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The Effect of Globalisation on CO2 Emissions in the East African  
Community Member Countries

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Submitted in partial fulfillment of the requirements for the degree of  
Bachelor of Business Science in Financial Economics at Strathmore  
University

Strathmore Institute of Mathematical Sciences  
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Nairobi, Kenya

February, 2021

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## Table of Contents

DECLARATION .....	I
ACKNOWLEDGEMENT.....	2
ABSTRACT .....	1
CHAPTER 1: INTRODUCTION.....	2
1.1 Background Information.....	3
1.1.1. Globalisation .....	3
1.1.2. CO2 Emissions .....	3
1.1.3. Globalisation, Urbanisation and CO2 emissions in East Africa .....	4
1.2 Problem Statement.....	8
1.4. Research Question .....	9
1.5. Scope of the study .....	9
1.6. Significance of Research.....	9
CHAPTER 2: LITERATURE REVIEW .....	11
2.1 Introduction .....	11
2.2. Theoretical Review.....	11
2.2.1 Environmental Kuznets Curve (EKC) Theory.....	11
2.2.2 Ecological Modernisation Theory (EMT) .....	12
2.2.3 Pollution Haven Hypothesis (PHH).....	12
2.3. Empirical Review .....	13
2.3.1. Globalisation and CO2 emissions in developed Countries .....	13
2.3.2. Globalisation and CO2 emissions in Emerging and Developing Countries .....	14
2.4. Research Gap.....	15
2.5. Conceptual Framework.....	15
CHAPTER 3: METHODOLOGY .....	17
3.1 Introduction .....	17
3.2 Research design .....	17
3.3 Population and sampling .....	17
3.4 Data collection .....	18
3.4.1 Type of data.....	18

3.4.2 Sources of data .....	19
3.5 Data analysis .....	20
3.5.1 Model .....	20
<b>CHAPTER 4: RESULTS AND ANALYSIS .....</b>	<b>24</b>
4.1 Introduction .....	24
4.2 Descriptive Statistics .....	24
4.3 Unit root Tests .....	25
4.4 Fixed effects and random effects.....	26
4.5 Pooled OLS regression.....	27
<b>CHAPTER 5: DISCUSSION AND CONCLUSION .....</b>	<b>29</b>
5.1 Introduction .....	29
5.2 Discussion.....	29
5.3 Conclusion.....	30
5.4 Recommendations .....	30
5.5 Limitations of the study .....	31
5.6 Areas for further research.....	31

**List of Figures**

Figure 1: Intergovernmental Panel on Climate Change (IPCC) (2014) ..... 4  
Figure 2: CO2 emissions per capita, World Bank (2019)..... 6  
Figure 3: Global carbon dioxide emissions per capita trend..... 7  
Figure 4: Urban Population growth of EAC member countries and the world ..... 7  
Figure 5: Conceptual Framework ..... 16

**List of Tables**

*Table 1: Variable definition and measurement* ..... 18

Table 2: Descriptive Statistics ..... 24

Table 3: Results of Unit root tests..... 25

Table 4:Pooled OLS regression Tests..... 27

## **List of Abbreviations and Acronyms**

CO<sub>2</sub>- Carbon dioxide emissions

EAC- East Africa Community

EKC- Environmental Kuznets Curve

GDP- Gross Domestic Product

INDC- Intended Nationally Determined Contribution

IPCC- Intergovernmental Panel on Climate Change

KOF- Konjunkturforschungsstelle

NCCAP- National Climate Change Action Plan

OECD- Organisation for Economic Co-operation and Development

SDGs- Sustainable Development Goals

VECM-Vector Error Correction Model

## **ABSTRACT**

Given that the East African Community continues to expand and grow economically, this has led to an increase in globalisation and urbanisation in the region hence it is foreseeable that these changes would have an effect on the environment in the region. This study sought to investigate the impact of globalisation on CO<sub>2</sub> emissions in East African Community member countries with globalisation, gross domestic product per capita and energy consumption as control variables and urbanisation as a moderating variable. Furthermore, the study sought to find the moderating effect of urbanisation on the relationship between globalisation and CO<sub>2</sub> emissions and to shed light on the Environmental Kuznets Curve hypothesis of the region. Using panel data, the study sought to explore these objectives for the period between 1990 to 2014 in Kenya, Uganda, Rwanda, Burundi and Tanzania. The pooled ordinary least squares regression model was utilized to estimate the parameters in the model and as a result, it was found globalisation and CO<sub>2</sub> emissions have a negative relationship and urbanisation has a positive moderating effect on the relationship between globalisation and CO<sub>2</sub> emissions. Moreover, the Environmental Kuznets Curve does not follow for the region. The study recommended that CO<sub>2</sub> reduction policies should be put in place and adopting of new technologies that help reduce pollution should be used to reduce the effect of CO<sub>2</sub> emissions in the region. Furthermore, the region needs to promote and facilitate economic-friendly globalisation and urbanisation to improve and sustain economic development without any ecological degradation.

## **ACKNOWLEDGEMENT**

I would like to express my sincere gratitude for the individuals that played a great role during the writing of this project. My loving parents Willis and Albina Akhwale and my sisters who have been a constant source of inspiration. I take this time to appreciate my supervisor Dr. Caroline Wanjiru Kariuki for her relentless effort in reading my work and giving wise counsel. I am grateful for the school for its support in availing necessary materials for this research. Above all, God for keeping me in good health to complete the study.

## **CHAPTER 1: INTRODUCTION**

### **1.1 Background Information**

#### **1.1.1. Globalisation**

Globalisation is subdivided into three major areas: economic, cultural, and political. Economic globalisation looks at the developing economic interdependence of the world's economies, populations and cultures brought up by trans-border trade in goods and services, investments, information, technology, and people. It comprises of globalisation of markets and production. Globalisation of production is obtaining goods or services from a different location for better costs and quality. Globalisation of markets is the union of markets into a massive global marketplace. Political globalisation is the growth of the global political system. Cultural globalisation is the movement of knowledge and values globally to intensify social relations.

The KOF Index of Globalisation was developed to measure the degree of globalisation among countries in the world. The index was conceived by Axel Dreher and is based on three principal criteria: economic globalisation, political globalisation, and social globalisation. According to Axel (2006), social globalisation consists of interpersonal, information and cultural globalisation. Under these dimensions, the variables covered include transfers and foreign population. The dimensions under economic globalisation include trade and financial globalisation. The variables covered under these dimensions include; foreign direct investment, trade and portfolio investing. Variables covered under political globalisation include; embassies, international organisations and participation in the United Nations Secretary Council membership.

#### **1.1.2. CO2 Emissions**

Climate change is one of the main worrying environmental problems as it is impossible to predict what its consequences will be. It comes mostly from the greenhouse effect, which is caused by the greenhouse accumulation of certain gases particularly Carbon dioxide (CO<sub>2</sub>). According to IPCC (2014), global greenhouse gases have increased by 70% between 1990 and 2004. CO<sub>2</sub> emission sources are mainly deforestation, industrial production and transportation. These three have recently been partly linked to accelerated globalisation (Huwart and Verdier, 2013). According to OECD (2013) for average countries, a single percentage increment in the trade leads to a 0.58%

increment in CO<sub>2</sub> emissions. CO<sub>2</sub> emissions are tied with fossil fuels which few economically viable substitutes have come up. CO<sub>2</sub> can also be emanated by human activities on forestry and land such as deforestation, land clearing and degradation of soils. Carbon dioxide is emitted during consumption of liquid, solid and gas fuels and gas flaring makes up the CO<sub>2</sub> emissions metric tons per capita. It is calculated as the total amount of carbon dioxide emitted by a country as an outcome of important human activities (utilisation and production) given the inhabitants of the country. Figure 1 shows the percentages of greenhouse gas emissions. Carbon dioxide from fossil fuel and industrial processes has the highest percentage. This shows that this type of emission has the greatest effect on the environment and emphasis should be put on it.

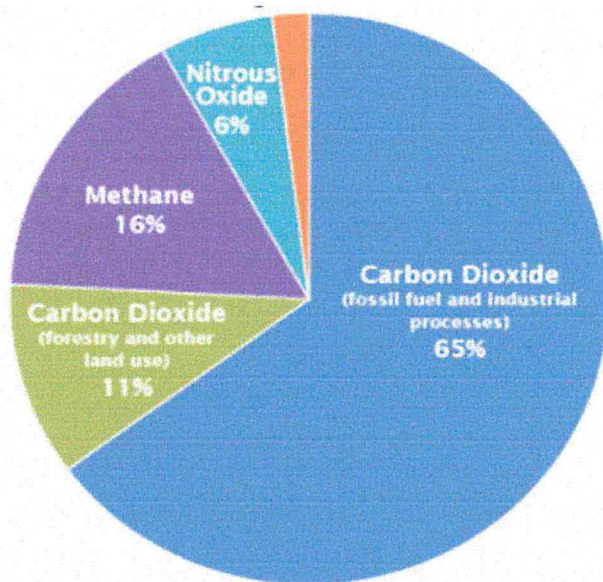


Figure 1: Intergovernmental Panel on Climate Change (IPCC) (2014)

### 1.1.3. Globalisation, Urbanisation and CO<sub>2</sub> emissions in East Africa

As one of the quickest developing regional economic blocs in the world, is broadening and deepening participation among the partner states in different aspects for their common advantages. These aspects include political, social and financial. The segments of globalisation incorporate GDP, the Human Development Index (HDI), and industrialisation. The GDP is the market cost of completed products and services created inside a nation's borders in a year and is a measure of a nation's overall economic yield. Globalisation has played a major role in the East Africa Community which contains: Kenya, Burundi, Tanzania, Rwanda and Uganda. The community has established a common market and customs union. The East African Community in the

integration of markets benefits as the region achieving urbanisation will attract foreign direct investment. Nyamache et al. (2014) argue that globalisation will decrease poverty in the region and strengthen democracy but also globalisation has a negative effect on prices of commodities in the market due to market liberalisation. East Africa nations are more likely to be affected by the negative effects of globalisation and there should be ways to evade the possibility of them becoming a reality.

CO2 emissions lead to climatic changes and sectoral climate impacts to fluctuate in Sub-Saharan Africa. East Africa is at a higher danger of flooding and infrastructure damages. West Africa is anticipated to see a serious effect on food production, and a negative impact on human wellbeing and employment. South Africa has concurrent dangers of drought (Serdeczny et al., 2015). Wageningen (2010) states the rural and agricultural zones in East Africa will be unequivocally influenced by environmental change and over the long haul, ecological issues will seriously influence development in equity and poverty reduction. It is noticed that the most widely recognised kinds of climate events in Africa are flooding, desertification, drought and soil degradation (Oladayo, 2017). As indicated by USAID (2017) Total greenhouse emissions in Kenya in 2013 were 60.2 million metric tons of carbon dioxide equivalent. Uganda emitted 49 million metric tons of carbon dioxide equivalent in 2012. Uganda's greenhouse gas emissions grew by 2% annually from 1990 to 2012. Tanzania's total CO2 emissions in 2014 were 286.49 million metric tons of carbon dioxide equivalent (MtCO2e). Greenhouse gas emissions in Tanzania increased 3% between 1990 and 2014, while GDP grew averagely at 5.2% annually. This could mean a positive relationship between GDP and GHG emissions. Total GHG emissions in Rwanda in 2014 were 7.59 million metric tons of CO2 equivalent. In 2018, CO2 emissions per capita for Burundi was 0.03 metric tonnes of carbon dioxide equivalent. Although Burundi CO2 emissions per capita wavered substantially recently, it tended to decrease through the 1999 - 2018 period ending at 0.03 metric tons of CO2 equivalent in 2018.

According to USAID (2017) Kenya plans on expanding on the National Climate Change Action Plan (NCCAP) activities through geothermal development, solar and wind energy production, improved waste administration, use on use on clean energy technologies, tree planting and upgrade of energy and resource effectiveness. In their intended Nationally Determined Contribution (INDC), Uganda promises to lessen

CO2 emissions by 22 percent underneath anticipated 2030 usual emissions and their activities are dependent upon worldwide finance, innovation and capacity- building support. Tanzania expresses its objective to set out on a climate supple development pathway that shall decrease GHG emissions by 10% to 20% by 2030, relative to the anticipated 2030 usual emissions. Rwanda vows to decrease emissions relative to the usual scenario emission levels by 2030, but a target has not been set. The Intended Nationally Determined Contribution (INDC) indicates that decreases in emissions depend on arrangements and activities that are modified on receiving of international finance, innovation, and capacity building. As indicated by the United Nations Development Program (UNDP) Burundi has created numerous adjustment projects to address antagonistic impacts of environmental change dependent on coping mechanisms and practices. seasonal early warning climate forecasts.

Figure 2 looks at the levels of CO2 emissions per capita in the EAC member states across some years. Kenya is more developed compared to the other countries and has a higher globalisation rate and is seen to have higher CO2 emissions per capita while Burundi has the least. The y-axis shows the CO2 emissions metric tons per capita and the x-axis the years. Figure 3 shows that the global co2 emissions per capita emitted by the world is way more but has been rather constant with a low range over the last couple of years.

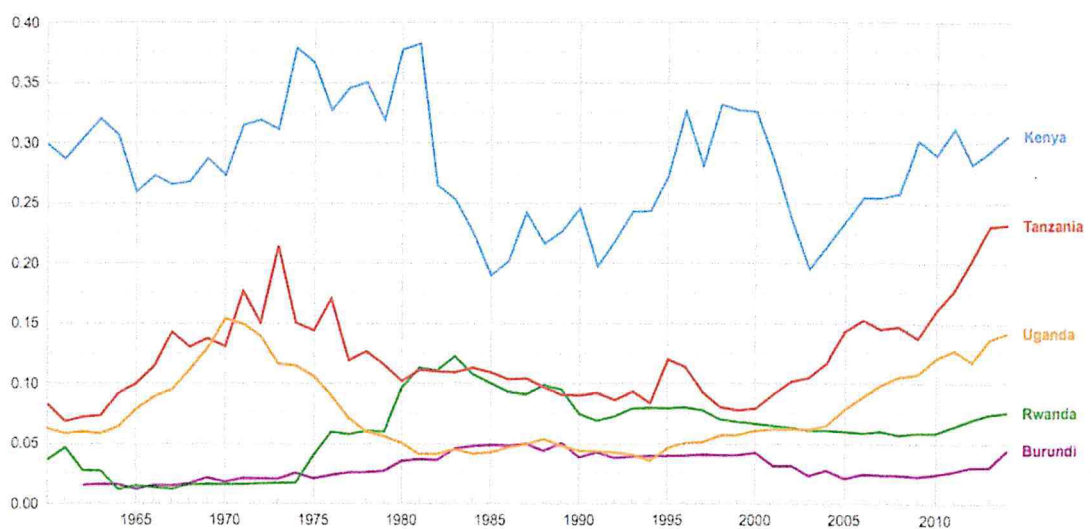


Figure 2: CO2 emissions per capita, World Bank (2019)

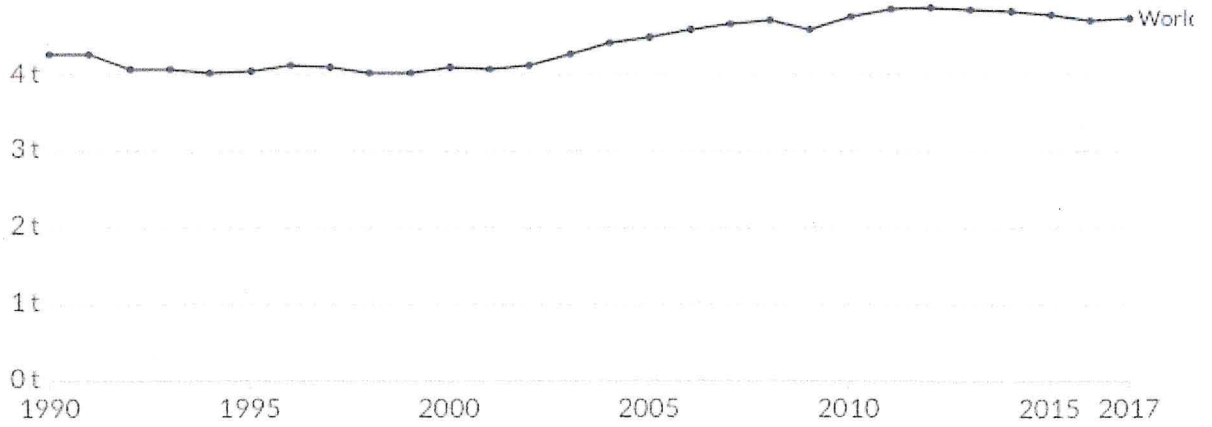


Figure 3: Global carbon dioxide emissions per capita trend

Population development expands rural-urban migration and thus increases resource and environmental degradation. Development of urban zones and population are significant drivers for environmental degradation, its increase and an explanation behind the escalated effects. The East African region is encountering incredible population and technological advances that is opening up industries and making the environment worse. The urban population growth of the EAC community members, which is slightly above the world average as shown on Figure 4, leads to increased energy demand. Hence, levels of carbon emissions in the region are increasing due to a growing economy. As the East African area keeps on urbanising, we see that carbon emission in the region will confound the climate system, an issue that the study sought to explore.

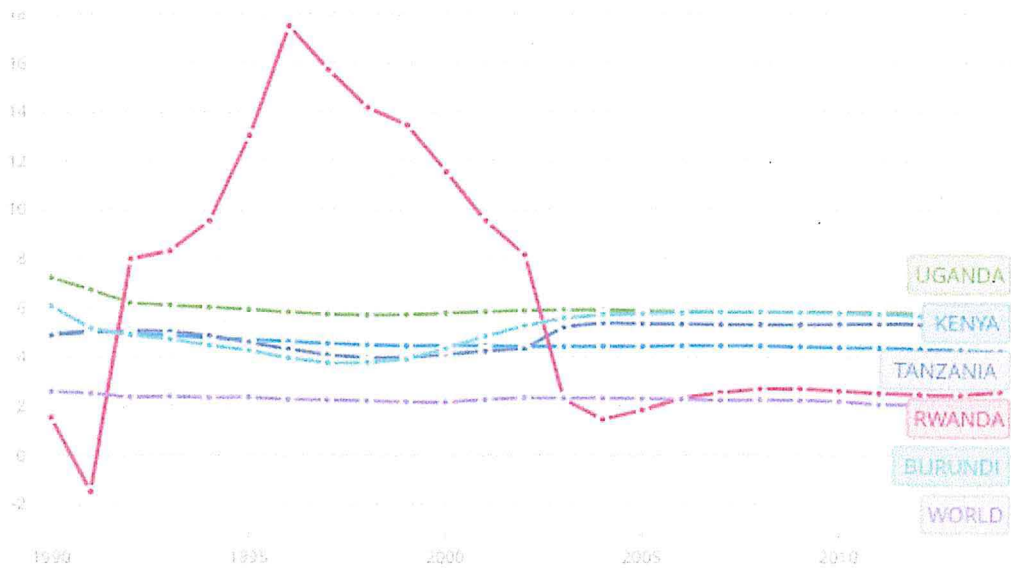


Figure 4: Urban Population growth of EAC member countries and the world

## **1.2 Problem Statement**

Global environmental change is perhaps one of the tremendous issues challenging the world in the 21<sup>st</sup> century. Levels of global warming have been increasing as the years go by. CO<sub>2</sub> emissions mainly contribute to this phenomenon. Despite this, CO<sub>2</sub> emissions from countries in the African continent account for a small part of global CO<sub>2</sub> emissions, (OECD, 2011) show that there is a continual rise of CO<sub>2</sub> emissions in Africa. Africa is a vulnerable continent and climate change is seen to be impacting the agricultural sector negatively. The agricultural sector forms a large part of the economy and this phenomenon would lead to lower levels of food security due to higher levels of drought (IPCC,2014).

Researchers such as (Shahbaz et al, 2015; Salahuddin et al 2019; Kalayci & Hayaloglu, 2018) have mainly focused on the impact of globalisation on CO<sub>2</sub> emissions for developed countries and hence proving Environmental Kuznets Curve (EKC) hypothesis. Shahbaz et al. (2016) incorporate globalisation and energy intensity and CO<sub>2</sub> emissions to probe the presence of EKC in 19 African countries. East Africa Community has set up an EAC Climate Change Policy to help combat the region's climate change. As a community, the East African Region is facing similar challenges such as droughts, floods and extreme weather events, and are trying to work together to find policies to eliminate environmental degradation. Studies have also not been done on the moderating effect of urbanisation on the relationship between CO<sub>2</sub> emissions and globalisation in the East African Region, which plans to work together to eliminate environmental degradation. Using statistical analysis, this research will measure the impact of globalisation on CO<sub>2</sub> emissions in the East Africa Community and will also investigate the moderating effect of urbanisation in the relationship between CO<sub>2</sub> emissions and globalisation in the East African Region. This study focused on the East Africa Community as it is well placed to undertake new development pathways to avoid the excesses of the developed countries to control environmental degradation due to CO<sub>2</sub> emissions. With regional integration in full swing, it is important to understand the effect globalisation has on CO<sub>2</sub> emissions and whether it is a threat to the region. This will enable East Africa Community members to strengthen their existing environmental policies for the future. Policies will also monitor the adverse effects of globalisation and urbanisation in the region.

### **1.3. Research Objective**

- i. To identify the effect of globalisation on CO2 emissions in East African Community member countries.
- ii. To identify the moderating effect of urbanisation has on the relationship between globalisation and CO2 emissions in EAC member countries.
- iii. Test if the Environmental Kuznets Curve hypothesis holds in the East African Community member countries

### **1.4. Research Question**

- i. What is the effect of globalisation on CO2 emissions in East African Community member countries?
- ii. Does urbanisation have a moderating effect on the relationship between globalisation and CO2 emissions in EAC member countries?
- iii. Does the Environmental Kuznets Curve hypothesis hold for East African Community members?

### **1.5. Scope of the study**

The study focused on the effect of globalisation on CO2 emissions in East Africa member countries, that is Kenya, Burundi, Tanzania, Rwanda and Uganda from 1990 to 2014. South Sudan was not included due to lack of data. This is because South Sudan became an independent country in 2011. More is needed to be done to control CO2 emissions. Working as a regional bloc provides East Africa with synergy to pool resources together as they work toward this goal.

### **1.6. Significance of Research**

Advanced economies have become more vigilant in their reduction of CO2 emissions in order to combat climate change, African economies should follow suit. The study aimed at assessing the effect of globalisation on CO2 emissions in the developing economies of the East Africa and looked further into the moderating effect of urbanisation on this relationship. The study shall guide further research on the subject as developing economies continue to grow and expand. Researchers will be focused more on the study of environmental degradation in Africa as the results are strongly felt in the region. This will also enable carbon finance projects to come up with efficient planning designed for developing countries. Carbon finance projects refer to

projects that are producing or are required to create greenhouse gas (GHG) emission reductions by the purchase of such emission reductions that are tradable on the carbon market.

This study will encourage policymakers to make policies and laws that directly and explicitly deal with CO<sub>2</sub> emissions in the region. Policies will be formulated in relation to the SDGs, one of the goals being to incorporate climate change into national strategies and planning. This study could be beneficial for the EAC Climate Change Policy Framework as they prepare and implement ways to tackle climate change in the region whilst still ensuring there is economic and social development. The study will also be useful to environmentalists as they will be able to formulate policies and strategies to combat environmental degradation in the region.

## **CHAPTER 2: LITERATURE REVIEW**

### **2.1 Introduction**

This chapter examines work done by researchers that have discussed the relationship between globalisation and CO<sub>2</sub> emissions and develops a conceptual framework. The chapter also has a summary of theoretical review, empirical review and expounds on the research gap.

### **2.2. Theoretical Review**

#### **2.2.1 Environmental Kuznets Curve (EKC) Theory**

The EKC is a hypothesis accustomed to define the connection between environmental improvement or degradation and economic development. It describes that pollution levels are multiplied as a country grows up to a precise level, however decreases with future increases in per capita income. The hypothesis states a U shaped relationship between different pollutants and earnings. Borghesi (1999) concludes that industrialised countries may have moved along the inverted U pattern but it should not imply that developing countries will or should use the same pattern.

The implications of the EKC are that because the economy is before industrial changes, the environment is free from the pollutants from industrial economic activities. As the economy begins to develop, the region is at a lot of risk of pollution and depletion of natural resources. Later on, when the economic growth continues, the curve returns to a clean environment and people are keen on improving the environment as they become more aware of the benefits of the environment. Xu (2011) postulates that the aim of coming up the environmental growth models is to find optimum growth methods for the relationship between pollution and economic growth, that is essential to justify the EKC theory. During this study, the connection between globalisation and carbon dioxide emissions in EAC countries may well be completely different from what is expected to hold in the EKC hypothesis.

### **2.2.2 Ecological Modernisation Theory (EMT)**

This theory states that when the economy grows, the amount of associated environmental degradation at some point may be unnoticed. The concept implies that through development of recent technologies, it is attainable to cut back emission of pollutants. Mol (2000) claims that the Ecological Modernisation Theory (EMT) could be an important conceptual framework used to get understanding of the ways in which environmental consideration and interests results in changes in international institutions and cultures that are heavily impacted by globalisation.

An ideal EMT framework consists of the following. First, there is orientation to the ecological modernisation theory. This needs that; the policy goals are to blend the economy with the environment, existence of standardised definitions to build up governance of ecological modernisation and adequate resources and related capabilities are present to confirm application of the policy. Secondly, the required result of the policy is identified. This might be science based mostly addressing particular environmental issues or a process-oriented model that wants to harmonise the economy and environment. Lastly, there are policy interventions that deliver the required outcome. This theory is related to the study as globalisation tends to increase as the economy grows therefore there might be a positive relation with environmental damage.

### **2.2.3 Pollution Haven Hypothesis (PHH)**

Population Haven Hypothesis (PHH) refers to when massive industrialised nations established factories abroad, they will search for the most affordable choice in terms of resources and labour. transnational companies relocate production of their polluting product to developing countries, that have low environment monitoring. Developing countries become a 'haven' to the world's polluting industries. Therefore, it is expected developed countries will profit in environmental quality from trade whereas developing countries will lose. EKC is probably a reflection of PHH as one of the factors that drives increase in environmental degradation is through world waste trade. Globalisation has led to foreign countries building their factories in East Africa and this might have an impact on the environment within the region because of use of fuels and energy.

## **2.3. Empirical Review**

### **2.3.1. Globalisation and CO2 emissions in developed Countries**

Kalayci and Hayaloglu (2018) support this in the study of the effect of globalisation on CO2 emissions in the case of Canada, Mexico and United States for 1990-2015. The study employs panel data analysis on CO2 emissions, GDP, trade openness, energy consumption per person and KOF globalisation index. The findings of the study show that greater economic globalisation with trade openness leads to greater CO2 emissions hence also showing evidence of the EKC hypothesis. Al Mulali et al. (2015) investigate the effect of monetary development, urbanisation, financial growth, renewable electricity, and trade openness in 23 European nations. The study employs VECM and Pedroni co-integration on CO2 emissions, gross domestic product, urbanisation, financed development, trade openness and renewable electricity production. The discoveries show exchange transparency lessens pollution over the long haul and stimulates non polluted businesses in the region. Jebli et al. (2015) explore the EKC theory by taking a gander at the role of renewable and non-renewable energy consumption and international trade for 25 OECD countries. The study looks into the relationship between CO2 emissions per capita, GDP, renewable and non-renewable energy consumption and international exchange over 1980 to 2010. The methodology includes a short run granger causality test, Pedroni cointegration tests and OLS tests. The findings back the EKC hypothesis. Hence, in the long run, more non-renewable energy consumption releases more CO2 emissions while an increase in trade or renewable energy diminishes CO2 emissions. Liu et al. (2020) through using a panel fixed effects model, investigate the connection between globalisation and CO2 emissions seven developed countries. The variables employed in the study are CO2 emissions, globalisation Index, consumption of energy and gross domestic product for the years 1970-2015. The results support the EKC hypothesis and shows that increments of monetary yield are related with measurably noteworthy development in CO2 outflows.

### **2.3.2. Globalisation and CO2 emissions in Emerging and Developing Countries**

Shahbaz et al. (2015) examines the effect of globalisation on CO2 emissions in China for period 1970-2012. The study employs the Bayer and Hanck co-integration tests and ARDL co-integration test. The causal relationship is investigated by VECM. The variables identified are: real gross domestic product, CO2 and KOF globalisation index. Findings show that at with lesser earnings, environmental deterioration tends to increase as individuals are more likely to just accept increasing environmental deterioration in place of more consumption. This verifies the validity of the EKC hypothesis.

Salahuddin et al. (2019) using time series data explores the impacts of urbanisation and globalisation on CO2 emissions for South Africa for 1984-2016. Employing ARDL cointegration tests to estimate causal direction among variables and long run and short run coefficients. The variables used are CO2 emissions, GDP, KOF globalisation Index, urban population and those that have electricity. The findings of this research are that urbanisation prompts CO2 emissions both in the long run and short run and the positive long run effects contradict the pollution haven hypothesis. Dinda (2009) contradicts this in his study that explains the impact of globalisation on levels of pollution, intensity of pollution and relative change of pollution for countries. The study carried out for the period 1965-1990 employs panel data technique on the variables: capital labour, trade imports and exports, level of income, population, relative capital ratio and income. The findings partially support the pollution haven hypothesis and postulates that globalisation helps developed countries reduce CO2 emissions but causes a rise of CO2 emissions in developing countries while the net impact of globalisation increases global warming.

The effect of economic international trade and globalisation on environmental degradation has attracted researchers. Shahbaz et al. (2016) incorporate globalisation and intensity of energy to the CO2 emissions function and investigate the presence of EKC in some African countries for the period of 1971-2012. The study applies the ARDL model testing approach to cointegration to examine the relationships in CO2 emissions, globalisation, energy intensity and real gross domestic product. The findings show different results. Most countries show that globalisation decreases emissions, while globalisation enhances emissions in seven countries.

#### **2.4. Research Gap**

Research has been done on the relationship between globalisation and environmental degradation in developed countries (e.g. Shahbaz et al., 2015; Salahuddin et al., 2019; Kalayci & Hayaloglu, 2018; Liu et al., 2020). Research has also been done on this relationship in some developing countries (i.e. Salahuddin et al., 2019, Dinda, 2009). Research on this relationship has not focused on the East African Community with urbanisation as a moderating factor. This research examined the effect of globalisation on CO<sub>2</sub> emissions in the East African Community and the moderating effect of urbanisation on this relationship. Globalisation is necessary for urbanisation as it affects the spatial allocation of resources and creates spatial impacts. Urbanisation is included as a moderator variable as urbanised cities are usually portrayed by rapid industrialisation which causes emissions of CO<sub>2</sub>. Studies have not been done on the East African Region, which plans to work together to eliminate environmental degradation. There has been the formation of the EAC climate change policy, which aims to work towards combating climate change yet no research has been done on the effect of globalisation on the EAC as a whole. This will be key in implementing and formulation of policies.

#### **2.5. Conceptual Framework**

The conceptual framework explains the constructs to be studied and their relationship either in a visual format or in words. This study followed a sequential framework. Variables like real gross domestic variable (GDP per capita), KOF globalisation index, urbanisation and energy consumption have an effect on CO<sub>2</sub> emissions (metric tons per capita) of Kenya, Uganda, Tanzania, Rwanda and Burundi. The study focused on globalisation having an effect on the emission CO<sub>2</sub> and how urbanisation affects this relationship. The CO<sub>2</sub> emissions will be the dependent variable. Urbanisation is the moderator variable and globalisation, GDP per capita and energy consumption are independent variables. The data will be acquired from the World Bank database on the World Development Indicators (WDI). The expected relationship between globalisation and CO<sub>2</sub> emissions is positive. It is expected that as globalisation increases, CO<sub>2</sub> emissions will increase due to increased use of fossil fuels and energy use. The expected relationship between gross domestic product and CO<sub>2</sub> emissions

would be positive. An increase in GDP per capita would mean positive economic growth and thus increase in CO2 emissions. The expected relationship for energy consumption and CO2 would be positive. This is because an increase in energy consumption would mean more industrial output as a portion of gross domestic output. More industrial output would result to more pollution hence more CO2 emissions. The expected effect of urbanisation which is the moderator variable is that as urbanisation increases, the effect of globalisation on CO2 emissions would increase. GDP and energy consumption are the control variables in the study. The choice of these variables was influenced by past literature discussed above, specifically by the study by Shabhaz et al. (2016), as adequate to determine the effect of globalisation on CO2 emissions.

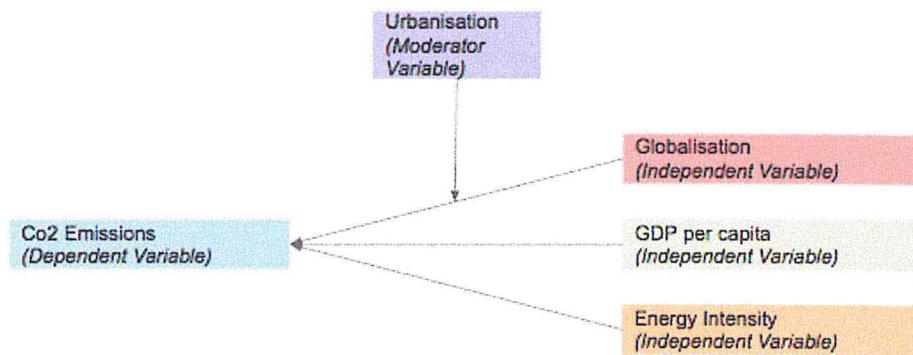


Figure 5: Conceptual Framework

## **CHAPTER 3: METHODOLOGY**

### **3.1 Introduction**

This chapter examined the empirical analysis of variables required to assess the effect of globalisation on CO<sub>2</sub> emissions in the East African Community. This section focused on the research design that had been followed to carry out the research. In addition, it focused on the population and sampling, which gives the range and scope that will be covered by the study. Furthermore, this chapter focused on the type of data used and where the data was retrieved. Finally, this chapter emphasised on how the data was analysed

### **3.2 Research design**

The study utilised causal research design while following a quantitative approach. A causal research design seeks to establish cause- effect relationships among globalisation and CO<sub>2</sub> emissions. Causal research design examines an investigation of a circumstance or a specific issue to clarify the pattern of relationships between variables. The research used causal research design as it helps in identifying the causes behind processes taking place in the system and this knowledge can help take necessary actions to fix the problem or optimise the outcome. It also helped in identifying the impacts of changing the processes and existing methods. This is in line with the research which looks into the effect of globalisation on CO<sub>2</sub> emissions. It will identify if in East Africa Community, globalisation has any effect or causes any changes in CO<sub>2</sub> emissions.

### **3.3 Population and sampling**

The target population under review is the East Africa Community. The countries in the community include Kenya, South Sudan, Rwanda, Tanzania, Burundi and Uganda. Given the list, this study focused on Tanzania, Rwanda, Kenya, Burundi and Uganda due to availability of data. The period of the study is 1990 to 2014. The time period is limited due to availability of data. Data on energy consumption was not available until the year 1990 for all the countries.

### **3.4 Data collection**

#### **3.4.1 Type of data**

Secondary data will be appropriate in the study. Given that the research assesses five countries in the EAC, panel data will be utilised. Panel data allows to study on the economic scale whilst combining cross-country and time series. This study explored the effect of CO2 emissions on globalisation with the variables real GDP per capita and energy consumption indicator as control variables. Urbanisation is a moderator variable for globalisation.

*Table 1: Variable definition and measurement*

<b>Variable</b>	<b>Definition</b>	<b>Measurement</b>
CO2 Emissions (metric tons per capita)	These are CO2 emissions discharged from the burning of fuels plus producing of cement.	This is measured in metric tonnes per capita and calculated as a ratio
Real GDP per capita	The total of gross value added by producers within the economy and product taxes and minus any subsidies not enclosed in the value of the product.	Gross domestic product/ midyear population. Measured in US (\$)
Energy Consumption	The total amount of energy or power used used in each country	Primary energy consumption is measured in terawatt-hours (TWh).
KOF Globalisation Index	It measures the degree of social, economic and political globalisation of countries	Measures globalisation on a scale of 1 to 100
Urban population (Urbanisation)	It measure the number of people living in urban regions	Measured as a percentage of the total population

### **3.4.2 Sources of data**

Secondary data was utilised from various sources. Data on globalisation was sourced from the KOF Swiss Economic Institute. Data on CO2 emissions, real gross domestic product, urban population and energy consumption came from the World Bank

Development Indicators. This study analysed annual panel data spanning from 1990 to 2014.

### 3.5 Data analysis

#### 3.5.1 Model

The econometric model used in this study was specified as follows:

$$CO2_{it} = \beta_0 + \beta_1 \ln(GDP)_{it} + \beta_2 \ln(GDP)_{it}^2 + \beta_3 (KOF)_{it} + \beta_4 (KOF)(URB)_{it} + \beta_5 \ln(EC)_{it} + m_{it}$$

where,

$\beta_0$  represents the constant

$CO2_{it}$  represents CO2 emissions metric tonnes per capita

$\ln(GDP)_{it}$  is the real GDP per capita for country i at time t. Logarithm is used due to the large variation in the real GDP per capita.

$\ln(GDP)_{it}^2$  is the log of real GDP per capita squared

$(KOF)_{it}$  represents KOF index of globalisation

$(KOF)(URB)_{it}$  represents the interaction term of urbanisation and globalisation

$\ln(EC)_{it}$  represents energy consumption

$m_{it}$  represents error term.

The t represents the time aspect and i denotes the countries. The coefficients ( $\beta_1$  to  $\beta_4$ ) represent the changes in the dependent variable for every change in the respective independent variable. Globalisation is key for urbanisation as it affects the spatial allocation of resources and creates spatial impacts. Urbanisation is incorporated as a moderator variable as urbanised cities are usually portrayed by rapid industrialisation which causes emissions of CO2. It is observed that the pattern of consumption of urban cities has more carbon than the rural regions.

#### 3.5.2 Unit Root Tests

Tests used to check for unit root in this study are the Levin-Lin-Chu (2002) and Im-Pesaran-Shin (2003). The tests were carried out so as to avoid spurious regressions. It is key to check for stationarity and order of integration thus on decide what model to

use. Akpansung and Babalola (2011) state that in panel data, the null hypothesis is outlined as, all panels contain a unit root. Failure to reject the null hypothesis that first differences of the data need to be calculated to induce stationarity. The Levin-Lin-Chu test includes individual and time specific tests. The null hypothesis;

$$H_0: \rho_1 = \rho_2 = \dots = \rho_N = \rho = 0$$

The alternative hypothesis is;

$$H_1: \rho_1 = \rho_2 = \dots = \rho_N = \rho < 0$$

The Im-Pesaran-Shin test allows for separate unit root tests to be taken for the N cross sections and thus it is claimed that Im-Pesaran-Shin test is a generalisation of the Levin-Lin-Chu test. A limitation of Im-Pesaran-Shin test is that it requires use of balanced panel data.

### 3.5.4 Hausman Test

To distinguish a Fixed impacts model and Random impacts model, a Hausman test was completed. The Fixed Effects model was utilised while looking into the impact of variables that change with eventually. The model controlled for time invariant contrasts between individuals, so the estimated coefficients of the fixed effects models cannot be one-sided because omission of time variation qualities. This equation for the model at that point is,

$$Y_{it} = \alpha_{it} + B_1 X_{it} + \mu_{it}$$

where;

$\alpha_i$  (i=1....n) is the unknown intercept for each entity (n entity-specific intercepts).

$Y_{it}$  is the dependent variable (DV) where i = entity and t = time.

$X_{it}$  represents one independent variable

$B_1$  is the coefficient for that independent variable

$\mu_{it}$  is the error term

In its simplest form, fixed effects is dummy variable with one dummy variable included for each individual. In order to avoid the dummy variable trap, the intercept is suppressed. The dummy variables estimation of the fixed effects model is;

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \dots + \beta_k X_{kit} + \gamma_2 E_2 + \dots + \gamma_n E_n + \mu_{it}$$

Where

$Y_{it}$  is the dependent variable (DV) where i = entity and t = time.

$X_{k,it}$  represents independent variables

$\beta_0$  is the coefficient for the independent variables,

$u_{it}$  is the error term

$E_n$  is the entity n. Since they are binary (dummies) you have n-1 entities included in the model.

$\gamma_2$  Is the coefficient for the binary repressors (entities)

The Random effects model will be utilised when the variation across entities is thought to be not correlated with the independent variable. The model expects the entity's error term is uncorrelated with the independent variable subsequently permitting time variant factors assume a role as explanatory variables. The equation of the model is

$$Y_{it} = \alpha + BX_{it} + \mu_{it} + \epsilon_t$$

In order to distinguish between the two models, the Hausman Test distinguished endogenous regressors in a regression model. The null hypothesis demonstrates that a random effect model is suitable and alternative shows that a fixed effect model is proper.

The Hausman tests the null hypothesis that the unique errors are corresponded with the regressors henceforth the preferred model would be a random effects model. The Hausman test statistic is

$$H = (b_1 - b_0) (\text{Var}(b_0) \text{Var}(b_1))^{-1} (b_1 - b_0)$$

### 3.5.5 Breusch-Pagan Lagrange Multiplier Test

Breusch Pagan lagrange multiplier test was completed so as to decide between pooled OLS regression and Random effects regression. The null hypothesis is that the changes across elements is zero, thus no panel effect and presence of random effects.

### 3.5.6 F-Test

F- Test is carried out to decide between pooled OLS regression and Fixed Effects model. If the test is significant, reject poolability and opt for the fixed effects model.

### **3.5.7 Pooled OLS Regression**

when time constant attributes are present Pooled OLS can be used to derive unbiased and consistent estimates of parameters. In the case of heteroscedasticity, the cluster option is used. Clustered standard errors are standard errors that are robust to correlation between error terms and heteroscedasticity.

## CHAPTER 4: RESULTS AND ANALYSIS

### 4.1 Introduction

This section focuses on the data analysis and the results of the analysis. This section focused on the descriptive statistics of the data. In addition, it looked at the pre-estimation tests and the method of analysis. Finally, it focused on how the data was analysed and the data was then presented.

### 4.2 Descriptive Statistics

Table 2: Descriptive Statistics

		CO2 emissions	LnGDP	LnGDP <sup>2</sup>	Globalisation	Urbanisation	LnEnergy
<b>Mean</b>	<b>Overall</b>	0.114	5.802	34.009	40.158	16.623	6.230
	<b>Between</b>						
	<b>Within</b>						
<b>Std Dev</b>	<b>Overall</b>	0.089	0.595	7.025	10.113	6.169	0.680
	<b>Between</b>	0.093	0.411	4.753	8.086	5.912	0.706
	<b>Within</b>	0.031	0.467	5.580	7.038	3.141	0.246
<b>Min</b>	<b>Overall</b>	0.021	4.732	22.396	23	5.416	4.912
	<b>Between</b>	0.033	5.156	26.643	29.568	8.804	5.370
	<b>Within</b>	0.040	4.847	23.365	25.442	8.252	5.773
<b>Max</b>	<b>Overall</b>	0.332	7.182	51.584	57	30.904	7.427
	<b>Between</b>	0.269	6.272	39.592	49.48	23.917	7.272
	<b>Within</b>	0.220	6.750	46.001	56.730	23.609	6.695

Table 2 shows the descriptive statistics of variables relating to the East African Community Countries. The range of CO2 emissions is not very large. Generally, the ranges of our dependent and independent variables show low variation. The mean of CO2 emissions is 0.115 metric tons per capita. This is way less than the average of the world which as of 2017 was 4.73 metric tons per capita. Hence the East Africa Community region generally emits less CO2 emissions (metric tons per capita) than other regions globally. The range of the data is also not very large hence meaning the

countries on average produce the same amount of CO2 emissions and the amount has not greatly changed over time.

The natural log of GDP per capita has a mean of 5.802 which is equivalent to 330.96 US dollars which is relatively lower than most countries globally hence indicating the countries focused on in the study fall under low-income countries or low middle-income countries.

The range of urbanisation which is between 5.416% and 30.904% of the urban population. This indicates that urbanisation has increased over time. Globalisation which is between 23 and 57 on a scale of 1 to 100 which too indicates the rate of globalisation in the East African Community has increased over time. The standard deviations of 0.089 in CO2 emissions and 0.680 in energy consumption show a small growth rates but a high growth rate of globalisation and urbanisation with standard deviations of 10.113 and 6.159 respectively.

### 4.3 Unit root Tests

Table 3: Results of Unit root tests

Variables	Levin_Lin Chu	Levin Lin 1 <sup>st</sup> Difference	IPS	IPS 1 <sup>st</sup> Difference
CO2 Emissions	0.992	0.082	0.991	0.017
LnGDP	0.814	0.000	0.997	0.000
LnGDP <sup>2</sup>	0.914	0.000	0.999	0.000
Globalisation	0.611	0.001	0.995	0.000
Urbanisation	0.990	0.001	1.000	0.000
LnEnergy	0.883	0.001	0.996	0.000

Before carrying out the regression model, it is important test for stationarity using unit root tests. If the series has unit root, first differences will be used to correct this and for further analysis to be done. The results on Table 3 represent the p- values of the unit root tests.

For this study, the level of significance was 0.05. The null hypothesis of the presence of unit roots is rejected if the p value is less than the level of significance. Given the findings of the study as shown in Table 3, using both Levin Lin Chu and IPS, the variables are not stationary at level. After differencing, the variables become stationary. Hence 1<sup>st</sup> differenced variables will be used in the model.

#### **4.4 Fixed effects and random effects.**

After running both fixed effects and random effects model, it was found that both models had no time effects. The p-value is 0.424 for the fixed effects model and 0.338 for the random effect model. Both of which are greater than 0.05 hence failed to reject the null that the coefficients for all years are jointly equal to zero, therefore no time fixed effects are needed in this case.

For the fixed effects model, the p value is 0.0257 which is less than the significant value of 5% hence the random effects model is appropriate. For the random effects model, the p value is 0.010 which is less than the significant value of 5% hence the random effects model is appropriate.

The p value for the F test in the fixed effects model was 0.8925 which is greater than the 0.05 significant value therefore accepting the null hypothesis that there are individual specific effects. Hence the Fixed Effects model is not appropriate

To decide between Fixed Effects and Random Effects, the Hausman test is carried out, where the null hypothesis is that the preferred model is Random effects. It tests whether the unique errors (the unobserved effects) are correlated with the regressors, the null hypothesis being they are not. The probability value of the chi-squared distribution in this test was obtained as 0.8780. Therefore, we fail to reject the null hypothesis. The most appropriate model to be used is a Random Effects Model. This is in line with the F test that states the fixed effects model is not appropriate.

#### **Heteroscedasticity**

The null is homoscedasticity. After carrying out the Wald Test. p-value is 0.000 hence reject the null and conclude heteroscedasticity. Therefore, in both models robust standard errors is used to correct for heteroscedasticity.

### Serial Correlation

The results are Prob>F= 0.107. The null is no serial correlation. Hence fail to reject the null and conclude the data does not have first-order autocorrelation.

### Cross Sectional Dependence

Pesaran CD test is used to test whether the residuals are correlated across entities. The output is:

Pesaran's test of cross sectional independence = -0.233, Pr = 0.815

The null hypothesis is that residuals are not correlated therefore we fail to reject the null hypothesis at 10% significance level. Hence, no cross-sectional dependence hence the cross sections are independent within the period under consideration

### Breusch Pagan Lagrange Multiplier test

Given the Breusch Pagan Lagrange Multiplier test, the probability value of the chi squared distribution was attained as 0.778. Therefore, the null hypothesis was not rejected meaning that the Random effects model is inappropriate. This is, no evidence of significant differences across countries, hence a Pooled OLS regression was used.

## 4.5 Pooled OLS regression

Table 4: Pooled OLS regression Tests

Variable	Coefficient	Robust Standard errors	P value	T statistic
LnGDP	-0.031	0.119	0.797	-0.26
LnGDP <sup>2</sup>	0.003	0.011	0.768	0.30
Globalisation	-0.002	0.001	0.162	-1.41
(Globalisation)(Urbanisation)	0.0002	0.00009	0.020**	2.37
LnEnergy	0.040	0.014	0.004**	2.91
Constant	-0.002	0.002	0.321	-1.00

Significant p-values at \*10%, \*\*5% and \*\*\*1%

The data was heteroskedastic thus robust standard errors were used to correct for heteroscedasticity. According to the regression analysis, the estimated regression line can be presented as:

$$CO2_{it} = -0.002 - 0.0311n(GDP)_{it} + 0.0031n(GDP)_{it}^2 - 0.002(KOF)_{it} + 0.0002(KOF)(URB)_{it} + 0.040ln(EC)_{it}$$

An increase by one unit in globalisation leads to a decrease in CO2 emissions by 0.0020 metric tons per capita holding all other factors constant. Meaning that an increase in globalisation leads to a decrease in CO2 emissions. An increase in urbanisation by one percentage point leads to an increase in CO2 by 0.0002 metric tons per capita given the value of the KOF index is one. The full effect of urbanisation on CO2 emissions depends on the level of globalisation. An increase in the GDP by one percent increase is EAC, decreases CO2 emissions by 0.00031% metric tons holding all other factors constant. As GDP increases, there is a positive effect on CO2 emissions. Higher GDP tends to increase CO2 emissions, an increase in the square of GDP by one percent will lead to a 0.00003% increase in CO2 emissions metric tons per capita. This relationship of GDP gives a U curve instead of an inverted U curve. A one percent increase in energy consumption led to a 0.0004% increase in CO2 emissions metric tons per capita holding all other factors constant.

According to the p values, at level of 5% significance, the results of the Pooled OLS regression model revealed that the interaction term between globalisation and urbanisation and energy consumption is statistically significant. This means that the variables have a significant influence on CO2 emissions in the East African community for the period 1990 to 2014. T-values test the hypothesis that each coefficient is different from 0. To reject this, the t-value has to be higher than 1.96 (for a 95% confidence). In this is the case interaction term between globalisation and urbanisation and energy consumption have a significant influence on CO2 emissions with energy consumption having more influence.

## **CHAPTER 5: DISCUSSION AND CONCLUSION**

### **5.1 Introduction**

This section focused on the conclusions of the study and recommendations given. It also includes areas for further research other researchers can look into in the future. The section focused on the interpretation of the results, linkages to past results and conclusions of the results. It further went ahead to look at recommendations and the limitations of the study.

### **5.2 Discussion**

The objective of the study was to find if globalisation influences CO2 emissions and does this change when urbanisation is introduced as an interaction term for 5 East African countries across the period of 1990-2012 using Pooled OLS Regression Estimation.

From the analysis, globalisation and CO2 emissions had a negative relationship. Meaning that an increase in globalisation would lead to a decrease in CO2 emissions. This is in line with the study of Shahbaz et al. (2016) where they find that globalisation decreases CO2 emissions in most African countries but increases it in some countries. From the analysis, it was found that the relationship between globalisation and CO2 emissions is negative. This changes with the moderating effect of urbanisation. This is in line with the claims of Salahuddin et al. (2019) who using time series data explores the impacts of urbanisation and globalisation on CO2 emissions and conclude urbanisation stimulates CO2 emissions both in the long run and short run and the positive long run. In conclusion, when urbanisation increases it increases the effect of globalisation on CO2 emissions.

The EKC theory expects a U shaped relationship in that eventually pollution levels decrease with future increases in per capita income. This study was not the case in the study. The study was in line with Borghesi.(1999) in that the EKC theory may have been true for industrialised countries but may have not followed for developing countries. This refutes the claims of Shab haz et al. (2015) who found that at with lesser earnings, environmental deterioration tends to increase as individuals are more likely

to just accept increasing environmental deterioration in place of more consumption thus confirming the validity of the EKC hypothesis. Moreover, energy intensity and CO2 emissions have a positive relationship which is in line with studies like that of Shahbaz et al. (2016) who found that the variable of energy intensity had a positive relationship with CO2 emissions. This would mean that as energy consumption increases, the level of CO2 emissions metric tons per capita increases.

### **5.3 Conclusion**

The study concludes that the relationship between globalisation and CO2 emissions is negative but when the interaction term is introduced, the relationship is positive. This means that urbanisation indeed affects the relationship between globalisation and CO2 emissions. This would mean countries in the region with higher urban population release more CO2 emissions than other countries.

The study also confirmed that the relationship between economic growth and CO2 emissions does not follow EKC. Meaning that the relationship between GDP per capita and CO2 emissions is negative until a certain point then positive after a certain point. Previous research, Borghesi (1999), shows that developing countries do not necessarily follow the Kuznets inverse curve U shape and this study is in line with this.

In conclusion, urbanisation has moderating effects on the relationship between globalisation and CO2 emissions as seen in the pooled OLS regression. Urbanisation in East African member countries has increased in the recent past, making the environment more polluted than before.

### **5.4 Recommendations**

There exists a negative relationship between CO2 emissions and globalisation, and including the moderator variable, urbanisation, increases the effect of globalisation on CO2 emissions making it positive. CO2 reduction policies should be put in place and adopting of new technologies that help reduce pollution should be used to reduce the effect of CO2 emissions in the region. The development of carbon reduction laws in the region should be emphasised. Laws such as the carbon footprint law in Tanzania is a great example of what other countries in the region can pick up. Another example

is the plastic bag ban in Kenya and Rwanda can help reduce pollution and hence CO<sub>2</sub> emissions (by burning the plastic) in the region if the other countries adopted this policy. Kenya announced that it would be launching an emissions trading platform which would be aimed at providing companies with a platform to sell their carbon credit to foreign buyers. Rwanda intends to transform its industries by implementing its Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon, which makes provision for building carbon trading capacity within the private sector. The GIZ Global Carbon Markets Programme, based in Uganda, support the development of economic and carbon pricing instruments that would facilitate NDC implementation among the countries of East Africa.

The EAC country members should focus on how globalisation and urbanisation can increase without necessarily degrading the environment. They need to promote and facilitate economic-friendly globalisation and urbanisation to improve and sustain economic development without any ecological degradation. Governments need to promote renewable energy consumption in urban areas to strengthen the structure of energy usage.

As the EAC country members do not follow the EKC hypothesis, this would mean the countries should come up with ways to reduce CO<sub>2</sub> emissions earlier as the hypothesis does not hold. If the region integrates structural and technical policies and uses techniques to reduce pollution, they can bypass the EKC path derived from the experiences of developed countries as soon as possible.

### **5.5 Limitations of the study**

The key drawback of the study was the availability of data. South Sudan is part of the East African community but it was not in the study due to availability of data and also availability of data from years above 2014 limited the study.

### **5.6 Areas for further research**

The study should be improved by looking at variables that could affect CO<sub>2</sub> emissions in the region such as foreign direct investments and trade openness. These were not included in this study as they are incorporated in the globalisation index. Hence a study

that would not use the globalisation Index could focus on these variables. Introducing other interaction terms such as financial development may also enhance the findings of the study. This is because financial development is a main driver of globalisation globally (Jiang and Ma, 2019) Future studies should also focus on how globalisation and urbanisation can increase without necessarily degrading the environment.

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