Climate Change, Industrial Activity and Economic Growth: A Cross Regional Analysis

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Abstract: *Industrial Activity and its related output continue to contribute to economic growth for emerging and already developed World economies. Industrial activity also has strong negative consequences for the environment, one of which is climate change, attributable to greenhouse gas emissions (GHG) and other causatives. This study investigates the link between climate change, industrial activity and growth for World regions using six regions of the World. The questions the study tries to answer include if industrial activity across regions were impacting climate change and if such industrial activity drives growth at the expense of climate change. The study provides an overview of the current implications of industrial activity on climate change at a time when world leaders and policy makers are drafting a World pollution mitigation blue print in Paris. It was found that there exists a link between industrial activity, climate change and economic growth. And that emission cuts and green economies are likely a way to go, in mitigating the impact of climate change on the environment.*

Keywords: *Climate Change, Entrepreneurial and Industrial Activity and efficiency, Innovation and Environmental Pollution*

JEL Classification: *C5, Q4*

1. Introduction

An introductory discuss is presented in this section. Carbon dioxide CO_2 is constantly being produced and exchanged among the atmosphere, ocean, and land surface and it is absorbed by many micro-organisms, plants, and animals. In reality, the removal of CO_2 by these natural processes tend to balance overall CO_2 content in the ecosystem (through the removal of radioactive forcing). It is on record that human activities have contributed substantially to climate change by adding CO_2 and other heat-trapping gases to the atmosphere (Environmental Protection Agency (EPA) 2013).Also according to the Environmental Protection Agency (EPA) of the United States "many industrial processes emit CO_2 through fossil fuel combustion. Several processes also produce CO_2 emissions through chemical reactions that do not involve combustion; for example, the production and consumption of mineral products such as cement, the production of metals such as iron and steel, and the production of chemicals". Therefore this study seek to find pressing answers to the following questions which include: Is there a link between climate change, industrial activity and economic growth? Does regional energy use play a role, in average world temperature increases? To what extent does industrial activity affect temperature levels across regions in the world? The EPA also provides evidence that Electricity which is a significant source of energy in the United States is used to power homes, business, and industry, and that in

2015 alone the combustion of fossil fuels used to generate electricity was the largest single source of CO_2 emissions in the US, responsible for almost 35 percent of total U.S. CO_2 emissions and 29 percent of total U.S. greenhouse gas emissions. Climate change, industrial activity and economic growth are often intertwined particularly in many developing countries like China. How to control smog, attributable to high coal use as well as industrial activity has become a strong challenge for the People's Republic of China in recent years, sparking red alert on air pollution in particular in over ten Chinese cities including Beijing (BBC Report, December 2015). While experts continue to argue for control of air pollution in particular other industrial externalities have also led to different negative consequences in other parts of the World and Africa in particular.

As of now experts and analyst have not managed to come up with a specific blueprint to reduce emissions and environmental pollution other than emission cuts and environmental policies aimed at pollution reduction. Carbon dioxide emissions are on the increase across regions largely due to population growth as well as increases in industrial activity across regions United Nations Statistics 2013. Industrial activity such as crude oil exploration, gas flaring in oil exploration processes in many developing countries, deforestation, mining of solid minerals, the production sector utilizing fossil power plants etc., contribute a great deal to greenhouse gas emissions. Also are domestic consumption patterns such as the use of automobiles, domestic gas usage, and the demand for wood in building and construction sectors driving activities that lead to increases in world average temperatures through emission and other industrial related pollution. This study examines the effect of a host of variables on climate change (temperature changes or global warming specifically). There also exist a strong debate on the effect of greenhouse gases and Co_2(Carbon dioxide) build-up on global average temperature increases often referred to as global warming. The resultant effect of which is known to cause flooding, poor harvest, and other unbearable living conditions.

Industrial activity according the United Nations statistics 2013 is also on the increase especially with positive growth in the economies of many emerging and other developing countries specifically in the South East Asian Pacific and sub Saharan African regions. Associated with industrial activity and growth is the tendency for firms and industries to generate negative externalities such as various forms of pollution which include both land, water, air and noise pollution. Regional industrial output itself can also lead to increases in emissions depending on the nature and technology used in production, specific reliance on fossils can also affect the nature of emissions for instance, coal is known to cause a lot of air pollution except with specific technology to harness clean coal generation process. Other alternative energy generation sources can also affect regional specific contribution to emission buildup for instance reliance on renewable energy sources are not likely to generate as much negative externality for the environment leading to reduced negative consequences for the environment (i.e. clean energy sources are not likely to result in high level of greenhouse gases andCo_2buildup).

1.1 Scope and Objectives of the Study

The scope and objectives of the study are introduced in this section. The study examines the link between climate change, industrial activity and economic growth in regions. The regions examined include Australasia (Australia and New Zealand), the European Union, Latin America, North American, South East Asia Pacific and Sub-Saharan Africa. The study depth involves examination of causes of climatic change with emphasis on temperature increases, the relationship between energy use and temperature changes and the relationship between industrial activity and climate change. The specific objectives of the study include to: a.) determine if there exist a link between climate change, b.) the relationship between industrial activity and economic growth, c.) investigate if regional energy use plays a role in average world temperature increases and the extent to which industrial activity affect temperature levels across regions.

2. Short Review of Literature

A short review of literature is conducted in this section. Literature state that climatic changes are attributable to increasing world population and unsustainable development activities by humans. Fankhauser and Tol (2005), also state that climate change affect growth. Halgatte (2005), Eboli, Parrado, Rason (2010) and Bretscheger and Valente (2011) also agree that climate change have strong consequences for economic growth. Without major justifications Dietz and Stern (2014), Moyer, Woollet, Matteson, Glotter and Weisbach (2014) and Moore et al (2016) agree that there exist a relationship between climate change and technological progress. Further evidence is provided by Dell, Jones and Olken (2014), using different econometrics methodologies on the relationship between climatic change and economic growth. Olsson, Ola and Hibbs (2005) also argue that there exists a relationship between geography and underdevelopment, stating categorically that cases of underdevelopment are attributable to geographical conditions.Gallup, Sachs and Mellinger (1999), state that there exist a link between climate, diseases and poverty levels. While relationship between climate change and agricultural pest was established by Masters and MacMillan (2001), who explained that extreme winter cold kills pest and enhances productivity.

Acemoglu, Johnsonand Robinson, (2001), (2002), and Easterly and Levine , (2003) state specifically that negative effects of climate change on development disappears when the impact of institutions are accounted for. Using a single Equilibrium model, however with strong support from multiple equilibrium models, Bloom, Canning and Sevilla (2003) find limited effects of climate change on past growth rates. The social cost of carbon is the environmental and economic cost of carbon on agents and stakeholders in the environmental sector of an economy, The environmental and social cost of carbon has been examined by Botzen and Van den Bergh (2012) and Van den Bergh and Botzen (2014), (2015) with both estimates paying primary concerns on alternative risk factors. Second estimates pay attention on preferences, risks aversion and inequality aversion (Anthoff et al, 2006, Tol, 1999, 2013a). Specifically Stern (2010), (2013); Van den Bergh and Botzen (2014), (2015) argue for a case of setting bounds on the social cost of carbon. Golosov,Hassler, Krussell and Tsyvinski (2014) explain that the social cost of carbon can be written as a function of total economic output, elasticity of damage due to atmospheric concentration of carbon dioxide and the rate of decay of carbon dioxide. Emerging statistics from International Energy Agency (IEA) and the World Bank 2013 depicts that there are increases in average World temperatures as well as CO_2 emissions Worldwide, showing a simultaneous increase in average world temperatures and regional emissions respectively even though past studies already state that in many instances no relationship have been found for both in many instances attributing such changes to increases in population (see the United States Environmental protection Agency Overview of greenhouse gases, 2013). Trends also show depict increases in World average temperature from 1960 till date (World Development Indicator Data of the World Bank) see Fig. 1. Increases in emissions across regions are also noticeable with North America, South East Asia (Comprising China) and the European Union Leading the regions in emission pollution. The trend in emissions also appear to coincide with systematic increases in industrial output suggestive of a relationship between the two.

Fig. 1

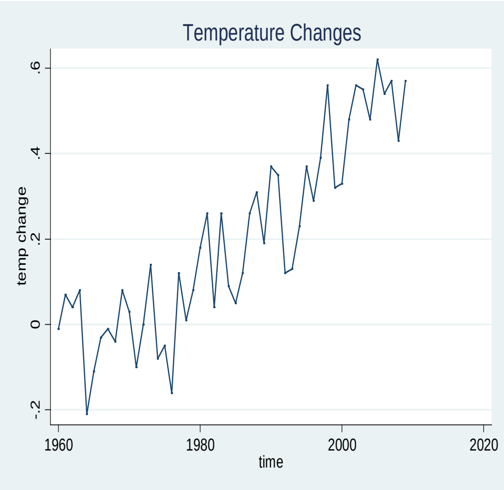
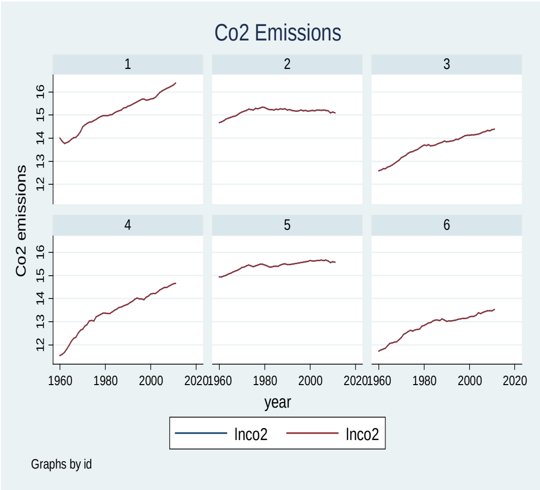


Fig. 2



Source: Authors Compilations- Note: figures 1 and 2 depict increases in World average temperatures as well as Co2 emissions

Fig.3

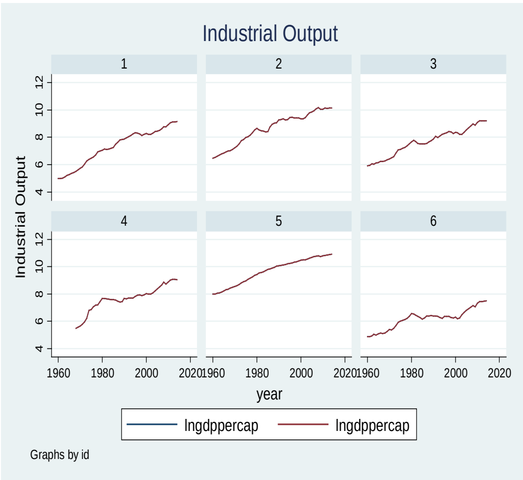
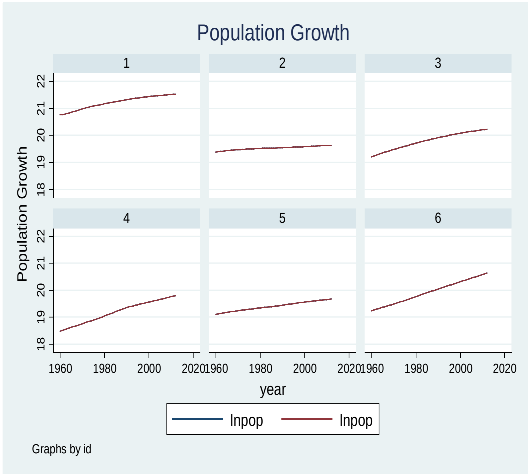


Fig. 4.



Source: Authors Compilations-Note: Figures 3 and 4 show growing industrial output and regional population increases

Trends in Fig. 3 and 4 on plotting the same data graphs, also show that population and industrial output were also increasing meaning that increasing industrial output demand is likely to be linked with increasing consumption trends across regions. The likely implication of this is that the practice of non-environmentally friendly industrial activities can have strong negative consequences for many countries across regions. World emission cuts talk have also progressed in recent times but many modalities are yet to be set in place for a proper implementation of a single emission cut policy that will yield significant decreases in greenhouse gases as well as save the environment from industrial related degradation. The scope of this paper as stated earlier is specifically to examine the effect of industrial sector activity on climatic changes (specifically global warming) for six regions which include East Asia Pacific, the European Union, Latin America, Middle East and North Africa, North America and finally Sub Saharan Africa. In achieving the study a host of factors such as increasing world population, industrial output, Co_2 emissions, use of fossils in regions as well as other alternative energy sources are identified to be likely factors that can affect global warming. Growing world population (See Fig. 4) for instance will mean increased consumption and this can place strong demand on industries forcing them to increase their productive capacities resulting in more volumes of pollution and increases in greenhouse emissions that can affect emission build up leading to increases in World average temperatures increases.Literature also admit that the world is threatened by human activity and greenhouse gases often traced to four types of gases which include carbon dioxideCo_2, methaneCH_4, Nitrous oxide N_2O and halocarbons (a class of gases which contain fluorine, bromine and chlorine) these gases are known to accumulate in the earth atmosphere in concentrates leading to the destruction of the earth's atmosphere Ozone layer. The consequences of industrial pollution have also been seen to have devastating consequences on clean inhalable air as well as visibility with night visibility more heavily hampered. See fig 5 and 6 respectively.Mecaptans, also pose strong consequences on humans through air pollution, with China facing strong negative effects of New Economic Growth of Industrialization, with its effect felt in strong air contaminations affection visibility, inhalable air and negative health conditions in general, (Fig. 5 and 6 show negative consequences of industrial pollution on inhalable air and visibility in Tianjin and environs of the People Republic of China).

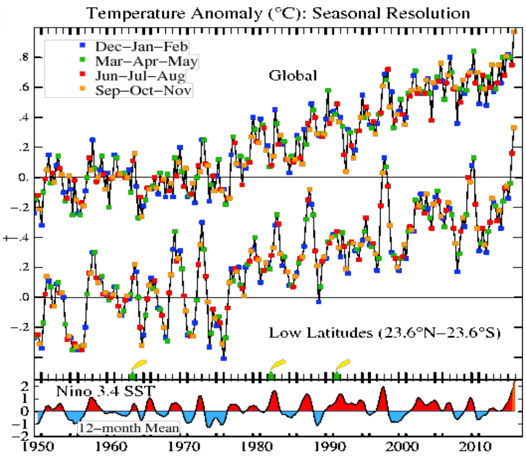
Fig. 5

Fig. 6

Source: Authors Compilations from BBC world Report on Asia December 2015- Note: Smog effects in Tianjin China affecting available clean inhalable air and burring night vision.

Fig.7

Fig.8



Source: Authors Compilations from BBC World Report December 2015 and EPA climate report 2015- Note: Fig.7 and 8. Depict Tianjin pollution prone region and US average temperature anomaly since 1800.

Fig. 9

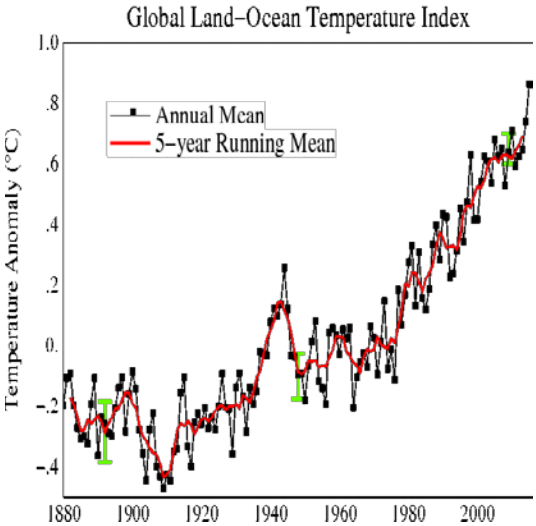
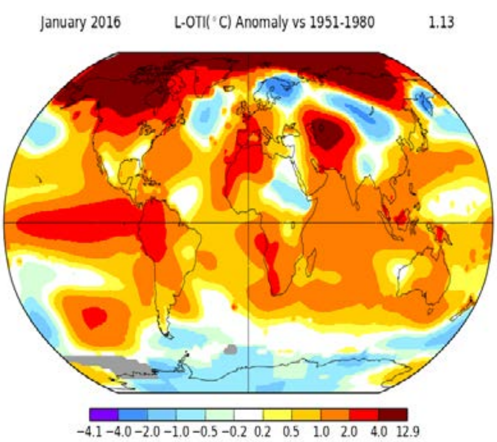
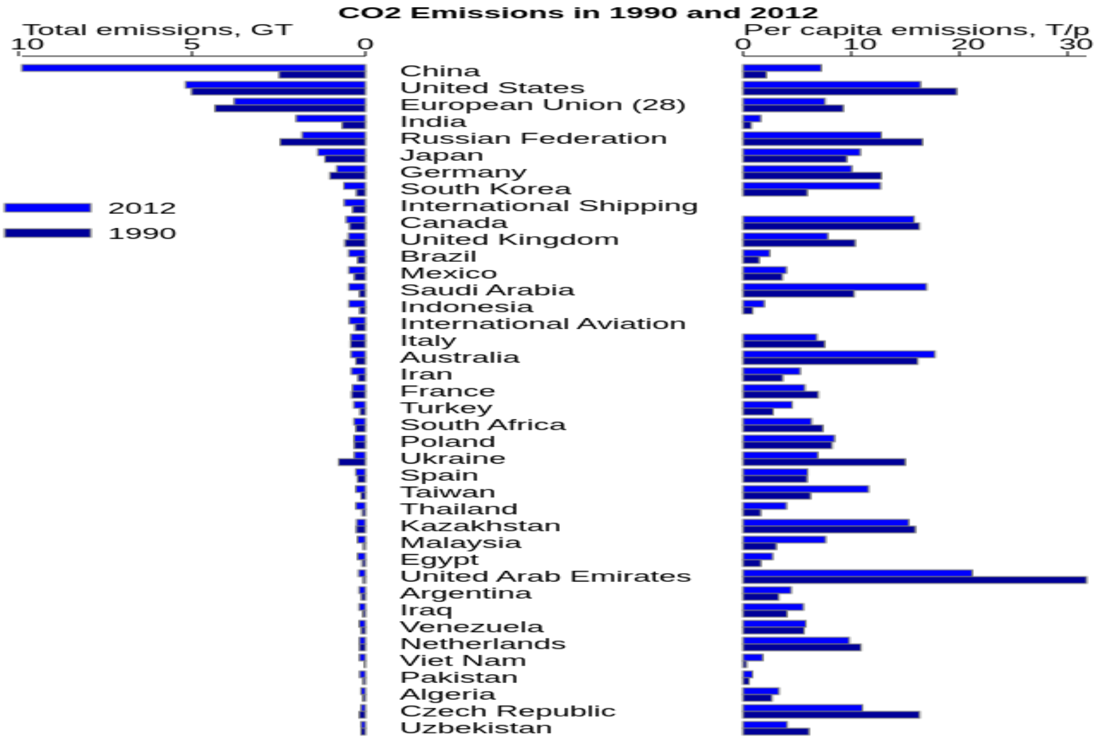


Fig 10



Source: Authors Compilations from EPA 2015 Report - Note: Fig. 9 and 10 show land – ocean Temperature index and average World Temperature Anomaly from 1880 to 2010 respectively.

Fig. 11



Note: The above show carbon dioxide emissions from 1990 to 2012 for selected countries.
Source: EPA Statistics 2013.

The World is also experiencing strong temperature anomalies and higher variations in temperature changes than ever before. With the highest increases experienced in the 1930s and early 1940s, and also in the late 1970s upwards (See Fig. 9 and 10). This is largely attributable to the rapid industrialization of many World economies. With this have come higher pollution levels and strong tremendous increases in human pollution which has placed strong demand on world industrial outputs in general. Statistics also show (see Fig. 11) that while China leads in total world emissions in general it lags behind the United States and the European Union in Per Capita emissions, making the United Arab Emirates, Saudi Arabia, Australia United States and the EU, the highest per capita emission generators globally.

3. Data Sources, Theory and Methodology

3.1 Data Sources

All data to be used in the study are presented in this section. In this study specific channels through which climate change (proxied using temperature increases) is affected are identified. Some of these channels include through increasing world population, industrial output, emissions (proxied using CO_2 emissions the singular most significant cause of global temperature increase) and two other variables that capture regional specific energy use which could reflect the current strength of the environmental policies which include use of coal energy sources to capture use of fossils which is termed unclean energy source and alternative energy use which is renewable and termed cleaner energy sources. Some specific question the study will address include a.) To what extent does the growing world population affect global temperature increase? b.) Does increases in world average industrial activity `drive World temperature increases? c.) Are emission increases affecting world temperature and affecting climate change and to what degree does regional energy use specifically the reliance on fossils,with emphasis on coal energy sources and other alternative energy sources affect climate change across regions. The study utilizes panel data for six regions which include the European Union, East Asia Pacific region including China, the Middle East and North Africa, Sub Saharan Africa, Australasia and Latin America and the Caribbean. The period under consideration is from 1960 to 2013 a period of 54 years although some years of data are missing. To control for unobservable effects year dummies are utilized. Other studies which utilized panel data in the studies of similar nature include Ojeaga and Odejimi (2014) and Ojeaga P. et al (2014) respectively.

3.2 Theory and Methodology

3.2.1 Theory

The theory utilized in the study is described in this section. In adapting to existing literature that emphasize on understanding and implementing climate change policies, the study revisits the dynamic integrated model of climate and the economy (DICE). The most unique subject of the concept been the social cost of carbon (SCC). Nordhaus D. (2016) state that DICE 2016 model is the most recent although there exist other versions, which include the DICE 2013 model etc. The DICE model itself is predated by the Ramsey Model which did not include climate investments, which were found to be analogous to capital investments in the standardized model (i.e. the 2016 model).The DICE 2016 model optimizes the social welfare function (SW), which is the discounted sum of population weighted utility of per capital carbon consumption, expressed below in equation 1 as adopted from Nordhaus (2016),

(Eqn. 1) $\boldsymbol{SW = \sum_{t=1}^{Tmax} N\,[C_t\,, L_t]\,R_t = \sum_{t=1}^{Tmax} U\,[C_t]\,L_t R_t}$

Where R_t is the discounted factor,$R_t = (1+\rho)^{-t}$ and ρ is the pure rate of social preference and discount rate of welfare, e_t is the per capital consumption L_t is population. The utility function is expressed as

(Eqn. 2) $\boldsymbol{U_C = C^{1-\alpha}/(1-\alpha)}$

The parameter α is the generational inequality aversion. The net output of damages and abatement to the environment is given by $Q_{(t)}$ expressed as

(Eqn. 3) $\boldsymbol{Q_{(t)} = \Omega_t\ [1 - \wedge_t\ ]Y_t}$

Where Y_t is gross output, which is given a Cobb Douglas function of capital, labour and technology. Total output in this case is the ratio of total consumption and total gross investment. The variables Ω_t and $\wedge_t$ are the damage and abatement functions respectively, (see Golosov ,Hassler, Krussell and Tsyvinski (2014) and Norhaus D., 2016). The damage function can be expressed as

(Eqn. 4) $\boldsymbol{\Omega_t = D_t\ /[1 + D_t\ ]}$

Where $D_t = \varphi_1\ T_{AT(t\,)} + \varphi_2\ [T_{AT(t\,)}\ ]^2$. The above describes the economic impact or damages of climatic change. This is in reality a key factor in calculating the SCC where T_{AT} is referred to as a sufficient statistics for damages. It should be noted that the damage function was revisited in 2016. Other uncontrolled industrial carbon dioxide emissions are given by a level of carbon intensity $\gamma_{(t\,)}$, times gross output. Total emissions $E_{(t)}$ are equal to uncontrolled emissions reduced by the emissions reduced rate$\mu_{(t\,)}$, plus exogenous land use emissions expressed as

$(\boldsymbol{Eqn.5})$ $\boldsymbol{E_{(t)} = \gamma_{(t\,)}\,[1-\mu_{(t\,)}\,]Y_t + E_{Land(t)}}$.

This can be linked geophysically to greenhouse gas emissions therefore to carbon cycle, radioactive forcings and climate change expressed below as ,

(Eqn.6) $\boldsymbol{M_{j(t)} = \emptyset_{oj}E_{(t)} + \sum_{1=1}^{3} \emptyset_{ij}\, M_{i(t-1)}}$

The three earth geophysical reservoirs are given by j, where j is = AT (Atmosphere), UP (Upper Oceans and biosphere) and LO (the Lower Oceans). All emissions are assumed to flow into the atmosphere, absorbed partly by the oceans and other ground or surface waters.The relationship between greenhouse gases (GHG) accumulators and increased radioactive forcing is shown below as :

(Eqn. 7) $\boldsymbol{F_{(t)} = \eta\{log_2\ [M_{AT(t)}/M_{AT(1750)}]\} + F_{EX(t)}}$

$\boldsymbol{F_{(t)}}$is the change in total radioactive forcings from CO_2 and other anthropogenic sources. It is essential to state that radioactive forcings lead to global warming, allowing us to express temperature changes in a specified two level global climate model as

(Eqn.8) $\boldsymbol{T_{AT(t)}= T_{AT(t-1)} + \varepsilon_1 \{F_{(t)} - \varepsilon_2\ T_{AT(t-1)} - \varepsilon_3\ [T_{TAT(t-1)} - T_{LO(t-1)}]\}}$

(Eqn.9) $\boldsymbol{T_{LO(t)}= T_{LO(t-1)} + \varepsilon_A[T_{TAT(t-1)} - T_{LO(t-1)}]}$

Where $T_{AT(t)}$ is the global mean surface temperature,$T_{LO(t)}$is the mean temperature of the deep oceans respectively. The above climate model have been revised to reflect the Earth Climatic Systems (See Nordhaus D. (2016) for further discussions). The social cost of carbon can therefore be expressed based on the aforementioned as

(Eqn. 10) $\boldsymbol{SCC_{(t)} = \frac{\partial sw}{\partial \varepsilon_t} / \frac{\partial SW}{\partial C_t} = \frac{\partial C_t}{\partial \varepsilon_t}}$

Thereby expressing $SCC_{(t)}$ as a ratio of change in consumption per unit change in emissions over time, depicting the value of consumption enjoyed per unit emissions in tons over time.

3.2.2 Methodology

In introducing the methodological section we follow the literature on the social cost of capital and assert that governments across regions will want to maximize its utility by imposing a cost on the use of energy specifically those that lead to high carbon emissions Botzen and Van den Bergh (2012) and Van den Bergh and Botzen (2014), (2015). Where energy policy (Epolicy) is dependent on regional specific energy use (Euse), available energy sources (Eresources) and specific environmental risks (Erisk) associated with such sources either through harnessing or specific utilization. This will be particularly true through since government will want to drive the use of clean energy sources (renewable and sustainable sources in particular), through available energy resources within its territories to cut issues of cost and capital flight associated with the purchase of external resources. It will also want to mitigate environmental risk associated with energy use and harnessing.This is enforced through its specific policy on energy use allowing us to state equation 11 and 12 as;

(Eqn. 11) Energy policy f(Euse, Eresources and Erisks)

(Eqn12.)Epolicy = Euse + Esources + Erisk

Emissions will also be dependent on the nature of energy use if it is largely domestic or industrial in nature with industrial use demanding larger generation and leading to higher pollution, human activity (Hactivity) which will affect energy consumption and will be a function of population increases, energy policy (Epolicy) which will be a function of cost and efficiency in the generation and allocation of energy resources and other associated risk to energy generation, such as hazardous nature of generation and its impact on the ecosystems and humans in general as depicted in equation 13.

(Eqn. 13)   Emissions=Euse + Hactivity + Epolicy + Erisk

Industrial output is also likely to cause major strains in energy demand, with the manufacturing and other production sectors of economies in countries across regions responsible for energy generation increases. Waste from industrial consumables is also likely to affect the climate leading to increases in greenhouse gases and affect health conditions generally.Therefore industrial output will depend on industrial demand (*Ind demand*), energy sources (*Esource*) and environmental risks (*Erisk*).

(Eqn. 14)Indoutput=Ind demand + Esource + Erisk

Climate change will also be affected by emission, increases in population (*Pop.Increase*), industrial output (*Indoutput*), use of fossils sources (*Fossilsuse*)which is termed unclean or environment polluting energy sources and finally use of renewable energy (Re*ne.use*) sources which is termed clean energy source.

(Eqn. 15) Clim.change= Emissions + Pop.Increase + Indoutput+ Fossilsuse+Rene.use

The econometric model to be estimated now becomes;

$(\boldsymbol{Eqn.16})\ \ \boldsymbol{Clim.change_{i,t} = \beta_1 Clim.Change_{i,t-1} \beta_2 Emissions_{i,t} + \beta_3 Pop.Increase_{i.t} +}$
$\boldsymbol{\beta_4 Indoutput_{i.t} + \beta_5 Fossilsuse_{i,t} + \beta_6 Rene.use_{it} + \varepsilon_{i,t}}$

Where Climate Change in equation 16, is captured using world temperature anomalies, and will depend on emissions captured using CO_2 emissions, population using logarithm of regional population increases, industrial output using regional specific GDP per capita, fossils use using coal energy generating capacity and renewable energy using clean alternative energy sources in countries across regions. The entire control variables are lagged to resolve issues of misspecification (e.g. multi-co linearity and serial correlation) although this was done for only one period. The variable year dummy is included to control for robustness in the estimation results while the country dummy results are not reported even though they are included in the regression. The control for the endogeneity of the control variables is based on past literature which suggests that specific independent variables are likely to be endogenous Przewoski A. (2004). The application of GMM in addition to control for multiple endogenous variables, deals with issues of panel bias and fixed effects since the disturbance term $\epsilon_{i,t}$ consist of the fixed effects $\mu_{i,t}$ and the idiosyncratic shocks$v_{i,t}$see Arellano, and Bond (1998), Doormik, Arellano, Bond (2002) and Roodman (2006). Some other obvious advantages of the GMM estimation are that it controls for long run effects and the estimates are robust even in the presence of heteroscedastic errors. The lag of the dependent variable $(\alpha_o - 1)$ is also added as an explanatory variable and the system GMM includes all explanatory variable and their lagged values as instruments allowing us to resolve the problem of searching for a suitable instrument, see Roodman (2006), for in-depth explanations of the GMM estimator technique.

3.3 Results Presentation and Discussion

The result of the study is presented in this section. The study investigates the relationship between climate change, industrial activity and economic growth in regions. Various factors were identified as likely drivers of climate change. Some of these included CO_2 emissions, industrial output (measured using regional GDP per capita), increases in regional population, and regional coal and alternative energy use respectively. To resolve issues of likely presence of endogenous regressors and omitted variable bias, the generalized methods of moment technique and panel data provided suitable means to do so and were hence employed for the study. The Arrelano Bond

Table 1. Temperature Change, Industrial Activity and Population Growth Regressions

VARIABLES	**(1)** **Panel Regression (OLS)** **Temperature change**	**(2)** **Differenced GMM** **Temperature change**	**(3)** **System GMM** **Temperature change**
Log Co2 Emissions	**-0.0735*** **	**-0.00624**	**-0.164* **
	(0.00840)	**(0.0130)**	**(0.0887)**
Log GDP per Capita	**0.0789*** **	**0.0693*** **	**0.117*** **
	(0.00730)	**(0.00738)**	**(0.0360)**
Log of Population	**0.0795*** **	**0.177*** **	**0.401*** **
	(0.00817)	**(0.0299)**	**(0.132)**
Log of Coalenergy use	**0.00138**	**0.0137* **	**-0.0117**
	(0.00238)	**(0.00734)**	**(0.0149)**
Log of Alternative energy use	**0.0184*** **	**0.0608*** **	**0.0227**
	(0.00420)	**(0.00779)**	**(0.0218)**
Year Dummy	**Yes**	**Yes**	**Yes**
Constant	**-0.788*** **	**-4.158*** **	**-6.025*** **
	(0.137)	**(0.520)**	**(1.423)**
Observations	**267**	**261**	**264**
Number of id	**6**	**6**	**6**

Note: Authors Compilation Using Stata. All Standard errors are in parentheses with *** p<0.01, ** p<0.05, * p<0.1 representing 1%. 5% and 10% significant levels respectively.

Test for serially correlated errors and the Hansen Test for over identifying restrictions were conducted in both cases for the difference GMM and the System GMM estimation techniques respectively Roodman (2006). The null hypothesis of no serially correlated errors was accepted and results depict the instruments were valid and relevant for both tests respectively. The year dummies also appear to be significant depicting that no specific unobservable effects affect temperature increases in the model specification other than those that have been stated in the model.The preferred results from the system GMM regressions is interpreted even though the OLS and System GMM results are all presented for interested readers, owing to its superiority as stated earlier. It was also observed that contrary to the notion that carbon dioxide emission affect temperature changes positively (and hence climate change negatively) it was having weak negative significant effects on average World temperatures (hence weakly affecting climate change positively) reducing average World temperatures by 16.4 percentage points. It was also found that the two most significant drivers of world temperature increases were regional population and regional industrial output (measured using regional GDP per capita) contributing 40 and 11.7% points to positive temperature changes respectively. Coal energy use and alternative energy use, was found to have no effect on global temperatures, depicting regional energy use had no significant effect on temperature increases globally. This showed the weakness of regional energy policy in reducing average world temperatures and mitigating the causes of global warming and climate change across regions specifically and therefore showing no strong direct link between emissions and climate change.

4. Conclusion and Recommendation

In this section of the study the research questions are answered and the study is concluded with recommendations made. The study investigates the relationship between climate change, industrial activity and economic growth for six regions name earlier. There already exist scientific findings which state that specific gases such as CO_2, N_2 0,CH_4 and halocarbons are the specific causative agents on climate change. However in this study we find no direct relationship between the proxy for emissions (CO_2) and climate change (temperature changes specifically) consistent with IEA 2013 Report. However increases in population and industrial activities appear to affect climate change (in this case temperature changes) significantly.It appears that increase in human activity due to growing world population and the associated growing demand for consumables from the industrial sector and other industrial related negative externalities(leading to radioactive forcing) is primarily responsible for global temperature increases and thus drastic negative changes in climatic conditions. The implication of this outcome for stakeholders in the environmental sector is that measures to adequately manage World population increases are becoming necessary as well as control of industrial and manufacturing companies practices. Regional specific energy policies appear weak with both coal and alternative energy sources remaining weak. This shows that industries in countries across regions were probably not doing enough in terms of policies to mitigate human and industrial activities that were not environmentally friendly, therefore innovative policies in this direction is hence necessary.

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