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Impact of Temperature and Precipitation Anomalies on Unemployment

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Abstract: *This paper adopted econometric analysis to examine the impact of increased temperature and precipitation anomalies on unemployment. An annual time series data on Nigeria is obtained from 1991 to 2023, covering annual temperature anomalies, average precipitation anomalies and unemployment rate. Results obtained indicate that a 1 percent increase in temperature anomaly, raises unemployment by 0.006 percent, while a 1 per cent increase in precipitation anomaly raises unemployment by 0.008 in the short run. Similarly, a1 percent increase in temperature anomaly, raises unemployment by 0.28 percent, while 1 percent increase in precipitation anomaly, raises unemployment by 0.7 per cent. These anomalies and their resultant risks are likely to slow down productivity and output. Accordingly, as climate related risks have different frequency and temporal distribution compared to other types of risks, taking these risks from a policy perspective requires concerted effort and leadership. Policy makers ought to ensure that adverse effects of climate change touches jobs and the economy in a positive way. It is therefore imperative to strengthen leadership and innovation around macroeconomic policies to integrate climate adaptation and mitigation strategies into the mainstream economic policy objectives. Thus, to achieve a long-term sustainable growth, economic policies should combine the trio-goals of employment generation, economic stability and environmental sustainability.*
Keywords: impact. temperature, precipitation anomalies, unemployment

INTRODUCTION

The implication of increased temperature and precipiation variabilities on employment and labour dynamics remains a contested area in the literature. Previous studies have largely ignored the impact of natural factors, especially climate change (Arestis et al. 2023; Jung and Pyung, 2023). However, there are few studies which focused on the impact of climate change on labour productivity and resultant effect on demand for labour among various sectors of the economy (Graff Zivin and Neidell, 2014; Zander et al., 2015; and Adhvaryu et al., 2019). Despite these contributions, there is still lack of sufficient quantitative evidence on the impact of global warming on unemployment rate and regional heterogeneity within countries, which reduces the efficiency of climate control policies and macroeconomic policies targeting employment. Understanding this relationship and the labor market makeup in terms of unemployment and how it responds to climate change is crucial for policy makers.

The risk of rising temperature has significantly increased and surpassed the previoius records in the history. Osman et al (2021) posited that approximately 20,000 years, the average surface temperature was approximately -7◦C. in the last 1000 years, this number has reached 0◦C and there has been a rapid increase in the last 150 years with the rapid growth of greenhouse gas emissions. There are six main greenhouse gasses; Carbon dioxide (Co2) account for 75% of emissions, methane (CH4), and Nitrous Oxide (N20), hydrofluorocarbons (HFCS), Perfluorocarbons (PFCs) and Sulphur Hexafluoride (SF6) which were developed for industrial applications. Studies also show that greenhouse gases have been the main contributor to global warming (Lashof and Ahuja, 1990; Kaufman et al., 2006). Scientifically, the prevalence of climate hazards, vulnerability and exposure of households constitute a climate risk.

In Nigeria Climate change trends are expected to increase the risk and intensity of flooding through increased frequency and intensity of heavy rainfall events. They are also expected to increased aridity and drought with significant impact on livelihood. The most significant temperature differences in Nigeria occurs between the coastal areas and its interior as well as between the plateau and the lowlands (World bank, 2021). The mean annual precipitation is 1,152.8 mm and experienced throughout the year with most significant rainfall occuring from April to October and with minimal rainfal occuring November to March (Ibid). The temperature and precipiataiton anomalies including its relation to unemployment has ramifications for socieity from planing labour demand to forecassting productivity and economic growth. The labor force in Nigeria increases on average by 2.6 million people per year, which means that the same number of jobs must be generated annually to maintain the current unemployment rate. Recent figures show the employment-to-population rate stood at 75.6 percent in Q3 2023, while the unemployment rates fell from 5.3 per cent in Q4 2022 to 4.1 percent in Q1 2023 (NBS, 2023). However, earlier estimate by Bandura and Hammond (2018) pointed out that 40 to 50 million jobs will need to be created between 2010 and 2030 to accommodate a growing population, which is likely to worsen, given the changing climatic conditions among other economic shocks.

This paper attempt to question the impact of temperature and precipitation anomalies on short term unemployment dynamics in Nigeria. It also questions the structural effects of these factors on unemployment and productivity. Indeed, by considering unemployment from the perspective of climate risk, this paper contributes to the literature on the dynamic relationship between climate change and unemployment.

OVERVIEW OF THE LITERATURE

There is a vast evolving literature on climate change and its macroeconomic implications. To begin with Dell et al. (2012), rising temperatures have a greater negative impact on economic growth in developing nations than in industrialized nations. According to Kotz et al. (2022) a rise in the number of rainy days and excessive daily rainfall, as well as a nonlinear reaction to the total annual and averaged monthly variations in rainfall, slows economic growth rates. Donadelli et al (2022) found data on the relationship between year temperatures variability and macroeconomic variables is scanty. However, Moore and Diaz (2015) Carleton and Hsiang (2016) found hotter climate reduces output by reducing investment, lowering worker productivity, worsening health outcomes, and lowering agricultural and industrial output-thereby by thwarting overall macroeconomic activity. Essentially, Batten (2018); Batten et al.

(2020); Ciccarelli and Marotta (2021); Kiley (2021) argued that the negative effect of climate risks or uncertainties emanates from demand-side and supply-side shocks (Batten 2018, batten et al 2020, Ciccarelli and Marotta 2021, Kiley 2021). From supply side, it disrupts output by adversely affecting prices and hampering future growth through extreme weather conditions and natural disasters- and perhaps affect physical capital as a demand side effect.

Empirically, Zhao et al. (2018) found that the impact of annual temperature on productivity can also vary widely among countries. Using global subnational short panel data, they review the link between temperature and economic growth, and demonstrate that climate-related negative consequences can differ at regional level. Dnadelli et al. (2017) demonstrated empirically that a temperature shock has substantial negative, and statistically significant effect on total factor productivity, production, and labor productivity. According to Rasson and Van der Mensbrugghe, (2012) the temperature rise may include both frictional unemployment and structural unemployment where in the short term, some jobs may be affected by high temperature weather, leading to factors such as employee turnover and seasonal labor shortage. Similarly, Kjellstronm et al. (2009) found that people may be affected by high-temperature weather, with an increase in search costs for jobs, which leads to an increase in the probability of unemployment. This also confirmed that in the long run, global warming might lead to a decrease in labor productivity in some industries, such as agriculture and mining, as well as an increase in the cost of labor engaged in these professions, resulting in a long-term downturn in industry employment rates (Dun et al., 2023).

Thus, the literature establishes the critical role of increased temperature, flood and other climate related disasters on macroeconomic volatility, investment, consumption, and output. This paper builds on these contributions to offer insight on the relationship between temperature and precipitation anomalies, and unemployment from a country perspective. Indeed, by examining the relationship between notable climate change uncertainties and unemployment, this study bring new and diverse insight to inform policy direction and scholarly discussion.

Empirical Methodology

This paper applies econometric models with the intention of disentangling and quantifying drivers behind the factors that positively or negatively affect unemployment.

Data Analysis

Using annual time series data from 1991 to 2023, this paper used historical quantitative data approach of past activities. Variables such as unemployment rate, temperature anomalies and average precipitation anomalies measured in average millimeters were obtained from the National Bureau of Statistics, World Bank and World Metrological Organization. Precipitation anomalies, which are deviations from long-run averages, help in identifying wet and dry periods which can be linked to climatically influenced patterns such as flooding and river flows that affects jobs in a particular geographical location. The temperature anomaly on the other hand, is a departure from a reference to value or long-term average on a positive or negative form. The average precipitation and temperature anomalies help in analyzing how unemployment behaves under the changing climatic conditions.

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The model

Autoregressive Distributed Lag (ARDL) is the adopted econometric technique for estimation in this paper. The model is specified in the following format.

UNEMP = (PRECI, TEM,) (1)

From the equation (1), UNEMP is the dependent variable while PRECI and TEM are the independent variables. Thus, equation (1) indicates that UNEMP is influenced by climate change. In addition, studies have noted that certain controlled variables have a relationship between macroeconomic factors like unemployment and climate change. This situation is likely to worsen, given the changing climatic conditions and rising population growth. Thus, negative or positive precipitation and temperature anomalies are assumed to affect the degree to which employment behave either through job generation or job loss depending on geographical location (coastal or hinter land, plateau or lowland). Thus, with controlled variables, the equation (1) with log can be rewritten as;

InTEM = (InPRECI, InUNEMP) (2)

Expressing equation (2) in a linear form and including the constant term, the stochastic error term and the logarithm form of the model, equation (2) is transformed to become;

$(InUNEMP_t)= Ø0 + (InØ_1PRECI_t) + (InØ_2TEM_t) + \varepsilon_t$ (3)

Where UNEMP is the log of unemployment (as the dependent variable), PRECI signifies average log of precipitation anomaly (proxy for climate change) and TEM represents mean log of temperature anomaly (proxy for climate change).

RESULTS AND DISCUSSION OF FINDINGS

The Unit root test was applied to determine the stationary levels of the variables. Results showing the stationary levels of the variables are given in Table1.

Table 1; Unit Root Test

	Level		1st Difference	
Variables	**C**	**C&T**	**C**	**C&T**
UNEMP	0.12552	0.258007	0.027738	0.095760
TEM	0.05055	0.010868	0.010868	0.004194
PRECI	0.01428	0.063850	0.013409	0.079308

** >=0.5% express the level of significance.

Based on the result, the variables become stationary at both level and first difference. This revealed that the series are integrated of order (1) at 5% level of significance. The optimal lag length applied was based on Alkike Information Criterion (AIC) and Bandwidth was chosen

using Newy-West Method Automatically. All tests are based on trend; and trend and intercept equation at both level and first difference. According to the unit root test result, there is no obstacle in the application of ARDL boundary test method to test the long- and short-term relationship between the variables.

Additionally, a co-integration test was run to test the correlation between variables. The result shows probability values of less >5 per cent. Therefore, we reject the null hypothesis, and conclude there is cointegration between variables. The ARDL test results obtained according to the installed model are given in Table 2.

Table 2; Short term coefficients from ARDL test

Variables	Coefficients	T- Statistic
UNEMP	1.12291716	4.198982***
PRECI	0.00807490	0.037354***
TEM	0.00633644	2.023131***

***1%, ** %5%, *10% express the level of significance

The result show that an increase in 1 percent temperature anomaly, increases unemployment by 0.006 per cent, while 1 percent increase in precipitation anomaly increases unemployment by 0.008 in the short run.

The long-term test result and coefficient values obtained from model are given in Table 3.

Table 3; Long term coefficients from ARDL test

Variables	Coefficients	T- Statistic
UNEMP	0.92684405	1.8977974***
PRECI	0.77152101	1.6468170***
TEM	0.28854427	1.3029898***

***1%, ** %5%, *10% express the level of significance

The results indicate that 1 percent increase in temperature anomaly, increases unemployment by 0.28 percent. It also shows that an increase of 1 per cent in precipitation anomalies raises unemployment by 0.77 percent. This means that temperature and precipitation anomalies which are proxies for climate change raises unemployment in both short and long run. While temperature anomalies appear to result to hotter years, prone to droughts and aridity in savannah and arid areas, the impact of precipitation on unemployment is more explosive through floods that can lead to erosion, damages to roads and infrastructure, damage to agricultural crops and put livelihood and economic growth at risk. This means that unemployment rises with climate risks, vulnerabilities and hazards, through the combination of frictional and structural unemployment, reduced labor productivity, output and wages across

different industries most especially agriculture which is the largest employer of labour in Nigeria.

These anomalies and the resultant risks are likely to slows down productivity and output. Accordingly, as climate related risks have different frequency and temporal distribution compared to other types of macroeconomic and financial risks, taking these risks from a policy perspective requires concerted effort and leadership (Lane, 2019). Overall, the National Council for Climate Change, monetary and fiscal authorities in Nigeria ought to ensure that adverse effects of climate change touches jobs and the economy in a positive way. On the other hand, technological innovation, adaptation and sustainability drive could change existing job structure, and expand labour demand in services, manufacturing and energy sectors which account for more than 90 percent of government revenue in Nigeria. It is therefore imperative for the policy makers to strenghen leadership and innovation around macroeconomic policies to integrate climate adaptation and mitigation policies into the mainstream economic policy objectives. Thus, to achieve a long-term sustainable growth, economic policies should combine the trio-goals of employment generation, economic stability and environmental sustainability.

CONCLUSION

This paper examined the relationship between climate change and unemployment. It started by testing for the presence of unit root, which indicates that all variables are stationary at the first difference and level. A cointegration of variables is established, using ARDL bound test for the model. The study found temperature and precipitation anomalies significantly impact unemployment. These anomalies could affect both existing and future jobs in different ways, including a combination of frictional and structural unemployment, reduced labor productivity, output and wages across different industries most especially agriculture and related sectors. While the anomalies analysed contributed to a rising unemployment, efforts to transit to sustainable production and consumption often leads to technological innovations which could potentially change labour demand and supply in services, manufacturing and energy sectors in a positive way. Understanding the interplay of these factors and drivers could help chart the labor market trajectories in tandem with regional and sectoral peculiarities in a country.

Declarations

I declare that there is no competing financial or non-financial interest that might have influenced the work in this paper.

The views expressed herein are solely those of the author and does not reflect the views of the affiliated institution (Central Bank of Nigeria).

Additionally, I declare that no funding was obtained for this study.

The dataset used in this paper are available from the author on request.

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