Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 4, Number 2, 2013, 245-277

Response of Cocoa Export Market to Climate and Trade Policy Changes in Nigeria

Arene, Chukwuemeka John and Nwachukwu, Ezea Christopher

Department of Agricultural Economics, University of Nigeria, Nsukka

Corresponding author: Arene, Chukwuemeka John, Department of Agricultural Economics, University of Nigeria, Nsukka

Abstract. This study examined the response of cocoa export market to climate and trade policy changes in Nigeria. Specific objectives were to describe the trend in cocoa export market and climate/trade policy changes in Nigeria; analyze the level effects of climate change in cocoa productivity arising from farmland area and labour changes, analyze the effects of cocoa productivity and trade policy changes on cocoa export market in Nigeria; forecast the possible future changes in cocoa export market due to climate and trade policy changes; and make policy recommendations based on the research findings. For the purpose of this study, secondary data were used. A comprehensive trend in cocoa export market and climate/trade policy changes was described. A 2-stage Least Square Dynamic Panel Regression Model was used to address cocoa production and export responses, respectively, while a Monte Carlo simulation test was used to simulate, under various climate and trade/price policy scenarios, for possible climate and trade policy impacts on future cocoa output and export. It was observed that the Nigerian cocoa export market has been fluctuating and would likely continue over time. It was also observed that there has been consistent fluctuation in temperature and precipitation although relatively smaller in comparison to the export market fluctuations but still significant since a minimal increase or decrease in these climate change variables could have a significant impact especially in agriculture compared to trade policy influencing factors. The Monte Carlo simulation test recorded a slight level of relationship between cocoa output/export and climate/trade policy variables. This implies that a 10% increase or decrease in these variables, would have slight effects on cocoa output/export in Nigeria. Based on the findings, it was recommended, among others, that there should be a trade-off between trade policy gains and losses due to forest conversion as a result of cocoa hectarage expansion.

Keywords: Cocoa export; Climate; Trade policy; Nigeria.

© Copyright 2013 the authors.

1.0 INTRODUCTION

1.1 Background Information

Cocoa *Theobroma Cacao*Linn is important as a foreign exchange earner in Nigeria and some parts of the West African sub region. The beans are very useful in the production of cocoa beverage, chocolate candies and cocoa butter which are very rich in proteins, fats, carbohydrates and Vitamin B complex.As the Nigerian cocoa production output witnessed fluctuating trend, so also the producer price of Nigerian cocoa has been fluctuating over the years.

Nigeria is the fourth-largest producer of cocoa beans in the world, behind Côte d'Ivoire, Indonesia and Ghana. After petroleum, cocoa is the country's most important export. Before independence, cocoa generated 90% of Nigeria's foreign exchange earnings, eclipsed these days by oil as the country's major export. Cocoa has been a leading agricultural export commodity and major source of foreign exchange earnings and economic development in Nigeria over time (Olayide, 1969; Olayide*et al.,* 1972; Olayemi, 1973;; Abang, 1984; Olalekun, 1985;; Abang*et al.,* 2002; Nkang*et al.,* 2006). As the number one commodity in the agricultural export list in Nigeria, its production, domestic consumption and exports have remained central concerns of government, exporters and importing countries alike.

Overtime Nigeria has remained in the first five positions globally, which emphasizes the nation's importance in cocoa production and export trade as shown in table 1.2.

Table 1.2: **The top 10 cocoa-producing countries in 2009**

	Country Rank	**Production (Metric tons)**
1.	Côte d'Ivoire	1,222,000
2.	Indonesia	800,000
3.	Ghana	662,000
4.	Nigeria	370,000
5.	Cameroon	226,000
6.	Brazil	218,000
7.	Ecuador	121,000
8.	Togo	105,000
9.	Papua New Guinea	51,000
10.	Dominican Republic	51,000

Source: UN Food and Agriculture Organization (2010).

The table below also shows cocoa producing countries, quantity produced and their percentages between 2006-2007.

Table 1.3: Cocoa producing countries, quantity produced and their percentages between 2006-2007

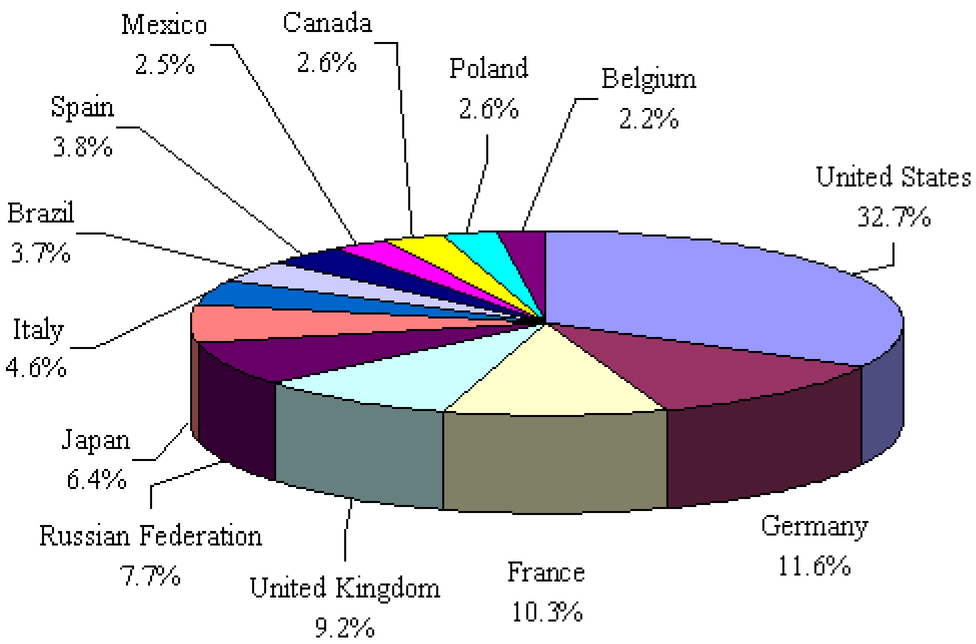
Country	Production	Percentage of World Production
Côte d'Ivoire	1,300,000	37.4
Ghana	720,000	20.7
Indonesia	440,000	12.7
Cameroon	175,000	5.0
Nigeria	160,000	4.6
Brazil	155,000	4.5
Ecuador	118,000	3.4
Dominican Republic	47,000	1.4
Malaysia	30,000	0.9

Source: International Cocoa Organization (2007).

This percentage is the proportion of the world's total of 3.5 million tonnes for the relevant period.

Although cocoa is largely produced in developing countries, it is mostly consumed in industrial countries. The buyers in the consuming countries are the processors and the chocolate manufacturers. A few multinational companies dominate both processing and chocolate manufacturing. The following figure represents the main consumers of cocoa in the world. The highest consuming country is the United States of America while the lowest consuming country is Belgium (Figure 1.1).

Figure 1:1: Share of main cocoa consuming countries in 2004/2005



Source: UNCTAD, based on the data from International Cocoa Organization, quarterly bulletin of cocoa statistics (2006).

Cocoa serves as an important crop around the world: a cash crop for growing countries and a key import for processing and consuming countries. Cocoa travels along a global supply chain crossing countries and continents. The complex production process involves numerous parties including, among others, farmers, buyers, shipping organizations, processors, chocolatiers and distributors. Cultivation of cocoa at the farm level is a delicate process as crops are susceptible to various conditions including weather patterns, diseases and insects. Unlike larger industrialized agri-business, the vast majority of cocoa still comes from family-run small farms who are often confronted with outdated farming practices and limited organizational leverage. With a steady demand from worldwide consumers, there are numerous efforts and funds committed globally to support and improve cocoa farm sustainability (WCF, 2010).

Cocoa is traded on two world exchanges in two currencies: London International Financial Futures Exchange (LIFFE-Pound) and New

YorkIntercontinental Exchange (ICE-USD). Africa has been and is projected to remain the principal cocoa producer with 70% market share (WCF, 2010).

Cocoa is one of the major agricultural exports from Nigeria. In terms of annual production size, the eight largest cocoa-producing countries, which are Côte d'Ivoire, Ghana, Indonesia, Nigeria, Cameroon, Brazil, Ecuador and Malaysia, represent 90% of the world production. Currently, Nigeria contributes 6% to the world market (Lundstedt*et al.,* 2009). Other cocoa producing countries in West Africa include Togo, Benin, Guinea, Liberia and Sierra Leone (ICCO, 2009). Overall, the West African sub-region contributes a total of 70% of world market share of cocoa and yields considerable revenue to these economies. World production is in excess of 3 million tones with exports of the beans and semi-processed products valued at more than US $5 billion (Lueandra*et al.,* 2007). This means cocoa production and export are very vital to the GDP and therefore economic performance of Nigeria.

1.2 Problem Statement

Cocoa trade flows like all other agricultural commodities depend to a large extent on the interaction between comparative advantage, which is determined by climate and resource endowments as well as wide ranging sets of macroeconomic policies. Because climate change results in new pattern of temperature and precipitation, cocoa's comparative advantage enjoyed by the Nigerian economy is likely to change, setting up the possibilities of changes in trade flows as producers respond to changing constraints and opportunities. As with any change in comparative advantage, unfettered international trade allows comparative advantage to be fully exploited. But debt crisis is now recognized as one of the most important contributory factors to climate change in Nigeria. To meet the debt servicing obligations, the Nigerian government has to undertake policies of macroeconomic stabilization and structural adjustment. In many cases, there was an increasing emphasis on the expansion of export earningsmostly from agricultural and other primary commodities. In response to high foreign exchange earnings due to the devaluation of the naira, farmers are switching from more sustainable and less erosive cropping systems-arable crops

(Mkpado *et al*., 2012). In effect, as Conway and Barbier (1990) concluded, cocoa export expansion on the basis of SAP places more stress on the forests, converting the forests to cocoa farms with consequent climatic change due to increase in global warming and depletion of ozone layer. There is an inherent tradeoff between the objective of global economic efficiency – which is being promoted by the west and western- dominated multilateral institutions via pressure for free trade and structural reform in the less developing countries – and national sustainability and equity between and within the nations..Based on this contextual problem, this paper attempts to investigate the impact of patterns and terms of cocoa export trade on climate change and draws conclusions on the response of export market to the nexus climate and trade policy changes in Nigeria.

2.0 CONCEPTUAL, THEORETICAL, AND ANALYTICAL FRAMEWORK

2.1 Conceptual framework

Prior to the Structural Adjustment Program (SAP) in Nigeria, trade policy consisted of quantitative import controls imposed by comprehensive licensing systems and prohibitions. In an effort to create a business environment conducive to efficient production and distribution of goods, the SAP liberalized trade. The SAP's export policy reforms sought to support growth and diversification of exports. To do soit reformed the exchange rate system in an effort to promote exports. In 1992, the exchange rates were unified and allowed to move freely according to market conditions. The passive devaluation of the naira increased the relative prices of tradable creating strong price incentives for exports (Arene and Okafor, 2001). The government licensing removed export duties and simplified export procedures. The agricultural commodity boards that wielded monopoly powers were abolished. These policy measures set the stage for cocoa farmers to increase production via hectarage expansion, by clearing the forests- deforestation (Okoye, 2002). According to Conway and Barbier (1990), cocoa export expansion induced by SAP trade policies places more stress on the forests, converting the forests to cocoa farms with consequent effects on climate due to increase in global warming and precipitation. Devaluation of the naira can stimulate cocoa export drive directly, but indirectly through forest conversion, increase in temperature, increase in precipitation, increase in cocoa production and, by implication, increase in cocoa export supply. Increased cocoa export earns Nigeria the desired foreign exchange needed for foreign debt services emanating from debt crisis resulting from IMF loans. The direct linkage is dictated by the IMF as a panacea for paying back debts from the World Bank. The indirect linkages are the consequences of the trade policy changes which are likely to cause changes in climate along the trend. These consequences are cocoa hectarage expansion through forest conversion in a bid to increase production and export supply, increased temperature as a result of global warming, and increased precipitation as a result of high temperature. These direct and indirect nexus are important issues worth investigating.

2.2 Theoretical Framework

Production and export supply theories combine to offer the theoretical basis for the impact of climate change on cocoa production and export in Nigeria. Production theory is anchored on the neo-classical economists' tradition. The ultimate objective of production is to demonstrate how output relates to inputs. The firm as an economic agent takes decision on the various ways that these inputs combine to produce output. The neoclassical production function is usually of the form:

$$Y = F(N, K) \quad \ldots\ldots (1)$$

Where Y represents output, *N* and *K,* the land and the labour inputs respectively. According to Silberberg (1990), equation (1) as a Neo-classical single output with two variable inputs can include any finite number of variable inputs; n = 2 merely allows geometric representation. Chambers, pp. 7-9 identifies the properties of the neoclassical production function as follows:

- N as non-negative and finite.
- F(N,K) as finite, nonnegative, real valued, and single value for all possible combinations of *N* and *K;*
- F(N,K) as everywhere continuous and everywhere twice continuously differentiable;

- F(N,K) is subject to the "law" of diminishing returns.

Prominent among these properties is the law of diminishing returns which argues that, if successive units of one variable factor are added to a fixed quantity of another factor (or fixed quantities of a combination of factors), total output varies through three distinct phase (stages). The first phase of the total-output curve begins at some point on the X-axis to the right of the origin where the ratio of the excessive factor (fixed input) to the deficient one (variable input) approaches infinity. This requirement is closely akin to Chambers' "strict essentiality" assumption, 1990, pg, 9.). Cassels (1936) argues that the law is symmetrical: total output again approaches zero in phase three when the variable-input rate gets large enough.

Some recent writers reject the existence of a third phase: "… no marginal physical productivities can be negative; else output would not be maximal since it could be improved by the same set of factors by leaving some idle" (Samuelson, 1983); "all marginal productivities are positive" (Chambers, 1990). Chambers acknowledges that, when an entrepreneur operates in uncertainty, marginal productivities may sometimes be negative. These views about the possibility of production in phase III are consistent with Cassels' argument that only the second phase is economically relevant. If the assumption of nonnegative marginal productivities is imposed by allowing only functions that never decrease, and if such functions are fitted to data in which output decreases as input increases, parameter estimates will be biased. No matter how phase III output is viewed, neoclassical theory permits a variety of production functions.

The theoretical literature has four main functional forms specifications. The earliest among them is the Cobb-Douglas production function by Knut Wicksell (1851-1926) but tested against statistical evidence by Charles Cobb and Paul Douglas in 1928 (Stewart, 2008). Arrow and Solow independently developed the CES production function which could be viewed as a generalization of both Cobb-Douglas and Leontief production function (Blaug, 1996). Edwin Diewert (1971) solved the flexible functional forms which enabled three or more inputs, and were less restrictive than the Cobb-Douglas or CES functions. He used two properties of duality theory viz Sheppard's Duality theorem and

Sheppard'sLemma (Allen and Hall, 1997). Parallel to Diewert's, a second flexible functional form was proposed, namely the transcendental logarithmic or translog by Kmenta (1967).

A production function with a single variable input is a special case of a function with two or more variable inputs. It permits no examination of the possibilities for substitution among inputs, which interests economists (Hall, 1998). However, many agronomic experiments are designed to investigate how output varies with variations in a single input. A useful production-function analysis ought to be applicable to such special cases as well as to more general cases. Special cases may provide evidence on the discriminating power of the criteria for choosing an empirical production function (Hall, 1998).

Ferguson (1969) identifies four main equations that represent production function as follows:

- Power: $y = \beta_0 + \beta_1 x^y, 0 < \gamma < 1$ (2)
- Quadratic Spline: $y = \beta_0 + \beta_1 x + \beta_1 x^2 + \beta_3 z^2$ (3)
- Square Root: $y = \beta_0 + \beta_1 x^{0.5} + \beta_2 x$ (4)
- Translog: $y = \beta_0 + \beta_1 x^{\beta_2 + \beta Inx}$ (5)

Where y is the output in common units, x is inputs and Inx is the natural log of input x. Recently, labour and capital have become the major inputs to most production functions.

The export supply theory leans on the original work of Heckscher-Ohlin theorem which is one of the four critical theorems of the Heckscher-Ohlin model (Ohlin, 1967). It states: "A capital abundant country will export the capital-intensive good, while the labour-abundant country will export the labor-intensive good (Appleyard*et al.,* 2006)". The (H-O model) itself is a general equilibrium mathematical model of international trade, developed by Eli Heckscher and Bertil Ohlin at the Stochholm School of Economics. It builds on David Ricardo's theory of comparative advantage by predicting patterns of commerce and production based on the factor endowments of a trading region (Edward *et al.,* 1995). The model essentially says that countries will export products that utilize their abundant and cheap factor(s) of production and import products that utilize the countries' scarce factor(s).

The critical assumption of the Heckscher-Ohlin model is that the two countries are identical, except for the difference in resource endowments. This also implies that the aggregate preferences are the same. The relative abundance in capital will cause the capital-abundant country to produce the capital-intensive good cheaper than the labour-abundant country and vice versa (Karl, 1999; Arene, 2008).

The Rybczynski theorem which builds upon Ohlin's theorem of export supply was developed in 1955 by the Polish-born English economist TadeuszRybczynski (1923-1998). The theorem states: "At constant relative goods prices, a rise in the endowment of one factor will lead to a more than proportional expansion of the output in the sector which uses that factor intensively, and an absolute decline of the output of the other good" (Appleyard*et al.,* 2006).

Literature has diverse approaches to assessing the impact of climate change on cocoa production and export because of the numerous components of exports. One observed approach has been the assessment of the impact of climate change on agricultural exports (see, Adams *et al.,* 1990; Mendelsohn *et al.,* 2001; Deschenes and Greenstone, 2007; Guiteras, 2007). Other researches examine ocean fisheries, fresh water access, storm frequency, migration, tourism and many other potential issues, as reviewed extensively in the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC, 2007).

Faced with these different channels, the traditional approach to estimating the overall economic impact of climate change has been the use of "Integrated Assessment Models" (IAM), which take some subset of mechanisms, specify their effects, and then add them up (e.g. Mendelsohn *et al.,* 2000; Nordhaus and Boyer, 2000; Tol, 2002). Implementations of the IAM approach require many assumptions about which effects to include, how each operates, and how they aggregate.

Quiroga and Iglesias (2007) in providing estimates of the impacts of climate change in European agricultural sector for future scenarios incorporated socio-economic projections and conducted the experiments using global climate models and regional climate models. To capture the impact of climate on agricultural trade flows, the quantitative results were based on simulations using the GTAP general-equilibrium models system which usually includes all relevant economic activities.

Zhai*et al.* (2009) in examining the possible long-term impacts of global climate change on agricultural production and trade in the People's Republic of China (PRC) used an economy-wide, global computable general equilibrium model to simulate the scenarios of global agricultural productivity change induced by climate change up to 2080.

At the Micro level, several studies have tried to use two methods to find the impact of climate change on crop revenue by regressing climatic variables such as temperature and precipitation on farm yields using the Ricardian approach or the reduced form crop model. The Ricardian method is a cross-sectional technique that measures the determinants of farm revenue. It is based on Ricardo's original observation that the value of land reflects its productivity (Asafu-Adjaye, 2008). The reduced form crop model on the other hand is a process-based model derived from a summary statistical estimate based on an agronomic model of crop growth coupled with a linear-programming model of the US farms (Mendelsohn and Neuman, 1999).

The production function approach relies on experimental evidence of the effect of temperature and precipitation on agricultural yields. The appealing feature of the experimental design is that it provides estimates of the effect of weather on the yields of specific crops that are purged of bias due to determinants of agricultural output that are beyond farmers' control (e.g., soil quality). Consequently, it is straightforward to use the results of these experiments to estimate the impacts of a given change in temperature or precipitation. Its disadvantage is that the experimental estimates are obtained in a laboratory setting and do not account for profit maximizing farmers' compensatory responses to changes in climate.

In an influential paper, Mendelsohn, Nordhaus and Shaw (MNS) proposed the hedonic approach as a solution to the production function's shortcomings (MNS, 1994). The hedonic method aims to measure the impact of climate change by directly estimating the effect of temperature and precipitation on the value of agricultural land. Its appeal is that if land markets are operating properly, prices will reflect the present discounted value of land rents into the infinite future. The problem with this approach is that unobserved variables such as irrigated water are likely to co-vary with climate. As noted by Oliver*et al*. (2006), cross-sectional hedonic equations appear to be plagued by omitted variables bias in a variety of settings.

- A less discussed methodology, but crucial, is the classic ideas that link export from productivity of perennial crops like cocoa to climate change (e.g., Montesquieu, 1750; Marshall, 1890; Huntingon, 1915) at the macro level. Meanwhile, there are well-established, substantial effects of temperature on mortality (e.g. Curriero*et al.,* 2002; Deschenes and Moretti, 2007; Deschenes and Greenstone, 2007), temperature on crime (e.g. Field, 1992; Jacob *et al.,*2007), and drought on conflict (Miguel *et al.,* 2005), all of which have direct and indirect effects on economic activities of a country. Those who have taken such step include Dell, Jones and Olken (2008). They used annual variation in temperature and precipitation over the past fifty years on economic activity throughout the world. Panel data technique from world trade data was used for the analysis. However, their study did not focus on perennial tree crops. They also found temperature as having positive impact on economic activity for both less developed and developed nations but precipitation was insignificant across the world.

A more recent work by Jones and Olken (2010) used international trade data to examine the effects of climate shocks on economic activity. In their study, panel models relating the annual growth rate of a country's exports in a particular product category to the country's weather in that year was used. However, their study like all other studies did not specifically look at how climate change impacts on export through productivity of the product under study. The work, in regressing the growth rate of export on temperature and precipitation for several countries in the world, came out with the same result. A methodological gap this study intends to fill is to demonstrate that climatic variables such as precipitation and temperature do not have direct link to export. The current study argues that the only way climate change impacts on exportable produce like cocoa is via production. This study intends to use a methodology that captures the effect of climate change on cocoa productivity and align the output from cocoa production to export of cocoa. In line with this approach, a Two-Stage Least Square is employed in a dynamicpanel technique to enable the introduction of more lags.

2.3 Analytical Framework

This leans on one input functional form of the production function and the export supply theory. In line with the background of the study, cocoa production uses little capital in the form of fertilizer and chemicals for pest control. The study considers a one-input specification of equation (1). As noticed by Hall (1998), the principal interest in an experiment is the effect of the choice variable, other applied inputs would be added at fixed rates to every experimental study. Variability due to known intrinsic inputs is controlled. Bias due to unknown, or unsuspected, variability in intrinsic inputs would be minimized by randomizing treatment assignments within each homogenous group. Therefore, this study assumes labour is the major input to cocoa production.

To pin down ideas, it is clear that there is no direct theoretical link between export and the effect of climate change. The climate variables to test in this study are temperature and precipitation. The only way these variables affect export is through cocoa production. Therefore, the study establishes this link by adopting the ideas of Dell *et al.* (2008) and assuming a simple production cocoa economy where aggregate output (Y) depends on Labour productivity (A), Population (L) and Climate (T).

$$Y_{it}^{c} = e^{\beta T it} A_{it} L_{it} \tag{6}$$

Where: Y_{it}^{c}= is the total output of cocoa in country i at time t.

β = level effects of climatic fluctuation (Temperature and precipitation) on country i in time t.

A_{it}= labour productivity in country i in time t

L_{it} = population of the economy of country i at time t.

Equation (6) captures the idea that climate can have a level effect on production of cocoa. This could be in the form of high or low precipitation and high temperature above the 27^0C required for cocoa growth.

To capture the growth effect of climate on the production of cocoa arising from policy influences, we find the growth rate of Labour Productivity as:

$$\frac{Y_{it}^{c}}{L_{it}} = e^{\beta T it} A_{it} \quad (7)$$

$$\frac{\Delta A_{it}}{A_{it}} = g_i + \gamma T_{it} \quad (8)$$

$$A_{it} = g + \gamma T_{it} \quad (9)$$

To get per capita productivity (per capita output), equation (6) becomes: $\frac{Y_{it}^{c}}{L_{it}} = y_{it}$ thus, equation (9) becomes:

$$y_{it}^{c} = e^{\beta T it} A_{it} \quad (10)$$

Taking natural log of equation (10) yields,

$$Iny_{it}^{c} = \beta T_{it} + InA_{it} \quad (11)$$

The impact of climate may not have instantaneous effect on the growth of cocoa production but the effect may linger over time. Therefore, to obtain a dynamic equation we take a differential of equation (11) with respect to time.

$$\frac{dlny_{it}^{c}}{dt} = \beta \frac{dlnT_{it}}{dt} + T_{it} \frac{dln\beta}{dt} + \frac{dlnA_{it}}{dt} = 0$$

$$\frac{\Delta y_{it}^{c}}{y_{it}^{c}} = \beta(T_{it} - T_{it-1}) + \frac{\Delta A_{it}}{A_{it}} \quad (12)$$

By substituting (7) into (12) yields (13) as:

$$g_{it} = \beta(T_{it} - T_{it-1}) + g_i + \gamma T_{it} \quad (13)$$

Further simplification gives

$g_{it} = \beta T_{it} - \beta T_{it-1} + g_i + \gamma T_{it}$. By re-arrangement:

$$= g_i + \beta T_{it} + \gamma T_{it} - \beta T_{it-1}$$

$$g_{it} = g_i + (\beta + \gamma) T_{it} - \beta T_{it} \quad (14)$$

$g_{it}$is the growth rate of per capita cocoa output in the economy of country *i*. Level effects of climate fluctuations on output appear through β and the growth effects of climate fluctuations which come through equation (7) appear through γ.

The expectation in this study is that because cocoa is a perennial crop temperature or precipitation effects will have a rather growth effect on the plant instead of level effects. Unlike arable crops, weather shocks will only have a level effect such that as soon as the weather shock reduces to normal, crop yield is restored. Climate effects play more slowly on growth of cocoa and therefore production. Due to this, incorporation of more standard distributed lags is necessary. Hence, employing a dynamic growth equation by introducing p lags yields:

$$y_{it} = A_{it} + \alpha_1 y_{it-1} + \cdots + \alpha_p y_{it-p} + \beta_0 T_{it} + \beta_1 T_{it-1} + \cdots + \beta_p T_{it-p} + \varepsilon_{it} \qquad (15)$$

Equation (15) is a generalized form of equation (6). It allows output to depend on p lags of past output and adding an error term. If equation (7) is generalized and allows for p lags then;

$$\Delta A_{it} = g_{it} + \gamma_0 T + \cdots + \gamma_p T_{it-p} \qquad (16)$$

Substituting (16) into (15) yields a dynamic panel estimation equation of the form:

$$\Delta y_{it} = g_i + \propto \Delta y_{it-1} + \cdots + \propto_\rho \Delta y_{it-p} + \gamma_0 T_{it} + \cdots \gamma_p T_{it-p} + \beta_0 \Delta T_{it} + \beta_1 \Delta T_{it-1} + \cdots + \beta_\rho \Delta T_{it-\rho} + \Delta \varepsilon_{it} (17)$$

Rewriting the ΔT term as T terms yields:

$$\Delta y_{it} = g_i + \alpha_i \Delta y_{it-1} + \cdots + \propto_\rho \Delta y_{it-p} + (\gamma_0 + \beta_0) T_{it} + (\gamma_1 + \beta_1 - \beta_0) T_{it-1} + \cdots + (\gamma_p + \beta_{p-1}) T_{it-\rho} - \beta_\rho T_{t-\rho-1} + \Delta\varepsilon \quad (18)$$

By` relabeling the coefficients on T, (18) can be rewritten as:

$$\Delta y_{it} = g_i + \alpha_1 \Delta y_{it-1} + \ldots + \alpha_\rho \Delta y_{it-\rho} + \sum_{j=0}^{p+1} \rho_j T_{ij} + \Delta \varepsilon_{it} \qquad (19)$$

At a steady state we assume that temperature is constant as such the growth effect will be:

$\Delta y_{it-j} = \Delta y \; and \; T_{ij} = T$, thus solving equation (19) implies;

$$\Delta y_1 = \frac{g_i}{1 - \alpha - \ldots - \alpha_\rho} + \frac{\sum_{j=0}^{\rho+1} \rho_j}{1 - \alpha_1 - \ldots - \alpha_\rho} T_i \qquad (20)$$

Equation (20)implies that growth effect of temperature is simply $\frac{\sum_{j=0}^{\rho+1} \rho_j}{1 - \alpha_1 - \ldots - \alpha_\rho}$

3.0 RESEARCH METHODOLOGY

3.1 The Study Area

The area of study is Nigeria. The Federal Republic of Nigeria is in West Africa between latitudes 4^0 to 14^0North and between longitudes $2^02'$ and $14^030'$ East. To the North, the country is bounded by Niger Republic (1497 km) and Chad (853 km) to the West by Benin Republic (773 km) to the East by the Cameroon Republic (1,690 km) and to the South by the Atlantic Ocean. The country takes its name from its most prominent river, the Niger. Nigeria has a land area of about 923, 769 km^2 (FOS, 1989); a north-south length of about 1, 450 km and a west-east breadth of about 800 km. Its total land boundary is 4, 047 km while the coastline is 853 km. The Federal Ministry of Environment of Nigeria (FMEN, 2001) 1993 estimate of irrigated land is 9,570 km^2 and arable land is about 35%; 15% pasture; 10% forest reserve; 10% for settlements and the remaining 30% considered uncultivable for one reason or the other. Boomie (1998) corroborated the irrigated land at 9, 570 km^2 with arable land at 33%; permanent crop 3%; permanent pastures 44%; forest and woodland 12% and others 8%. Cleaver and Shreiber (1994) put the surface area of Nigeria as 91.07 million hectares; 57% of which is believed to be the either under crops or pastures while the remaining 43% is divided amongst forest, water bodies and other uses. Nigerian water bodies consist of area of about 13,000 sq km while the remaining, which is land is about 910, 769 sq km.

Nigeria's climatic environment varies among regions: equatorial in the south, tropical in the centre and arid in the north. It is a country of marked ecological diversity and climatic contrasts. The lowest point is the Atlantic Ocean at sea level of 0m, while the highest point is the ChappalWaddi at 2,419 m. Nigeria has a population of over 150 million people, with diverse biophysical characteristics, ethnic nationalities (more than 250), agro-ecological zones and socio-economic conditions. It has evolved over time and space in terms of administrative structures and nature of governance (Eroarome, 2005).

The country is faced with some natural hazards such as periodic drought and flooding, as well as environmental issues such as soil degradation, rapid deforestation urban air and water pollution, desertification, oil spills (oil pollution – affecting water, air and soil), loss of arable land, rapid urbanization and so on.

3.2 Sampling Technique

Most of the data requirements of this study were fulfilled by adopting a survey as the design of the study. The survey was basically to trace the trend in climate change with respect to its effect on cocoa export in the country.

3.3 Data Collection

The data for the study were collected from secondary sources. Data on cocoa production and export were collected from Cocoa Research Institute of Nigeria (CRIN), Ibadan, while data on temperature and precipitation, which are the key climate variables determining the distribution and yield of crops (Ayoade, 2004) were obtained from the Nigerian Meteorological Agency (NMA), Oshodi, Lagos. Meteorological data would also be obtained from weather stations located within states in the study area.

Other relevant data were collected from existing literature including journals and publications from relevant bodies related to this study.

3.4 Data Analysis

Data for the study were explored through the application of both descriptive and inferential statistical tools. Objective (i) was analyzed through the use descriptive statistics. Objectives (ii) and (iii) were actualized using a 2 Stage Least Square Dynamic Panel Regression (2SLSDPR) to address cocoa production and export, respectively. To achieve objective (iv), a Monte Carlo simulation test was used to simulate under various climate and trade/price policy scenarios for possible climate and trade policy impacts on future cocoa output and hence, export. This was done by increasing and decreasing the levels of each of climate and trade variables deliberately by 10 percent and recording the differentials in cocoa output and export volumes (See equations 23 and 24 below for the variables).

Following from the theoretical and analytical frameworks and as noted by Bond *et al.* (2007) and illustrated in Dell *et al.* (2008), cocoa production and export effects were estimated by running panel regressions of the form:

$$g_{it} = \theta_i + \theta_{rt} + \sum_{j=0}^{L} \rho_j T_{it-J} + \varepsilon_{it} \quad (21)$$

Where θ_i are country fixed effects and θ_{rt} are time fixed effects. ε_{it} is the error term clustered by country i and T_{it} is a vector of climate variables (Temperature and Precipitation) with several lags.

$$g_{yit} = \emptyset_{ci} + \gamma_{ct} + \beta_1 TEM_{it} + \beta_2 PRECIP_{it} + \varepsilon_{it} \quad (22)$$

Concerning cocoa export, the study considers an export supply response function specification, following the works of Houthakker and Magee (1969), Taplin (1973), Hickman and Lau (1973), Goldstein and Khan (1978), Bond (1985), and Lukonga (1994). In this case, cocoa export is modeled as a function of cocoa output (g_{it}), the ratio of the producer price to the domestic price *(RPP)* and the ratio of the export price to the producer price (*RPX)*.

$$QX_{it}^{c} = f(RPP_{it}, EXR_{it}, RPX_{it}, g_{it}) \quad (23)$$

Where: QX_{it} = Cocoa export supply measured in tonnes.

RPP_{it} = the ratio of the producer price to the domestic price index.

EXR_{it} = Exchange rate. It is incorporated because the study considers a small economy such that exchange rate can influence export.

RPX_{it} = the ratio of the export price to the producer price.

g_{it}= output of cocoa from country i at time t (stemming from equation 22).

RPP_{it} measures the behavior of cocoa farmers. It is given as the ratio of the producer price (in local currency) to a measure of the domestic price index. This domestic price index is intended to reflect changes in the cost of producing the export crop. If this cost increases in relation to what the farmer gets for selling the crop, the profitability of producing the export crop will fall. Also, given that the resources used in the production of export crops can equally be used for other purposes, the relative profitability of producing export crops falls with an increase in domestic prices. This relative price term was lagged five times to reflect the lag in adjustment of export supply to changes in producer prices. The five times lags indicate the five-year gestation period for cocoa to start producing efficiently.

The second price variable RPX_{it} measures the behaviour of exporters. It is expressed as a ratio of the export price and what is paid to farmers (the producer price). The price paid to producers represents a cost to exports. If this cost increases in relation to the export price, it becomes less profitable to export. If it is the export price that increases more than the producer price, more will be put on the market. We expect a positive coefficient.

α_{ci}captures fixed effects of the differences in the growth rate of cocoa exports of country i.γ_{ct} is the yearly fixed effects which captures time specificities in Nigerian climate fluctuations on the export of cocoa. $\beta_1$and β_2 are supposed to show the impact of temperature increase and precipitation decline in time t on the production of cocoa. $B_3$and β_4 are expected to capture the behaviour of cocoa farmers and exporters (if the country has fully liberalized its market).

$$L(QX_{it}^{c}) - L(QX_{it-1}^{c}) = \alpha_{ci} + \gamma_{ct} + \beta_1 RPP_{it} + \beta_2 RPX_{it} + EXR_{it} + \beta_3 g_{yit} + \varepsilon_{cit} (24)$$

To estimate the effect of climate fluctuations on cocoa export in Nigeria, a Two Stage Least Square dynamic panel regression was explored as mentioned earlier. The two equations estimated are equations (23) and (24).

Exogenous factors in equations(23) and (24) werevaried following Monte Carlo simulation test by increasing and decreasing the levels of each of the factors deliberately by 10 percent and recording the likely future differentials in cocoa output and export volumes.

4.0RESULTS AND DISCUSSION

4.1 Trends in Cocoa Export, Climate and Trade Policy Changes from 1980-2010

The Nigerian cocoa export market has been a fluctuating one from the pre-independence era to date and would likely remain thus, especially now that the marketing system has been liberalized and controlled by the forces of demand and supply with little or no intervention by the government. The result of this liberal marketing system has given rise to free market operations enabling many private industries, firms and corporate bodies to engage in domestic trading and exportation of cocoa beans. Firms sell to the private entrepreneurs directly or through intermediaries. Product prices are also determined by the law of demand and supply in the international market (Folayani, 2006).

The fluctuation in cocoa production and hence export, is also seen to have been influenced by climatic and trade/price policy factors over the years. There has been a slight decade-by-decade increase in most of these variables which might have had a resultant gross effect on production (output) and export. (Table 4.1).

Table 4.1: Climate and Trade Policy Nexus.

Trend (Years)	Exchange Rate (%)	Hectarage Expansion (Ha)	Temperature (O^0C)	Precipitation (mm)	Cocoa Output (MT)	Cocoa Export (MT)
1980	9.50	700000	135.2958	16599	153000	285058
1981	10.00	700000	191.0229	14900	174000	194567
1982	11.75	700000	189.8646	12147	156000	136656
1983	11.50	700000	192.5063	12361	140000	206024
1984	13.00	700000	191.2334	14031	160800	130800
1985	11.75	700000	190.15	18450	160000	92891
1986	12.00	700000	189.2771	13545	148000	148426
1987	19.20	700000	195.9917	16822	150000	106000
1988	17.60	700000	192.8729	17448	253000	211766
1989	24.60	708000	191.4354	16080	256000	138940
1990	27.70	715000	194.3438	16613	244000	147915
1991	20.80	726000	192.1521	19633	268000	155691
1992	31.20	730000	190.9521	15583	292000	108024
1993	36.09	735000	191.6521	15672	306000	152079
1994	21.00	751000	191.1354	16463	323000	142361
1995	20.79	788000	193.1979	19255	203000	132713
1996	20.86	739000	193.3334	18891	323000	170009
1997	23.32	739000	192.2271	15453	318000	140000
1998	21.34	743000	197.0771	14845	370000	128065
1999	27.19	744500	192.425	18751	225000	196377
2000	21.55	966000	193.7229	16216	338000	139000
2001	21.34	966000	194.5563	15636	340000	175272

2002	30.19	1030000	193.8542	17946	362000	180723
2003	22.88	1002000	196.475	16763	385000	230560
2004	20.82	1062000	194.1792	16805	412000	255000
2005	19.49	1088700	194.7438	15454	441000	267700
2006	18.70	1104000	192.7834	16486	485000	189500
2007	18.36	1359550	188.9625	18262	360570	174900
2008	18.70	1349130	189.2334	15000	367010	227303
2009	22.62	1354340	191.1917	14417	363510	247000
2010	22.51	1272430	189.875	19143	399200	226634

Figures 4.1 to 4.7 show the so called trade/price policy → cocoa hectarage expansion (forest conversion) → climate change → cocoa output/export nexus. Figure 4.1 shows that devaluation of the naira can stimulate cocoa export drive directly, but indirectly through forest conversion, increase in temperature, increase in precipitation, increase in cocoa production and, by implication, increase in cocoa export supply. Increased cocoa export earns Nigeria the desired foreign exchange needed for foreign debt services emanating from debt crisis. The direct linkage is dictated by the IMF as a panacea for paying back debts from the World Bank. The indirect linkages are the consequences of the trade policy changes which are likely to cause climate change along the trend.

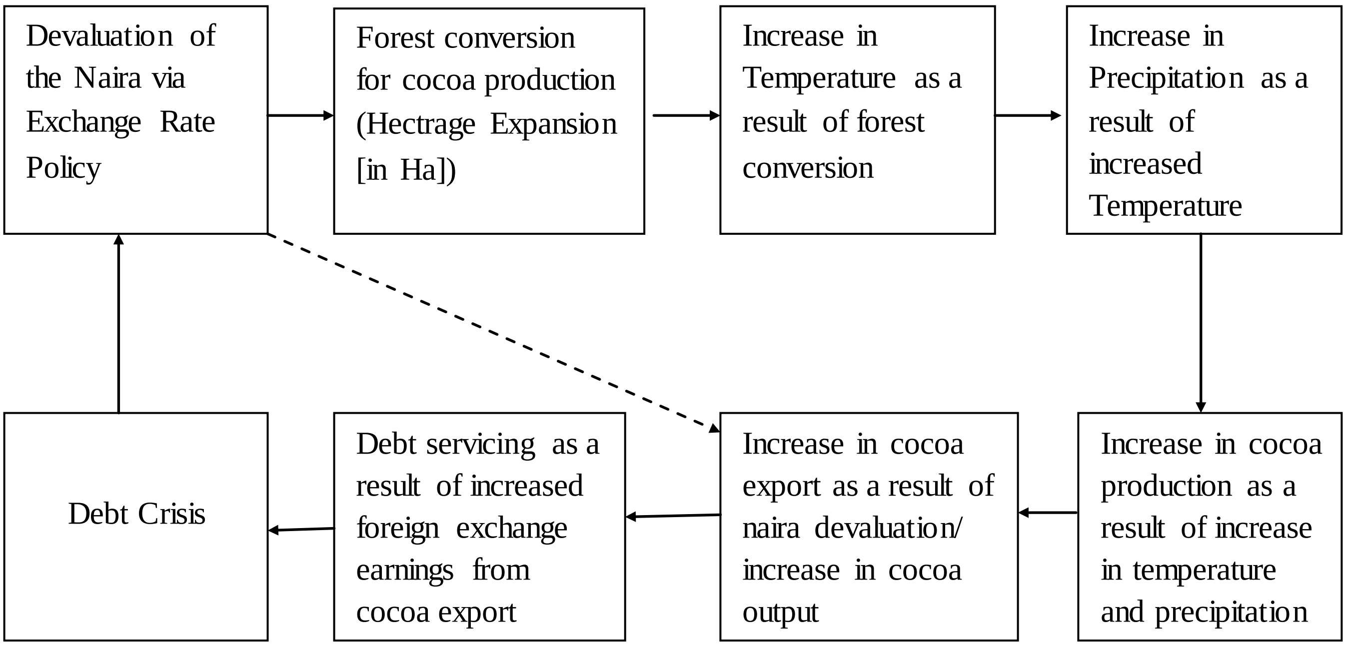


Fig. 4.1: Trade/Price Policy, Cocoa Hectarage Expansion and Climate Change Nexus

The interactive posture of this nexus is demonstrated in figures 4.2 to 4.7

Figure 4.2

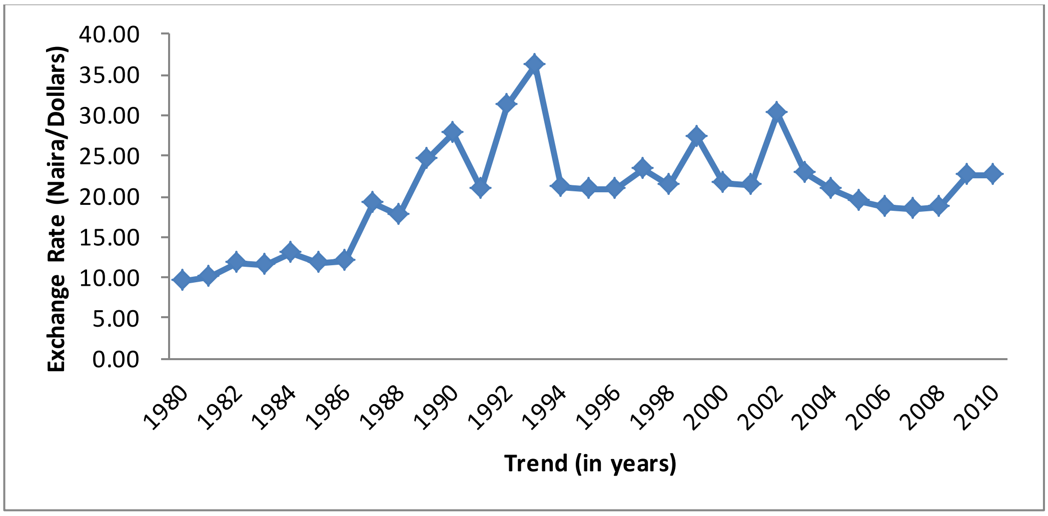


Figure 4.3

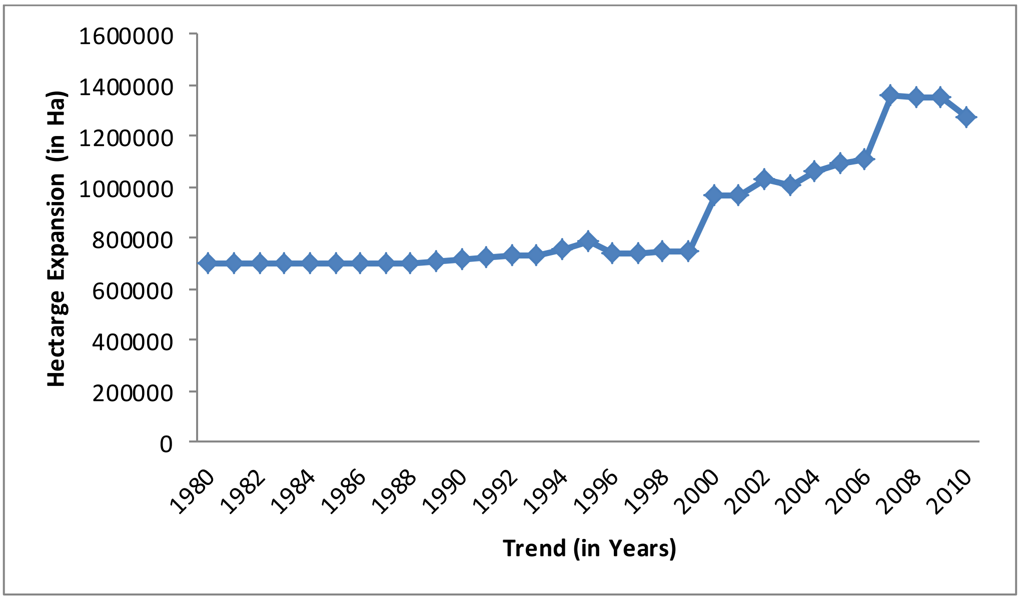


Figure 4.4

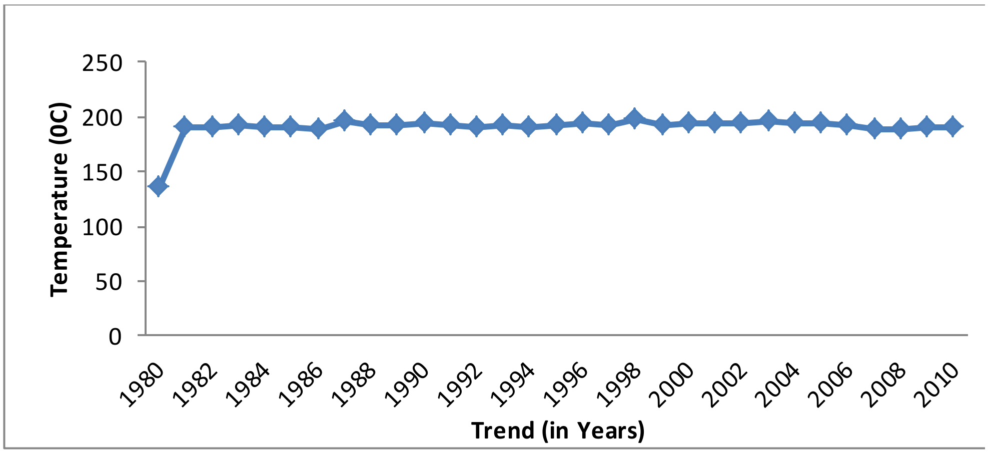


Figure 4.5

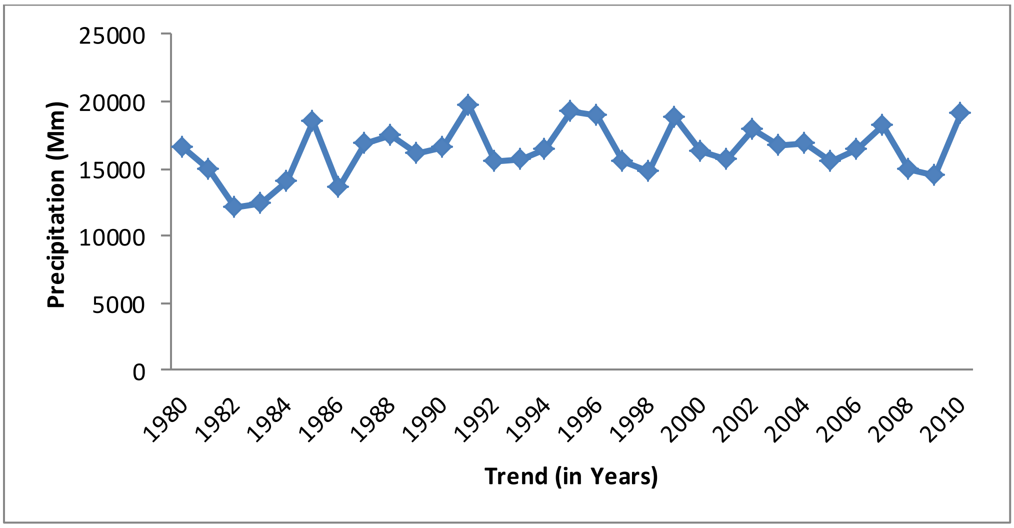


Figure 4.6

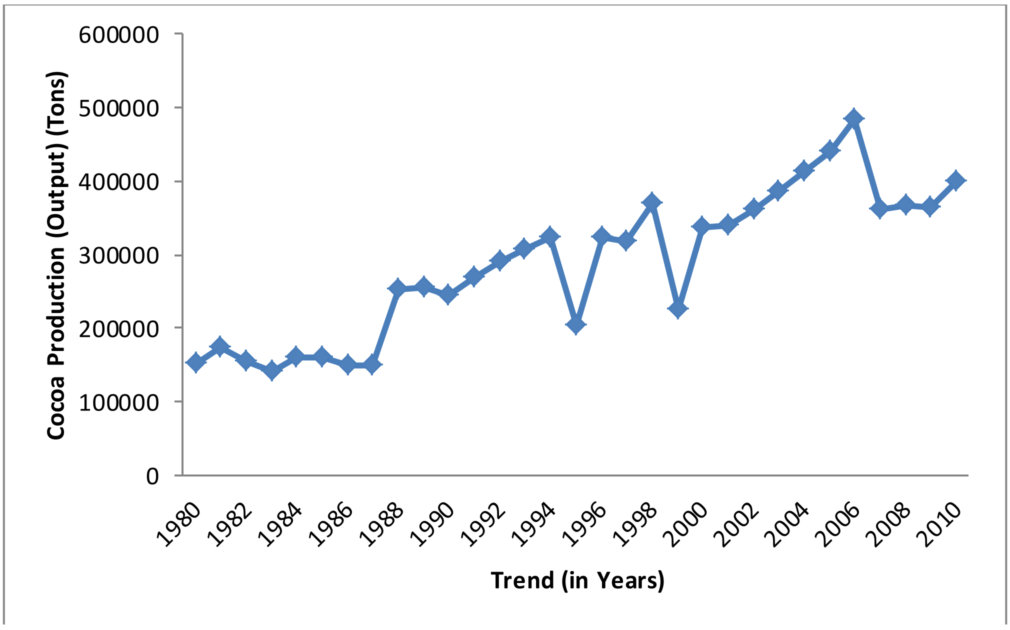
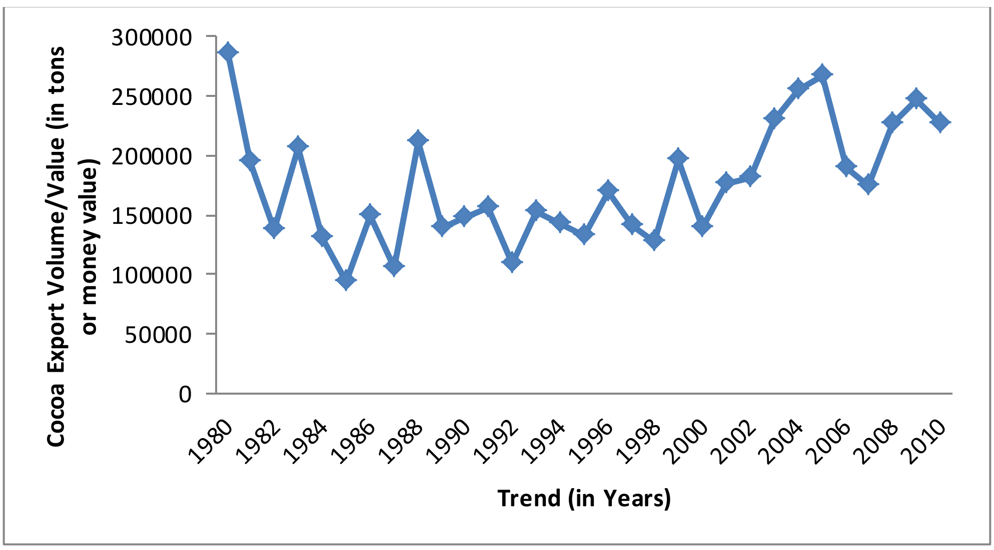


Figure 4.7



The figures show fairly but stable trend over the years (1980-2010) among the variables, even though temperature and rainfall patterns seem stable. However, there were sharp declines in cocoa output and export volumes between 1992 and 1994, when naira exchange rate was highest. This is contrary to expectation as naira devaluation was expected to stimulate cocoa production and export. Probably, this phenomenon may be as a result of political turmoil during that period that made the international community to place economy/export sanctions on Nigeria. The turmoil was short-lived as cocoa hectrage expansion, output, and export supplies continued after this period on the average (Figures 4.3, 4.6 and 4.7).

4.2 Level Effects of Climate Change on Cocoa Production arising from Farm Land Area and Labour Changes

Data gathered from the survey for the analysis of level effects of climate change on cocoa production arising from farmland area and labour changes were analyzed using a regression analysis. The linear function was chosen. The summary statistics assessed and reported include:

i. R^2 which is the square of the multiple correlation coefficients. It can also be referred to as coefficients of determination.

ii. R^2 – adjusted ($\bar{R}^2$).

iii. t-values, i.e., the standard error of coefficients having more number of factors with statistically significant coefficient.

iv. F-values which define the critical region of the test at the chosen level of significance.

The R-squared (R^2) value of 0.995 or 99.5% showed the variations in years as accounted for by the variation in the four variables put together. The R^2 adjusted ($\bar{R}^2$) supports it with a value of 0.995 or 99.5%. The t-value showed the significance of the individual regression coefficients. The coefficients of all the variables (Land area, temperature, precipitation and labour) were positive and significant at 2.403, 3.151, 2.453 and 31.671, respectively – showing that as the "years increased, production, temperature, precipitation and labour also increased – but labour was far higher as a result of higher increase in population in agriculture due to higher increase in the national population with respect to other variables.

Hypothesis 1, which stated that: level effects of climate change, and growth effects of farmland area and labour do not influence cocoa output was tested using the F-value in the regression table. The F-calculated from the regression was 1388.741, and greater than the F-tabulated of 2.69 at 10% level of significance. Thus, the null hypothesis was rejected and the alternative accepted. Therefore, the level effects of climate change, growth effects of farmland area, and labour influence cocoa output- and the overall regression is statistically significant.

Table 4.2: Coefficients of regression, t-value and levels of significance of climate changevariables,hectarage and labour on cocoa output

Variables	Coefficient	Std. Error	t-values	Level of Sig.
(Constant)	1945.610	2.521	771.639	0.01
Land area	6.273E-6	.000	2.403	0.05
Temp	.039	.012	3.151	0.01
Preciptn	.000	.000	2.453	0.05
Labour	9.566E-5	.000	31.671	0.01

$R^2 = 0.995$

F-value = 1388.741

4.3 Effects of Cocoa Productivity and Trade Policy Changes on Cocoa Export Market in Nigeria

Linear function of the regression model was also used to analyze the data collected for each of the variables in the analysis of the effects of cocoa productivity and trade policy changes on cocoa export market in Nigeria. The summary statistics reported and assessed were as shown in table 4.2.

The R^2 value of 0.631 indicated that 63.1% of the variation in export quantity was accounted for by the variations in the four variables put together. The t-values showed the individual significance of the variables.

The coefficients of production (in metric tonnes) and the ratio of the export price to the producer price (RPX) were positive and significant. This is as expected, implying that an increase in them would lead to an increase in quantity exported.

The coefficient of the ratio of the producer price to the domestic price index (RPP) was positive but not significantly related to quantity exported. This may imply that this ratio had minimal effect on the quantity of cocoa exported. Exchange rate had a negative but significant coefficient. This implied that a reduction in the value of the naira would bring about an increase in quantity of cocoa exported. This is expected because devaluable of the domestic currency increases export drive (Arene, 2008).

F-calculated statistic value of 10.071 was greater than the F-tabulated, showing that there was also significant relationship between the dependent and the independent variables. Hence the null hypothesis which stated that cocoa productivity and trade/price policy changes do not influence the quantum of cocoa export market was rejected.

Table 4.3: Coefficients of Regression, t-values, and Levels of Significance of Productivity and Trade Policy Changes on Cocoa Export Market

Variables	Coefficients	Std. Errors	t-values	Levels of Significance
(Constant)	101527	53577.139	1.895	0.10
RPP	266.442	560.996	.475	N.S.
EXR	-2324.818	1969.789	-1.180	0.10
RPX	2160.510	1641.633	2.316	0.05
G	.378	.115	3.291	0.01

R^2 = 0.631

F-value = 10.071

4.4 Simulation Result with 10% Increase in Values of the Independent Variables

The R^2 value of 0.294 explains that only 29.4% of the variation in export quantity was accounted for by the variation in the four variables put together when their values were increased by 10%. The t-values show the individual significance of the variables.

The coefficient of the ratio of the export price to the producer price (RPX) was positive and significant which explains that a unit increase in this variable would lead to 2597.661 units increase in quantity of cocoa exported. The coefficient of the ratio of the producer price to the domestic price index (RPP) was positive but not significant, while exchange rate had a negative coefficient that was not significant. This implied that a unit increase in these variables had minimal effects on the quantity of cocoa that is exported. However, the g coefficient representing climate change variables is positively and significantly related to cocoa export volume.

The F-calculated statistical value of 2.710 was greater than the F-tabulated, showing that there was a significant level of relationship between the quantity of cocoa exported and climate/trade policy changes.

Table 4.4: Regression Analysis Result with 10% Increase in Values of theIndependent Variables

Variables	Coefficients	Std. Errors	t –value	Level of Significance
(Constant)	90854.638	61736.377	1.472	.10
EXR	-1322.085	2203.464	-.600	NS
RPP	144.899	579.318	.250	NS
RPX	2597.661	1687.618	1.539	0.10
G	.370	.118	3.141	0.01

$R^2 = 0.294$

F-value = 2.710

4.5 Simulation Result with 10% Decrease in Values of the Independent Variables

The R^2 value of 0.328 explains that 32.8% variation in export volume is accounted for by the variation in the four independent or exogeneous variables. This shows that 32.8% of the variation in export quantity was accounted for by the variation in the four variables put together when their values were reduced by 10%.

The coefficient of RPX was still positive and significant, while those of RPP and EXR account for less. Higher exchange rate which implies devaluation of the local currency, makes export markets more competitive.

The F-calculated statistical value of 3.177 was greater than the F-tabulated, showing that there was a significant level of relationship between the dependent and the independent variables.

Table 4.4: Regression Analysis Result with 10% Reduction in Values of the Independent Variables

Variables	Coefficients	Std. Errors	t-values	Level of Significance
(Constant)	87935.197	47625.660	1.846	0.10
EXR	-2207.671	1942.725	-1.136	0.10
RPP	271.324	550.787	.493	NS
RPX	2234.824	1624.014	1.376	0.10
G	.384	.114	3.379	0.01

$R^2 = 0.328$

F-value = 3.177

In conclusion, it could be observed that the effects of climate and trade policy changes are quite obvious and observable. However, it appears that trade policy changes impact more on cocoa export market than changes in climate in the short-run.

5.0 Recommendations

In view of the findings of this study, various assertions were made and recommendations follow thus:

(i) There should be a trade-off between trade policy gains and losses due to forest conversion as a result of cocoa hectrage expansion. Forest conversion increases climate change via increases in global warming, temperature and precipitation.

(ii) Efforts should be made in stabilizing these policies so that the impacts of these changes would not be devastating on the market participants.

(iii) There is need for policies on climate change adaptive strategies in Nigeria, especially with respect to agricultural trade-able, for sustainable food security and foreign exchange earnings.

(iv) Part of the gains from trade should be used to cushion the effects of climate shock on the farming environment through funding research on climate change adaptation strategies.

ACKNOWLEDGEMENT

This paper is derived from the second author's M.Sc dissertation. The first author is the dissertation supervisor. The authors are grateful to the African Network for Agriculture, Agro-Forestry and Natural Resources Education (ANAFE),based in Nairobi, Kenya, for providing financial support.

References

[1] Abang, S. O. (1984). Stabilization Policy: An Economic Analysis and Evaluation of its implication for Nigerian Cocoa Farmers. Ph. D. Dissertation, Oklahoma State University.

[2] Abang. S. O. and H.M. Ndifon (2002). Analysis of World Cocoa Production Trends and their Production share Coefficients (1975-2006). *Nigerian Agricultural Journal,* 3:

[3] Allen, C. and H. Stephen (1997).Macroeconomic Modeling in a Changing World.John Wiley & Sons Printing Press.

[4] Appleyard, Field and Cobb (2006).International Economics (5th Edition).McGraw-Hill Irwin.ISBN 0-07-287737-5.

[5] Arene, C. J. (2001). "Exchange Rate Policies and Productioon of Major Cash Crops in Nigeria". Modelling Measurement and Control, D., Vol. 22, No. 3, pp. 25 – 36.

[6] Arene, C. J. (2002). "Differential Effects of Agricultural Activities of Men and Women Return Migrants on Forest Land Conversion in Anambra State of Nigeria". *Journal of Agriculture and Environment for International Development*, Vol. 96, Issue ½ pp. 73 – 84.

[7] Arene, C. J.and A. O.Okafor (2001). "Exchange Rate Liberalization as a Policy Instrument for stimulating Non-Traditional Agricultural Exports in Nigeria," Economic Affairs, Vol. 46, No. 4., pp. 236 – 24.

[8] Asafu-Adjaye (2008).Climate Change and Economic Development in Sub-Sahara Africa. African Economic Research consortium (AERC).AERC Senior Policy Seminar X, Addis Ababa Ethiopia. 7-9 April, 2008. Pg 63-67, AERC publication.

[9] Ayoade, J. O. (2004). Introduction to Climatology for the Tropics. Spectrum Books Limited, Ibadan, Nigeria. Pp. 230.

[10] Bond, M. (1985). Export Demand and Supply for a Group of Non-Oil Developing Countries. Climate change on Growth and Development, Chapter Four: Implications of Climate Change. http://forecast.fao.org/default.aspx.

[11] Cassels, J.M. (1936). On the Law of Variable Proportions. Reading in the Theory of Income Distribution, *The American Economic Assn,* Pp. 103-118. Homewood, IL.: Richard D. Irwin, Inc. 1946 (Reprinted from Explorations in Economic). New York: McGraw-Hill Book Co.

[12] Conway, G. R. and E. B. Barbier (1990), After the Green Revolution: Sustainable Agriculture for Development. London, Earthscan, p. 79.

[13] Curriero, F. C.; K.; J.Samet; S. Zeger; L. Strug; J.A. Patz (2002). Temperature and Mortality in 11 cities of the Eastern United States, *American Journal of Epidemiology -155 (1):* 80-

[14] Dell, M. B. F. Jones and B. A. Olken (2008). Climate Change and Economic Growth: Evidence from the Last Half Century. National Bureau of Economic Research Working Paper #13227.

[15] Deressa, T. T. (2011). Effects of Climate Conditions and Agro-Ecological Settings on the Productive Efficiencies of Small-Holder Farmers in Ethiopia. Working paper 223/

[16] Deressa, T.; R. M. Hassan and C. Ringler (2008b). Measuring Ethiopian Farmers' Vulnerability to Climate Change Across Regional States. International Food Policy Research. Institute (IFPRI). Discussion Paper No. 00806. Environment and Production Technology Division, IFPRI, Washington D.C.

[17] Deschenes, O. and E.Moretti (2007).Extreme Weather Events, Mortality and Migration. NBER Working Paper #14132.

[18] Deschenes, O. and M. Greenstone (2006).The Economic Impact of Climate Change: Evidence from Agricultural Profit and Random Fluctuations in Weather. American Economic Review 97, 354-385. Development, 92-121.

[19] Eroarome, Martin Aregheore (2005) Country Pasture/Forage Resource profiles.

[20] FAOSTAT online Database of the Food and Agricultural Organization of the United Nations. Cocoa and International Trade. Accessed on 5th of July, 2012.

[21] Federal Office of Statistics (FOS) (1989).Yearly Economic Review. December.

[22] Field, S (1992). The Effect of Temperature on Crime. *The British Journal of Criminology 32:* 340-351.

[23] Food and Agriculture Organization (FAO) (2007). Adaptation to Climate Change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities. A publication by the United Nations Food and Agricultural organization Rome, Italy.

[24] Food and Agriculture Organization (FAO) (2007).Climate Change and Food Security.United Nations Joint press Kit for Bali Climate Change Conference.3rd-14th December, 2007.

[25] Food and Agriculture Organization (FAO) (2010). Top Cocoa bean producers in 2009. United Nations Food and Agricultural Organization Release.www.faostat.org.

[26] Goldstein, M. and M S. Khan (1978). The Supply and Demand for Exports: A Simultaneous Approach. *The Review of Economics and Statistics, Vol LX, No.2:* 275-286.

[27] Hall, H. (1998). Choosing an Empirical Production: Theory, Non-nested Hypotheses, Costs of Specialization. *Agricultural Economics Research Report No. 59.*

[28] Hickman, B.G. and J. Lawrence (1973). Elasticities of Substitution and Export Demand in a World Trade Model. *European Economic Review 4,* 347-380.

[29] Houthakker, H. S. and S. P. Magee (1969). Income and price Elasticities in World Trade. This REVIEW 51, 111-125

[30] Intergovernmental Panel of Climate Change (IPCC) (2007). Climate Change 2007: Impact, Adaption and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, 1000pp.

[31] Jones, F. and Olken, A. (2010).Climate Shock and Export. National Bureau of Economic Research.

[32] Lueandra, N. and Andrew, J. (2007).Competitiveness of Cocoa Production systems in Trinidad and Tobago. Food safety and Value Added Production and Marketing of Tropical Crops. CAES 26th West Indies Agricultural Economic Conference, Caribbean Agro-Economic Society (CAES). Puerto Rico, July 2006 pp 50-58.

[33] Lueandra, N. and Jacque, A. (2007).“Competitiveness of Cocoa production system in Trinidad and Tobago. Food safety and Value Added Production and Marketing of Tropical Crops”. Caribbean Agro-Economic Society (CAES).

[34] Lukonga, I. (1994). Nigeria’s Non-Oil Export: Determinants of Supply and Demand, 1970.

[35] Lundstedt. H. and Parssinen, S. (2009). “Cocoa is Ghana-Ghana is Cocoa”. Evaluating Reforms of the Ghanaians Cocoa sector”. NationalekonomiskaInstitutionen Vid Lunds (Department of Economics at the University of Lund Universitet), Minor Field Study Series No. 198, Sweden.

[36] Mendelsohn, R. and Neumann, J. (1999). The Impacts of Climate Change on the U.S. Economy Cambridge University Press, Cambridge, UK, Pp. 55-93.

[37] Mendelsohn, R., Arellano-Gonzalez, J., & Christensen, P. (2009).A Ricardian analysis of Mexican farms. Environment and Development Economics 15: 153-171

[38] Mendelsohn, R., W. Nordhaus& D.G. Shaw (1994).The Impact of Global Warming on Agriculture; Reply. In: Deressa, T.T. (Ed). (2003). Measuring the Impact of Climate Change on South African Agriculture. The Case of Sugarcane Growing Regions. Unpublished M.Sc. Thesis, University of Pretoria, South Africa.

[39] Miguel, E and M. K. Cugerty (2005). Ethnic Diversity, Society Sanction and Public Goods in Kenya, *Journal of Public Economics, 89* (11-12), 2325-34.

[40] Ohlin, B. (1967). International and International Traded. Harvard Economic Studies 39 Cambridge, MA: Harvard University Press.

[41] Okike, I.; M.A. Jabbor.; V. Manyaong.; J.W. Smith.; J.A. Akinwumi and S.K. Ehui (2011). Agricultural Intensification and Efficiency in the West African Savannahs: Evidence from

Northern Nigeria. Socio-economic and Policy Research Working Paper 33, Nairobi, Kenya: ILRI (International livestock Research Institute) Pp.54.

[42] Okoye, C. U. (2000), "Income and Employment Effects of Biotechnology in Nigeria: The Case of Cocoa Butter Substitute". *Unpublished Ph.D. Thesis*, Department of Agricultural Economics, University of Nigeria, Nsukka.

[43] Olalekun, T. (1985). Cocoa Export of Nigeria. *Nigerian journal of Financial Management*. 4:63-65.

[44] Olayemi, J. K. (1973). Some Economic Characteristics of Peasant Agriculture in the Cocoa Belt of Western Nigeria. *Bulletin of Rural Economics and Sociology,* 1:24-30.

[45] Olayide, S. O. (1969). Some Estimates of Supply and Demand Elasticities for Selected Commodities in Nigeria's Foreign Trade. *Journal of Business and Social Studies,* 1:176-193.

[46] Olayide, S.O. and D. Olatunbesun (1972).Trend and Prospects of Nigeria's Agricultural Exports. NISER Technical Report.

[47] Omindeet.al., (1991): A Change in Weather, African Centre for Technology Studies (ACTS) Press, Nairobi, Kenya..

[48] OyekaleA.S., M.B. Belayi and O.W. Okwa (2009). The Effects of Climate Change on cocoa production and vulnerability Assessment in Nigeria. Agricultural Journal Year; 2009.Vol. 4 Issues 2.Pp 77.85.

[49] Quiroga, S. and Iglesias, A. (2007). Projections of Economic Impacts of Climate Change in Ramanathan, Ramu (1995). Introductory Economics with Application.3rd Edition. The Dryden Press.

[50] Samuelson, P.A. (1983). Foundations of Economics Analysis, Enlarged Edition. Cambridge: Harvard University Press.

[51] Silberberg, E. (1990). The Structure of Economics: A Mathematical Analysis Second Edition. New York: McGraw-Hill Publishing Co. U.S.A.

[52] Tol, R. (2002). Estimates of the Damage Costs of Climate Change – Part II: Dynamic Estimates, *Environmental and Resource Economics 21,* 135-160.

[53] Toplin, G. (1973).A Model of World Trade. In: R.J. Ball (ed). The International Linkage of National Economics Models (Amsterdam; North Holland Publishing Company, 1973), 177-223.

[54] United Nations Conference on Trade and Development (UNCTAD) (2009).Responding to the Global Crisis. Climate Change Mitigation and Development –Trade and Development Report. UNCTAD Secretariat, ISBN 978-92-1-112776-8. ISSN 0255-4607.New York and Geneva.

[55] World Cocoa Foundation (2010).Cocoa Market Update. A publication Compiled by the World Cocoa Foundation from published Reports and Resources. May, 2010.

[56] Zhai, F.; and J. Byambador(2009). A General Equilibrium Analysis of the Impact of Climate Change on Agriculture in the Peoples Republic of China. Munich Personal RePEc Archive. Asian Development Bank 6 ADB Avenue, Metro Manila, Philippines.