Offshore Economic Activities and Environmental Quality: Nexus among Economic Growth (GDP), Foreign Direct Investment (FDI), Trade Openness, Energy Consumption and Carbon (CO_2) Dioxide Emission

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Submitted to the
Institute of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
in
Economics

Eastern Mediterranean University
August 2019
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

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ABSTRACT

The abstract is organized in as a rundown of different abstracts from different articles written by the author as they connect to the variables mentioned in the topic of this thesis.

The first study explores the triangular nexus among Foreign Direct Investment (FDI), international tourism, and energy use in determining the environmental quality in China. Emphasis is laid on the triangular nexus among the tourism arrivals (TA), Foreign Direct Investment (FDI) energy use (EU) and (CO_2) pollution/emissions which portrays how the interwoven relationship that exit among the chosen variables and tailored towards impacting the economic growth GDP) of China which in turn impact on the environmental quality of the country. The author's intention of investigating the triangular nexus among the choice variables is to provide answers to the questions raised at the conception of this idea, thus: Is there really an association among the FDI and CO_2 emissions through energy consumption? Is there a transmission among the GDP, FDI and carbo dioxide emission? Is there connecting factor between the GDP and carbon dioxide? The findings are: economic growth (GDP) has a positive relationship with both tourism arrivals, energy use, FDI and CO_2.This contributes to heavy CO_2 emissions which the author classified as the outsourced/offshore CO_2emissions in China FDI. Tourism arrivals have a bi-directional (feedback) causal relationship with energy use, and a uni-directional causal relationship with CO_2(transmitting from tourism to CO_2). Both FDI and energy use have bi-directional (feedback) causal relationship, CO_2, energy use and tourism

arrivals have a unidirectional relationship with GDP which established the triangular nexus among causality among the variables and impact on the GDP.

The second study investigates the interacting force between Carbon emission and offshore intensive activities and was tagged a fresh evidence for China. The study displayed nexus among the offshore economic activities, the economic growth (GDP), energy use and CO_2 emissions for a clear picture of the relationship among them. The study incorporated the Foreign Direct Investment (FDI) and Tourism Arrivals (TA) to account for the offshore effects. The study employed the converted Chinese annual data to quarterly data that covers the period of 1995Q1 -2016Q4 because of unavailability of Tourism data, and was estimated with ARDL and Granger causality approaches for both short and long run effects.

The findings are: CO_2 emissions have a positive relationship with both energy use, FDI and GDP. This contributes to heavy CO_2 emissions which the author classified as the outsourced CO_2 emissions in China FDI. Tourism arrivals have a bi-directional (feedback) causal relationship with energy use, and a uni-directional causal relationship with CO_2(transmitting from tourism to CO_2 emissions). Both FDI, energy use, CO_2 emissions and tourism arrivals have a unidirectional relationship with GDP which established the triangular nexus among causality among the variables and impact on the GDP.

The third study investigates and report clearly the environmental implication of offshore economic activities by linking amongst the economic growth, energy use and environment (CO_2) in a cointegrated and causality manner. We tried to find out if the effect of the carbon emission is positive to the performance of the Indonesian

economic growth with an eye on the energy intensity via offshore (FDI and Openness) economic and industrial activities in the economy.

The findings are: 1. The ARDL long run (elasticity) of economic growth is significantly positive associated with carbon emissions. But this finding changed in the lag 1 & 2 with negative and significant relationship between GDP and CO_2 emissions. 2. Positively significant relationship between economic growth and energy use (as expected). 3. Negative and significant relationship is found between openness and economic growth but positive and significant relationship was observed between openness and growth in the 1st and 2nd lag. 4. A negative but not significant relationship between economic growth and Foreign Direct Investment, inflow in the short-run, while in the long-run, the relationship became significantly positive; 5. A uni-directional causation is found passing to Foreign Direct Investment (FDI) from economic growth (GDP) at 5%, significant level; 6. Uni-directional transmission passing from energy to openness, CO_2 emissions, and from FDI to CO_2 emissions, while there is a feedback causation between openness and CO_2 emissions. The findings of this study have implication to the environmental quality of Indonesia via economic growth, hence, the higher and better the economic growth of the country the lesser the carbon emissions and the better the environmental quality. This support the pollution halo hypothesis, where FDI enhance economic growth which impact energy consumption and reduce carbon emission in the host country.

Keywords: Carbon dioxide (CO_2) emissions, Energy use, Foreign Direct Investment, Trade openness, Tourism arrivals, Offshore activities, Economic growth, China, Indonesia.

ÖZ

Bu bölüm, tezde bahsedilen değişkenlerle bağlantılı olarak yazar tarafından yazılan dört farklı makalenin özeti olarak düzenlenmiştir.

İlk çalışma, Çin'de çevresel kalitenin belirlenmesinde rol oynayan doğrudan yabancı sermaye yatırımları, uluslararası turizm ve enerji tüketimi arasındaki üçlü bağlantıyı araştırmaktadır. Seçilen değişkenler arasında var olan iç içe geçmiş ilişkiye dikkat çekmekte ve turizm geliri, doğrudan yabancı sermaye yatırımları, enerji kullanımı ve karbondiyoksit emisyonu arasındaki üçlü ilişkiye vurgu yapılmıştır. Aynı zamanda bu ilişki, ülkenin çevre kalitesi üzerinde etki yaratan ekonomik büyümeyi de etkilemektedir. Seçili değişkenler arasındaki üçlü ilişkiyi araştırmak amacıyla, şu sorulara cevap aranmaktadır: Enerji tüketimi vasıtasıyla doğrudan yabancı sermaye yatırımları ile karbondioksit emisyonu arasında bir ilişki var mıdır? Ekonomik büyüme, doğrudan yabancı sermaye yatırımları ve karbondioksit emisyonu arasında bir geçiş var mıdır? Ekonomik büyüme ve karbondioksit emisyonu arasında bağlantı var mıdır? Elde edilen bulgulara göre ekonomik büyüme ile turizm gelirleri, enerji kullanımı, doğrudan yabancı sermaye yatırımları ve karbondioksit emisyonu arasında pozitif bir ilişki tespit edilmiştir. Bu durum, yazarın Çin'de doğrudan yabancı sermaye yatırımları üzerindeki dış kaynaklı karbondioksit emisyonu olarak sınıflandırdığı ağır karbondioksit emisyonlarına katkıda bulunmaktadır. Turizm gelirleri, enerji kullanımı ile iki yönlü nedensellik ilişkisine sahipken, karbondioksit emisyonu ile tek yönlü nedensellik ilişkisine sahiptir. Hem doğrudan yabancı sermaye yatırımları hem de enerji kullanımı çift yönlü nedensellik ilişkisine sahiptir ve karbondioksit emisyonu,

enerji kullanımı ve turizm gelirleri ile ekonomik büyüme arasında tek yönlü nedensellik ilişkisi bulunmaktadır.

İkinci çalışma, karbon emisyonu ile off-shore yoğun aktiviteleri arasındaki ilişkiyi araştırmaktadır. Çalışma, off-shore ekonomik aktiviteleri, ekonomik büyüme, enerji kullanımı ve karbondioksit emisyonu arasındaki ilişkiyi açık bir şekilde göstermektedir. Çalışmada, deniz etkilerini de değerlendirebilmek adına doğrudan yabancı sermaye yatırımları ve turizm gelirleri değişkenleri dâhil edilmiştir. Turizm verilerinin mevcut olmamasından dolayı, Çin için yıllık veriler çeyreklik verilere dönüştürülerek 1995: Q1-2016: Q4 döneminde hem kısa hem de uzun vadeli etkileri incelemek için ARDL ve Granger nedensellik analizi uygulanmıştır. Bulgular, karbondioksit emisyonu ile enerji kullanımı, doğrudan yabancı sermaye yatırımları ve ekonomik büyüme arasında pozitif bir ilişki olduğuna işaret etmektedir. Turizm gelirleri ile enerji kullanımı arasında çift yönlü nedensellik ilişkisi bulunurken, karbondioksit emisyonu ile tek yönlü nedensellik ilişkisi bulunmuştur. Ekonomik büyüme ile doğrudan yabancı sermaye yatırımları, enerji kullanımı, karbondioksit emisyonu ve turizm gelirleri arasında ise tek yönlü nedensellik ilişkisi tespit edilmiştir.

Üçüncü çalışma ekonomik büyüme, enerji kullanımı ve çevre ile eşbütünleşik ve nedensel bağlantı kuran offshore ekonomik faaliyetlerinin çevresel etkilerini araştırmaktadır. Karbon emisyonunun, offshore ekonomik ve endüstriyel aktivitelerden dolayı Endonezya'nın ekonomik büyümesi üzerinde olumlu bir etkiye sahip olup olmadığı tespit edilmeye çalışılmıştır.Elde edilen bulgulara göre, 1. ARDL analiz sonuçları, ekonomik büyüme ile karbon emisyonu arasında uzun dönemde pozitif ve anlamlı bir ilişki olduğuna işaret etmektedir. Ancak bu sonuç, 1. ve 2. gecikmelerde ekonomik büyüme ile karbondioksit emisyonu arasında negatif ve

anlamlı bir ilişki olduğu yönünde değişiklik göstermektedir. 2. Ekonomik büyüme ile enerji kullanımı arasında beklentilerle uyumlu olarak pozitif ve anlamlı bir ilişki bulunmuştur. 3. Açıklık ve ekonomik büyüme arasında negatif ve anlamlı bir ilişki bulunmuştur ancak birinci ve ikinci gecikmede açıklık ve ekonomik büyüme arasında pozitif ve anlamlı bir ilişki olduğu tespit edilmiştir. 4. Ekonomik büyüme ile doğrudan yabancı sermaye yatırımları girişleri arasında kısa dönemde negatif ve anlamsız bir ilişki bulunurken, uzun dönemde bu ilişkinin pozitif ve anlamlı olduğu görülmektedir. 5. %5 anlamlılık düzeyinde, ekonomik büyümeden doğrudan yabancı sermaye yatırımlarına doğru tek yönlü nedensellik ilişkisi bulunmuştur. 6. Açıklık ve karbondioksit emisyonları arasında geri etki nedeni varken, enerjiden, açıklığa ve karbondioksit emisyonuna doğru ve doğrudan yabancı sermaye yatırımlarından karbondioksit emisyonuna doğru tek yönlü nedensellik ilişkisi bulunmaktadır. Bu çalışmanın bulguları, ekonomik büyümenin Endonezya'nın çevresel kalitesini etkilediği sonucuna ulaşmıştır ve ülkenin ekonomik büyümesi ne kadar yüksek ve iyi olursa, karbon emisyonları da o kadar az olacak ve sonuç olarak çevre kalitesi artacaktır. Bu sonuç, doğrudan yabancı sermaye yatırımlarının, enerji tüketimini etkileyen ve söz konusu ülkede karbon emisyonunu azaltan ekonomik büyümeyi arttırdığını ileri süren "Kirlilik Halo Hipotezi" desteklemektedir.

Anahtar kelimeler: Karbondioksit (CO_2) emisyonları, Enerji kullanımı, Doğrudan yabancı yatırım, Ticaret açıklığı, Turizm gelişleri, Açık deniz aktiviteleri, Ekonomik büyüme, Çin, Endonezya.

DEDICATION

This piece of work is dedicated to my Parents

Nze Fidelis Adigwe Chukwuebuka Udemba

&

Lee Roseline Ifeyinwa Nnebuife Udemba

ACKNOWLEDGMENT

At first, let me use this medium to tell my God that I am highly indebted to Him all the days of my life for with Him I am who I am and without him I am nothing! thank you my good God for the grace to achieve this stride.

My deepest respect and regards goes to my Supervisor Assoc. Prof. Dr. Hasan Güngör who played a fatherly and counselor's role all through the period of this work. My respect equally goes to Chair of Economics Department, Prof. Dr. Mehmet Balcilar. My appreciation goes to the entire staff and post graduate students of the great department, Economics Eastern Mediterranean University, North Cyprus for their impactful contributions towards the success of My academic carrier. I pray may God bless you all and keep you all for greater purpose in Life.

My profound gratitude to my Boss in Cyprus (Dr Hallow Al-Tabali) whom God used to grace my PhD studies, may God bless you sir, I won't forget your contributions towards my present academic success.

My warmest regards to my one and only Uncle's wife, Mrs. Sabina Augustine Nwaizugbe. I owe you more than I can pay but don't worry, my God is able to repay you bountiful and the needed grace in life. My only Brother, Mentor and Spiritual father (Rev. Emma Udemba Adigwe), I appreciate your fatherly and mentoring role all through my stay away from home. Will I forget the one and only wife of my youth, Mrs Edmund Victoria Bosede Udemba? My God will keep you Love. My sisters, Fidelia Amaka Udemba and Augusta Oluchi Udemba, I celebrate God for your prayers also. I won't forget to mention My brother's wife, Victoria Adigwe whom I fondly

call our wife and our (her) little babies, Christabel and Deborah Adigwe, I appreciate your prayers also.

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Chapter 1

INTRODUCTION

Climate change has become a global phenomenon and contemporary issue that calls for urgent attention from all works of life, having seen its causes cut across many fields of life. The speedy environmental degradations that most times give rise to climate change in form of global warming are attributed to many activities of man on the surface of the earth. The man's activities could come from different sectors as it connects across divers fields of life such as manufacturing and economic activities, agricultural sectors, household practicing, building sectors, mining and oil exploration activities, transportation sectors, and scientific activities.

Economic activities such as manufacturing (both onshore and offshore), trades, hospitality and tourism are all contributing to the climate change through the excessive energy consumption which in turn emit carbon dioxide. Most of the heavy machines use in the course of manufacturing or building of physical structures for the companies consume a lot of energy and in the process pave way for high emissions that eventually affect the environment adversely. These economic activities as they concern manufacturing could be in form of domestic (*onshore, where the local or the domestic producers engaged in productive ventures in the country*) or Foreign Direct Investment (*offshore, where the manufacturing or productive ventures are mainly influence by the foreign investors*). Whichever way the industrial activities take place there is always some level of energy consumption that will always permit carbon

dioxide emissions which impact both on the environment and climate change. Agricultural activities such as land reclaiming for farming which most times leads to deforestations contributes greatly to climate change. This permits the exposure of the environment to excessive heat because of lack of enough plants and trees that help in tracking and reduction of excessive carbon dioxide, and this contributes to global warming. The ability of plants to convert the excessive carbon dioxide and water into carbohydrates and oxygen respectively via photosynthesis process is no more attainable because of the deforestations. Activities of the animal husbandry such as herders on both land and water bodies also lead to environmental dilapidations. The methane which is inclusive in the composition of greenhouse gas emissions are produced via livestock which are mainly cows and buffalos, and also rice cultivation which most times dominate agricultural produce, mostly in Asian parts of the world (e.g. India). The chemical substances such as fertilizers used in farming equally contributes to the climate change through emissions of nitrogen oxide, even the production process of such substances which entails the mixture of other chemical substances could lead to climate change and all these processes bring about global warming. According to Carbon Brief Profile (2019), Agriculture accommodates about 16 percent of Indian greenhouse gas (GHG) emissions and the sector is majorly dominated by livestock and rice cultivation which contribute immensely to the GHG emissions via methane, and nitrogen oxide from fertilizers. The household practices such as cooking on unhealthy biomass equipment like stoves, usage of inefficient lightening like candles or kerosene supported lamps, use of coal or biomass heating systems gives credence to climate change and constitute some health hazards. A significant of housing practices that contributes to climate change are connected to the electricity consumption through electric cookers, stoves and heaters, lightening, air

conditioning and other electric consume appliances. The household practices emit carbon dioxide through the use of fuel burning appliances such as fuel-based cookers and stoves and heating systems and all these contribute to the climate change. Building and construction sector is another climate changing factor that contributes towards the global warming. Building entails replacement of forest with buildings and this act always leads to deforestations and contamination of the environment through the building materials such as cements, paints and soldering of iron. Even after the building, the occupants of those building will turn to impact the environment through their household practices such as mentioned above (e.g. cooking on biomass method, application of fuel and diesels in cooking appliances which emit carbon dioxide). All these equally contribute to the climate change. Transportation sector is among the powering agents of climatic change. Up until now, most of cars and heavy-duty trucks are all maintained by the use of oil and gas products, and these machines emit carbon mono oxide into the environment which contributes to the climate change. Mining and oil explorations which comes either in form of coal or oil spillage affect the environmental quality. Coal as among the sources of energy generating and a substitute to electricity has its consequences towards environmental impacts. Countries like China and India rely much on coal for their energy consumption capacities. Most of the air pollutions are coal induced emissions in such regions. Oil and gas is a major source of energy virtually in every sector. They are use in powering machines for manufacturing purposes, building purposes, farming purposes, transportation purposes, housing practices purposes and so many other purposes, and burning of these liquids and gasses gives rise to the climate change. The processing of oil gives birth to other liquefied gases such as kerosene, diesel and fuel which are put into use by filling and powering the machines. Asides this, the exploration and spillage

of crude oil is hazardous to the environment through its impact on both the water body and the land. It's adverse impact is felt on the aquatic life of the water bodies which most times reduces the amount of water inhabited animals and fishes and even turn them into poisonous sea foods, and the green life such as planting and farming in these regions where oil explorations are carried out are most times redundant and unfertile (e.g. South-South region of Nigeria).

The speed at which human activities increases and the expansion of activities in the aforementioned sectors leads to high energy consumption demand and this is among the major sources of carbon dioxide emissions. Energy consumption has been doubled since the world economic, political and social activities are getting more globalized thereby giving room for competitive spirit in terms of development. This has not left the entire globe the same, the globalization phenomena have put the world in a unified shape thereby paving ways for interactions of the entire nations both in positive and negative ways. The transferring of economics activities come with different positivity and negativities such as transferring of carbon emissions and pollutions. Rosenberg, 2001, in his follies of globalization theory, opined that urgent intellectual modification is now needed; it is arguably dangerous to give mechanical territorialism further lease on life in a globalizing world. The less developed or developing nations are increasingly doubling their speed of development by utilizing any means which is seen in their policies as regards economic activities such as industrialization, manufacturing, attracting the foreign investors. The more the effort towards development increases the more the tendencies to rely on heavy energy consumption which eventually impact on the environment. Studies have proven that developing countries tend to contribute more to the climatic change in their guest to catch up with the developed nations, while their developed counterparts are thinking of how to

control their emissions by shifting to a more conservative and renewable energy sources. Countries like China, India and other Southeast Asian countries have been fingered as major emission countries who are still struggling to come to terms with both Kyoto and Copenhagen targets of emissions cut from the summits. In their guest for speedy developmental catch up with other industrialized nations, some of these nations have succeeded in attracting the foreign investors into their economies with less stringent policies which permit the easy access of investing and doing business in countries like China and the rest, coupled with less expensive cost of production in regards to cost of labor. Most of foreign investors who cannot cope with the stringent policies and high cost of production as it entails the labor cost in their respective countries quickly seize the opportunity to transfer their manufacturing activities either by starting fresh manufacturing investments or by investing on the existing firms by buying them of the hands of the original owners. This is where we conceive the idea of outsourced or offshored carbon emissions in our various studies which is captured with Foreign Direct Investment (FDI) and trade openness and this is discussed properly in the subsequent chapters. According to our study, the offshore economic activities are the activities that are done across the border of a country, the foreign investors from developed countries are investing outside their countries because of some factors such as less expensive labors and relaxed laws against the foreign investors which are found in some developing countries like China or other Southeast Asia countries. Offshore activities could connote both investing into a foreign economy and outsourcing the industrial activities to a domestic company for the reason of reducing cost of production. We measured the outsourced or offshored carbon emissions with either FDI, trade openness or international tourism because, it is understandable that from the economic activities of the outlined variables constitute

the offshored/ outsourced economic activities in those countries giving rise to the carbon emissions in the domicile countries. In their quest to attain some heights in development by increasing their economic growth (GDP) they are losing sight of the impact of their actions to the environmental quality of their countries. Of recent China and India have been named among the fastest growing economies but on a surprising ground they are taking the lead in the global ranking of carbon emission leading to global warming. It is revealed that most developing countries are not balancing their economic growth with the environmental impact in their act of pursuing their economic goals while the developed countries are striving hard to balance these two phenomena (economic growth and environmental quality). To the best of our knowledge, few scholars (Liu *et al.,* 2018; Liu *et al.,* 2018b; Chen *et al.,* 2017; Chen *et al.,* 2016; Omri and Kahouli 2014; Ozturk and Al-Mulali, 2015; Shahbaz *et al.,* 2019 etc) have done some studies combining economic factors in researching on energy and emissions related issues as it concerns environmental quality and global warming, but none of them have conceived the idea of testing the environmental quality with offshored economic activities as we chose in this study. By doing this, our study tends to close the gap and as well open up a space for future researchers who may find this topic interesting to research on.

We explored the various studies in this thesis with the following variables: Economic growth (GDP); Foreign Direct Investment (FDI); Trade openness; International tourism; Energy use and Carbon dioxide. The choice of the variables is for proper exposition into the interactions among the forces that aid offshore economic activities and their impact to the environmental quality. The countries of our interest are China and Indonesia which we culled from Asia and Southeast Asia regions.

The second chapter of this work is a-two in one analyses with focus on China with same methodology and data, but with two different mode specifications targeted on two areas of our interests (Economic growth performance and Carbon economy performance). The main reason for this is for the expositions on how the current trend of Chinese economic growth is achieved through the offshore economic activities, and how the offshore activities of other countries in China are affecting the environmental quality of the country. The first model which is growth model is posited in a way of testing growth per capita with FDI, International tourism, energy use and carbon emission. We found the GDP being the dependent variable is affected positively by the selected variables, but specifically, FDI and international tourism is affecting GDP positively and significantly. This suggests the ability of China to handle and promote the economic growth by attraction of FDI and international tourism. The second model which is carbon model is also posited in a way of testing growth carbon emission with energy use, GDP, FDI and International tourism. We found the C02 being the dependent variable is affected positively by the selected variables, but specifically, FDI and is affecting C02 emissions positively and significantly. This is definitely suggesting that both FDI and energy use are contributing to environmental pollution in China.

The third chapter is a study on Indonesian economic performance with the implication to the environment quality of the country. We found pollution halo hypothesis according to Shahbaz, (2015). Foreign Direct Investment and energy use is affecting the economic growth of the country while still maintaining a good environmental quality.

The rest of the chapters will be structured in this order: chapter 2-4 will be the presentation of the studies we made on this topic. Chapter 5 will be the concluding and policy implication part of the study.

Chapter 2

TRIANGULAR NEXUS BETWEEN FOREIGN DIRECT INVESTMENT, INTERNATIONAL TOURISM, AND ENERGY CONSUMPTION IN THE CHINESE ECONOMY: ACCOUNTING FOR ENVIRONMENTAL QUALITY

2.1 Introduction

China is considered a hub of many commercial activities which translate into above average use of energy. It is estimated that China's basic use of energy increased to 3billion tons oil equivalent, amounting to 23% of the global total (Chen *et al.,* (2017). China in a quest to keep up with its fast pace of development trough industrialization have considered the ever-rising request and use of the inadequate energy resources a major obstacle. For this, extensive policies to foster the sustainability of the energy use has been enforced such as the Energy Development Strategy Action Plan (2014-2020), the Thirteenth Five-year Plan for Electric Power Development and Medium and Long-term Development Plan for Renewable energy (Liu *et al.,* 2013). Energy use has been intensified since the global economic activities are seriously shifting into era of outsourced manufacturing goods and trade. China in particular has achieved a commendable economic growth over the past three years of improvement and liberalization. China GDP has moved from a mere 6% to over 60% approximately

(Zhang, 2018). This rapid shift into trade and manufacturing is linked with great cost of natural resources and the climatic change (Chen, 2016).

The energy use is among the sources of carbon dioxide (CO_2) emissions, and this with other greenhouse gases is considered to account for global climate change (Quadrelli and Peterson, 2017). In extant literature, a strong transmission is shown between economic activities (e.g. heavy industrial and manufacturing activities) and their adverse impacts on environmental quality, and this is agreed to be among the causes of environmental dilapidation through CO_2 emissions (Uchiyama, 2016). Several advanced and developing countries are putting needed struggles to reduce and if possible to overcome the problem of increased CO_2 emissions. Following a unique framework (CGE model) that connects Chinese energy structure and economy, the work found that Chinese coal use measuring CO_2 pollution, should grow to the highest sometime in the year 2020, while the country's total CO_2 emissions would increase to maximum around 2030 (Peter. D, MIT, 2016). Environmental problems are sensitive areas of worry not only for the community but also in terms of making economic selection (Sy *et al.*, 2016). To curtail the inflammatory injuries of the CO_2 emissions to the global change has been among the worldwide struggle (Tamazian and Rao, 2010). China as perceived the global highest contributor of card bon dioxide after USA is facing serious pressure in a bid to reduce the world's climate change. This is the evidence of the outcome of the world's foremost concise climate treaty entered into force in Paris (UN, 2016). China as a principal actor amid the parties involved has been tasked to look into reasonable improvement plans of reducing energy use and curtail CO_2 emissions.

Aspect of energy use which has not been explored is the indirect and off-site energy use as regards to trade and FDI. Li *et al*., (2017) recognized this fact by pointing out that efforts so far has been centered on direct and on-site energy use without much concern to the indirect and off-site energy use as it regards to trade. Also, Davis and Caldeira (2013); Wiedmann *et al.* (2013) noted that for the rising world economy, many studies are of the view that energy consumption and pollution emission can be transferred as well as goods and services along the supply chains in cross-boundary commercial activities. Through the involvement of commercial transactions, an area or an industrial segment could purchase high consuming energy goods from other region or segment, to avert its immediate energy consumption. From the former research on energy use in the manufacturing areas in China, the volume of subsidiary energy use embedded in local commercial activities alone amounted so much than that of immediate energy use (Liu *et al*., 2012).

Shifting a bit from a direct or indirect energy use to a more interesting and attention seeking area of energy use, embodied energy. On this background, the embodied energy as a blend of the immediate and non-immediate use of energy has drawn more concern in the research community in the direction of energy evaluation aimed at china (Costanza, 1980; Chen and Chen,2010; Chen *et al*., 2010; Zhang *et al*., 2013; Zhou, 2008). Assessment of the energy blending (embodiment) in China's foreign business portrays blended energy transfer of china has increased greatly with the space of five years (Tang *et al*., 2016). Zhang *et al*., (2016) has come up with a detailed study on the embodied energy use which has shown the particular area of blended energy shifting motivated by diverse levels of concluding request.

Embodied energy use has been limited to only trade activities within the country without duly attention paid to the offshore economic activities. The full impact of the west outsourced manufacturing activities to China can be felt from the emissions of the greenhouse gases. Studies have shown that half of the current upsurge of China's CO_2 emissions is as a result of the industrial products for other nations (UK, USA and emerging economies) (Duncan Clark, 2009). The reason is not far-fetched from the Kyoto resolution about the CO_2 emissions. The Kyoto resolution maintained that countries where pollutions are produced are to bear responsible (Duncan Clark, 2009). By this rule, developed nations (e.g. UK, USA and other European countries) consider it as an advantage to easily exempt themselves from the CO_2 emissions and this informed of their emission reduction to 18% or below which is more sufficient to meet Kyoto target. Efforts are put in place to make do of less Kyoto's rule but to adopt the resolution of the Copenhagen Summit. The offshore emission is among the key unresolved issues as regards the energy use and CO_2 emissions. This has brought the world leaders to breaking of energy use and CO_2 emissions into consumption of CO_2 emissions and Production of CO_2 emissions.

To this end, the research seeks to contribute to the current literature by attempting to address the following salient questions while accounting for the effect of environmental degradation: Is there really a correlation between the FDI and CO_2 emissions through energy use? This has been debated and empirically explored in many works in current literature, nevertheless findings remain unsettled (Omri and Kahouli, 2014; Shahbaz *et al.*, 2015). Is there a transmission among the GDP, FDI and carbo dioxide emission? Is there connecting factor between the GDP and carbon dioxide?

Also, following the contention on who will bear the responsibility of the CO_2 emissions of some of the heavily industrialist but developing countries such as China, and Considering different views of researchers as regards to the classification of the energy use and CO_2emissions but with little or no insight into the contribution of the offshore economic activities, the present study seeks to investigate and advise on who will bear the responsibility of CO_2. With this, the current research bridges the gap by examining the association amongst FDI, CO_2 pollution by integrating the role of monetary development (GDP) for China. This, we plan to do by incorporate the Foreign Direct Investment (FDI) and Tourism Arrivals (TA) to account for the offshore effects. What informs the idea of using FDI in accounting for the offshore activities is that most of the manufacturing and industrial activities are outsourced from one country to another, like the case of China and most of them come in form or are regarded as Foreign Direct Investment (FDI). Also, most of the tourist arrivals into a country other than theirs is considered as offshore activities and the impact is felt mostly from the energy consumption angle which is utilized in maintaining the tourist sector, this, gives rise to high CO_2 emissions via energy consumption.

2.1.1 FDI as a promoter of both GDP and carbon emissions of Chinese

From the manufacturing sector, FDI is considered as a key provider in the economic growth (GDP) of China (Yabuki, 2018). Also, industrial activities in China has been identified as the mainstream contributor to the Chinse economy output (Yabuki,2018). FDI is among the contributing factors in expansion of industrial sector in China through the mobilization of foreign resources via offshore or transferring of manufacturing activities from foreign countries –especially developed countries to China. Hence, Khan and Kim (1999) argue in favor of nurturing manufacturing benefits needs the backings of foreign resources which is considered a very essential

element for the advancement of the manufacturing sector. The expansion in industrial sector via manufacturing activities leads to high energy consumption request and this is among the main cause of CO_2 emissions (Shahbaz et al., 2015). However, this revelation has its implication on the economy growth trajectory and environment at large. Further, FDI inflow to China could impact CO_2 releases through scale, technique and structure effects (Khuda Bakhsh, 2017).

Energy use has been intensified since the global economic activities are seriously shifting into era of offshore manufacturing goods and trade. China in particular has achieved a commendable economic growth over the past three decades of reform and opening-up. China's GDP has moved from a mere 6% to over 60% approximately (Zhang, 2018). This rocket speed- like in economic advancement without full attention from government side as regards to the environmental effect has place the country in a position to face some severe environmental degradations. Apart from its impact to global climatic changes, China is also among the global leaders in other forms of emissions that constitute pollution, considering its huge populace coupled with its determination to grow into the next global commercial recognized nation. Revealing from World Health Organization (WHO), latest levels of pollution emissions in China far surpass global ecological criteria (Atapattu and Schapper, (2019). Fresh studies show that the air in some Chinese regions encompasses much larger gas emissions with ability to be stored in human lungs and causes series of wellbeing issues (Liu and Bae, 2018). According to findings, it is revealed that China's coal use, a major source of global carbon dioxide (CO_2) emissions should double anytime in the year 2020, while the country's overall C02 emissions would double around 2030 (Davidson et al. (2016). This is to say that Chinese energy consumption is among the global environmental threats, hence, call for a check. Because of the excessive energy

consumption by China through the economic activities in the country, China has been identified as highest emitter of C02 emissions in the global ranking in 2017 and 2018 consecutively. This is illustrated graphically as follows:

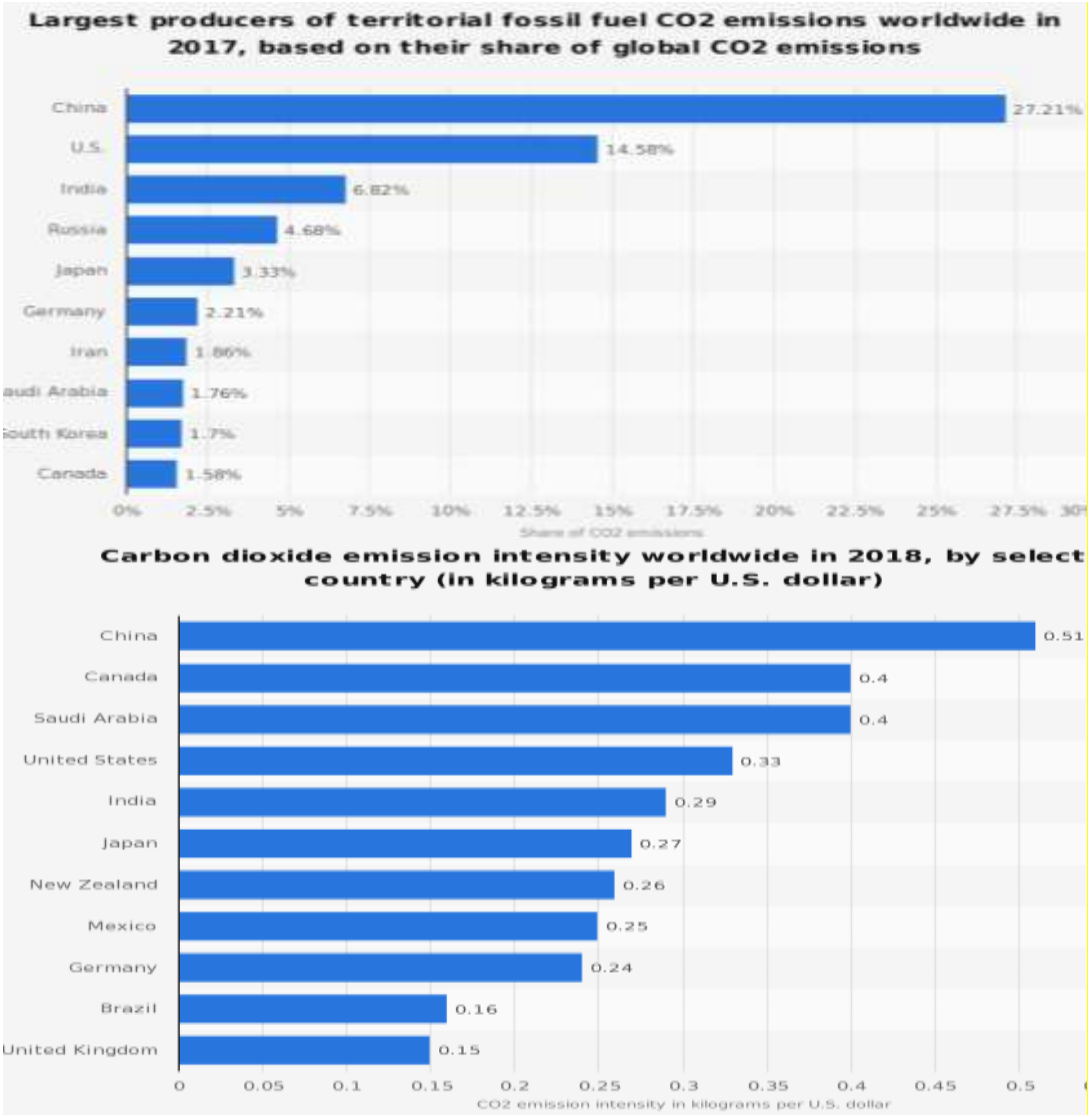


Figure 1: Highest emitter of C02 emissions in the global ranking in 2017 and 2018
Source: World Energy Council @ Statista, 2019

China has posed as a center of manufacturing activities both inward and outward. Half of the recent rise in Chinese carbon dioxide pollutions is caused by the manufacturing of goods for other countries-particularly developed nations such as UK (Duncan Clark, 2009). It was revealed that China's carbon emissions are as a result of producing goods

for export which is single out as offshored emissions. According Glen Peters (2009; 2011), 9% of total Chinese emissions are as a result of manufacturing goods for the US, and 6% are from producing goods for Europe. This has posed as one of the crucial points raised in Copenhagen summit in attempt to replace the Kyoto protocol. Under Kyoto, emissions are allocated to the country where they are produced without reminiscent on the side of the originality of the offshored productions in the case of China. This has made some developed countries such as UK to submit that they have sufficiently reduced emissions to meet its Kyoto expectation. Qin Gang, (2018) once said that China remains a world factory which he justified by saying: Lots of the items that proffer solutions to man's basic needs manufactured in China (which directly infers that China increase both production and increases emissions). Yang Ailu, (2018) also maintained that what the developed countries do is export much part their production activities to China and turn China into a global factory base. China still hinge on coal (the most horrible and filthiest of all the fossil fuels) for the major part of its energy use even when its striving to go on a cleaner energy (Brown, 2015). Isabel Hilton, (2016) is of view that the industrialist nations should consider it responsibility to shoulder some of its emissions to help China develop into a greener economy. He said, this suggests significantly decreasing their emission and assisting China with the funding and the needed expertise to move to a moderate and a low-carbon economic structure. Since the concern for the carbon dioxide (C02) emissions started gaining global attention, there has been a contention on who will bear the responsibility of the CO_2 emissions of some of the heavily industrialist but developing countries such as China. Also, Jonathan, (2009) suggests that the only residence to record pollution releases is in the place of origin (in this case, China). He backs his claim by citing the complexity of double counting in global accounting system for greenhouse gases.

Several developed and emerging economies are putting needed efforts to reduce and if possible, to overcome the problem of increased environmental pollution. As put by (Sy et al., 2016), ecological problems are sensitive zones of worry not only for the municipal but also in terms of initiating economic policies. Reducing of the demagogic injuries of the CO_2 emissions to the universal climatic change has been among the global fight (Tamazian and Rao, 2010). China is the world's largest emitter of carbon dioxide (CO_2) after USA and the country is under massive pressure in international climate change negations (Clémençon, 2016).

Based on inconclusive ground on the association between the FDI and carbon emissions through energy consumption (Omri and Kahouli, 2014; Shahbaz et al., 2015), the second research model that presents the study in carbon emission function seeks to add to the existing literature by reinvestigating the relationship among the FDI and C02 for dependable and reliable pragmatic analysis. The author tends to establish the consistent empirical analyses through addressing the following questions while accounting for the effect of environmental degradation: Is there really any meaningful relationship between FDI and carbon emissions through energy consumption? Is China to be blamed and bear the responsibility of CO_2 emissions by FDI or not? So, doing, this study will fill the gap via exploring the association between FDI, CO_2 release by integrating the part of economic advancement for China. Novelty of the present study are the following: Acknowledging the impact of offshore economic activities to the environmental quality of China, and Measuring the offshore economic activities with FDI and Tourism which will open up a new debate on who will bear the emissions generated via offshore economic activities. The idea of measuring the offshore economic activities using FDI is that most of the manufacturing and industrial activities are outsourced from one country to another,

like the case of China and most of them come in form or are regarded as Foreign Direct Investment (FDI).

2.1.2 Recent Development of Chinese renewable energy production

Following the steady increase in the utilization of energy, and in a bid to curtail the its contribution towards global emission, China has adopted some extensive policies to foster the sustainability of the energy use and to embrace renewable energy. Policies such as the Energy Development Strategy Action Plan (2014-2020), the Thirteenth Five-year Plan for Electric Power Development and Medium and Long-term Development Plan for Renewable energy has been enforced (Liu et al., 2013). China's 13th Five –year plan is targeted at a policy plan named "four revolutions and one corporation in energy boosting" which are, innovation, coordination, green, liberalization, and sharing. This four-plan policy is mainly framed towards clean, low-carbon, safe, efficient development policy, and to heed to the global energy transformation. Also, improvement of the policy structure for the purpose of stimulating developing renewable energy firms is among the evolutional policies to sustain the continuous shift into renewable energy. Currently, Chines energy industries are undergoing full scale development with experience of development of large-scale incremental replacement and regional stock replacement. In the first stage, Chinese tradeable renewable energy consumption is pegged at 436 million tons of coal accounting for 10% of the total key energy use. It was added to the contribution of the nuclear power, and all non-fossil energy use accounted for 12% of the key energy use. In effort to boost renewable energy, China have succeeded in installing both hydropower, wind power and photovoltaic grid-connected machines amounting to 320, 129 and 43.18 million kilowatts respectively. China is operating the total amount of renewable energy generated at 1.38 trillion kilowatts. Secondly, the scientific

evolution of renewable energy has increased both in technology and equipment. With these latest developments, China has moved a large renewable energy consumer to a powerful renewable energy producer. The country has a matured large-scale hydropower structure and management capabilities, and due to its renewable energy productive capacities, China has manufactured and put into working condition a single-capacity 800,000 kilowatt, 350,000 kilowatt class pumped-storage power plant and a mastered 500-meter water head. Generally, China is said to have crossed above average in maintaining the principles of moving away from non-renewable to renewable energy.

The remaining parts of this research are organized as: Section 2 explores the review of previous works in a nexus structures among the choice variables (nexus of GDP and FDI, nexus of FDI and CO_2 emissions, and nexus of GDP and CO_2 emissions); Section 3 presents the data, theoretical backgrounds and methodology; Section 4 presents the empirical results, interpretations and discussion and Section 5 presents the conclusions and policy implications.

2.2 Review of Related Literature

The review of previous related literature will be based on comparison and in analysis mediation among the variables. This section is structured to examine the literature by analyzing the relationship between FDI and GDP, FDI and CO_2 emission, CO_2 and GDP. Hence;

2.2.1 Nexus between GDP and FDI

Here, the present study explores some works on causality or relationship between the FDI and the GDP growth. Xing (2010), found that FDI improve the efficiency of Chinese domestic economy through intensified competition between the state-owned

enterprises and foreign invested firms in China. Hoang *et al.,* (2010) are of opinion that FDI can only impact the level of income through its contribution to capital accumulation without impacting the long-run growth rate. Hansen and Rand (2006) found strong transmission link between GDP and FDI in their investigation of 31 emerging states for the duration of 1970 to 2000. John C Anyanwu (2012) found that among the drivers of FDI is a traceable good robust economic growth rate which he observed in the economy of East and South African regions. (Toone, 2012) studied the Gulf cooperation council and establish no connection among FDI and monetary growth (GDP). (Teng *et al.*, 2014) examined the Ghanaian economy and noticed there is no causation among the FDI and GDP. On the same note, Karimi and Yusop, (2009) did a work on Malaysian economy and finding shows no causation among the FDI and economic development. Also, Irandoust and Ericsson (2001) did a work on FDI and growth and found no causality between them. Chakraborty and Basu (2002) explored the causation amongst the FDI and GDP with granger causality test and establish unidirectional connection amongst the FDI and economic advancement. Irandoust and Ericsson (2001) utilized Toda and Yamamoto to test a granger causation relationship amongst the economic growth and FDI on Scandalevian countries (Denmark, Norway, Finland and Sweden), they found a two-way transmission among the variables in Sweden and a one-way transmission from FDI to GDP for Norway but no causality relationship for the Denmark and Finland.

2.2.2 Nexus between GDP and CO_2 emissions

Chen *et al*., (2016) found in his work for Chinese interregional differences in CO_2 emissions that the rate of emitting is difference with some at high emissions while some at lower emitting but majority depicts positive association amongst the economic growth and CO_2 emission. Twerefou *et al.,* (2015) argued with his findings that per

capita income in Ghana has an adverse association with CO_2 pollution implying improve quality of the environment. Lee (2013) found an adverse association amongst the economic advancement (GDP) and CO_2emissions in his work on G20 countries. Furthermore, examining the direct effect of economic growth on CO_2 pollutions he establishes a positive connection amongst the growth and CO_2 emissions. Sharma (2011) found a positive influence of economic development on CO_2 pollutions. Also, Omotor (2015) confirmed the positive connection between GDP and the environment (CO_2) in his work on ECOWAS region. Boopen *et al*., (2011) establish an adverse connection amongst the GDP and the environment positing his findings to the increasing rate of human activities. Meanwhile, Acharya, (2009) is of the view that FDI have a positive effect on the CO_2 discharges through output growth, in other words, he opined that there is a progressive connection amongst GDP and CO_2 pollutions.

2.2.3 Nexus between FDI and Energy Use

Several studies have been carried out patterning the relationship between FDI and energy use. Paramati et al., (2017). Did a work titled "Financing clean energy projects through domestic and foreign capital: The role of political cooperation among the EU, the G20 and OECD countries" and found a significant positive association between FDI and energy use. Sbia et al., (2014) is of opinion that a significant positive association between FDI and economic growth (with regards to energy savings capacity) in UAE. Nayan et al., (2013) in his work found positive relationship between energy use and FDI. In Lee, (2013) 3stage model, he found a positive relationship among the FDI, CO_2and energy use. Ellit et al., (2013) demonstrated in his panel work on China that significant negatives association between FDI and energy use. Expending a dynamic pooled data, Omri and kahouli, (2014) confirmed a progressive

connection amongst FDI and energy consumption. Zaman et al., (2012) found a positive correlation between FDI and energy. Khatun and Ahamad (2015) in their causal work on Bangladesh found FDI to have positive relationship with the energy use. Also, in his causal work on China Kuo et al., (2012) explored the connection amongst FDI, energy consumption and economic growth between 1978 and 2010, he found a feedback transmission amongst the energy consumption and FDI.

2.2.4 Nexus among the FDI and CO_2 release

Studies of the link amongst the foreign investments and the environmental pollution proxy as CO_2 has garnered much space and still on-going. The few of the studies with mixed findings are reviewed here as follow: Pazienza (2015), did a study on OECD countries, considering the relationship between FDI and the environment with focus on how FDI inflow to the "agriculture and fishing" sector enhance CO_2 emission level, his findings shows an adverse connection amongst FDI and CO_2. Blanco *et al.*, (2013) deviate from the finding of Pazienza but showing that foreign investments inflows in high pollution emission industries can be associated with increase in environmental degradation via CO_2emissions per capita and per unit of GDP. Shahbaz *et al*., (2014), in his panel work on 110 developed and developing countries found a positive connection amongst the FDI and the environmental degradation. This indicates that FDI increases CO_2 emissions. Omri *et al.*, (2014) found in his work that FDI arrivals advances the CO_2 pollutions by 0.19%. In his work for the developing countries, Talukdar *et al.*, (2001) found an adverse significant association amongst FDI from the developed countries and CO_2 emissions. Kheder (2010) observed a positive association amongst French manufacturing FDI and CO_2 pollution in host states. Kheder (2006) investigated the association amongst FDI and the CO_2 emissions in China and found positive connection amongst FDI and ecological deterioration. Also,

Ajide *et al.*, (2010) in his work on Nigeria found the positive relationship between FDI (in terms of oil exploration) and CO_2 emissions.

2.2.5 Nexus between CO_2 and Energy Use

Alola et al., (2019) did a work titled "The role of renewable energy, immigration and real income in environmental sustainability target. Evidence from Europe largest states" and found transmission passing from energy consumption to carbon emissions. Balsalobre-Lorente et al., (2018) did a work titled "How GDP, renewable electricity and natural endowment add to CO2 release?" found a positive linking amid energy use and carbon release. Also, from the work of Sarkodie and Strezov, (2019) on the effect of FDI on carbon emissions in emerging nations they found carbon emission transmitting to energy use. A research work from Bekun et al., (2019) for 16-EU on a sustainable environment found a one-way transmission from energy use to carbon emissions. The work of Shyamal and Rabindra, (2004) revealed the negative relationship between CO_2 and energy use because of the improved energy efficiency and fuel switching. Sheinbaum-Pardo et al., (2012) in their work for Mexican manufacturing industries, found the relationship between energy intensity and the CO_2 to be negative in all the small sectors. Lean and Smith (2009) investigated the nexus association amid the CO_2 emissions and energy consumption through a cross sectional estimation for five ASEAN countries. He found a statistically significant positive relationship between energy consumption and emissions. Menyah and Rufael, (2010) established a progressive outcome of CO_2 release on energy use. Also, Niu et al., (2011) found progressive association amid energy use and CO_2 release in his study on 8 ASEAN countries. Also, Arouri et al., (2012) did a panel work on the 12 emerging countries and found a progressive substantial effects of energy use on CO_2 release.

2.3 Data, Methodology and Empirical Findings

2.3.1 Data

Our work employed the converted annual to quarterly data. That is the quadratic match-sum technique to transform yearly occurrence data into quarter frequency data. The study covers the period of 1995Q1 -2016Q4. It is established and validated that the outcomes of the annual series technique are unresponsive from those of the quadratic match-sum technique (Shahbaz, *et al.*, 2017; Romero, 2005 and, Emir and Bekun, 2018). The variables used in the current research are International tourism (figure of arrivals), Gross Domestic Product (GDP) constant 2010 US$, CO_2 emissions from solid fuel consumption (kt), Foreign Direct Investment net inflows (FDI), Energy use (kg of oil equivalent per capita). All the variables are combed from the World Bank Development Database (2018) and are all expressed in logarithmic form.

2.3.2 Theoretical Background

The current work constructs a hypothetical framework to explore the connection among the carbon dioxide (CO_2), energy use and offshore intensity activities and the economic growth. In order to be more direct to our claim, the study adopt Ehrlich and Holdren's (1972) IPAT model. Following to the IPAT framework, the per capita environment is determined by technology and income per capita. The fundamental framework is expressed as follows:

$$y_{1t} = f_2(A_{1t}, T_{1t}) \quad (1)$$

Where y_{1t}=l_{1t}/P_{1t}, and y_{1t} is the per capita CO_2 emissions effect. A_{1t} represents wealth, and is calculated by gross domestic product (GDP) per capita; T_{1t} represents technology.

Though, technology is difficulty to calculate precisely, former works (e.g. Javorick and Spatareanu, 2008; Keller, 2004) pointed out that increasing FDI impacts

technology through a spillover effects from investment wealth. Also, Hubler and keller (2010) studied the current literature and found that more effective technologies of external industries can equally add to an energy-subsiding method effect via skill knowledge transfer. To this, the level of tech can be negating or captured by the Foreign Direct Investment (FDI) and substituted by FDI. A few works have investigated the influence of FDI or have used it as a significant cause of environmental quality (Shahbaz *et al.*, 2014; Pazienza, 2015; Omri *et al.*, 2014; Talukdar *et al.*, 2001; Khedar, 2010 and Ajide *et al.*, 2010).

The deviation from the traditional Kuznets curve (EKC) theory (in which increasing decreasing relationship between GDP and environmental quality are measured) shows that it can be analyzed empirically applying diverse procedures of ecological qualities. For instance, is the works of Musolesi *et al.*, (2010) who used the traditional EKC to study local pollutant emissions and global pollutant emissions. Also, Galli,1998; Hubler and Keller, 2010; Sadorsky. 2010 apply the EKC in testing energy intensity. Moving a bit further from an old-style of EKC model, where GDP remains the single controlled variable, Selden and Song (1994) revealed that the initial and higher terms of GDP per capita are insignificant. Earlier works that have applied EKC model failed to recognize the problem where the order–one I (1) of square of an integrated process is having a unit root (Shu-Cheng Chang, 2014). Wagner (2008) argued that presently there is no assessment methods for pools as well as nonlinear transformations of unified process are in place. Hence, it is wrong for the model to add income per capita and its multiplied term when the income is an integrated process. Following the view of Wagner (2008) that at maximum, income and its multiplied form can be a unified process (i.e. when income is in unified process) the current work failed to include unified form of income (GDP) but rather interchange the position of the (CO_2)

emissions per capita effect with income (GDP per capita). This, we undertake in order to research on the vigorous interaction among carbon dioxide (CO_2) pollution, growth (GDP), energy use, tourism arrivals and Foreign Direct Investment (FDI) and also, bearing in mind the model specification which has GDP per capital as our explained factor. The specification will aid in measuring both the connection of economic growth and the (CO_2) pollution/emissions, and also the nexus connections between the economic growth (GDP), CO_2 emissions, FDI, TA and energy use. This will aid the author to justify the above raised questions (Is there really an association among the FDI and carbon emissions through energy consumption? Is there a transmission among the GDP, FDI and carbo dioxide emission? Is there connecting factor between the GDP and carbon dioxide?)

The Model is specified as follows:

$$y = f(CO_2, FDI, TA, EU) \quad (2)$$

$$y = f(GDP, FDI, TA, EU) \quad (3)$$

Where from both equation 2 and 3, y is measured by GDP per capita of Chinese economy , $CO_{2_{1t}}$ denotes carbon dioxide(CO_2) emission , TA denotes tourism arrival, FDI denotes Foreign Direct Investment (FDI) which capture a technology effect, and reflect the offshore manufacturing activities that give rise to high energy consumption and high emissions of CO_2, as cited in the introduction According, Glen Peters, (2009), some major percentage of Chinese total (CO_2) emissions are the outcome of manufacturing industrial products for the US, and other remaining percentages are from manufacturing industrial products for Europe, and EU denotes energy use.

We employ natural logarithms and a stochastic disturbance term ($\in$t) in order to show an easy identifiable empirical model and to reflect the concise nature of the data. The

effect of offshore activities and the high energy consumption on CO_2 emissions can be expressed as:

$$GDP=\alpha+\beta_1 + \beta_2 CO_2+\beta_3 FDI+\beta_4 TA+\beta_5 EU+ \varepsilon_t \quad (4)$$

$$CO_2=\alpha+\beta_1 + \beta_2 GDP+\beta_3 TA+\beta_4 EU+\beta_5 FDI+\varepsilon_t \quad (5)$$

Where GDP denotes log of GDP, CO_2 represents log of carbon dioxide emission, FDI denotes log of FDI, TA reps log of tourism arrival, EU reps log of energy use and ε_t is the error term. The $\beta_{1,}\beta_2, \beta_3, \beta_4 and\ \beta_5$ are the coefficients respectively. For the growth function, β_2 is the level of impact of CO_2 emissions to the income (GDP), and shows the variation in GDP for additional unit variation in CO_2 emissions? The GDP in the Eq. (4) shows the association among GDP and CO_2emissions, and reveals the growing or declining effect of CO_2 emissions on GDP, controlling for other variables, β_3 is the level of impact of FDI to the GDP which shows the variation in GDP for additional unit variation in FDI. While, the β_4 & β_5 show the variation in GDP for additional unit variation in tourism arrival (TA) and energy use (EU) respectively. For the carbon emission function, β_2 is the minimal influence of GDP to the CO_2 emissions, and denotes the variation in CO_2 emissions for each unit variation in GDP? The GDP in the equation (4 &5) exposes the connection amid GDP and CO_2emissions, and reveals the effect of increase in GDP on CO_2 emissions., controlling for other variables, β_3 is the minimal effect of TA to the CO_2 emissions which denotes the variation in CO_2 emissions for each unit variation in TA. While, the β_4 & β_5 signify the adjustment in CO_2 emissions for each unit change in EU and FDI respectively. Where GDP denotes log of GDP, CO_2 represents log of carbon dioxide emission, FDI denotes log of FDI, TA reps log of tourism arrival, EU reps log of energy use and $\in$t is the error term. The $B_{1,}B_2, B_3, B_4 and\ B_5$ are the coefficients respectively. B_2 is the

level of impact of CO_2 emissions to the income (GDP), and shows the variation in GDP for additional unit variation in CO_2 emissions? The GDP in the Eq. (3) shows the association among GDP and CO_2emissions, and reveals the growing or declining effect of CO_2 emissions on GDP, controlling for other variables, B_3 is the level of impact of FDI to the GDP which shows the variation in GDP for additional unit variation in FDI. While, the B_4 & B_5 show the variation in GDP for additional unit variation in tourism arrival (TA) and energy use (EU) respectively

2.3.3 Unit Root Test

Because of the prevalence of the breaks and shocks in the political and economic occurrences in most economies time series data are always considered not stationary. For this, the time series examination demands the ascertaining of the non-unit root of the variables applied in the research to avoid wrong estimations and falsified results from such analysis. Before the consideration of the model in this study, the stationarity and integrated order of the variables has been checked. We employed and combined different techniques such as Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1981), Phillips-Perron (PP) (Phillips and Perron, 1988) and Kwiatkwoski-Phillips-Schmidt-Shin (KPSS) (1992) unit root checks to determine if the variables have non-unit root. Table 1 explicitly indicate a mixture of integrating order of the variables at l (0) & l (1).

Table 1: The Results of the Unit Root Tests.

	Unit Root Test at Level		
Variables	ADF	PP	KPSS
LGDP	-2.004	7.774***	1.1837***
LTA	-1.623	-1.171	1.1583***

LFDI	-1.625	-1.555*	0.8085***
EU	-3.126	-2.201	1.1772***
L CO_2	-2.924	3.523**	1.1362***
		Unit Root Test at 1st Diff	
Variables	ADF	PP	KPSS
LGDP	-2.3843**	-2.895	1.1418***
LTA	-3.0317**	-4.0396**	0.2212
LFDI	-2.4391**	-4.1280	0.1232
EU	-3.2836**	-3.5333**	0.1149
L CO_2	-1.0740	-1.0949	0.3801**

Note: here ***, **, ***** denotes statistical rejection of the null hypothesis at the 1%, 5% and 10% respectively.

2.3.4 ARDL-Bound Testing Approach

For proper model specification and to reduce the likelihood of arriving at misleading or spurious results and analyses, we consider the ARDL approach more suitable for our estimation following the output of the unit root test from different techniques for robust check. Following Pesaran *et al.,* (2001), we considered ARDL suitable technique for this analysis with the presence of mixture of order of integration from the unit root test.

2.3.4.1 ARDL Specifications

The econometric specification of ARDL can be written as follows:

$$Y=\alpha+\beta_1+\beta_2\ CO_2+\beta_3 FDI+\beta_4 TA+\beta_5 EU+\varepsilon_t \quad (6)$$

$$CO_2=\alpha+\beta_1+\beta_2 GDP+\beta_3 TA+\beta_4 EU+\beta_5 FDI+\varepsilon_t \quad (7)$$

Where Y reps log of GDP, CO_2 reps log of carbon dioxide emission, FDI reps log of Foreign Direct Investment (FDI), TA reps log of tourism arrival, EU reps log of energy use and E_t reps the error term. The $\beta_1, \beta_2, \beta_3$ and β_4 are the coefficients respectively.

Further expression and arrangement of the ARDL is the expansion of the model into ARDL long run and short run models. The two models take into considerations the relationship(long and short run) that exist from the GDP to tourism arrivals, FDI, energy use and CO_2 emissions in two separate equations 8-11, thus;

$$Y_t=\alpha+\beta_1 y_{t-1}+\beta_2\ CO_{2_{t-1}}+\beta_3 FDI_{t-1}+\beta_4 TA_{t-1}+\beta_5 EU_{t-1}+\varepsilon_t \quad (8)$$

$$\Delta Y_t=\alpha+a_1\ \sum_{i=1}^{n}\Delta y_{t-1}\ a_j\quad \sum_{j=1}^{n}\Delta CO_{2_{t-j}}+a_k\ \sum_{k=1}^{n}\Delta FDI_{t-1}+a_l\ \sum_{l=1}^{n}\Delta TA_{t-l}+$$

$$a_m \sum_{m=1}^{n}\Delta EUP_{t-m}+ECM_{t-1}+\varepsilon_t \quad (9)$$

$$CO_{2t}=\alpha+\beta_1\ CO_{2_{t-1}}+\beta_2\ \mathrm{GDP}_{t-1}+\beta_3 TA_{t-1}+\beta_4 EU_{t-1}+\beta_5 FDI_{t-1}+\varepsilon_t \quad (10)$$

$$\Delta CO_{2_t}=\alpha+a_1\ \sum_{i=1}^{n}\Delta CO_{2_{t-1}}\ a_j\quad \sum_{j=1}^{n}\Delta GDP_{t-j}+a_k\ \sum_{k=1}^{n}\Delta TA_{t-1}+$$

$$a_l\ \sum_{l=1}^{n}\Delta EU_{t-l}+a_m \sum_{m=1}^{n}\Delta FDI_{t-m}+ECM_{t-1}+\varepsilon_t \quad (11)$$

Where the parameters in equation (8 & 10) ; $\beta_{1,}\beta_2,\beta_3,\beta_4\ and\ \beta_5$ are long run coefficients while in equation (9 & 11); $a_{1,}a_j,a_k,a_l\ and\ a_m$ are the short run coefficients. Δ and ECM_{t-1} represent the first difference of variables and the speed of adjustment over the long run respectively. We further expand the ARDL analysis by checking the long run relationship between the underlying variables using bound testing approach. We determine the long run by comparing the lower 1(0) and upper 1(1) boundaries with F&T statistics. If the F OR T statistics is greater than the lower and upper boundaries, it shows the existence of long run connection and vice versa. we specify the long-run restriction approach of equation (8) to capture the interactions among the variables. Thus,

$$gdp_t=\alpha_0+\Sigma\delta\beta_1\ gdp_{t-1}+\Sigma\delta\beta_2\ CO_{2_{t-1}}+\Sigma\delta\beta_3\ \mathrm{fdi}_{t-1}+\Sigma\delta\beta_4 ta_{t-1}+\Sigma\delta\beta_5 eu_{t-1}+$$

$$\beta_6 ec_t+\varepsilon_t \quad (12)$$

Table 2: ARDL Dynamic Estimate of the GDP Equation.

Variables	Coefficients	SE	t-statistics	Prob

Short-run				
D(LGDP(-1))	0.6276***	0.0866	7.2487	0.0000
D(LTA)	0.6810**	0.3330	2.0636	0.0154
D(LFDI)	0.007100***	0.0000003	23.333	0.0000
COINTEq(-1)	-0.001820***	0.000427	-4.265082	0.0001
Long -run				
LTA	0.3696**	0.1602	2.3071	0.0243
LFDI	0.0071***	0.0000004	3.22	0.0020
EU	1.5300	1.0000	1.5224	0.1328
L CO_2	0.0055	0.552	0.2492	0.8039
C	-1.6100	1.3300	-1.2055	0.2324
Bound test(Long-run)				
F-statistics	=6.54***, K=4	1%	1(0) bound=3.74	1(1) bound=5.06
Wald test(short-run)				
F-statistic	77.1			
P-value	0.0000			

Note**: *, **, ***** Denotes rejection of the null hypothesis at the 1%, 5% and 10%
Sources: Authors computation

The ARDL estimation for both the long-run and short-run is displayed in Table 2, with optimum lag as indicated by AIC. The cointegration equation for this work exposes .002% speed of adjustment to the equilibrium path on GDP via the impact of tourism arrival (TA), FDI, Energy use (EU) and CO_2 on a quarterly basis. The result confirms the positive significant association among economic growth (GDP) and the variables (tourism arrival and FDI) in the short-run, and (tourism arrival, FDI, energy use and CO_2) in the long run. This means that GDP is impacted positively by both tourism arrival and FDI positively in the short run and long run. This not surprising especially from the angle of FDI considering the rate of outsourced manufacturing and economic

activities from some developing nations (e.g. UK and USA) into china's economy. This result shows the long run (elasticity) of GDP in terms of CO_2 emissions, FDI, tourism arrivals and energy use are significantly positive. That is to say one percent rise in CO_2 emissions upsurges GDP by 0.005%. A one percent rise in foreign investments also surges the GDP by 0.007%, likewise the one percent increase in both tourism arrivals (TA) and energy use (EU) will lead to 0.369% and 1.53% respectively. Supposedly, from our findings a good economic performance synonymously economic growth is attributed to the ability of China to attract FDI and tourism arrivals as they are significantly and positively impacting the economic growth of China. Over a decade now, there has been a glaring tremendous rise on Chinese FDI and inbound tourism. Also, this translate to the FDI flow into the china's economy via outsourced mode from other countries impact the tourism sectors which will lead to expansion in the economic activities. This agrees with the take of Shahbaz *et al.,* (2017) who maintained that the tourism sector can stimulate investments, technological progress and increase in human capital capacities of nations. Also, we found a positive association amongst the GDP and the energy use and CO_2,this implies that over a period of time say in the long term, rise in the GDP upsurges the energy use and this consequently increases the C02 emissions. This is in consonant with the findings of Fei *et al.,* (2011). The outcome of this result supports the views of Huanying Cui (2016) which shows that china still advances economic growth at the expense of high energy use and drastically environmental degradations.

$$CO_{2_t}=\alpha_0+\Sigma\delta\beta_1 CO_{2_{t-1}}+\Sigma\delta\beta_2 gdp_{t-1}+\Sigma\delta\beta_3 \mathrm{fdi}_{t-1}+\Sigma\delta\beta_4 ta_{t-1}+\Sigma\delta\beta_5 eu_{t-1}+\beta_6 ec_t+\varepsilon_t \quad (13)$$

Table 3: ARDL Dynamic Estimate of the CO_2 Equation

Variables	Coefficients	SE	t-statistics	Prob
Short-run				
D(L CO_2 (-1))	0.6276***	0.0866	7.2487	0.0000
D(LGDP)	0.0120	0.309	0.0414	0.967
D(LFDI)	0.8907***	0.2279	3.9078	0.0003
D(EU)	0.4057***	0.1085	3.7405	0.0005
COINTEq(-1)	-0.0012***	0.000220	5.6267	0.0000
Long -run				
LGDP	0.0120	0.309	0.0414	0.967
LTA	0.0007	0.0013	0.5024	0.6178
LFDI	0.8907***	0.2779	3.2055	0.0024
EU	0.4057***	0.1272	3.1884	0.0025
C	0.1723	0.0746	2.3066	0.0255
Bound				
test(Long-run)				
F-statistics	=5.84***, K=4	1%	1(0)	1(1)
			bound=3.74	bound=5.06
Wald				
test(short-run)				
F-statistic	83.22			
P-value	0.0000			

Note here ***, **, ***** Represents denial of the null hypothesis at the 1%, 5% and 10%
Sources: Authors computation

From the table 3, we found co-integration equation for the current study with CO_2 as a dependent variable to have maintained 1.2% promptness of modification to the long run stability path via the impact of TA, FDI and EU on a quarterly basis. The result confirms the positive significant relationship between CO_2 and all the variables in both the short-run, and the long run. This means that the underlying variables (FDI, Tourism arrivals, GDP and EU) impact favorably and significantly to the amount of CO_2 emissions in China. The result shows the long run elasticity of CO_2 in respect to tourism arrival, GDP, EU and FDI are positive and significant. Hence, a one percent increase in tourism arrival induces the rise in CO_2 emissions at 0.01%, a one percent in GDP will lead to 0.012% CO_2 emission in the long run. This means that economic growth of China induces carbon emissions but not in a significant level. This finding is in support of the works of Sarkodie and Strezov, (2019) that validate pollution haven hypothesis for China, Alola *et al*., (2019) in their study on large economies of Europe; Emir and Bekun, (2018) in their work on Romanian. A one percent increase in energy use will amount to 0.4% of CO_2 emissions. This suggests that the energy consumption induces the CO_2 emissions of China as expected, no doubt, the high offshore economic activities in China goes with high energy intensity which will definitely lead to environmental impact this is in consonance with the findings of Bekun *et al*., (2019) in their study on 16-EU countries , Alola *et al*., (2019) in their study on large economies of Europe, Akadiri *et al*., (2019) . Also, one percent upsurge of FDI will cause 0.9% rise in CO_2 emissions in China. Our result here is in consonance with the discoveries of (Saboori, Suleiman& Shahbahz, 2012) for Malaysia and (Fei *et al*., 2011) for China. Hence, the positive significant relationship exhibited between the CO_2 and GDP is a clear indication that economic growth via outsourced industrial and manufacturing activities enhance higher carbon emission in China. This is similar to

findings of Emir & Bekun, 2018 for Romanian study. Also, a positive significant association found amid the CO_2 and energy use is expected following the speed of coal engagement in energy generating via the industrial activities in China. China is seen competing favorably with other developed countries following its speed of attracting outsourced industrial and manufacturing activities (in terms FDI) from other countries. This amounts to heavy energy consumption in China to keep up with the steady increase of economic activities in the country. No doubt, this trend of accelerated good economic performance and growth of China can be ascribed to the accommodation of the outsourced economic activities from other nations like UK and USA to China. This is a pointer to the correlation or nexus causality that exist among the energy consumption, GDP and CO_2 emission. This result exposes the implication of different policies in the economic activities and performance of the China's economy toward the inducement of the CO_2 emissions in the country. It portrays the different policies responsible to the inducement of CO_2 emissions in China, hence, policy implication should be channeled towards the sustainable management of the policies to reduce the rate of environmental pollution. This is in agreement with Huanying Cui, (2016) who opined through his findings that China still encourages economic advancement at the cost of great energy consumption and significantly environmental pollution.

2.3.5 Granger Causality

The conventional regression does not portray a clear cut of causation even though the cointegration employed by the authors with the ARDL-bound approach confirmed the presence of causal relationship. This is limited in determining the path of the causation or transmission. This informed our choice of testing further the causation and the direction of the choice variables with granger causality.

The theoretical view of granger causality is captured with the Gregory and Hansen (1996) approach. This model is a two-sage approximation procedure which the first step is the evaluation of the following regression expression:

$$W_{1t} = c + \alpha_t + \gamma\Delta U_t(\lambda) + \theta_i w_{2t} + \varepsilon_t \quad (14)$$

Where W_{1t} and W_{2t} are of 1(1) and W_{2t} is a variable or a set of variables; and $\Delta U_t(\lambda)$=1 for t>Tλ, otherwise $\Delta U_t(\lambda)$=0 ; λ=$T_{B/T}$ signifies the place where the structural break lies ; T remains the sample size; T_B is the date when the structural break occurred. The second step is to test if ε_T in equation (4) is of 1(0) or 1(1) via ADF technique. If ε_T is found to be consistent with 1(1), it will be assumed that cointegration exit between W_{1t} and W_{2t}. Once the numerical property of ε_T is confirmed, one can implement the bivariate VAR approach to exam the granger causality. Again, if the co-integration is found between W_{1t} and W_{2t}, an Error correction Term is required in analysis of granger causality which is revealed as:

$$\Delta W_{1t} = \alpha_0 + \delta_1\left(\Delta W_{1t-1} - y\Delta W_{2t-1}\right) + \sum_{i=1}^{k} a_{1i}\Delta W_{1t-1} +$$

$$\sum_{i=1}^{k} a_{2i}\Delta W_{2t-1} + \varepsilon_{1t} \quad (15)$$

$$\Delta W_{2t} = \beta_0 + \delta_2\left(\Delta W_{1t-1} - y\Delta W_{2t-1}\right) + \sum_{i=1}^{k} \beta_{1i}\Delta W_{1t-1} +$$

$$\sum_{i=1}^{k} \beta_{2i}\Delta W_{2t-1} + \varepsilon_{2t} \quad (16)$$

For the consistency in the findings that causality exists among the choice variables (GDP, TA, CO_2, EU and FDI), the authors applied the pairwise granger causality test which also serves as a robust check to the findings from the error correction estimation. Hence, the pairwise granger causality test is displayed in the following tables below.

Where δ_1 and δ_2 account for the speed of adjustment. As shown by Engle and Granger (1987), the existence of the cointegration implies a causality among the set of variables as shown by $[\delta_1]+[\delta_2]>0$. Failing to reject the null hypothesis $(H_0) : a_{21} = a_{22=\ldots\ldots} a_{2k=0}$ and $\delta_1 = 0$ implies that $C0_2$ emission do not granger cause GDP or other variables while failing to reject $(H_0) : \beta_{11} = \beta_{12=\ldots\ldots} \beta_{1k=0}$ and $\delta_2 = 0$ shows that GDP and other variables granger cause CO_2. Hence, to test whether CO_2 granger cause GDP and other variables we examined the null hypothesis $(H_0) : a_{21} = a_{22=\ldots\ldots} a_{2k=0}$ and $\delta_1 = 0$. Conversely, to test if GDP or other variables granger cause CO_2 we examined $(H_0) : \beta_{11} = \beta_{12=\ldots\ldots} \beta_{1k=0}$ and $\delta_2 = 0$. We noticed that adding the error correction terms does not change the lead-lag relationship.

For the consistency in the findings that causality exists among the choice variables (GDP, TA, CO_2, EU and FDI), the authors applied the pairwise granger causality test which also serves as a robust check to the findings from the error correction estimation. Hence, the pairwise granger causality test is displayed in the following tables below.

Table 4: Pairwise Granger Causality Test (Short Run Causality Test Result)

Null hypothesis	F-stat	P-value	Causality	Direction
LTA→LGDP	3.1948	0.0461**	YES	UNI-DIRECTION
LGDP→LTA	1.4402	0.2428		
LFDI→LGDP	0.7081	0.4956	YES	UNI-DIRECTION
LGDP→LFDI	8.0868	0.0006***		
LEU→LGDP	2.9883	0.0568*	YES	UNI-DIRECTION
LGDP→LEU	0.7908	0.4575		
L CO_2→LGDP	1.5254	0.2247	YES	UNI-DIRECTION
LGDP→L CO_2	3.2338	0.0452**		
LFDI →LTA	1.0532	0.3535	NO	INDEPENDEDNT

LTA→ LFDI	1.9233	0.1527		
LEU→LTA	4.03146	0.0220**	YES	BI-DIRECTION
LTA→LEU	2.91019	0.0611*		
L CO_2→ LTA	1.4804	0.2346	YES	UNI-DIRECTION
LTA →L CO_2	3.1325	0.0498**		
LEU→LFDI	3.13392	0.0497**	YES	BI-DIRECTION
LFDI →LEU	3.82685	0.0265**		
L CO_2→LFDI	2.3789	0.1001	NO	INDEPENDEDNT
LFDI→L CO_2	1.9036	0.1567		
L CO_2→ LEU	0.4502	0.6394	YES	UNI-DIRECTION
LEU → L CO_2	5.2283	0.0077***		

Note**: *, **, ***** Denotes rejection of the null hypothesis at the 1%, 5% and 10%
Sources: Authors computation

The result from the table 4 shows the output from the granger causality estimation. The findings give credence to the findings of the dynamic and the ARDL –bound approach above. According to the result, there is a uni-directional causality passing from tourism to GDP, from GDP to FDI, from energy use (EU) to GDP, from GDP to CO_2, from tourism arrival to CO_2 and from energy use to CO_2 This reveals and validate the findings from the ARDL-bound testing that China's economic growth is not far-fetched from energy-induced growth, hence, the transmission from energy use to GDP. However, there is a bi-directional causality between energy use and tourism, between energy use and FDI. This shows a trade-off for environmental quality degradation considering the heavy energy consumption emanating from tourism arrivals maintenance, and FDI activities coming from the industrial and manufacturing

activities. The findings are in agreement with other related studies in this area (Shahbaz, Loganathan, Zeshan & Zaman).

The causality is demonstrated in a graphical form (Triangular form) as follows:

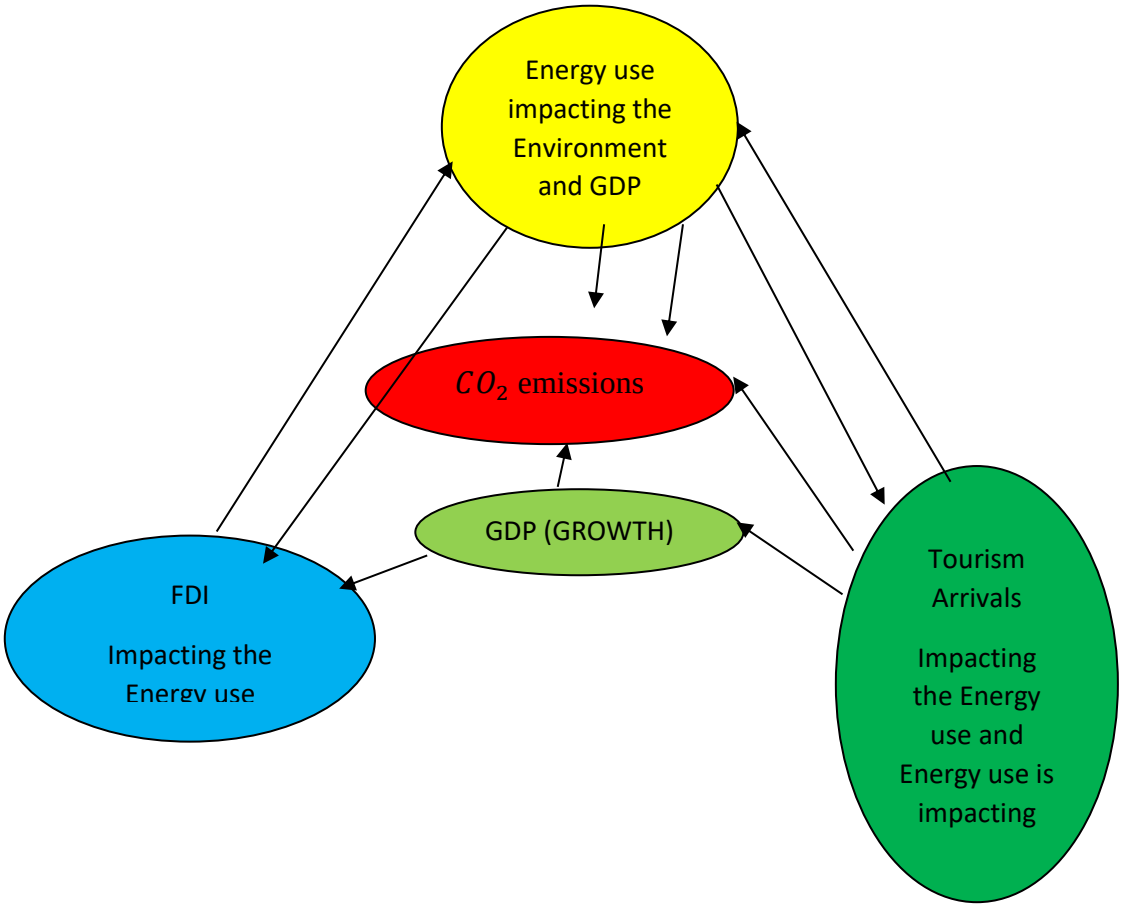


Figure 2: Triangular relationship among CO_2 emissions, Energy use, FDI, Tourism Arrivals and Growth in the Case of China

The arrows are designed in such a way to show the direction of the transmitting. Where one arrow is seen moving from one variable to the other without transmitting back with another arrow, it shows a uni-directional causality, but where there are two arrows moving in opposite direction between two variables (e.g. energy use & FDI and energy use & tourism arrival), it shows a bi-directional causality.

2.3.6 Diagnostic Test

We further carried a diagnostic test to check if, and be sure that our analysis is free from any form of wrong estimation or misspecification which will eventually lead to

a spurious result. We checked for the stability and the reliability of the short and long run ARDL model. According to Brown et al., (1975), we employed: (a) cumulative sum (CUSUM) tests and (b) cumulative sum of square test on residuals of the model. The test clearly showed that the stability of the coefficients over the investigated period was ascertained. It is opined that if the plot of the blue line shifts outside the area of 5% critical line, embodied with red line, it means that the coefficients are not stable (Okunola, 2016). Hence, the results obtained in the figure 3 & 4 shows that at the 5% significant level for the applied framework in this work, parameters and variance are stable under both CUSUM and CUSM square tests.

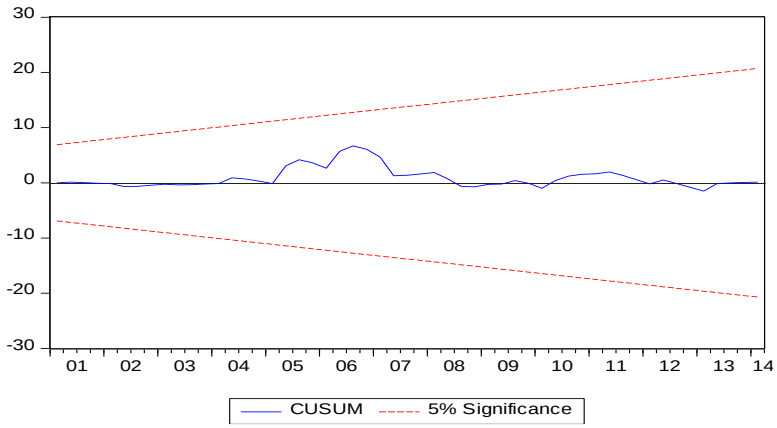


Figure 3: (Plot of Cumulative Sum of Recursive Residuals)
(The conventional Lines denote critical bounds at 5% significance level)

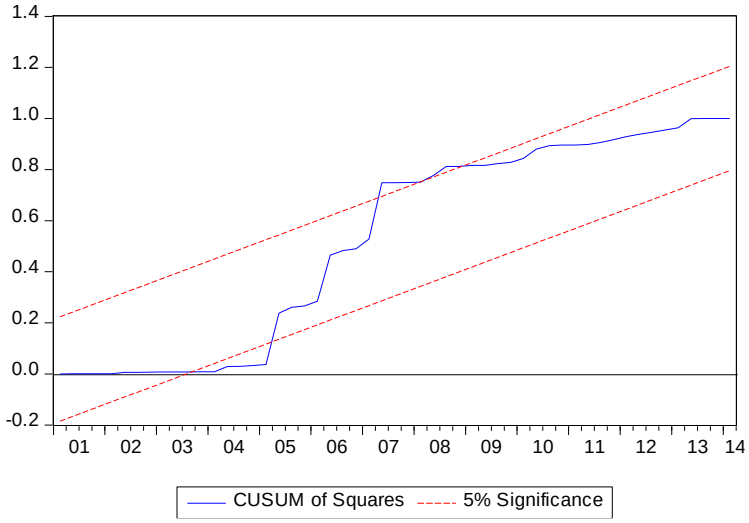


Figure 4: (Plot of Cumulative Sum of Square of Recursive Residuals)
(The conventional Lines denote critical bounds at 5% significance level)

2.4 Conclusion and Policy Implications

The current paper focuses on the mediation among the choice variables of the authors. Emphasis is laid on the triangular nexus among the tourism arrivals (TA), Foreign Direct Investment (FDI) energy use (EU) and (CO_2) pollution/emissions which portrays how the interwoven relationship that exist among the chosen variables is tailored towards impacting the economic growth GDP) of China which in turn impact on the environmental quality of the country. The ARDL bound test confirms that long run relationship exists among the GDP, tourism arrivals, FDI, energy use and CO_2. Among the findings is that FDI have a positive relationship with both energy use and CO_2 and this contributes to CO_2 emissions which we classified as the outsourced CO_2 emissions in China. As remarked earlier, what informed our claim that this be classified as outsourced CO_2 emissions are because of the outsourced economic activities that exist in China through the developed countries like UK and USA. Also, we found that tourism arrivals have a positive and significant relationship with energy use and CO_2 emissions. Also, we found that both FDI, energy use, CO_2 and tourism

arrivals have positive and significant association with GDP which established the triangular nexus causality among the variables and impact on the GDP. This finding affirmed the findings from the studies of (Shahbaz *et al*., 2013) and (Aceleanu *et al*., 2017), where they found positive influence of energy consumption to the economic growth as found in our study. Also, the findings in our study have affirmed the cost implication of heavy energy consumption that is induced from both the outsourced manufacturing activities and the tourism arrivals. This supports the findings of (Shahbahz *et al.*, 2012) for Malaysia and (Fei *et al*., 2011) for China. This is also in agreement with Huanying Cui, (2016) who opined through his findings that China still advances economic growth at the cost of high energy consumption and drastic environmental degradation.

From the findings of the both estimations (Dynamic &ARDL-bound test and granger causality), this study have really provided answers to the questions raised as to what triggered the author's intention of investigating the triangular nexus among the choice variables, thus: *Is there really an association among the FDI and* CO_2 *emissions through energy consumption? Is there a transmission among the GDP, FDI and carbon dioxide emission? Is there connecting factor between the GDP and carbon dioxide?*

To this end, the evidence from this result also exposes the components that contribute to CO_2 emissions in China, which include GDP growth rate, FDI, tourism activities and high energy use via the causality output. Therefore, the policy implication of China should look into carbon dioxide emissions and shift from high carbon economy to low carbon economy without much distraction of economy growth. Hence, shifting away from high coal generating energy to renewable energy that is capable of

promoting cleaner system. Also, a concerted effort should be made in moving away from coal to more manageable energy sources (e.g., wind or solar power) in combating high CO_2 emissions. Reducing the rate of the tropical deforestation and encouraging the manufacturing of vehicles with good fuel efficiency, and even switching to solar energy consumption vehicles should be among the policies in consideration. This, the country can do by consolidating the FDI and tourism activities and reducing the CO_2 emission in sustaining the good performance of the economy via economic growth. Also, looking at the correlation that exist between the energy consumption and the economic activities, it is no doubt that CO_2 emission will definitely follow in the cycle which will be the end product of the whole activities which is also detriment to the environment. This call for a watch over the economic and manufacturing activities in the country while considering the policy implication. Conclusively, china should assist in global environmental cooperation, encourage energy saving and climatic change conservation.

Chapter 3

ENVIRONMENTAL IMPLICATION OF OFFSHORE ECONOMIC ACTIVITIES IN INDONESIA: ANALYSIS OF COINTEGRATION AND CAUSALITY

3.1 Introduction

Indonesia economy has been a center of focus because of its proactive action of improving on deforestation but rapidly increasing its greenhouse emissions in other sectors. It has been identified as among the developing economies that set its priority in alleviating the poverty rate of its citizenries above other issues such as environmental degradation and climate change. The geographical terrain of Indonesia accommodates a large number of small islands that is spread within the boundaries that is threatened by the rising sea level and might probably cost Indonesia some of its coastal environment areas together with the small island (Huguet, ,2011). Indonesia was by ranking doubled as the 16th biggest economy and the largest in Southeast Asia and the 4th biggest C02 emitter as at 2015 (AZMY, 2019). Indonesia has been identified as among the fast-growing developing economies from the Southeast Asian region with a well manageable debt –to-GDP ratio (Fullerton *et al*., 2019). According to the Economic outlook, the economic growth rate of Indonesia is forecasted to be average 5.3 percent from 2016 till date. There has been a consistent with a healthy continuous growth of the Indonesian economy from 2007 till date. The trilemma policies which are indicators inducing the economy are predominantly labor market

with good prospects for job opportunities, steady and continuous improvement in the investment with a proof on the rate of production, and the private consumption. With the good performance of the Indonesia economy, there has been plans by the handlers of the economic affairs of the country to adopt more sustainable economic development strategies for the sustainability of the growth pattern with a target of delivering 5.6 to 6 percent economic growth over the next 25 years (Kadarusman and Pramudya, 2019). The performance of Indonesian economy is presented in the figures 5-8 as follows:

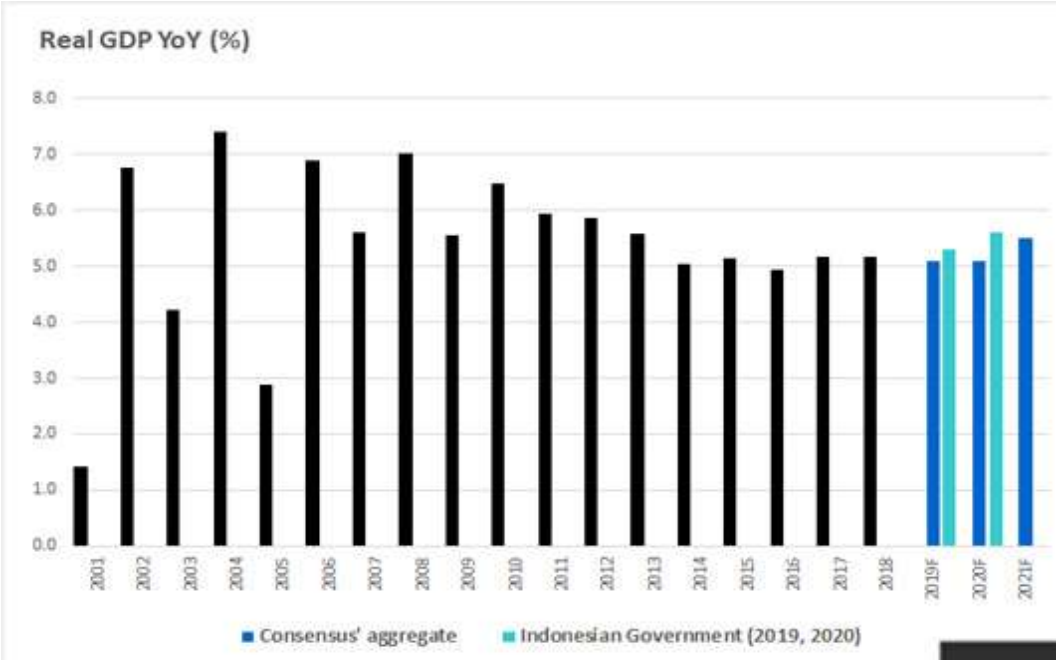


Figure 5: Indonesia Real GDP by Expenditures from 2001 to 2018(consistently above 5%)
Source: Bloomberg, iFAST Compilations, June 2019

The figure portrays the factors as mentioned above that are inducing the good performance of the Indonesia economy such as investment and consumption.

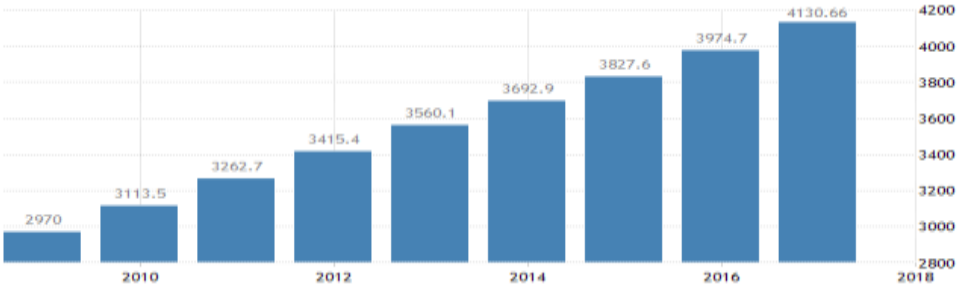


Figure 6: Indonesia per Capita Growth
Sources**:** Tradingeconomics.com/ WORLD BANK

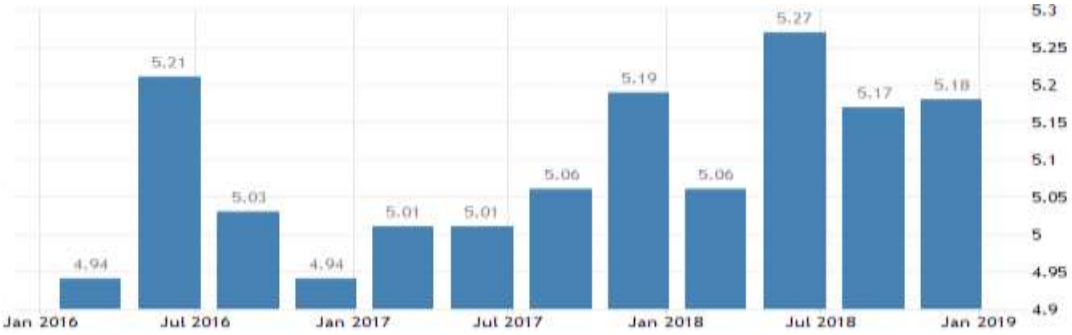


Figure 7: Indonesia GDP Annual Growth Rate | 2019
Sources: Tradingeconomics.com/ STATISTCS INDONESIA.

Figure 8: Indonesia GDP Constant Prices | 2019
Sources: Tradingeconomics.com/ STATISTCS INDONESIA.

Figure 9: Indonesia Position in World GDP Ranking
Sources: IMF World Economic Outlook, April 2019.

The drivers of the Indonesian economy can be seen from the table below (GDP by sector. % of GDP is at 2011, and growth is from 2010-2011).

Table 5: Breakdown of Indonesia Economic Growth by Sectors

sectors	Percentage of GDP (%)	Growth rate (%)
Agriculture	12.74	2.95
Mining	7.68	1.36
Oil/gas manufacturing	1.90	-0.92
Non-oil/gas manufacturing	23.85	6.83
Utilities	0.77	4.82
Construction	6.50	6.50
Trade and hospitality	17.75	9.18
Transport	3.73	7.63
Communication	6.07	12.66
Finance and real estate	9.58	6.81

Government	3.97	5.37
Services	5.47	7.76

Source: Statistics Indonesia, Compiled by the authors

However, it is pertinent to note that most of the vibrant developing economies (Indonesia inclusive) accelerating in economic activities are equally accelerating in greenhouse gas emissions. The economic growth often leads to uncontrolled utilization of natural resources and excessive energy consumption which causes environmental damage and pollution. This is a clear indication that the relationship or link between the economic growth and CO_2 emissions is unavoidable inseparable following the impact of energy use which is a connecting factor between economic growth and CO_2emission. The relationship could be positive portraying a complimentary growth (in this case economic growth is growing at the expense of the environment quality) or negative showing that while economic growth is trending upward the CO_2 emissions is decreasing (in this case, the economy is growing while impacting positively to the quality of the environment). Indonesia has been identified as the prospective Southeast Asia's biggest economy and the world's 4th largest greenhouse gas emitter after the likes of US, China and India. This means that the economic growth and the greenhouse gas emission are almost growing in the same rate. They are expected to be in the same direction of up-surging if appropriate Low Carbon Development Initiatives (LCDI) are not taking to make the economic growth more environmentally friendly. No doubt, this alert has prompted the country to peg its emissions cut target at 43rd percent by 2030 while targeting to deliver the annual economic growth of 5.6 and 6 percent in the next 25 years. It is said of Indonesia that it can overcome further environmental degradation by not adhering to the experience of Countries such as China which is battling with pollution following their activities

that have aided them to walk out of poverty into higher income categories (Hans Nicholas Jong, 2019). As attributed to the Indonesian Planning Minister, Bambang Brodjonegoro in his report made available to the joint initiative of World Resources Institute and a global research group ‘’ *Indonesia wants high economic growth void of environmental sacrifice*” (Kadarusman, and Pramudya, 2019, Sustainable Business, JAKARTA, Reuters, 2019). He went further to outline ways of attaining and sustaining the target such as adopting policies to foster agricultural productivity, prevention of deforestation, improving of waste management and shifting from non-renewable energy to renewable energy. With effective implementation of these policies, it will amount to reduction in the greenhouse gas emissions. Nevertheless, the vision of the country to shift to a low-carbon economy would amount to nothing if the country still slacks in curtailing the excessive use of coal. Currently, the country is still relying on fossil fuels to sustain its economy. Out of this coal, gas and oil are generating 59 percent,23 percent and 6.2 percent of electricity respectively, while renewable energy only accounts for 13 percent of electricity (Hans Nicholas Jong, 2019).

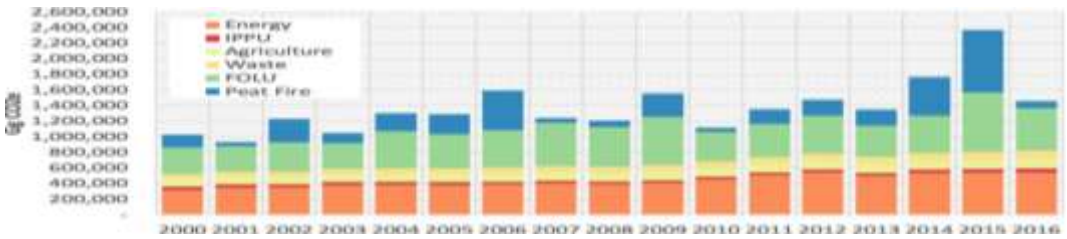


Figure 10: Annual total growth of Indonesia emissions from 6 different sources

Indonesia’s total emissions from 2000-16. Emissions from peatland fires (blue), forestry and other land use (“FOLU”; green), waste (yellow), agriculture (pale green), industry (“IPPU”; red) and energy (orange) are shown. Emissions are shown in gigagrams of CO2 equivalent (GgCO2e, millions of tonnes). It is worth noting that the figures are self-reported. **Source**: *Ministry of Environment and Forestry, Indonesia*.

The linkage between the economic growth and environment can never be separated from the both the domestic and international economic activities. Among the economic activities that can be viewed both from the domestic and international aspects are production as it links to investments (both Foreign investments and domestic investments) and trade as it relates to import and export. Every country or region making headway in economic growth must have witnessed increasing utilization of energy that impact negatively on the environmental quality through great emissions of CO_2. The rise in energy use is connected with a spark in industrial production which is connected to both investment and trade and this will definitely cause environmental problems. Offshore economic activities as it concerns Foreign Direct Investment (FDI) and trade are at the center of coordinating the industrial and productive activities in most developing economies because of less preventive policies by the host countries. Foreign investors have literally shifted their economic activities and practices to the developing countries with less preventive measures towards the impacts of these foreign industries to their environments (Mabey and McNally, 1999). Even though FDI role has seen becoming controversial and debatable, the relatively and significant of increase in economic growth of Indonesia is not exempted from the boost on the industrial activities in the country which Foreign Direct Investment (FDI) and trade are inclusive. It is noticeable that FDI encourages and promote economic growth and development in the host country (Alfaro *et al*. 2010). Foreign Direct Investment (FDI) has proved to be a means of financing external economic activities and has equally serves as a uniting force between the savings and investments domestically (Bustos, 2007; Ndikumana and Verick, 2008). Apart from savings and making available funds for investments, FDI also induces economy by the provision of positive externalities and technological and skill transferring from the industrialized

nations to the developing nations (Lee, 2013; Shahbaz *et al*., 2015). Offshore economic activities which accounts for FDI and trade includes outsourcing or relocating or planting of foreign industries into another country due to some factors such as easy access to cheap or less expensive labors, market location for the products, and tax incentives could induce a massive economic growth but to the detriment of the host countries because of the excessive energy consumption by those foreign owned companies (Shahbaz *et al*., 2015). This is called pollution haven hypothesis which acknowledged the less concern of the host country towards the harm of the foreign firms to the environmental quality because of less stringent policies to curtail FDI excesses (Cole and Elliott, 2003). Most times, foreign firms are encouraged to make and expand their investment in an economy with less stringent environmental laws to boost their productive activities, this is called industrial flight hypothesis (Asghari, 2013). Shifting a bit from the pollution haven hypothesis where the FDI is working and flourishing to the detriment of the environment, FDI could also be a tool of improving the quality of surroundings in the host economy. This is attainable when FDI comes in with advance technological equipment and energy efficient technology with a disciplined and better management principles which will eventually lead to enhancement of the environmental quality in host economy. This is what Shahbaz hypothesized as pollution halo hypothesis where FDI enhance economic growth which impact energy consumption and carbon emission favorably in the host country (Shahbaz *et al.,* 2015). Also, from the angle of trade induced CO_2 emissions, we consider production, import and export as they relate to the greenhouse gas emissions. Most productions are undertaken with great energy consumption from either fossil fuel or coal. The fossil fuel or the coal could be imported and exported and the goods produced with these sources could also be imported or exported. If Indonesia import

fossil fuel from India for the sole aim of production by the companies domicile in Indonesia, this is could be classified as trade induced CO_2 emissions and is expected to be included in the calculation of the environmental impact even though it is still debatable. The importer and the exporter of the CO_2 are the Indonesia and India respectively, and it is sometimes called territorial-based emissions because it reflects emissions within the country's geographical boundaries (Peters *et al.*, 2014). Based on the surging of economic growth and industrialization, the greenhouse gas emissions from industries, transportations and power generation are equally increasing. It is projected that CO_2 emissions of Indonesia will grow and more than doubled in the next few years (Michael Barnard, 2017)

However, as poor quality of environment is always linked to unchecked economic and industrial activities of industries, firms or individuals, and most often the poorly economic regulations usually affect the quality of the environment negatively (this is what generates pollution haven hypothesis by Cole and Elliott, 2003). Likewise, the environmental regulations have economic effects, however, any analysis concerning the welfare effects of variations in regulations should consider both economic and environmental effects as it concerns welfare. Upon this, we integrate Foreign Direct Investment (FDI) and trade openness in our model in attempt to investigate and report clearly the environmental implication of offshore economic activities by linking among the economic growth, energy use and environment (CO_2) in a cointegrated and causality manner.

The novelty of this study is the incorporation of both the FDI and trade openness in the analysis framework to drive home the environmental impact of offshore economic activities in Indonesia which to the best of our knowledge has not been mentioned in

any previous literature. We measure the offshore economic activities by FDI and trade openness which we incorporated and augment in the economic model This, the authors built around the econometric and scientific modelling which gives us enabling ground to estimate both short run and long run effects with an eye on the offshore activities. The current study expands on the work of Azam *et al*., (2016). We did this by utilizing both dynamic Autoregressive distributed Lag (ARDL) with 4 lags (based on AIC lag selection criteria), ARDL-bound estimation, Johansson co-integration, and pairwise Granger Causality in attempt to expose both the short and long run impact and the transmission among the selected variables (GDP, CO_2 emissions, Energy use, FDI and Trade Openness). Also, given the position of Indonesia to the Paris pledge and being among the Southeast Asian countries that are exposed to the danger of the environmental degradation via industrial activities and the threat from the rising sea level, it is very important to research on the economy and aid the policy makers with findings for better environmental improvement of the country.

The remainder of this study are structured in this manner: Section 2, presents the brief review of previous related works on nexus style among the choice variables (GDP and CO_2 emissions, GDP and trade openness , FDI and GDP, FDI and C02 emissions, and trade openness and CO_2 emissions); Section 3, presents the data with theoretical background and methodology; Section 4, presents the empirical results and discussions of the findings and Section 5, presents the concluding part with the policy implication.

3.2 Review of Related Literature

The literature review examined and analyze the related studies by revisiting the relationship that exist between the chosen variables (GDP and CO_2 emissions, GDP

and trade openness , FDI and GDP, FDI and CO_2 emissions, and trade openness and CO_2 emissions). The review of the past related works will be tailored on the principles of relationship style among the chosen variables.

3.2.1 Studies Analyzing the Relationship between Economic Growth GDP and CO_2 Emissions.

Many research works have been done in focus with the relationship with the economic growth and carbon emission but no substantial agreement has been strike. Some are of opinion that positive relationship exists, while others are of contrary opinion with the positive relationship view based on their findings. The inconclusiveness of the findings and the non-unified views has left the subject open for researchers to study. Some of the studies that have researched on this subject are Emir and Bekun, 2018; khuda. B *et al*., 2017; Chen *et al*. 2016; Twerefou *et al*., 2015; Omotor, 2015; Lee, 2013; Sharma, 2015; Boopen *et al*., 2011; Acharya, J.,2009. Balsalobre-Lorente *et al*., (2018) in their work titled "How economic growth, renewable electricity and natural resources contribute to CO_2 emissions?" found the existence of N-shaped relationship between economic growth and CO_2 emissions. They also found that economic growth has a positive impact on CO_2 emissions. Bekun *et al*., (2019) did a work that is captioned "Toward a sustainable environment: Nexus between CO_2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries", they found among others that economic growth increases carbon dioxide emissions. Alola *et al.*, (2019) in their work titled "The role of renewable energy, immigration and real income in environmental sustainability target. Evidence from Europe largest states", found a significant nexus of carbon emissions with gross domestic product (GDP). Emir and Bekun, (2018) in their work titled "Energy intensity, renewable energy, and economic growth nexus: New insights from Romania", found a positive relationship between

economic growth and CO_2 emissions in Romanian economic performance cum energy intensity. Akadiri and Bekun, (2019) found a bidirectional transmission among economic growth and carbon emission. Sarkodie and Strezov, (2019) found a negative relationship between economic growth and pollution in their work on developing countries. Akadiri *et al.,* (2019) in their studies titled "Towards achieving environmental sustainability target in Italy. The role of energy, real income and globalization", found no significant relationship between real income (GDP) and per capita of carbon emissions. Al-mulali *et al.,* (2015) found a positive relationship between economic growth and pollution both in the short and long run. Khuda *et al*., (2017) in their findings on Pakistan economic study in relation with CO_2 emissions conclude that GDP has a negative relationship with CO_2 emissions. Chen *et al*. (2016) applied panel study across the different regions of China and came with a non-unified result, some showing positive relationship while others showed negative relationship between economic growth and CO_2 emissions.Twerefou *et al*., (2015) in their work on Ghana economy as it relates economic growth and CO_2 emissions found a negative connection between economic growth of Ghana and carbon emissions. Omotor, (2015) researched on some ECOWAS countries and found a positive relationship between GDP and environmental quality (CO_2 emissions). A study on the G20 countries by Lee, (2013) confirmed a negative relationship amongst GDP and CO_2 release. Boopen *et al.,* (2011) researched on the connections between GDP and carbon emissions and found a negative relationship with emphasis on human activities that coordinates the pollution pattern. Sharma (2011) in his work found a positive effect of the economic growth on CO_2 pollutions. Acharya, (2009) found a positive relationship between GDP and CO_2 emissions which he backs his argument on the effect of Foreign Investment flow on the CO_2 pollutions.

3.2.2 Studies Analyzing the Relationship Between Economic Growth GDP and Trade Openness

Many research works have been done in regards to the connectivity of GDP and trade openness. Hye, (2012) applied ARDL approach to study Pakistan economy with respects to its relationship with openness, he found a negative relationship between GDP and trade openness. Using ARDL, Akadiri *et al.*, (2019a) found a positive significant relationship among the trade and GDP. In the case of Ghana economy, Shahi, (2012) confirmed a progressive connection amongst trade libralization and economic growth. Investigating I'vore coast economy with regards to trade openness, kebo, (2017) found a significant positive impact of trade on economic growth of the country. Also, on Ghana economy, Kwame, (2013) came up with a finding that proved a positive relationship between economic growth and trade openness. On Nigerian economic performance as regards to trade openness, Nduka *et al*., (2013) confirmed a significant positive relationship between economic growth and trade. Marelli *et al*., (2011) investigated the China and India economic performance based on trade openness, he found a positive relationship between economic growth and trade. Kim, (2011) researched on 61 countries which includes both developed and developing countries, he found a positive relationship for the developed countries while that of the developing economies depicts negative relationship. Barua *et al*., (2015) did a work on the same subject and found a positive relationship between economic growth and trade.

3.2.3 Studies Analyzing the Relationship Between Economic Growth GDP and FDI

Literature on the connection between GDP and FDI have generated some debated grounds, with some scholars in support of the positive connection while others are in

support of the negative connectivity between the two variables. Many others found causality (uni-directional and bi-directional) between GDP and FDI. Analysis of the connection between GDP and FDI on 41 developing countries was made using GETS methodology and he found a negative effect on economic growth. Garcia-santana *et al*., (2016) found FDI positively contributing to the economic development of Spain. FDI is found impacting economic growth of Spain for over 40 years (Villa Verde and Maza,2012). Using Toda Yamamoto granger causality in a panel studies by Irandoust and Ericsson (2001), they found a feedback transmission amongst GDP and FDI for Sweden, one-way transmission for Norway and no transmission for Denmark and Finland. Basu, (2002) researched the causality between economic growth and FDI and found a uni-directional transmission passing from economic growth to FDI. Also, in a panel study of East and South African regions, John C. Anyanwu, (2012) found that FDI impact economic growth. In their work on the Gulf Cooperation council, Toone, (2012) found no causality between economic growth and FDI. Likewise, the work on Ghana, Frimpong *et al*., (2007), they equally found no causality between the FDI and growth. Also, a work on Malaysia by Karimi, *et al*., (2009) shows no causality between the two variables either. Irandoust and Ericsson, (2001); have equally worked on the causality between the FDI and growth and found no causality between them

3.2.4 Studies Analyzing the Relationship Between Foreign Direct Investment (FDI) and CO_2 Emissions

Studies that have investigated the relationship between FDI and CO_2 emissions are many but with little or less agreement on a unified finding. Just like any other subject of research, many researchers are of opinion that positive relationship exist while some other scholars are of contrary view. Sarkodie and Strezov, (2019) in their work titled "Effect of foreign direct investments, economic development and energy consumption

on greenhouse gas emissions in developing countries", they found a strong impact of energy use on carbon dioxide emissions because of the FDI impacting force on the economy validating pollution haven hypothesis. Shahbaz and Balsalobre, (2019) explores the link amongst (FDI) and CO_2 releases for the Central East and North African (MENA) province in 1990–2015, and N shape connection is revealed between FDI and carbon emissions. Akadiri *et al*., (2019) in their work titled "Towards achieving environmental sustainability target in Italy. The role of energy, real income and globalization" and they found that globalization index led to 0.914 percent decrease in metric ton per capita of CO_2 emissions in the short run and 1.769 percent decrease in metric ton per capita of CO_2 emissions in the long run. Globalization is platform through which FDI flourished in the modern-day global economy, this means that whenever globalization is considered in any writing, it accommodates both trade and FDI. Also, in attempt to establish a connection between FDI and carbon emissions the work of Paramati *et al*., (2017) which is titled "Financing clean energy projects through domestic and foreign capital: The role of political cooperation among the EU, the G20 and OECD countries" found that both FDI and stock market developments play a significant role in promoting clean energy consumption which impact positively on carbon emissions. Kheder, (2010) did a research work on pollution and found that the pollution emitting from the activities of the French industries are significantly positive with pollution in the host countries. Also, his (Kheder, 2008) work on China economy found positive relationship between FDI and CO_2 emissions. A research work on OECD countries by Pazienza, (2015) shows a negative association between FDI and environment (Agricultural and fishing sectors). A research work on Nigeria by Ajide *et al*., (2010) found a positive relationship between FDI (in terms of the activities of the multinational oil and gas firms) and CO_2 emissions. Omri *et al.,*

(2014) observed that FDI inflows causes increase or raise CO_2 emissions substantially by 0.19 percent. In his panel work of 110 developed and developing countries, Shahbaz *et al*., (2014) found a positive relationship between the foreign investments and CO_2 emissions in terms of environmental degradation. Blanco et al., (2013) demonstrated on his studies that FDI inflow has a positive relationship with environmental degradation. Also, Talukdar *et al.,* (2001) in his studies found a negative significant connection between FDI (from developed countries) and CO_2 emissions in the developing countries.

3.2.5 Studies Analyzing the Relationship Between Trade Openness and CO_2 Emissions

Many research works have considered this subject, either as a joint analysis with energy consumption or financial development. In the work of Balsalobre-Lorente *et al*., (2018) which is titled "How economic growth, renewable electricity and natural resources contribute to CO_2 emissions?" they found that the interaction between the trade openness and economic growth exerts a positive impact on carbon emissions. A research work was done on newly industrialized countries (NIC) by Hossain, (2011), he found a uni-directional short run transmission from trade openness to carbon emissions. Shahbaz, (2011) investigated the South African economy with respects to interaction between trade openness and environmental performance, he found a long run relationship between trade opens and environmental quality. Muhammad and Fatima, (2013) did a work on Pakistan economy as regards the relationship among economic growth, carbon emissions, financial development and trade openness. He among others, they found a significant on carbon emission from trade openness. Also, Turkey was researched by Ozturk and Acaravci, (2013) for the period of 1960-2007 and they found that trade openness has a positive relationship with carbon emissions.

Shahbaz, (2013a) did a research work on China using financial development, energy use and trade openness, he found a feedback among the variables. Also, Shabaz, (2013b) researched on Indonesia economy as regards the relationship among financial development, energy use and trade openness, he found a negative relationship between trade openness and carbon emissions.

3.3 Data, Methodology and Empirical Findings

3.3.1 Data

Indonesian annual data has been used for the period that covered from 1980-2017 in the current research work. Data on GDP per capita (constant 2010 US$), CO_2 emissions (metric tons per capita), energy use (Kg of oil equivalent per capita), Foreign Direct Investment, net inflows (Bop, current US$) and Trade openness (IMP(Const. 2010 US$)+EXP(Const. 2010 US$)/GDP (Const. 2010 US$)) are all sourced from the 2018, World Development Indicator (WDI),2018 and these are the selected variables for this study. The chosen variables are all expressed in logarithm form. Definitions and summary of the variables are displayed in Table1 below.

Table 6: Variables and their Measurements

Full Description of the Variables	Short names of the Variables	Measurement/calculations
GDP per capita	GDP	Constant US$(logGDP)
Carbon dioxide	CO_2 emissions	metric tons per capita
Energy use	Energy use	kg of oil equivalent per capita
Trade Openness	Open	Export+Import/GDP (All in US$)
Foreign Direct Investment, net inflows	FDI	Bop, current US$

Source**:** Authors Compilation.

Table 7: Descriptive Statistics of the Variables

	LN CO_2	LNGDP	LNEN	LNFDI	LNOPEN	POP
Mean	1.303061	21206313	662.3227	5.38E+09	86139933	2.07E+08
Median	1.256117	20047029	689.6921	1.84E+09	84505718	2.07E+08
Maximum	2.559750	37549519	893.9110	2.51E+10	1.24E+08	2.64E+08
Minimum	0.642650	11188870	377.6794	-4.55E+09	54025568	1.47E+08
Std. Dev.	0.512549	7519449.	178.8905	8.12E+09	24185896	34545137
Skewness	0.506956	0.576213	-0.355925	1.282490	0.147126	-0.032497
Kurtosis	2.583998	2.357670	1.698413	3.315933	1.576598	1.845935
Jarque-Bera	1.901705	2.756065	3.484693	10.57498	3.345041	2.115477
Probability	0.386411	0.252074	0.175109	0.005054	0.187773	0.347240
Sum	49.51632	8.06E+08	25168.26	2.04E+11	3.27E+09	7.86E+09
Sum Sq. Dev.	9.720147	2.09E+15	1184067.	2.44E+21	2.16E+16	4.42E+16
Observations	38	38	38	38	38	38

Source: Authors Compilation.

Table 7 displays the output of the distribution statistics. The result clearly shown that the data is normally distributed except the case of FDI. Considering for the fact that other diagnostic tests support the normality and stability of the analyses, this has no effect to the determination of the stability of this estimation. Also, the minimum and maximum range between the variables attest to the normality of the estimation except the energy consumption that seems to be very big gap. The energy utilization by Indonesia could be the reason for this.

3.3.2 Methodological Process

The methodological framework employed in the present study includes the following; test for unit root, descriptive statistics, Optimal lag selection criterion, dynamic Autoregressive Distributed Lag (ARDL) and Causality testing. The author employed applications like Dickey-Fuller (ADF-Dickey &Fuller, 1981), Phillips-Perron (PP-Phillips and Perron, 1988) and Kwiatkwoski-Phillips-Schmidt-Shin (KPSS, 1992) unit

root tests to determine if the selected variables are stationary at level, at first difference or mixed order. VAR lag order selection criteria was employed for optimal lag selection and this was done with Akaike Information Criteria (AIC), descriptive statistics was employed for the identification of the mean, minimum and maximum range of the selected variables, and dynamic Autoregressive Distributed Lag (ARDL) with 3lags together with ARDL-bound estimation (both short run and long run) as proposed by (Pesaran *et al.,* 2001) is employed in this present study to estimate both the long run and the short run connections amongst the economic growth (GDP) , carbon emission, energy use, openness and FDI, pairwise granger causality is equally employed in order to trace and establish the nexus that exist among the variables which assisted in investigating and reporting clearly the environmental implication of offshore economic activities by linking among the economic growth, energy use and environment(CO_2) in a cointegrated and causality framework.

3.3.3 Theoretical Background and Model Specification

3.3.3.1 Theoretical Background

The study by Bekun *et al*., (2019) which is titled "Toward a sustainable environment: Nexus between CO_2 emissions, resource rent, renewable and nonrenewable energy in 16-EU countries" was done by utilizing the selected variables which are adopted in this present study. The variables such as GDP per capita, carbon emission and energy use were utilized in their work and the found energy use and economic growth impacting carbon emissions. Also, economic growth and carbon dioxide emission were incorporated by Alola *et al*., (2019) in their work titled ''The role of renewable energy, immigration and real income in environmental sustainability target. Evidence from Europe largest states. They found a significant nexus amongst GDP and carbon release. Trade, energy use and GDP were employed by Akadiri *et al*., (2019a) in their

study which is titled “The role of natural gas consumption in Saudi Arabia's output and its implication for trade and environmental quality” and a positive relationship among the variables. Foreign Direct Investment (FDI) is among the variables utilized by Sarkodie and Strezov, (2019) in their research titled “Effect of foreign direct investments, economic development and energy consumption on greenhouse gas emissions in developing countries” and the found a strong positive effect of energy consumption on greenhouse gas emissions. FDI was considered as a variable by Sun *et al*., (2017) to investigate its impact on C02 emissions and the work established the validity of pollution haven hypothesis. Also, Behera and Dash (2017) utilized FDI in their work and found a positive impact of FDI on C02 emissions. The works of Zhu *et al*., (2016), and Zhang and Zhou (2016) adopted FDI as among the variables in testing the pollution haven hypothesis and they found contrary results their studies. Zakara *et al*., (2015) employed FDI in their studies on Brazil, Russia, India and China and they found a long –run effect of FDI and energy consumption on carbon emissions. Shahbaz *et al*., (2017) used openness in the energy sustainability researched and found a positive relationship between trade openness and carbon emissions. Also, still on the consideration of trade openness as among the variables to tests the environmental implication of economic activities Keho, (2017), and Copeland and Taylor, (2017) found in their studies that trade openness affects and transmit on carbon emissions positively. Ahmed *et al*., (2016) in their studies found that trade openness sparks high carbon emission in the case of India, Brazil and China.

The above x-rays of other literature that have employed the selected variables in their studies, is to justify the application of the chosen variables (GDP per capita, FDI, Openness, CO_2 emissions and energy use) by the author. However, most of the cited literature that employed the chosen variables either as their variable of interest or state

control variables in establishing a relationship amongst the chosen variables without prior effort to reconsider the nexus nature or the causal feedbacks among the variables. The main author's concept that birth the idea of chosen trade openness and FDI in this current study is the need to investigate the environmental impact of the offshore economic activates arising from the foreign investors and merchandise whose motives is to maximize profit. According to (Shahbaz *et al*., 2015) less expensive labor and easy to harness by the foreign investors in most developing countries (especially from the ASEAN countries), tax incentive and location of markets for their products are among the factors that pull attention of the investors, and this explains why most foreign investors are outsourcing their industrial activities to such countries in search of easy-found human resources. Most times, the foreign investors explore and cling on loose regulations and policies guiding their activities and mode of operations in the country of their interest and run their economic operations at the expense or to the detriment of the environment thereby validating pollution haven hypothesis (Cole and Elliott, 2003). Also, the author attempt to establish a nexus amongst the selected variables and to infer the level of greenhouse gas emissions induced by excessive offshore economic activities (as measured by openness and FDI). A graphical illustration is used to establish the nexus among the chosen variables. By employing FDI and trade openness to measure the offshore activities in determining the environmental quality, will therefore fill in the gap in the studies in growth, energy efficient and environmental sustainability. The findings establish from this study will assist the policy makers in designing environmental conservative and energy sustainability policies to balance the economic performance of the country and the general welfare without hurting either the economic growth or the environmental quality.

3.3.3.2 Model Specifications

As stated earlier**,** the main author's concept that birth the idea of chosen trade openness and FDI in this current research is the need to examine the environmental effect of the offshore commercial activates arising from the foreign investors and merchandise whose motives is to maximize profit. Economic activities are always centered and measured in the GDP performance or the economic growth of a given country in which the spillover effects are felt in other spheres of live in the country (ranging from economic dimension, political, social to environmental dimensions). With this in mind, the current study seeks to analyze the environmental implication of offshore economic activities by linking the selected variables in a linear manner with economic growth (GDP) as a dependent variable and others (such as CO_2 emissions, energy use, openness and FDI) are independent variables. The research model specification and the entire estimation approach of this study is based on ARDL approach. In order to establish and analyze the linear relationship that exist among the chosen variables (Economic growth (GDP), CO_2 emissions, energy use, trade openness and FDI). The econometric form is expressed as:

$$Y = A\mathrm{CO}_2{}^{\theta 1} EU^{\theta 2} OPEN^{\theta 3}\, FDI^{\theta 4} \qquad (17)$$

Y represents income (GDP per capita) in a constant local currency, *A* represents the level of technological use in the country, and it is considered to be fixed, (CO_2 represents environment (CO_2 emissions), EU represents energy use, while OPEN and FDI represent trade openness and Foreign Direct Investment, inflow respectively. The subscripts ($\theta 1, \theta 2, \theta 3, \theta 4$ *and* $\theta 5$) denote the return to scale which is linked to the variables in use. All the series are converted and expressed in logarithm in order to express to model the non-linear form of Cobb-Douglas production function in a linear relationship form. There is a level of spurious findings always emanating

from a non-linear specification which will tend to mislead the audience of this study and stall the policy making process and purpose. On the above premise, the current study builds and extends on the study of (Azam *et al.*, 2016):

$$Y_t = A + \theta_1 C0_{2t} + \theta_2 EU_t + \theta_3 OPEN_t + \theta_4 FDI_t + \varepsilon_t \quad (18)$$

From Eq. (18), the relationship amongst the economic growth, CO_2 emissions, energy use, trade openness and FDI is estimated while holding the technology (A) fixed. This is later framed in a linear model while keeping the technology fix as follows:

$$Y_t = \theta 0 + \theta_1 C0_{2t} + \theta_2 EU_t + \theta_3 OPEN_t + \theta_4 FDI_t + \varepsilon_t \quad (19)$$

Where Y denotes GDP per capita, C02 denotes environment (CO_2 emissions), EU represents energy use, OPEN denotes trade openness and FDI denotes Foreign Direct Investment, inflows, ε and *t* denote error term and time index.

3.3.4 Estimation Procedure

3.3.4.1 Stationarity Test

Time series data or country specific analyses are always believed to have unit root, for this purpose and in a way of avoiding spurious estimation and analyses, it is important for the stationarity test to be conducted. This study employed some of the generally accepted techniques like Dickey-Fuller (ADF) (Dickey & Fuller, 1981), Phillips-Perron (PP) (Phillips and Perron, 1988) and Kwiatkwoski-Phillips-Schmidt-Shin (KPSS) (1992) to determine if the variables have non-unit root. The stationarity was tested and the output confirms that the data are non-stationary and that all variables are integrated to the order of one I (1). Furthermore, the tests account for structural break dates. The break dates show the new governments striving with reforms such as fiscal policy, monetary policy, political climate. The reforms include improving the investment climate and boosting growth which is tailored towards expanding investments in public infrastructure, minimizing the stringency of public(government)

policies, and creating new sectors of the economy to private investment. These reforms are targeted to opening of the Indonesian's economy for the attraction of foreign investors with caution as it concerns welfare and environmental issues. The appearance of 2010 as among the accounted break dates is in line with global financial crises that hit the global economy from 2008 -2010/2012. The results of the above-mentioned techniques and the structural break are displayed on the tables below.

Table 8: Unit Root Test

		AT LEVEL		1st Diff	
Variables	With intercept	intercept& trend	With intercept	intercept & trend	Conclusion
ADF					
LNGDP	2.4167	-0.1808	-3.8835***	-4.4473***	I(1)
LN CO_2	-1.1018	-3.1497	-6.0682***	-5.9783***	I(1)
LNENERGY	-1.8802	-1.6098	-6.6229***	-4.5693***	I(1)
LNOPEN	-1.3805	-3.4355*	-8.0636***	-7.9614***	I(1)
LFDI	-1.7971	-2.7493	-6.4656***	-6.3490***	I(1)
PP					
LNGDP	2.4167	-0.4372	-3.8835***	-4.4320***	I(1)
LN CO_2	-0.8677	-3.1395	-7.0744 ***	-6.8957***	I(1)
LNENERGY	-1.1387	-1.4931	-6.7505***	-7.3533***	I(1)
LNOPEN	-1.2398	-3.4326*	-8.0636***	-7.9614***	I(1)
LNFDI	-1.0017	-2.5300	-6.4526***	-6.3099***	I(1)
KPSS					
LNGDP	0.7176**	0.1634**	0.3958*	0.0977	
LN CO_2	0.6905**	0.0662	0.1449	0.1440*	
LNENERGY	0.7185**	0.1810**	0.1868	0.1681**	
LNOPEN	0.6820**	0.0637	0.0738	0.0676	
LNFDI	0.5032**	0.1559 **	0.1321	0.0743	

Notes: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%(b): Lag Length based on SIC (c): Probability based on (1) MacKinnon (1996) one-sided p-values (2) Kwiatkowski-Phillips-Schmidt-Shin (1992,).
Source: Authors computation.

Table 9: Break-Point Unit Root Tests

Variable	ADF	P-value	Lag	Break date	CV(1%)	CV(5%)
Level						
LNGDP	-7.884	< 0.01***	5	1997	-5.348	-4.8598
LN CO_2	-7.491	< 0.01***	9	2010	-5.348	-4.8598
LNENERGY	-4.932	0.0401**	0	1989	-5.348	-4.8598
LNOPEN	-4.1705	0.275	8	1998	-5.348	-4.8598
LNFDI	-3.8550	0.4651	9	1997	-5.348	-4.8598
1st Diff						
LNGDP	-12.490	< 0.01***	9	1997	-5.348	-4.8598
LN CO_2	-7.286	< 0.01 ***	1	2012	-5.348	-4.8598
LNENERGY	-7.886	< 0.01***	9	1990	-5.348	-4.8598
LNOPEN	-11.1344	< 0.01***	0	1988	-5.348	-4.8598
LNFDI	-6.1463	< 0.01***	0	1984	-5.348	-4.8598

Notes: (*) statistically Significant level at the 10%; (**) statistically Significant level at the 5%; (***) statistically Significant level 1%.
Source: Authors computation

3.3.4.2 ARDL-Bound Testing Approach

The unit root tests confirmed the integration of all the variables to order of one I (1). Bearing in mind the generality (the all accommodating) of application and insensitivity of ARDL towards the number of survey (Pesaran *et al.*, 2001), the author chose ARDL approach for the analyses. The current study chose ARDL because of its advantage in displaying its estimation results in lags order thereby giving in the relationship history of the selected variables. This aids the author to accommodate the relationship trend in the analyses without being bias at the initial result which might obstructs the expectations of the author, and it also helps in policy formulation in a research study.

This is the case where the lag order of the result comes in a mixed order of negativity and positivity, where in one lag the variables maybe displaying positive association with the dependent variable but with a negative relationship in next lag. This will expose the variables that needed to be managed for a certain time period even though, they are not yielding the expected result in the current time but considering the positive trend in the subsequent lags it could be handled with care, bearing in mind of the possible future impact. ARDL approach has been misunderstood by many researchers and this led to a general conclusion that it is limited to only where the order of integration is mixed but in actual sense, ARDL does not select the order of integration (see Pesaran, *et al*., 1998 & 2001). Hence, the current study adopted ARDL-bound approach.

3.3.4.2.1 ARDL specifications

The econometric specification of ARDL equation can be written as follows:

$$Y = \theta_0 + \theta_1 C0_2 + \theta_2 EU + \theta_3 OPEN + \theta_4 FDI + \varepsilon \quad (20)$$

Y represents log of GDP per capita, CO_2 represents log of carbon (CO_2 emissions) emissions, EU represents log of energy use while OPEN and FDI stand for log of openness and log of Foreign Direct Investment, inflows respectively, and ε represents the error term. The θ_0, θ_1, θ_2, θ_3 denote the coefficients of the variables in the model. The Eq. (20) is expanded from the ARDL dynamic equation to contain both the long run (ARDL-bound testing) and short run equations (Error Correction tests) equations. The two models (long run and short run) are expressed in Eq. (21) & (22) as follow:

$$Y_t = \theta_0 + \theta_1 Y_{t-1} \theta_2 C0_{2t-1} + \theta_3 EU_{t-1} + \theta_4 OPEN_{t-1} + \theta_5 FDI_{t-1} + \varepsilon_t \quad (21)$$

$$\Delta Y_t = \theta_0 + \theta_i \sum_{i=1}^{n} Y_{t-i} \theta_j \sum_{j=1}^{n} C0_{2t-j} + \theta_k \sum_{k=1}^{n} EU_{t-k} + \theta_n \sum_{n=1}^{n} OPEN_{t-n}$$

$$+ \theta_m \sum_{n=1}^{n} FDI_{t-m} + \mathrm{EC}M_{t-1} + \varepsilon_t \quad (22)$$

From Eq. (21) , θ_0, θ_1, θ_2, θ_3 and θ_4 and Eq. (22) θ_0, θ_I, θ_J, θ_K , $\theta_N and\ \theta_m$ are the long run coefficients, and the parameters in Eq.(22); are the short run coefficients. Δ In Eq.(22), denotes the 1st Difference of the variables, while ECM_{t-1} shows the speed of adjustment over a certain period of time which is usually considered as the long run. Before the proper estimation of ARDL dynamic tests, it is vital to check the long run association among the choice variables using Bound testing procedure.

It is hypothesis with a claim of no co-integration in the model as follows:

Ho: $\theta_0 = \theta_I = \theta_J = \theta_K = \theta_N$=0 against the alternative hypothesis H1: $\theta_0 = \theta_I = \theta_J = \theta_K = \theta_N \neq 0$. with a view of co-integration.

The ascertainment of co-integration is done by comparing the estimated F-statistics (T-statistics) with critical lower I (0) and upper I (0) bound values. Bound testing is done to check for long run associations and often denoting Wald or F-test. According to Pesaran et al., (2001), the estimated F-statistics value with bound testing approach is compared to the estimated critical value, and if the estimated value of F-test is greater than the tabulated value, it shows that long run association between variables exist. Hence, the null hypothesis of no co-integration is rejected. However, if the F-statistics is lesser than the lower bound critical value the alternative hypothesis of the existence of co-integration is rejected, while the result becomes inconclusive when the F-statistics is in between the two (upper and lower) bounds critical values. The ARDL-bound approach test model employs a more general approach of conditional error correction model (ECM). This approach combined with the option of imposing restriction on intercept, trend, and or both as shown in the general model of Eq. (22) expressed in the above specification. Hence, the results are presented as follows:

Table 10: ARDL Dynamic Estimates of GDP Equation

Variables	Coefficients	SE	t-statistics	Prob-value
Short-run				
D(LN CO_2)	2.651	0.542	4.888	0.0002***
D(LN CO_2 (-1))	-1.658	0.674	-2.458	0.0258**
D(LN CO_2 (-2))	-1.113	0.549	-2.028	0.0595*
D(LNENERGY)	0.922	0.348	2.647	0.0176**
D(LNENERGY(-1))	-2.558	3.642	-0.702	0.4925
D(LNENERGY(-2))	-3.623	4.008	-0.903	0.3795
D(LNOPEN)	-0.041	0.011	-3.667	0.0021***
D(LNOPEN(-1))	0.032	0.012	2.624	0.0184**
D(LNOPEN(-2))	0.063	0.013	4.893	0.0002***
D(LNFDI)	-2.980	4.430	-0.673	0.5117
D(LNFDI(-1))	0.642	0.093	6.902	0.0000***
D(LNFDI(-2))	0.306	0.098	3.108	0.0077***
CointEq(-1)*	-0.147	0.018	-8.228	0.0000
Long-run				
LN CO_2	2.651	0.838	3.163	0.0060***
LN CO_2 (-1)	-0.191	0.104	-1.842	0.0841*
LN CO_2 (-2)	0.055	0.114	0.475	0.6411
LNENERGY	0.922	0.425	2.168	0.0455**
LNENERGY(-1)	-0.371	0.538	-0.689	0.5008
LNENERGY(-2)	-0.106	0.603	-0.176	0.8622
LNFDI	0.013	0.004	3.226	0.0053***
LNOPEN	-0.041	0.015	-2.721	0.0151**
LNOPEN(-1)	-0.017	0.014	-1.232	0.2359
LNOPEN(-2)	0.031	0.015	2.135	0.0486**
C	2321	6863	3.382	0.0038***
Bound test(Long-run)				

F-statistics	10.8***	K=4,@ 1%	I(0)bound=3.74	I(1)bound=5.06
T-statistics	-8.23***	K=4,@1 %	I(0)bound= -3.4	I(1)bound= -4.6
Wald test(short-run)				
F-statistics	7.075***			
P-value	0.000			
Serial Correlation test				
F-statistics	1.378			
Heteroskedasticity Test				
F-statistics	0.893			

Note: ***, **, ***** Denotes rejection of the null hypothesis at the 1%, 5% and 10%
Sources: Authors computation

Table 10 above shows the results of both the long-run (ARD-bound testing) and the short-run (ECT) derived with Autoregressive Distributive Analyses (ARDL) estimation. The optimum lag selection is 4 as indicated Akaike Criteria (AIC). The Akaike information Criteria was considered appropriate for the optimum lag selection because of its superior properties over other criteria (see Shahbaz &Rahman, 2012). According to the output from the (AIC), lag 4 is considered appropriate for the sample size of this analyses. See *Appendix* for the lag selection result. The ECM coefficient with a negative sign and highly significant at even 1% shows the speed of adjustment in restoring the disjointed equilibrium in the dynamics model, it is also an indicator that there is a convergence among the variables in the long run to an equilibrium (See Bannerjee *et al*., 1998). The cointegration equation for this study revealed (*ECT*= *-0.147*) 15 percent(approximately) speed of adjustment to the equilibrium path on GDP from the impact of CO_2 emissions, energy use, trade openness and FDI on annual

basis. The outcome of the estimation shows a mixed pattern of relationship between the variables and the economic growth (GDP). The displayed result on the table 6 confirms the ARDL long run (elasticity) of economic growth is significantly positive associated with $C0_2$ release. This revelation is in consonance per the findings of Alola *et al*., (2019) in their study on large economies of Europe; Emir and Bekun, (2018) in their work on Romanian, but this finding changed in the lag 1 &2 with negative and significant relationship between GDP and CO_2 emissions. This means that economic growth of Indonesia induces carbon emissions in the initial stage, but in the 1st and 2nd lags both in the short-run and long run, the otherwise is the case, meaning that economic growth of Indonesia is reducing the carbon emission which is a laudable trend for the economy. This finding corresponds to the findings of Sarkodie and Strezov, (2019) who found a negative relationship between economic growth and pollution in their work on developing countries. Akadiri *et al*., (2019). Numerically, a one percent increase in the carbon emissions significantly impacted the economic growth positively by 2 percent, but surprisingly to the good of the Indonesian economy, this trended was altered in lag 1 and 2. Hence, a one percent increase in the economic growth reduces carbon emission by 1.6 percent and 1.1 percent in both first and second lags respectively. Also, finding shows a positively significant relationship between economic growth and energy use (as expected). This portrays a success trend in balancing the economic growth and the environmental quality because whenever the economic is growing, there is every tendency that the energy consumption will be high in the economy, but where the energy consumption is efficiently moderated and carefully shifted to a more conservative renewable energy it will go a long way to reduce the carbon (CO_2)emission as we found in the growth relationship with the CO_2 emissions in the 1st and 2nd lags. This research finding is in agreement with the findings

of Sarkodie and Strezov, (2019) that validate pollution haven hypothesis for Indonesia at initial stage, but with the careful observation of a change of pattern in both 1st and 2nd lags and the trend in figure 6 which shows a decline in total emissions in 2016 countered the findings from Sarkodie and Strezov, (2019). Also, the projection of Michael Barnard, (2017) where It is projected that CO_2 emissions of Indonesia will grow and more than doubled in the next few years is equally faulted with this finding and the decreasing trend of CO_2 emissions in figure 6 above. This is in agreement with the works of Emir and Bekun, 2018 for Romania; Paramati *et al*., (2017) and Balcilar *et al*., (2019) in their Pakistan's study. Negative and significant relationship is found between openness and economic growth but positive and significant relationship was observed between openness and growth in the 1st and 2nd lag. This is a true picture of a trade deficit and import oriented country like Indonesia. Indonesia trade openness does not reflect a favorable one because of its over dependent on importation of primary and non-technological products, but a reversal was observed in the lag periods and the same trend was observed even in the long run which is a good sign and healthy to the economy of Indonesia. This finding is in agreement with the works of Hye, (2012) for Pakistan who found negative relationship between economic growth and openness and, Akadiri *et al*., (2019a) for Ghana with positive result. As for the findings on the relationship between the economic growth and FDI, the result shows a negative but not significant relationship between economic growth and Foreign Direct Investment, inflow in the short-run, while in the long-run, the relationship became significantly positive. This shows that FDI is impacting favourably to the Indonesia economic performance which is yielding to the government reform policy of shifting from public to private investment, and it is a healthy to the economy and at the same time very attractive to the foreign investors. This has implication to the environmental

quality of Indonesia via economic growth, hence, the higher and better the economic growth of the country the lesser the carbon emissions and the better the environmental quality. This support the pollution halo hypothesis by Shahbaz, (2018b), where FDI enhance economic growth which impact energy consumption and carbon emission favorably in the host country. This supports the findings of Paramati *et al*., (2017) in their work on G2O, OECD nations, and John C. Anyanwu (2012).

3.3.4.3 Granger Causality

The Conventional regression will only show the relationship and impact with the level of the impact as significant or insignificant but does not really exhibit a direct causation (transmission) which is behind the relationship amongst the variables adopted in any research studies. Not minding the fact that the applied (ECT) as employed in this very work shows causality (transmissions) among the variables but it is limited with the causality without much light to the direction (feedback) of the causality. Hence, this informed the choice of testing further to ascertain both the transmission and the direction of the transmission among the employed variables (GDP per capita, CO_2 emissions, energy use, trade openness and FDI). In attempt to identify the direction of the transmitting among the variables, the current study considered Pairwise granger causality technique appropriate approach to be employed. The theoretical background of granger causality is established in line with the Gregory and Hansen (1996) mode. The equation is expressed as follows;

$$Y = c + \propto + \gamma \Delta W(\lambda) + \delta Y + \mu_t \quad (23)$$

Where Y_{1t} and Y_{2t} are of 1st difference (i.e. I(1)), Y_{2t} represents the set of variables (*GDP per capita, CO_2emissions, energy use, openness and FDI*); $\Delta W_t(\lambda)$ =1 for t >Tλ, otherwise, $\Delta W_t(\lambda)$ =0; λ=T_a /T denotes the location where the structural break lies; *T* remains the sample size while T_a denotes the date of the occurrence of structural

break (*1984, 1988, 1989,1990,1997,1998,2010 and 2012*) . Also, there is a need to check whether the error term, μ_t in Eq. (23) is stationary at level I(0) or 1st difference I(1) through any of the ADF or PP techniques. If it is (i.e. μ_t) found to be consistent with I(1), it is assumed that cointegraion exist between Y_{1t} and Y_{2t}. If the statistical features of μ_t is established, one can use the bivariate vector autoregressive (VAR) model to estimate the granger causality.

The VAR model can be expressed as follows;

$$Y_t = \theta_0 + \sum_{i=1}^{n} + \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{n} \delta_i \Delta \mathrm{CO}_{2\ t-i} + \sum_{i=1}^{n} \beta_i \Delta EU_{t-i} + \sum_{i=1}^{n} \lambda_i \Delta OPEN_{t-i}$$

$$+\sum_{i=1}^{n} \gamma_i \Delta FDI_{t-i} + \varepsilon_t \quad (24)$$

$$C02_t = \theta_0 + \sum_{i=1}^{n} + \sum_{i=1}^{n} \alpha_i \Delta \mathrm{CO}_{2\ t-i} + \sum_{i=1}^{n} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_i \Delta EU_{t-i} + \sum_{i=1}^{n} \lambda_i \Delta OPEN_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta FDI_{t-i} + \varepsilon_t \quad (25)$$

$$EU_t = \theta_0 + \sum_{i=1}^{n} + \sum_{i=1}^{n} \alpha_i \Delta EU_{t-i} + \sum_{i=1}^{n} \delta_i \Delta \mathrm{CO}_{2\ t-i} + \sum_{i=1}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \lambda_i \Delta OPEN_{t-i}$$

$$+\sum_{i=1}^{n} \gamma_i \Delta\Delta FDI_{t-i} + \varepsilon_t \quad (26)$$

$$OPEN_t = \theta_0 + \sum_{i=1}^{n} + \sum_{i=1}^{n} \alpha_i \Delta OPEN_{t-i} + \sum_{i=1}^{n} \delta_i \Delta \mathrm{CO}_{2\ t-i} + \sum_{i=1}^{n} \beta_i \Delta EU_{t-i} + \sum_{i=1}^{n} \lambda_i \Delta Y_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta\Delta FDI_{t-i} + \varepsilon_t \quad (27)$$

$$FDI_t = \theta_0 + \sum_{i=1}^{n} + \sum_{i=1}^{n} \alpha_i \Delta POP_{t-i} + \sum_{i=1}^{n} \delta_i \Delta \mathrm{CO}_{2\ t-i} + \sum_{i=1}^{n} \beta_i \Delta EU_{t-i} + \sum_{i=1}^{n} \lambda_i \Delta OPEN_{t-i} + \sum_{i=1}^{n} \gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (28)$$

The current study applies Pairwise granger causality which serves as a robust check to the findings of from the error correction estimation. The Pairwise granger causality is shown in the below table.

Table 11: Pairwise Granger Causality Test (Short Run Causality Test Result)

Null Hypothesis	F-statistics	Prob	Causality	Direction
LN CO_2→ LNGDP LNGDP→ LN CO_2	0.10049 1.85873	0.9047 0.1728	No	Neutral
LNENERGY→LNGDP LNGDP→LNENERGY	0.03379 0.01187	0.9668 0.9882	No	Neutral
LNFDI→LNGDP LNGDP→LNFDI	0.10113 3.72402	0.9041 0.0355**	Yes	Uni-directional
LNOPEN→LNGDP LNGDP→LNOPEN	0.17012 10.3056	0.8443 0.0004***	Yes	Uni-directional
LNENERGY→LN CO_2 LN CO_2→LNENERGY	5.76815 0.04614	0.0074** 0.9550	Yes	Uni-directional
LNFDI→LN CO_2 LN CO_2→LNFDI	1.41649 4.41186	0.2578 0.0206**	Yes	Uni-directional
LNOPEN→LN CO_2 LN CO_2→LNOPEN	2.59832 5.24343	0.0905* 0.0109**	Yes	Bi-directional
LNFDI→LNENERGY LNENERGY→LNFDI	0.34059 1.61217	0.7140 0.2157	No	Neutral
LNOPEN→LNENERGY LNENERGY→LNOPEN	1.00137 5.66398	0.3789 0.0080**	Yes	Uni-directional
LNOPEN→LNFDI LNFDI→LNOPEN	1.16011 1.03677	0.3267 0.3666	No	Neutral

Note: ***, **, ***** Denotes rejection of the null hypothesis at the 10%, 5% and 1%
Sources: Authors computation

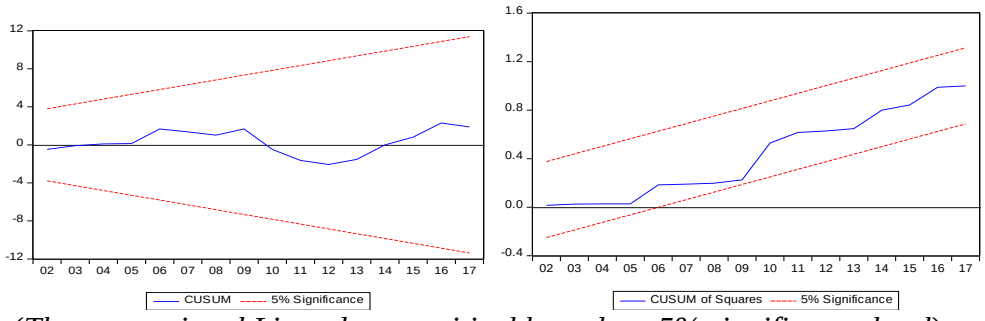
Table 11 encompassed and displays the outcome from the pairwise granger causality test. The findings give credence to the revealing of the dynamic, ARDL-bound (long-run) and ECT (short run) estimations above. It is established from the findings that a uni-directional causation passing to Foreign Direct Investment (FDI) from economic growth (GDP) at 5%, significant level. This is a signal of a good economic

performance that poised on attracting investors. This is laudable, and attests to the fact that the new government's striving with reforms such as fiscal policy, monetary policy, political climate is yielding positive results by attracting FDI. Hence, GDP causing FDI. The reforms include improving the investment climate and boosting growth which is tailored towards expanding investments in public infrastructure, minimizing the stringency of public (government) policies, and creating new sectors of the economy to private investment. These reforms are targeted to opening of the Indonesian's economy for the attraction of foreign investors with caution as it concerns welfare and environmental issues, and this finding is in consonance with the target. This finding is in support of the findings in the works of Tuyen and Winai, (2017); Hongfeng *et al*., (2016) on Vietnam and Chinese economy. The causality tests equally show uni-directional transmission passing from energy to openness, CO_2 emissions, and from FDI to CO_2 emissions while there is a feedback causation between openness and CO_2 emissions. This established how the economic growth of Indonesia and the carbon emissions are impacted through the nexus amongst the selected variables. Thus, it is a clear indication that Indonesian economy is not far-fetched from energy induced growth considering the highly dependent of the economy on manufacturing and industrial sectors. It gives vivid direction of the transmissions and how the environmental quality is impacted, hence, energy consumption is causing CO_2 emissions through (offshore) economic and industrial activities such as foreign investments. FDI with openness are equally causing CO_2 emissions respectively and this has environmental implication which can be either negative or positive. This is definitely going to be a pointer to policy makers on how to frame policies to achieve a balanced economic growth with efficient energy use in other to maintain a free lethal

CO_2 emissions. The findings as it concerns energy use transmitting to CO_2 emissions are in agreement with the findings of Alola, *et al*., (2019); Akadiri, *et al*., (2019b).

3.3.4.4 Diagnostic Test

Diagnostic test was carried out in attempt to ascertain the stability of the analyses. The test was done with some estimations as regards to the normality, correlation and stability of the analyses to ensure that the analysis and estimations are free from wrong estimations or misspecification which will lead to a doubt on the validity of our claims. The findings from the tests of serial correlation, normality test and heteroscedasticity show that the study is normally distributed and free from any form of serial correlation, see the findings on the below of ARDL-bound test table immediately after bound test. The stability and reliability of the short run and long run ARDL model was checked with cumulative sum (CUSUM) tests and cumulative sum of square tests (CUSSUM) (Brown et al., 1975). The finding clearly indicates that the stability of the coefficients over the period researched is assured. The results are shown below in figure 11.



(*The conventional Lines denote critical bounds at 5% significance level*)

Figure 11: (Plot of Cumulative Sum of Square of Recursive Residuals)

Source**:** Authors Computation

3.4 Concluding Remark and Policy Implication

This study integrates Foreign Direct Investment (FDI) and trade openness in its model in attempt to investigate and report clearly the environmental implication of offshore economic activities by linking amongst the economic growth, energy use and

environment (CO_2) in a cointegrated and causality manner. The author tried to find out if the effect of the carbon emission is positive to the performance of the Indonesian economic growth with an eye on the energy intensity via offshore (FDI and Openness) economic and industrial activities in the economy. This, we do by building a linear relationship between the chosen variables (economic growth (GDP), energy use, carbon emissions, trade openness and population) to buttress the effect of the carbon pollution on the growth of India. We apply this principle in this study based on the new government reforms that entails shifting to private investments from solely state-owned economic practice, also, considering the economic structure of Indonesia which is built within the manufacturing and industry sectors and prone to high energy consumption. Investigating the sustenance of the positive and significant economic growth amidst high carbon(CO_2) dioxide emissions will aid the author to address some salient policy questions such as, can Indonesia pursue policies such as adopting clean technologies to increase sustainability of the energy economy, and conservative measures to reduce carbon pollutions without harming the positive significantly trending economy?

The study is estimated with the combination of ARDL (Dynamics)-bound tests and pairwise granger causality estimation approaches. Long equilibrium is established with findings of ARDL-bound testing and robust check for confirmation of the long run stability and ability to adjust after disequilibrium was done with error correction model (ECM). The output confirmed long run equilibrium with the ability to adjust at -0.15%. Some key variables (such as CO_2 emissions, energy use, trade openness and FDI) displayed mixture of positive and negative both at initial stage and at different lags with the economic growth and all are significant. In consideration to the output

of the long run association estimation from table 6. It rightly depicts the relationship that is established between the economic growth and the explanatory variables. The outcome of the estimation shows a mixed pattern of relationship between the variables and the economic growth (GDP). The displayed result on the table 6 confirms the ARDL long run (elasticity) of economic growth is significantly positive associated with carbon emissions. But this finding changed in the lag 1 &2 with negative and significant relationship between GDP and CO_2 emissions. This means that economic growth of Indonesia induces carbon emissions in the initial stage, but in the 1st and 2nd lags both in the short-run and long run, the otherwise is the case, meaning that economic growth of Indonesia is reducing the carbon emission which is a good trend for the economy. Also, findings showed a positively significant relationship between economic growth and energy use (as expected). This portrays a success trend in balancing the economic growth and the environmental quality because whenever the economic is growing, there is every tendency that the energy consumption will be high in the economy, but where the energy consumption is efficiently moderated and managed, and carefully shifted to a more conservative renewable energy it will go a long way to reduce the carbon emission as we found in the growth relationship with the CO_2 emissions in the 1st and 2nd lags. Negative and significant relationship is found between openness and economic growth but positive and significant relationship was observed between openness and growth in the 1st and 2nd lag. This is a true picture of a trade deficit and import oriented country like Indonesia. Indonesia trade openness does not reflect a favorable one because of its over dependent on importation of primary and non-technological products, but a reversal was observed in the lag periods and the same trend was observed even in the long run which is a good sign and healthy to the economy of Indonesia. As for the findings on the relationship between the

economic growth and FDI, the result shows a negative but not significant relationship between economic growth and Foreign Direct Investment, inflow in the short-run, while in the long-run, the relationship became significantly positive. This shows that FDI is impacting favourably to the Indonesia economic performance which is yielding to the government reform policy of shifting from public to private investment, and it is a healthy to the economy and at the same time very attractive to the foreign investors. This has implication to the environmental quality of Indonesia via economic growth, hence, the higher and better the economic growth of the country the lesser the carbon emissions and the better the environmental quality. This support the pollution halo hypothesis by Shahbaz, (2018b), where FDI enhance economic growth which impact energy consumption and carbon emission favorably in the host country.

With the findings of this present study that provides justifiable evidence of nexus transmissions amongst economic growth, CO_2 emissions, energy use, openness and FDI, the government policy implication should be framed and centered on how to mitigate between energy intensity, openness and FDI to sustain the present economic growth trend of Indonesia while reducing the CO_2 emissions in the economy. This should be done with an eye on the attraction of foreign investors with environmental conscious policy which will balance the gains of the investors and the quality of environment. Also, cost effective yardstick should be a better way of improving the efficiency and reduction of the energy intensity thereby meeting up with its target of cutting emissions to 43rd percent in 2030 while targeting to deliver the annual economic growth of 5.6 and 6 percent in the next 25 years. The handlers of the economy should engage on energy security and diversification by shifting from a crude and traditional energy generating sources such as fossil fuel to a more conservative

and renewable energy such as wind and solar sources of energy. Again, considering the causation amongst CO_2, FDI and openness especially the feedback transmission between openness and CO_2 emissions, it provides important policy implications for controlling pollution emissions in Indonesia. Currently, the Government of Indonesia provides incentives to foreign investors to create avenue for attracting FDI. No doubt FDI plays an important contribution in the betterment of economy of any developing country like Indonesia but, this should not sway the attention of the government authorities from the environmental impact of the offshore (openness and FDI) economic activities in the country. With these implications in mind, adequate and balanced regulatory policies should be in place to moderate between the economic performance and environmental consequences of the offshore economic activities.

Chapter 4

CONCLUSION AND POLICY RECOMMENDATIONS

This study is the exploration of the link between the offshored economic activities and the environmental quality through the interactions of the selected variables (FDI, Trade openness, international tourism, Energy use, Carbon ($C0_2$) emissions and GDP per capita). The style employed in this thesis is the step by step presentation of different studies done in line of the chosen topic with focus on different countries in both Asia and Southeast Asia regions. We arrived at different conclusions coupled with different policy implications based on each study, and the conclusion of this thesis will be based on the summary of the conclusions of the different studies.

From the first studies that made up chapter two, the first model that is hinged on growth function, the nexus amongst FDI, international tourism, energy use and GDP was investigated to determine the environmental quality. The environmental quality is measured with carbon ($C0_2$) emissions. Among the findings is positive association between GDP and the controlled variables (*FDI, international tourism, energy use and $C0_2$ emissions*). Tourism arrival has a bi-directional causal relationship with energy use and a one-way causal relationship with carbon emissions (transmitting from tourism to $C0_2$ emissions). Both FDI and energy use have bi-directional causal relationship, CO_2, energy use and tourism arrivals have a unidirectional relationship with GDP which established the triangular nexus among causality among the variables and impact on the GDP. The findings affirmed the findings from the studies of

(Shahbaz *et al*., 2013) and (Aceleanu *et al*., 2017), where they found positive influence of energy consumption to the economic growth as found in our study. Also, the findings in our study have affirmed the cost implication of heavy energy consumption that is induced from both the outsourced manufacturing activities and the tourism arrivals. From the model two which is hinged on carbon emissions function, we examined the interacting force between carbon emissions and offshored intensive activities with a focus on China as a country. This study is triggered to answer the outline questions in the research such as Is there really any meaningful relationship between FDI and carbon emissions through energy consumption? Is China to be blamed and bear the responsibility of CO_2 emissions by FDI or not? So, doing, this study will fill the gap via exploring the association between FDI, CO_2 release by integrating the part of economic advancement for China. The findings are as follow; CO_2 emissions have a positive relationship with both energy use, FDI and GDP. This contributes to heavy CO_2 emissions which the author classified as the outsourced CO_2 emissions in China FDI. Tourism arrivals have a bi-directional (feedback) causal relationship with energy use, and a uni-directional causal relationship with CO_2 (transmitting from tourism to CO_2). Both FDI, energy use, CO_2 and tourism arrivals have a unidirectional relationship with GDP which established a nexus among causality among the variables and impact on the GDP.

From chapter four, we researched on the environmental implication of offshored economic activities in Indonesia. A dual analysis of cointegration and causality was utilized. We integrate Foreign Direct Investment (FDI) and trade openness in our model in attempt to investigate and report clearly the environmental implication of offshore economic activities in Indonesia, this, was done by linking among the

economic growth, energy use and environment (CO_2) in a cointegrated and causality manner. Offshored economic activities were measured by FDI and trade openness which we incorporated and expands in the economic model This we built around the econometric and scientific modelling which gives us enabling ground to estimate both short run and long run effects with the help of ARDL model with an eye on the offshore activities. The study expands on the work of Azam *et al*. (2016). The findings of this study are as follows; 1. The ARDL long run (elasticity) of economic growth is significantly positive associated with carbon emissions. But this finding changed in the lag 1 &2 with negative and significant relationship between GDP and CO_2 emissions. 2. Positively significant relationship between economic growth and energy use (as expected). 3. Negative and significant relationship is found between openness and economic growth but positive and significant relationship was observed between openness and growth in the 1st and 2nd lag. 4. A negative but not significant relationship between economic growth and Foreign Direct Investment, inflow in the short-run, while in the long-run, the relationship became significantly positive; 5. A uni-directional causation is found passing to Foreign Direct Investment (FDI) from economic growth (GDP) at 5%, significant level; 6. Uni-directional transmission passing from energy to openness, CO_2 emissions, and from FDI to CO_2 emissions while there is a feedback causation between openness and CO_2 emissions.

The policy implication of these findings is; China should look into carbon dioxide emissions and shift from high carbon economy to low carbon economy without much distraction of economy growth. Hence, shifting away from high coal generating energy to renewable energy that is capable of promoting cleaner system. Also, a concerted effort should be made in moving away from coal to more manageable energy sources

(e.g., wind or solar power) in combating high CO_2 emissions. Reducing the rate of the tropical deforestation and encouraging the manufacturing of vehicles with good fuel efficiency, and even switching to solar energy consumption vehicles should be among the policies in consideration. This, the country can do by consolidating the FDI and tourism activities and reducing the CO_2 emission in sustaining the good performance of the economy via economic growth. Also, considering the association that occur between the energy use and the economic activities, it is a clear evidence that CO_2 emissions will certainly follow in the cycle which will be the end product of the entire process and this is detrimental to the quality of environment. This call for the attention of the Chinese authorities over the economic and manufacturing activities in the country while building the policy implication framework. The government policy implication should also be framed and centered on how to mitigate between energy intensity, openness and FDI to sustain the present economic growth trend of Indonesia while reducing the CO_2 emissions in the economy. This should be done with an eye on the attraction of foreign investors with environmental conscious policy which will balance the gains of the investors and the quality of environment. Also, cost effective yardstick should be a better way of improving the efficiency and reduction of the energy intensity thereby meeting up with its target of cutting emissions to 43rd percent in 2030 while targeting to deliver the annual economic growth of 5.6 and 6 percent in the next 25 years. The handlers of the economy should engage on energy security and diversification by shifting from a crude and traditional energy generating sources such as fossil fuel to a more conservative and renewable energy such as wind and solar sources of energy. Again, considering the causation amongst CO_2, FDI and openness especially the feedback transmission between openness and CO_2 emissions, it provides important policy implications for controlling pollution emissions in Indonesia.

Currently, the Government of Indonesia provides incentives to foreign investors to create avenue for attracting FDI. No doubt FDI plays an important contribution in the betterment of economy of any developing country like Indonesia but, this should not sway the attention of the government authorities from the environmental impact of the offshore (openness and FDI) economic activities in the country. With these implications in mind, adequate and balanced regulatory policies should be in place to moderate between the economic performance and environmental consequences of the offshore economic activities.

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