_2 emissions and that the EKC hypothesis is not applicable in Kenya. The evidence also indicated that energy intensity affects pollution in Kenya, a finding that is supported by Lin et al. (2015).

This finding on the effect of globalization on pollution implies that undertaking policies that encourage trade openness will improve environmental quality. This can be through importation of the green technology and though more sensitization on the need for environment conservation. This is supported by Copeland and Taylor (2004), who argue that it is imprudent for governments to use trade protectionism measures as a means of environmental protection. These findings, however, contradict the postulates of the pollution haven hypothesis and the displacement hypothesis.

The other study that confirmed the invalidity of the EKC hypothesis is by Al-Mulali et al. (2015). Their study covered Central and Eastern Europe, Western Europe, America, East Asia and the pacific, Sub-Saharan Africa Southern Europe and South Asia. The study used non-stationary panel data techniques, OLS and VECM in the analysis. They found out that renewable energy does not have a significant effect on CO_2 emissions in Sub-Saharan Africa. According to the study, the environmental Kuznets curve is only applicable in regions where renewable energy has a significant effect on pollution. They also observed that opening up to trade has positive effects on pollution in Sub-Saharan Africa and therefore recommended that the countries in the region should focus on trade-related policies so as to increase environmental quality.

Narayan and Narayan (2010) tested the EKC in 43 developing countries, using CO_2 emissions as a measure of environmental quality. They based their conclusion on the short-run and long-run income elasticity, such that if the short-run income elasticity is higher than the long-run, then it means that a country's CO_2 emissions have reduced and therefore EKC is valid.

The study used time series data to analyze the individual countries and panel data to do the regional analysis. The time series analysis for Kenya revealed that emissions reduce with an increase in income. The panel data analysis, however, indicates that the EKC is not applicable in Africa. This shows that studies should focus on individual countries rather than regions. It may be misleading to draw a conclusion about a country based on the regional results, because of individual country heterogeneity.

Using deforestation to proxy environmental quality, Bhattarai and Haming (2001) investigated the EKC with a special focus on the effect of institutions in Latin America, Africa, and Asia. They performed a panel data analysis and found out that the EKC hypothesis is valid for the three continents. The paper further reveals that institutions and macroeconomic policy reduce deforestation significantly.

2.3 Overview of the literature

The empirical literature reveals clearly that the relationship between economic growth and environmental quality remains controversial. Most studies have indicated that the Environmental Kuznets curve is not applicable in Africa (see for example; Narayan and Narayan (2010); Al-Mulali et al. (2015); Lin et al. (2015) and Ozturk et al. (2016)). They revealed that economic growth increases pollution. This can be explained by the fact that African countries are still developing and therefore have not reached the turning point yet. More so, most of these countries are pursuing policies that encourage industrialization and therefore, pollution is expected to rise further. Industrialization will grow the economies towards the turning point.

The findings of existing literature also differ based on the measure of environmental quality used. Bhattarai and Haming (2001) used deforestation as a proxy of pollution and found out that EKC hypothesis is applicable in Africa. Most studies that have used CO_2 emissions have found its invalidity. Researchers who support the use of carbon dioxide emissions argue that it is the main source of pollution.

This study seeks to contribute to the existing literature in two ways. First, it uses the ecological footprint which is a better measure of environmental quality (Al-Mulali, 2015). Secondly, the study focuses on Kenya, a country that very few studies have considered.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the theoretical framework and econometric approach adopted in the study. It also defines the dataset and the data sources.

3.1 Conceptual Framework

Based on the theoretical and empirical literature, population, affluence, technology, urbanization, energy use, energy structure and trade openness are considered to affect environmental quality. They are therefore treated as the independent variables in this study. The dependent variable is environmental quality as proxied by ecological footprint. This relationship is presented in figure 3.1.

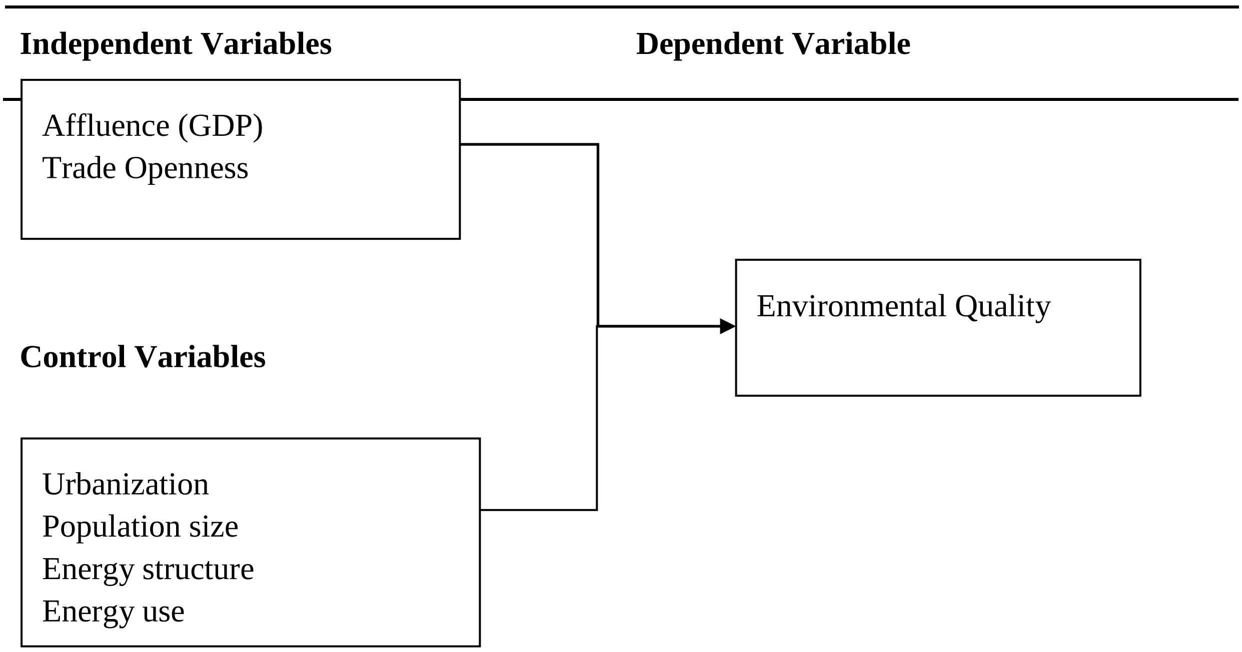

Figure 3.1: Conceptual Framework

Source: Author

3.2 Theoretical Framework

This study adopts the STIRPAT identity which is a modification of the IPAT identity. The IPAT model was first put forward by Ehrlic and Holdren (1974). It analyzes the effects of human activities on the environment. It states that Environmental impact is a product of population, affluence and technology. That is,

$$I = P * A * T \qquad (1)$$

Where I is impact, A is affluence and T is technology. The specification of the model indicates that the driving forces do not independently influence the environment. When one factor changes, it affects the impacts directly, and the other factors affect the impact through the scale effects (York et al. 2002). This framework has been criticized in literature with the argument that it assumes proportionality in the functional relationship. More so, it is considered to be a mathematical relationship that cannot be subjected to hypothesis testing (York et al. 2002).

The Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) was developed to overcome the shortcomings of the IPAT model. It was put forward by Dietz and Rosa (1994). It is specified as a Cobb-Douglas function:

$$I_i = aP_i^b A_i^c T_i^d \qquad (2)$$

Where I, P, A and T is Impact, Population, Affluence and Technology respectively. b, c and d are ecological elasticities of population, affluence and technology respectively and *i.* is specific country or region. The IPAT identity assumes that that b=c=d=1 which may not always be the case. Taking logs of equation 2 yields:

$$LogI = \log a + b \log P + c \log A + d \log T \qquad (3)$$

This paper adopts the STIRPAT model with a slight modification to include other variables that affect environmental quality. According to York et.al (2003), other variables can be included to the STIRPAT model as long as they theoretically fit in the multiplicative specification of the model.

3.3 Model Specification

The following models are estimated.

Model1:

$$LnEFPC = \beta_0 + \beta_1 LnRGDPPC + \beta_2 LnRGDPPC^2 + \beta_3 LnUBN + \beta_4 TO + \beta_5 ES + \beta_6 EU$$

Model 2: $LnEFPC = \beta_0 + \beta_1 LnRGDPPC + \beta_2 LnUBN + \beta_3 TO + \beta_4 ES + \beta_5 EU$

where RGDPPC is the real gross domestic product per capita at market prices (constant 2010 US$), UBN is urbanization rate, TO is trade openness, EU is energy use measured as kilogram of oil equivalent, ES is energy structure proxied by fossil fuel consumption as a percentage of total final energy consumption and EFPC is ecological footprint per capita.

β_1, β_3, β_4 β_5 β_6 and β_2 of model 2 are the ecological elasticities. β_1 is the income elasticity which is used to assess the applicability of the EKC hypothesis. The short run and long run income elasticities are compared and if the long run coefficient is less than the short run, we conclude that the EKC is applicable. We also compare β_2 and β_1 of model 1 such that if β_1>0 and β_2<0, then we conclude that the EKC is applicable.

Urbanization is included because according to the African Economic Outlook (2016), the continent is urbanizing at a historically fast rate and this is likely to affect the environment. Growing urban population puts a strain on the urban resources resulting to excessive use, hence environmental degradation. Urbanization is measured as the proportion of total population living in urban areas.

Trade openness is also included because there is empirical evidence that it has an effect on the environment through the pollution haven and displacement hypotheses (Dinda, 2004). Investors prefer countries with relaxed environmental standards because it reduces the cost of production. This is normally the case for most developing countries. Multinationals are attracted to such countries to put up highly polluting industries. This study uses trade intensity as a measure of trade openness (Sbia et al., 2014). Trade intensity is calculated by dividing the sum of imports and exports by real GDP per capita.

Trade openness also captures technological progress of the country. This is because Kenya is a net importer and most of its imports are capital intensive products. The high technology embodied in these products comes to the country by opening up (Strauss & Ferris, 1996).

By including urbanization, energy use, energy structure and trade openness, our STIRPAT model is modified to STIRPAUrbToEuEs. The two models are estimated using time series data analysis as described in the next section.

3.4 Estimation Procedure

When carrying out a normal regression analysis, the assumption is that the data under consideration is stationary, that is, the moments of the series such as mean and variance are time invariant. Running a regression when one or more variables are non stationary may result to spurious and inconsistent results especially when the variables have a trend over time. In order to avoid this, this paper starts the analysis by testing for non stationarity, also referred to as test for the presence of a unit root.

This study adopts the Augmented Dickey-Fuller test. The ADF test is an improvement of the Dickey-Fuller test which assumes that the error term is uncorrelated. The ADF test addresses this shortcoming by correcting for autocorrelation. Given a variable X, then the equation of the ADF test is given as:

$$\Delta X_t = \beta_0 + \beta_1 t + \beta_2 X_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \varepsilon_t \qquad (4)$$

Where m is the optimal lag length and ε_t is a pure white noise error term. The Akaike information criterion is used to determine the optimal lag length. The null hypothesis under this test is that β_2 is equal to zero, that is, the variable is non-stationary or there is a unit root.

As noted earlier, running a regression analysis when one or more variables are non stationary may result in spurious and inconsistent results. In cases where the results are not spurious then we say that there is cointegration. The presence of cointegration implies that there is a long-run relationship between the variables. It means that the linear combination of a non-stationary series is stationary. Therefore, there is the need to test for cointegration after running the unit root test. This will help in avoiding spurious situations.

The most commonly used tests for cointegration are Engle-Granger approach and the Johansen approach. The Engle-Granger test involves first estimating the long-run equation, then obtaining the residuals and finally applying the ADF test on the residuals. If the residuals are stationary, then the variables are cointegrated. However, this approach has a number of shortcomings: first, it does not allow the estimation of more than one cointegrating relationships yet there could be more than one relationship in cases where more than 3 variables are involved. The other problem paused by this approach is how to deal with the error correction term for each cointegrating relationship. In the case where there is one relationship, the error correction model is employed. It, however, does not apply in cases where we have multiple cointegrating relationships. This study prefers the Johansen approach in testing for cointegration because it addresses the shortcomings of the Engle-Granger approach. The presence of cointegration can also be detected by looking at the coefficient of the error correction term in the ARDL results. If it is negative and significant, then there is cointegration.

Cointegration test results dictate the model to adopt. VAR model is recommended if there is no cointegration. VECM is appropriate if Johansen test reveals the presence of a long run relationship.

3.5 EKC Applicability Criteria

In order to determine whether the hypothesis is applicable in Kenya, this paper uses two criteria: The Narayan and Narayan, 2010 approach which compares the long run and short run income elasticities such that if the short run elasticity is higher than the long run, then we conclude that the EKC is applicable. This means that the negative effect of affluence on environmental quality reduces in the long run.

The other available criterion is including the square of GDP in the regression. If the coefficient of GDP is positive and that of GDP squared is negative, then the EKC is applicable. However, this criterion has been criticized because of high multicollinearity.

3.6 Data Sources and Description of Variables

This study uses time series data for a period of 42 years, from 1970 to 2012, because of availability of data. Data on urbanization, trade openness, energy use, energy structure and GDP is obtained from the world development indicators. Ecological footprint data is obtained from the Global Footprint Network.

Urbanization is measured as a proportion of total population that stays in the urban areas. Trade intensity is used as a measure of trade openness. Trade intensity is calculated by dividing the sum of imports and exports by real GDP per capita, all variables in US dollars. In the study, affluence is measured as real GDP. The effect of population on the environment is captured by measuring all variables in per capita terms.

Environmental quality, which is the dependent variable, is proxied by the ecological footprint. It is basically the area of land and ocean (in hectares), that is needed to support a country's consumption. The ecological footprint is computed using the consumer-based approach. This means we use the ecological footprint of consumption, EF_C which is obtained as:

$$EF_C = EF_P + EF_I - EF_E$$

Where, EF_P, EF_I and EF_E are ecological footprints of production, imports and exports respectively.

Table 3.1 Variables Definition, Description and a priori Expectations

Variable	Description	Expected Sign
Dependent Variable		
Environmental Quality	Ecological footprint	
Independent Variable		
Energy Structure	Percentage of fossil fuel in total energy consumption	Positive
Trade openness	Trade intensity (Sum of imports and exports divided by real GDP per capita)	Positive
Energy Use	Kilo gram of oil equivalent.	Positive
Urbanization	Proportion of population living in urban areas.	Positive
GDP Per Capita	Real GDP Per Capita	Positive
GDP per capita squared	Real GDP Per Capita	Negative

CHAPTER FOUR: EMPIRICAL FINDINGS AND DISCUSSIONS

4.0 Introduction

This chapter presents empirical results and the discussions in an effort to examine the applicability of the environmental Kuznets curve in Kenya, and how trade openness affects environmental quality. The study employs time series data ranging from 1971 to 2012.

4.1 Summary Statistics

This section gives the summary of the variables included in the model and the correlation. They include: Ecological footprint per capita (L_EFPC), real GDP per capita (L_RGDPPC), real GDP per capita squared (LRGDPPCsqd), Trade openness (L_TI), urbanization (UBN), Energy use (L_EU) and Energy structure (ES).

Looking at Table 4.1, we can observe that the energy structure of Kenya consists of 18% fossil fuel, on average. The minimum proportion ever recorded since 1970 is 13% and the maximum is about 22%.

Skewness and Kurtosis are tests for normality. Skewness indicates the scale and bearing of asymmetry while Kurtosis measures the heaviness of the tails of a given distribution. Table 4.1 indicates that L_EFPC, ES, and L_UBN are skewed to the left and L_RGDPPC, L_EU and L_TI are skewed to the right. However, the degree of skewness is small given that the figures are not very far from zero. Most variables have a Kurtosis of around 3 indicating normality but LEFPC and L_TI have light tails since their Kurtosis is 1.6 and 1.8 respectively.

Looking at the mean and median, we can conclude that the data used is not seriously skewed since the mean and median are almost the same. This means the data is well behaved for regression. Skewed data would affect the reliability of the findings.

Table 4.1 Descriptive Statistics

Variable	Mean	Median	N	Min	max	Kurtosis	Sd	skewness
L_EFPC	0.2433	0.2574	42	-0.0066	0.4735	1.551	0.1592	-0.1028
L_RGDPPC	6.771	6.758	42	6.564	6.950	4.463	0.0700	0.1167
LGDPPCsqd	45.86	45.67	42	43.08	48.30	4.428	0.9481	0.1692
L_UBN	-1.750	-1.761	42	-2.228	-1.412	2.529	0.2102	-0.364
L_TI	16.06	15.85	42	15.38	16.99	1.784	0.5061	0.4090
L_EU	6.114	6.111	42	6.061	6.190	3.690	0.0284	0.8752
ES	17.95	17.85	42	12.96	21.83	2.241	2.182	-0.0158

NOTE: The variables are described as follows: EFPC is ecological footprint per capita, RGDPPC is real gross domestic product per capita, EU is energy use measured in kilogram of oil equivalent per capita, ES is the energy structure measured as fossil fuel energy consumption as a percentage of total final energy consumption, UBN is urbanization, TI is trade intensity which is a measure of trade openness.

Source: Research data

In order to describe the data further, we present the correlation matrix in table 4.2. This will enable us assess the degree of multicollinearity between the variables.

The correlation matrix in table 4.2 indicates high and significant correlation between most variables. High correlation is for example observed between LEFPC and L_TI, LEFPC, ES and LUBN. This is expected because theory recognizes affluence, technology and population to be the major drivers of environmental impact. The African Economic Outlook (2016) also reveals that urbanization is likely to affect the environment in Africa. When GDP per capita, trade openness and urbanization increase, ecological footprint per capita declines and this relationship is significant at 1%. This implies an improvement in environmental quality. According to Ozturk et al. (2016), use of fossil fuels increases pollution and this explains the high (70%, positive and significant correlation between LEFPC and energy structure in our model.

A high positive correlation is also observed between urbanization and RGDPPC (72%). This means a growing GDP tends to create more opportunities in the urban areas hence encouraging rural- urban migration.

In as much as these variables are highly correlated, we will go ahead and include them in the model because theory allows. The STIRPAT identity demands that we include affluence, population and technology. Trade openness, urbanization and energy structure are also key variables affecting the environment (Ozturk et al., 2016)

Table 4.2: Correlation Matrix

	L_EFPC	**L_RGDPPC**	**LGDPPCsqd**	**L_UBN**	**L_TI**	**L_EU**	**ES**
L_EFPC	1.00						
L_RGDPPC	-0.5381*	1.00					
LGDPPCsqd	-0.5381*	1.0000*	1.00				
L_UBN	-0.9318*	0.7276*	0.7268*	1.00			
L_TI	-0.9128*	0.5343*	0.5366*	0.8511*	1.00		
L_EU	-0.3470**	0.6429*	0.6471*	0.3850*	0.5223*	1.00	
ES	0.7084*	-0.2117	-0.2088	-0.6735*	-0.4961*	0.3204**	1.00

NOTE: Note: * = Significant at1%; **=Significant at 5%; **=Significant at 10%.

Source: Research data

4.3 Empirical results

The main goal of this study is to investigate the relevance of the EKC in Kenya and the effect of trade openness on the environment. Given that the study makes use of time series data, it is important to first investigate the behavior of each variable over time. This involves testing for presence of unit roots. The presence of a unit root means the moments of the variable, such as the mean and variance fluctuate over time. Working with such non-stationary data may result in spurious and inconsistent estimates. The findings of this test at different levels of differencing will dictate the appropriate methodology to adopt.

This study uses the Augmented Dickey Fuller (ADF) test for stationarity because it corrects for autocorrelation (Gujarati, 2014). The null hypothesis is that the variable is non-stationary. The Akaike Information Criterion is employed to obtain the optimum lag length for each variable before running the test. Results of the ADF test and AIC test statistic with and without trend at level and at first difference are presented in table 4.3 and4.4 respectively.

From table 4.3 and 4.4, we can observe that there is no difference in the results of the test whether there is trend or no trend except for urbanization. Therefore we can conclude that the aspect of trend of a variable does not significantly affect the variations in the mean and variance.

We further note that log of ecological footprint per capita, log real GDP per capita, log trade intensity, log energy use and the energy structure are integrated of order 1 since they are stationary at first difference. Log urbanization rate is stationary at level and therefore, it is integrated of order 0. This paper therefore adopts the Autoregressive Distributed Lag (ARDL) methodology because according to Pesaran & Shin (1995), the ARDL model yields reliable estimates that are asymptotically normal irrespective of whether the variables are I(0) or I(1).

4.3.1 Unit Root Test

Table 4. 3: Augmented Dickey Fuller Test for Stationarity- At level

	With Trend		No Trend		
Variable	**ADF Statistic**	**P- Value**	**ADF statistic**	**P- Value**	**Comment**
LEFPC	-1.773	0.718	-0.309	0.924	Non-stationary
LGDPPC	-1.785	0.712	-0.973	0.763	Non-stationary
L_TI	-1.87	0.670	0.905	0.993	Non-stationary
L_UBN	-4.163	0.005	-0.543	0.883	Stationary
L_EU	-2.345	0.409	-1.968	0.301	Non-stationary
ES	-2.729	0.224	-2.386	0.146	Non-stationary

Source: Research data

Table 4. 4: Augmented Dickey Fuller Test for Stationarity- At First Difference

	With Trend		No Trend		
Variable	**ADF Statistic**	**P- Value**	**ADF Statistic**	**P- Value**	**Comment**
LEFPC	-4.238	0.004	-4.315	0.0004	Stationary
LGDPPC	-4.127	0.006	-4.131	0.0010	Stationary
L_TI	-7.953	0	-7.602	0.0000	Stationary
L_EU	-5.228	0	-5.153	0.0000	Stationary
ES	-5.384	0	-5.387	0.0000	Stationary

Source: Research data

4.3.2 Regression Results

Under this section, we estimate model 1 and model 2 to examine the effect of GDP per capita, trade openness, urbanization, energy use and energy structure on environmental quality which is proxied by ecological footprint per capita. We achieve this by employing the ARDL methodology. The results of this estimation are presented in table 4.5.

In table 4.5, we observe that the coefficient of the error correction term is negative and significant at 1% level of significance in both models. This means that the short run shocks converge to a long run stable equilibrium at a speed of 0.67%. It means there is a long run relationship between environmental quality and the explanatory variables (GDP, trade openness, urbanization, energy use and energy structure).

The results in Model 1 indicate that the coefficient of GDP is positive while that of GDP squared is negative as expected. However, the coefficients are not statistically significant. The shortcoming of this model is that there is high multicollinearity between GDP and GDP squared, with a correlation of 100%. Narayan & Narayan(2010) discredits this model citing high multicollinearity. The interpretation will therefore mainly focus on model 2, which drops the square of GDP.

Table 4. 5: ARDL Results

Variables	**Model 1**		**Model 2**	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
	Long run Results			
LGDPPC	4.7571	26.0215	0.8063**	0.3681
L_RGDPPCsqd	-0.2931	1.9181		
L_Urbnrate	-0.2878	0.1975	-0.2117	0.1826
L_T intensity	-0.1335***	0.0693	-0.1535**	0.0653
L_EU	-2.0362**	0.9892	-1.994**	0.9701
ES	0.0265**	0.0107	0.0276**	0.0107
Error Correction Term	-0.6870*	0.1957	-0.6698*	0.1869
	Short run Results			
LGDPPC	-16.0894	16.8703	0.1948	0.2309
L_RGDPPCsqd	1.2114	1.2547		
L_Urbnrate	1.0121	0.9159	1.167	0.8836
L_T intensity	0.8893	0.0669	0.1085**	0.0599
L_EU	0.4061	0.8539	0.411	0.8375
ES	0.004	0.0097	-0.0046	0.0094

Note: * = Significant at1%; **=Significant at 5%; **=Significant at 10%

Source: Research data

The estimated parameters for the long run relationship in model 2 reveal that if all other factors remain unchanged, a 1% increase in real GDP per capita significantly increases ecological footprint per capita by 0.8%. The effect of GDP on ecological footprint per capita is positive in the short run but insignificant. Therefore based on the Narayan and Narayan, 2010 approach, the applicability of the environmental Kuznets curve in Kenya cannot be confirmed. This means the country has not reached the turning point as at now as revealed by the positive coefficients both in the short run and long run.

This finding is supported by Ozturk et al. (2016) who also found out that GDP increases air pollution both in the long run and in the short run. This means that most people are still too poor to demand a clean environment. They are worried more about getting the basic needs and environmental quality is regarded as a luxury good which is demanded by a few. The poor people, who are the majority in the country, continue engaging in economic activities that are harmful to the environment such as deforestation and authorities are reluctant to the strictly enforce environmental regulations. This finding can also be explained by the fact that country is still at its initial stages of industrialization and therefore carbon emissions are quite high. More so, fossil fuels form a significant proportion of the energy structure hence contributing to the worsening environmental quality.

The effect of trade openness on ecological footprint per capita is positive and significant in the short run. This means that trade openness negatively affects the environment in the short run. A 1% increase in trade openness increases ecological footprint per capita by 0.11% *ceteris paribus.* The effect is however positive in the long run where a 1% increase in trade openness reduces ecological footprint per capita by 0.15%. This implies that the country's foreign trade policy tends to be environment-sensitive with time, and revenue earned is used to engage in pollution abatement. This finding also implies that opening up allows countries to share information and green technologies hence improving the environment over time. Shahbaz et al (2015) also observed that globalization reduces CO_2 emissions in Africa.

The short run effect of trade openness confirms the pollution haven hypothesis and the displacement hypothesis. It means that when a country opens up too much, highly polluting industries tend to find their way to the country so as to take advantage of lower environmental standards. Ozturk et al (2016) observed a similar trend both in the short run and the long run.

Table 4.5 further indicates that energy structure as measured by the proportion of fossil fuel in energy utilization has a significant negative effect on the environment. If all other factors are held constant, an increase in the proportion of fossil fuels in the energy structure will result to an increase in ecological footprint by 0.01% in the long run. The effect of fossil fuels on the environment is insignificant in the short run. Similar findings were reported by Ozturk et al (2016) and Lin et al (2015). The use of fossil fuels results to high CO_2 emissions which contribute 60% of the ecological footprint.

CHAPTER 5: CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

This paper focuses on examining the relevance of the Environmental Kuznets Curve hypothesis in Kenya and to establish how trade openness affects environmental quality. This subject has been given minimum attention by researchers in Kenya with only one paper focusing on the topic. It is important to put more emphasis on the environmental matters given that the world is focusing on environmental sustainability. The topic is motivated by the deteriorating environmental quality, despite the growing affluence. More so, developing countries are under immense pressure to achieve economic growth, inclusive development and environmental sustainability simultaneously.

The STIRPAT identity framework is used with a slight modification to include trade openness, urbanization, energy use and energy structure. ARDL model is employed in analyzing the time series data ranging from 1971 to 2012.

The results indicate that real GDP per capita is a key driver of environmental degradation as it increases ecological footprint per capita over time. The effect of affluence on the environment is also negative but insignificant in the short run. This empirical evidence reveals that the EKC hypothesis is not applicable in Kenya. This finding is supported by Ozturk et al. (2016) who used CO_2 emissions to quantify environmental quality. Most of the other studies in Africa and Sub Saharan Africa also observed the invalidity of the hypothesis (See for example Lin et al. (2015); Al-Mulali et al. (2015) and Shahbaz et al. (2015)). This trend can be attributed to the reality that Kenya and Africa as a whole are still developing and probably have not gotten to the turning point of the Kuznets curve.

The findings of this study also reveal that trade openness has a significant negative effect on the environment in the short run and a positive effect over time. This implies that the country's international trade policy tends to be environmentally sensitive over time. More so, encouraging openness and stimulating economic integration by reduction or removal of tariff and non-tariff trade barriers will result to a better environment. Opening up facilitates transfer of clean technologies between countries and sharing of information on the need for better environmental regulation (Shahbaz et al., 2015). This finding is supported by Copeland and Taylor (2004). They argue that it is wrong for a country to adopt trade protectionism as a way of enhancing environmental quality.

The use of fossil fuels is also seen as a key driving force of pollution in Kenya. Fossil fuel constitutes about 18% of the energy structure of Kenya (WDI, 2016) and given that it has a negative effect on the environment, there if need for efforts to reduce this. The results show that urbanization has a positive but insignificant effect on the environment. This shows that it can play a role in reducing pollution by reducing strain on rural resources such as forests.

5.2 Policy Implications

Given that the Environmental Kuznets hypothesis is not valid for Kenya, then it means that it is not a sound basis of environmental policy of the country. Policy makers should therefore focus on environmentally friendly development instead of expecting that economic growth will automatically lead to a cleaner environment. More focus should be given to pro-poor growth as this will help in reducing environmental degradation.

Trade policy makers are encouraged to open up further so as to encourage free flow of greener and cleaner technologies to the country. We should however be careful so that we don't compromise our environmental standards so as to attract foreign direct investments. This trend has been observed with many poor countries and this should be avoided by Kenya.

This paper also recommends that consumption of fossil fuels be minimized and use of renewable energy for example geothermal, solar and wind be encouraged. A study by Al-Mulali et al. (2015) observed that the environmental Kuznets curve is applicable in regions where renewable energy has a considerable negative effect on CO_2 emissions. This means that the use of clean energy contributes significantly towards the turning point, hence that need to embrace it. This can be achieved by providing resources to support research and development in the area. This study further cautions the government about the Lamu coal plant. It should be slow with the project as this will frustrate the effort of reducing fossil fuel consumption. Thorough research and environmental assessment should be done before the project is implemented.

5.3 Areas of Further Research

This paper recommends that future studies in Kenya try to focus on explaining why the EKC hypothesis is not applicable in Kenya and the circumstances under which it will apply. Theory states that rich countries are in a better position to employ more environmentally friendly technologies, and this explains the inverted U shape of the EKC. The fact that this hypothesis does not hold for Kenya implies we have not yet fully exploited our renewable energy potential.

Future research should also try to disintegrate economic growth into different sectors such as agriculture and industry. This will provide analysis of the effect of sector composition on the environment. Theory tries to justify the nature of EKC by arguing that the domination of agriculture in the early stages of economic development explains the positive slope. The expansion of the industry sector further increases the steepness of the positive slope and later on, the service sector accounts for the negative slope. This should be investigated for Kenya.

APPENDIX

Appendix 1: Data used in the Analysis

YEAR	GDP PER CAPITA (US$)	ECOLOGICAL FOOTPRINT PER CAPITA	IMPORTS(constant 2010 US$)	EXPORTS(constant 2010 US$))	ENERGY USE (Kilogram of oil equivalent)	URBANIZATION (Urbanization rate)	FOSSIL FUEL ENERGY(% of Total energy consumption)
1971	708.8398	1.600241	2931174281	2478364364	451.4831	0.10777999	21.17697
1972	800.6888	1.559698	2461977910	2213008346	455.5136	0.11282003	21.8304
1973	817.6772	1.564735	2423973963	2404375402	450.9928	0.11804999	21.04075
1974	820.3055	1.563453	2905825656	2768796879	451.3031	0.12349002	20.94443
1975	797.5489	1.520864	2213846219	2447114735	445.6524	0.12913999	19.891
1976	785.0554	1.509268	2155164632	2493619973	450.487	0.13502997	20.90969
1977	827.8521	1.53325	2549663260	2563178457	455.6261	0.14112003	21.59173
1978	852.5412	1.605621	3249551090	2606213154	452.2507	0.14745002	20.71256
1979	883.4978	1.534467	2631130127	2486974258	451.3688	0.15400998	20.40543
1980	898.1228	1.494696	2893882373	2622015186	450.8578	0.15583001	20.48918
1981	897.092	1.470007	2285116674	2512227974	446.3351	0.15680999	19.47137
1982	876.4533	1.501677	1916602756	2592124237	437.6523	0.1578	17.83925
1983	854.7508	1.507504	1564019547	2532903533	428.7843	0.15879	15.98336
1984	837.5546	1.379137	1843462008	2555055916	437.0103	0.15979001	17.61966
1985	841.6666	1.392361	1712180826	2726692583	439.4355	0.16079	17.85977
1986	869.6544	1.41924	2000585499	2993141452	461.7448	0.16180002	18.84861
1987	888.7493	1.381463	2266394770	3000909554	464.0093	0.16280998	19.34183
1988	911.1807	1.350493	2470987590	3139169963	459.3085	0.16383001	18.70246
1989	921.5475	1.347894	2712340661	3434505543	460.1296	0.16485	18.88564
1990	928.3187	1.337575	2803975460	4208657505	454.412	0.16747998	17.93793
1991	911.0571	1.274858	2678276668	4156377878	447.9002	0.17042998	16.929
1992	875.0433	1.301511	2615560186	4123976326	445.1118	0.17342	16.63471
1993	851.1017	1.254268	3500008778	5423878191	442.2456	0.17645001	16.04022
1994	847.7929	1.285776	4088780396	5361201715	434.0755	0.17951999	14.85062
1995	860.4128	1.246894	4803972337	4950466986	442.5142	0.18262999	15.65289
1996	872.4127	1.162512	4891429834	5176155470	446.6886	0.18579001	16.36872
1997	854.485	1.141705	5407631491	4625123651	441.0077	0.18897998	15.59137
1998	861.0343	1.133975	5660745812	4399216488	446.7754	0.19222	16.55343
1999	859.4701	1.156373	5577015681	4807473549	445.8419	0.19549999	16.9749
2000	843.3445	1.132541	5684009635	4862037580	450.6686	0.19892	18.23856
2001	853.3175	1.119421	6790660862	5037429949	445.7591	0.20238999	16.40632
2002	836.2352	1.054561	6024270041	5395843363	440.9687	0.20591001	15.62917
2003	838.7173	1.007151	6020559607	5784995184	439.3543	0.20948	12.95763
2004	858.8384	0.997942	6760839979	6513611780	450.9121	0.21310001	14.17484
2005	886.1112	1.050077	7771137751	7124576785	455.7979	0.21674999	15.34655

2006	919.1026	1.10334	9738560265	7376815886	464.4233	0.22045	16.91424
2007	956.6392	1.064192	10167606001	7831045618	462.2203	0.2242	16.49183
2008	933.9423	0.993431	11463352539	8016782585	465.7663	0.22800001	16.82044
2009	939.6305	1.041044	12420282508	7598381028	479.2506	0.23182999	18.7464
2010	991.8505	1.03668	13427982209	8262811549	487.6538	0.23571001	19.29323
2011	1024.73	1.063279	15205555873	9023786087	485.5091	0.23966999	18.91485
2012	1043.124	1.034817	16021501011	9004434899	477.5641	0.24370001	17.01539

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