Investigating the Trend and Sources of Economic Efficiency in the Sugar Industry in Nigeria

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Author's contribution

*This work was carried out by author SBA. He designed the study, wrote the protocol, and
wrote the first draft of the manuscript. Also, he managed the literature searches, statistical
analyses and approved the final manuscript.*

Research Article

ABSTRACT

This study analyzed economic efficiency indices in the sugar industry in the period 1970
to 2010 in Nigeria. Secondary data were obtained from the sugar firms, Food and
Agricultural Organization (FAO), Central Bank of Nigeria (CBN) and National Bureau of
Statistics (NBS) as well as the federal Ministry of Finance. Stochastic Cobb-Douglas cost
function for the sugar industry was estimated from which indices of economic efficiency
were obtained. Trend in the estimated economic efficiency indices showed time invariant
fluctuations across the study period with an average index of 41.80% and excess cost
efficiency of 58.20%. Multiple-regression of various forms based on the ordinary least
squares technique was used to determine factors that influence the economic efficiency in
the industry. Empirical result revealed that economic efficiency in the sugar industry was
influenced positively by the industry's sales growth and capital-labour ratio. On the other
hand, the industry's expenditures on research and training, physical capacity utilization
rates and the real exchange rate of naira for US dollar impacted negatively on the
economic efficiency of the industry. It is recommended that capital intensive method of
production should be adopted as a means of promoting economic efficiency of resource
use in the industry. Also, effective marketing policy on the sugar industry manufactures is

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strongly recommended. Government should increase budgetary allocation to the Sugarcane Research Development and Training Center to intensify its activities in areas of manpower development. Finally, the industrial policy package for the industry during import substitution period should be used as a basis for regulating economic efficiency in the sugar industry in Nigeria.

1. INTRODUCTION

Prior to the Structural Adjustment Programme (SAP) period (1986-1993) in Nigeria, sugar sub-sector was one of the vibrant industrial sub-sectors that contributed to the economic development of the country [1]. As indicated in Table 1, the performance of the sugar sub-sector was impressive in the early 1970s evidenced by the high indices of sugar production. During this period, the sugar industry in the country had fully integrated its operations backward through its direct involvement in sugarcane farming and sourcing of other raw materials locally [2]. One major characteristic of the Nigeria's economy in this era was the stability in some key macro-economic fundamentals [3,4].Towards the middle of 1980s till late 1990s, the performance of the sub sector started to decline. The index of sugar production declined from 117.8 % in the period 1986 to 1990 to 47.7 % in 2001 to 2005 period [5]. One of the consequences of the declined in the sugar production was the massive importation of semi-processed sugar into the country [5]; with its attendance implications on the development of the domestic industry and net foreign asset of the country. The situation was made worst by the continuous increase in volatility of some key macroeconomic variables [6]. For instance, by the middle of 1980's, the country's foreign exchange earnings declined significantly arising from the global oil glut [6]. By the early 2000s, the high import dependence manufacturing sector in the country became a serious liability on the country's economy [7].

Table 1. Average index of agro-based manufacturing sub-sectors in Nigeria (1970-2005)

Agro-based industry	1970-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Sugar	420.3	534.3	149.6	117.8	101.2	56.4	47.7
Textiles	110.6	171.4	100.9	100.8	117.2	97.4	94.2
Foot work	253.6	255.9	111.1	62.1	73.7	47.7	45.0
Total GR	24.8	80.5	-169.7	-65.5	20.9	-58.9	-24.4
Ave.GR. (%)	8.3	26.8	-56.6	-21.8	7.0	-19.6	-8.1

Source: Computed by authors using data from [8]. (1985= 100); GR= Growth rate.

Many analysts have attributed the dwindling trend in the productivity of the sugar industry during the SAP period and post SAP period to instability in some macro-economic variables and agro-based firm related constraints [7,6,9]. According to them, the effect was transmitted through the country's rising inflation rate, low external reserves which constrained importation of sugar industry's equipment, deteriorated value of naira as well as demand and other production constraints imposed by the low real GDP per capita as well as insufficient subsidies to the sub-sector.

According to reports by the Central Bank of Nigeria [5] and National Sugar Development Council of Nigeria [1], the domestic consumption of sugar in Nigeria is in excess of 1.5 Mt/a. Currently, the domestic production of sugar is slightly less than 5 % of the country's annual requirement [5,1]. From 2000 to 2003, the domestic sugar production declined significantly reaching all time low value of less than 1.00 % of the domestic sugar consumption in the country [1]. The country's economic environment and the industrial policies have often been blamed on the current fortune of the sugar sub sector [9,8]. In an attempt to improve the manufacturing sector in the country, government has carry out several policy measures to increase the manufacturing capacity in the economy and at the same time curb excessive fluctuations in some key macroeconomic variables. The government policy measures varied from the pre-structural Adjustment Programme (Pre-SAP) period (1970-1985) to the SAP (1986-1993) and post-SAP (1994 to date) periods. Direct monetary control techniques were employed in the pre-SAP period [10]. In the SAP period (1986-1993), indirect measures were adopted such as deregulation policy among others. In the post-SAP period (1994 to date), administratively controlled measures were first adopted in 1994 and were abandoned in 1995 for policy of guided deregulation. Apart from the monetary policies, the government also employed some fiscal policy measures to ensure full employment and efficient use of resources in the manufacturing sector. Some of the measures include tax holidays, tariff protection, import duty relief, banned on imports and the provision of credit facilities as well as export processing zones.

In the sugar industry, several economic and institutional policies have been employed over the years to boost sugar production in the country. These policies include; 50 % tariff on the importation of white sugar, 5 % levy on imported raw sugar, free excise duties on sugar production, reduce import duties on sugar industry machineries, 5-year tax holiday to sugar refineries and privatization of the major sugar firms in the country as well as the sugar expansion programme in collaboration with the African Development Bank (ADB) and African Development Fund (ADFs) in 1989 and 1991 respectively. These measures were meant to stimulate the local production and hence increase the productivity of the sub-sector. Also the National Sugar Development Council (NSDC) was established by decree 88 of 1993. The NSDC was mandated to develop strategies that would promote local production of sugar such that 70 % of the country's sugar requirement would be met by domestic production [11,1]. Based on the government policy of direct participation and investment in the sugar industry, NSDC strategies were the expansion and rehabilitation of the four government owned sugar industries; establishment of 5 medium scale and many mini sugar plants in the country as well as the establishment of sugarcane Research Development and Training Center. The Council however recorded some successes in implementing some of its strategies but could not still upsurge local production of sugar in the country [12]. In spite of these policies and institutional measures, Nigeria still imports over 90 % of its sugar mostly in semi-processed form [1]. The country has the largest demand for sugar in the West Africa sub-region and second in Africa in addition to large area of cultivable land suitable for the growing of industrial sugarcane [11,13,14]. Despite the favorable agro-climatic and soil conditions for the production of industrial sugar-cane in addition to the long period of existence of sugar mills; sugar requirements of the country remains largely unmet from domestic sources [15]. The cost implication of sugar imports in the country is devastating: for instance, about ₦26 billion or about 173.33 MUSD (at N150 for 1 dollar) was spent on sugar importation in 2008 [16]; while ₦217 billion or (1.45BUSD) was spent in 2010 [17].

Therefore based on salient issues raised and the need to assess the level of resource utilization using economic efficiency indices in the sugar industry, this study has provided

answers to the following research questions: how economically efficient is the sugar production in Nigeria? What are the macroeconomic factors that influence the economic efficiency in the sugar industry from 1970 to 2010 in Nigeria? Which industrial policy regime(s) promoted high performance in the sugar industry in Nigeria? Given the importance of the sugar industry in the Nigeria's economy in terms of its contribution to the employment and food self sufficiency as well as creating significant impacts on the rural economy in the country [18,13,14,19]; there is need to identify the fundamental macroeconomic variables that could contribute to the surging performance of the industry over the years. Hence, the study specifically established the empirical relationship among economic efficiency in the sugar industry and some key macroeconomic factors as well as the industrial policy regimes in the country.

2. THEORETICAL FRAMEWORK

The economic principle suggests that a rational firm aims at minimizing cost of production. The firm's cost minimization concept assumes that firms minimize total operating costs subject to exogenous factors such as; prices of variable inputs, quantities of fixed inputs and outputs, environmental factors, their own managerial inefficiency and random error. Cost efficiency is therefore an ability of a firm to achieve the minimum possible production cost, given the prices and levels of resources of that firm [9]. The stochastic cost frontier model focused on the average performance, optimal and extreme performances of firm. The zone below the cost frontier is unattainable; therefore, all productive units are either on or above the frontier. Those on the frontier have the lowest or minimum cost of factors of production for a given level of output.

The cost efficiency function model used in this analysis is described as follows [46]:

$$C_i = f(P_i; Y_i; \beta_i) + (V_i - U_i) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where *Ci* represents the total variable cost of production, P_i is the vector variable of input prices. Y_i is the output of sugar firm, β_i is the parameter to be estimated. The systematic component *Vi* represents the random disturbance term due to factors outside the scope of firms. It is assumed to be identically and normally distributed with zero mean and constant variance as N $(0, \delta^2)$. *Ui* is the one-sided disturbance term used to represent cost efficiency and is independent of *Vi*. Thus, *Ui* = 0 for a firm whose costs lie on the frontier, *Ui* > 0 for firms whose cost is above the frontier, *Ui* < 0 for firms whose cost is below the frontier. Thus economic efficiency of an individual firm is derived in terms of the ratio of the observed or frontier minimum total variable cost C_j^* to the corresponding actual total variable cost C_j given the price of variable inputs (P_i), output (Y_i) and the level of fixed factors (Z_i) of production of firms. This is expressed as:

$$EECUR_t = \frac{C_j^*}{C_j} = \frac{f(P_i, Y_i, Z_i; \beta_i)exp(V_j)}{f(P_i, Y_i, Z_i; \beta_i)exp(V_j - U_j)} = \frac{1}{\exp(-U_j)} \dots\dots\dots\dots\dots\dots\dots\dots (2)$$

2.1 Review of Related Literature

Despite the extensive investigation of efficiency indices in several industries in developing countries, the concept of economic efficiency has been sparsely investigated [9]. In Nigeria there is limited literature on the economic efficiency in agro based industries vis-à-vis the entire industrial sector. Few researches on the subject matter in the developing countries do

not focused on agro-based firms. For instance, Bitros [20] in Greece provided empirical evidence of low economic efficiency among public manufacturing firms in the period 1979 to 1988. Onn [21] analyzes the role of economic efficiency in small and medium industries performances in Malaysia. He identified effective policy and incentives as major ways of improving economic efficiency in the sub sectors. Majority of researches on firm efficiency focused on the technical efficiency estimation and analysis. For example Ogun [22] and Soludo [23] in Nigeria carried out empirical researches on the performance of the manufacturing sector in various policy regimes in Nigeria. The result reveals positive relationships between technical efficiency in the manufacturing sector and import substitution period in Nigeria. Also Adewuyi [24] study the impact of trade policy reform on technical efficiency in Nigeria's manufacturing sector. The result revealed that the nominal protection rate and import penetration ratio had positive significant effects on the technical efficiency of the manufacturing sector. Negative effects were obtained for the interest rate and exchange rate respectively. The study concluded by asserting that the trade policy reform produced positive impact on the technical efficiency in the Nigeria's manufacturing sector.

Alam [25] employed regression analysis on firm's related data from Peru manufacturing sector between 1988 and 1992 to obtain a similar result. They also discovered that firm's size had a negative significant effect on the technical efficiency of firms. Njikam [26] in Cameroon, found a positive significant relationship between manufacturing firm's technical efficiency and effective protection, official tariff rates, import penetration ratio, and share of manufacturing in exports. Chirwa [27] also confirmed positive significant relationship between firm's technical efficiency and share of the manufacturing in exports, capital-labour ratio and worker skill in Malawi. The result also showed that tariff rate, share of manufacturing in imports and firm size had negative significant relationship with firm's technical efficiency. Albert [28] analyzed factors explaining technical efficiency in Spanish industrial sector in the period 1991 to 1994. The result revealed that technical efficiency had a significant positive relationship with the firm size and investment level and a negative relationship with the value of expenditure on research and development. Djankov and Murrell [29] in their empirical investigation concluded that privatization improves firm performance and efficiency and in addition that concentrated ownership enhances firm performance. Admassie [30] explores technical efficiency level of the small and medium scale enterprises (SMEs) in Tanzania, and found that the mean technical efficiency level for all firms was about 50 percent, meaning that by operating at the full technical efficiency levels, these firms could increase their productive level by about 50 percent. The study also indicates that the technical inefficiency of the Tanzanian SMEs is significantly related to firm age, firm size, and human capital development. Alvarez and Gustavo [31] conducted a study on the determinants of the technical efficiency in small firms in Chilean manufacturing industry. Using plant survey data and Non - Parametric Deterministic Frontier Methodology; they estimated efficiency that was positively related to the experience of workers, modern capitals and innovation in products. In contrast, outward orientation, owner's education and participation in public programs have significant negative impact on firm's efficiency.

Badunenko and Stephan [32] used cross sectional data from 241 industries in Germany between 1995 and 2001 to estimate the technical efficiency and its determinants. The results revealed that technical efficiency was positively and significantly influence by the index of new firm formation and human capital, and negatively correlated to the concentration indices. The results also showed that, the technical efficiency was not related to sales growth, research and training expenditures, capital intensity and firm size. A similar study was conducted by Badunenko et al. [33] using panel data from 35,000 German firms in the period 1992 to 2004. The report indicated that, firm size increases the technical efficiency

while outsourcing, research and development decrease technical efficiency. Faruq and David [34] used the Data Envelopment Analysis (DEA) technique to estimate the technical efficiency of firms in Ghana across six manufacturing industries during 1991 to 2002. They observed that the manufacturing firms in Ghana were significantly less efficient than their counterparts in other countries. In addition, their results reveal that firm characteristics such as size, age, foreign ownership, and the mix of labor and capital used during the production process have positive effects on firm's efficiency. Niringiye et al, [35] also investigated the relationship between technical efficiency and firm size in Uganda and Tanzania manufacturing sector. The result showed a negative association between firm's size and technical efficiency in both countries. Chu and Kaliappa [36] examined the impact of trade liberalization and other variables on Vietnamese manufacturing firm's efficiency. The results revealed that trade liberalization and share of skilled workers have significant positive effect on the sector's efficiency, while capital-labour ratio had a negative influence. Only few research works have specifically delved into economic efficiency of firm and policy reform. Evidence is found in the empirical work of Ray [37] in India. He investigated the impact of economic reforms on the manufacturing efficiency in the period 1991 to 2001. The finding supported positive relationship between firm's efficiency and import liberalization in India.

3. RESEARCH METHODOLOGY

3.1 Study Area

The study was conducted in Nigeria; the country is situated on the Gulf of Guinea in the sub Saharan Africa. Nigeria lies between 4⁰ and 14⁰ north of the equator and between longitude 3⁰ and 15⁰ east of the Greenwich. The country has a total land area of 923,768.622km^2 or about 98.3 million hectares (98.3Mha) and population of over 140 million [38]. Industrial sugarcane is cultivated in commercial quantity in the northern part of the country, and is mostly planted in irrigated lands or swampy areas. Niger state, Kwara state, and Adamawa state are the major industrial sugarcane producers in the country [39]. There are four major sugar producing firms and two sugar refineries in Nigeria. These are, Nigeria Sugar Company at Bacita, Kwara State established in 1964 with initial installed capacity of 40,000 t/a; Savannah Sugar Company Limited at Numan, Adamawa State established in 1980 with initial installed capacity of 65,000 t/a; Lafiaji Sugar Company in Kwara State and Sunti Sugar Company in Niger State are mini sugar plants. The refineries are BUA and Dangote sugar refineries located in Lagos state. The refineries are not involved in direct production of sugar, but refined semi processed sugar imported from Brazil and other sugar producing countries [1].

3.2 Data Source

Data used in this study were collected from the sugar producing firms in Nigeria and macro economic data published by the Central Bank of Nigeria (CBN), Food and Agricultural Organization, National Bureau of Statistics, Federal Ministry of Finance and Federal Ministry of labour and Productivity as well as the Federal Ministry of Agriculture and Rural Development. Two major sugar producing firms were purposely selected for data collection. This was because the firms depend fully on the domestic sugarcane for the production of sugar and produced more than 95 percent of the domestic produced sugar in the country [1]. The sugar firms selected were; Bacita Sugar Company in Kwara state and Savanna Sugar Company in Adamawa state. The data collected covered the period of 1970 to 2010.

3.3 Analytical Models

The empirical model was specified based on the demand of the objective of the study. Following Battese [40], Ogundari and Ojo [41] and Aigner et al. [42] specifications; the stochastic cost function (EE) was defined as follows:

$$EE_t = \frac{TVC_j^*}{TVC_j} = \frac{(P_j, Q_j, Z_j; \beta)exp(V_j)}{(P_j, Q_j, Z_j; \beta)exp(V_j - U_j)} = \frac{1}{exp(-U_j)^*} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, TVC_i is the actual or firm total variable cost of production, TVC_i^* is the frontier or minimum total variable cost, P_i represent prices of all inputs of i_{th} firm, Q_i is the output level, and Z_i represent other variables; while βs' are parameters to be estimated. Note, in the cost function; total variable cost (TVC) was used instead of the total cost (TC) because of insufficient information on the fixed factors of production in the industry. However, the used of the TVC was justified on the fact that changes in the TC are attributed to changes in the TVC of factors of production in the industry.

The economic efficiency (EE) of the sugar industry presented in equation *(3)* was estimated using equation *(4)* specify in log-linear form as follows:

$$LnTVC_t = \delta_0 + \delta_1 LnWNP_t + \delta_2 LnPLP_t + \delta_3 LnRPK_t + \delta_4 LnWPW_t + \delta_5 LnPS_t + \delta_6 LnEC_t +$$
$$\delta_7 LnPOI + \delta_8 LnSOI_t + \delta_9 LnTEP_t + V_j - U_j \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where;

TVC_t = annual total variable cost of sugar industry (N) (Note, the book value)
WNP_t = average wage rate of non-production workers (N) $(\delta TVC_t/\delta WNP_t < 0)$
PLP_t = price of land used for sugarcane production (N) $(\delta TVC_t/\delta PLP_t > 0)$
RPK_t = real depreciation cost of capital as a proxy of the rental price of capital stock (N) $(\delta TVC_t/\delta RPK_t > 0)$
WPW_t = average annual wage rate of production worker (N) $(\delta TVC_t/\delta WPW_t > 0)$
PS_t = average annual price of sugarcane (N/tonne) $(\delta TVC_t/\delta PS_t > 0)$
EC_t = real energy consumption, proxies by annual expenditure on energy (N) $(\delta TVC_t/\delta EC_t > 0)$
POI_t = average price of other inputs (N) $(\delta TVC_t/\delta POI_t > 0)$
SO_t = sugar output (tonnes) $(\delta TVC_t/\delta SO_t > 0)$
TEP_t = technological progress capture by time trend $(\delta TVC_t/\delta TEP_t > 0)$
δ_s = are coefficients to be estimated

Note: Equation (4) was estimated independently by maximizing the likelihood function using the computer program frontier version 4.1MLE [43]. Although Frontier 4.1 software could jointly estimates equation (4) and (5), we decided to ignore the estimates of equation (5) generated by frontier 4.1 and rather went for the separate OLS estimation of equation 5. This means that, the economic efficiency indices (EE) generated earlier was used to estimate equation 5 separately. This was done to observe the various functional forms of equation (5). Following the assumption of the Ordinary Least Squares estimation technique, the use of OLS is justified if the error or residual generated is normally distributed provided other assumptions about the error terms are fulfilled [43].

3.4 Determinants of Economic Efficiency (EE) in Sugar industry in Nigeria

To determine factors that influence economic efficiency in the sugar industry in Nigeria, efficiency equation model was specified as in equation 5 [44,41]. A dummy variable (D) was introduced into equation *(5)* to capture the policy impact on the economic efficiency in the sugar industry in Nigeria [24]. Note; various forms of this function was estimated (linear, semi-log, exponential and double–log).

$$EE_t = \eta_0 + \eta_1 SIMP_t + \eta_2 INFLA_t + \eta_3 SG_t + \eta_4 ERT_t + \eta_5 RER_t + \eta_6 FS_t + \eta_7 K_t/LA_t + \eta_8 GGDP_t$$
$$+ \eta_9 OTR_t + \eta_{10} PXR_t + \eta_{11} HC_t + \eta_{12} PCUR_t + \eta_{13} RWS_t + \eta_{14} D$$
$$+ U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where,

EE $\quad$ = economic efficiency of sugar industry in Nigeria
$SIMP_t$ = real sugar import (Nm)
$INFL_t$ = inflation rate (%)
SG_t $\quad$ = sales growth (proxy by output growth, %)
ERT_t $\quad$ = real expenditure on research and training in the sugar industry (Nm)
RER_t $\quad$ = real exchange rate (N/ \$)
RWS_t = average real wage of skilled workers (N/skilled worker)
FS_t $\quad$ = firm size proxies by the sugar industry's employment growth rate (%)
K_t/LA_t = capital-labour ratio (real capital to labour) (N/worker)
$GGDP_t$ = growth rate of real GDP per capita (%)
OTR_t $\quad$ = official tariff rate on sugar imports (%)
PXR_t $\quad$ = parallel market exchange rate premium (measured as the ratio of the official exchange rate to parallel market rate)
HC_t $\quad$ = human capital (number of skilled and unskilled workers)
PCUR $\quad$ = physical capacity utilization rate in sugar industry (%)
D $\quad$ = dummy variable which takes the value 1 in the liberalization period (1986-2010) and 0 otherwise (1970-1985))
U_t $\quad$ = Stochastic error term.

η's are coefficients to be estimated.

Note: the physical capacity utilization rate for the industry (PCUR) was estimated independently using production function approach and injected into this analysis as a variable in equation 5.

As shown in Battese and Broca [45], for the distribution assumptions made about the random term (μ_i), the elasticity of economic or cost efficiency with respect to a given explanatory variable described in equation (5) is given by:

$$\left\{ \frac{1}{\sigma_u} \left[\frac{\varphi\left(\frac{\mu_i}{\sigma_u} - \sigma_u\right)}{\phi\left(\frac{\mu_i}{\sigma_u} - \sigma_u\right)} - \frac{\varphi\left(\frac{\mu_i}{\sigma_u}\right)}{\phi\left(\frac{\mu_i}{\sigma_u}\right)} - 1 \right] \right\} \frac{\delta\mu_i}{\delta InX_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where $\phi(.)$ and $\phi(.)$ are density and distribution function of a standard normal variable respectively. X's are independent variables described in equation (5). The elasticity was estimated for each explanatory variable described in equation (5).

3.5 Estimation Techniques

Equation (4) was estimated by using the Maximum Likelihood method, while various forms of equation (5) were estimated using Ordinary Least Squares method.

4. RESULTS AND DISCUSSION

4.1 Unit Root Test for Variables Used in Equation (5)

The Augmented Dicker Fuller (ADF) test was conducted on the time series variable specified in equation (5). Table 2 shows the result of the Augmented Dicker Fuller (ADF) test for the logged and non-logged variables defined in equations (5).

Table 2. Result of the unit root test for variables

Non-log variable	Level	1st difference	Order of integration	Log variable	Level	1st difference	Order of integration
$SIMP_t$	-2.033	-5.856**	1(1)	$SIMP_t$	-2.332	-7.260**	1(1)
$INFL_t$	-3.321	-6.204**	1(1)	$INFL_t$	-3.849*	-	1(0)
SG_t	-6.851**	-	1(0)	SG_t	-7.361**	-	1(0)
ERT_t	-2.843	-9.244**	1(1)	ERT_t	-1.497	-6.844**	1(1)
RER_t	-0.964	-5.404**	1(1)	RER_t	-1.884	-4.352**	1(1)
RWS_t	-2.397	-8.523**	1(1)	RWS_t	-2.176	-8.877**	1(1)
FS_t	-5.483**	-	1(0)	FS_t	-7.145**	-	1(0)
Kt/L_t	-3.779*	-	1(0)	Kt/L_t	-5.212**	-	1(0)
$GGDP_t$	6.461**	-	1(0)	$GGDP_t$	-6.368**	-	1(0)
OTR_t	-1.866	-5.651**	1(1)	OTR_t	-1.456	-4.988**	1(1)
PXR_t	-1.947	-6.780**	1(1)	PXR_t	-1.932	-6.303**	1(1)
HC_t	-1.736	-5.434**	1(1)	HC_t	-1.646	-6.610**	1(1)
$PCUR_t$	-4.156*	-	1(0)	$PCUR_t$	-4.040*	-	1(0)
EE_t	-7.208**	-	1(0)	EE_t	-7.712**	-	1(0)
Critical values							
5%	-3.52	-3.53			-3.52	-3.53	
1%	-4.20	-4.21			-4.20	-4.21	

*Note: Asterisks *, and ** represent 5% and 1% significance levels respectively. Variables are as defined in equations (5). These tests were performed by including drift and a deterministic trend in the regressions.*

PC-Give 10 and gretl econometric software's was used to carry out the test. The results revealed that some variables were stationary at level and some at first difference. For logged and non-logged category, the estimated economic efficiency (cost efficiency) indices were stationary at level. This implies that the nature of the relationship among the specified variables in equation (5) could be determined by multiple regression at the level of the variables provided the diagnostic statistics are satisfactory and showed no evidence of spurious regression (i.e. R2 > D.W) or any econometric problem [46,39].

4.2 Cobb-Douglas Stochastic Cost Function of the Sugar Industry in Nigeria

Maximum likelihood estimates of the Cobb-Douglas stochastic cost function for the sugar industry as defined in equation (4) is presented in Table 3. The result revealed a significant

sigma squared coefficient of 0.5351 at 5 % level of probability. This indicates a good fit and correctness of the specified distribution assumption of the composite error term for the model. The variance ratio or gamma (λ) indicates the proportion of variation in the total variable cost in the sugar industry in Nigeria that is due to deviation from cost or economic efficiencies. The gamma ratio of 0.4171 suggests that the presence of economic or cost inefficiency in the sugar industry in Nigeria explained about 41.71 % variations in the total variable cost of the industry. The generalized likelihood ratio test for the equations is highly significant and this confirms the presence of one - sided error component in the composite error term. Therefore, the result of the diagnostic test confirms the relevance of the stochastic parametric cost function and maximum likelihood estimation technique.

Table 3. Maximum likelihood estimates of Cobb-Douglas stochastic cost function of the sugar industry in Nigeria as defined in equation (4)

Variable	Coefficient	t-value
Constant	-0.1882	-0.09315
Wage rate of non prod. workers (WNP_t)	-0.2685	-0.3839
Land price (PLP_t)	-0.1278	-1.8235*
Depreciation cost (RPK_t)	-0.5039	-3.665***
Sugar output (SO_t)	0.9259	0.7854
Wage rate of prod. worker (WPW_t)	0.7709	2.0479*
Price of sugarcane (PS_t)	0.9154	0.2374
Expenditure on electricity (EC_t)	-0.3379	-0.5446
Price of other inputs (POI_t)	0.1614	2.1173**
Technology progress (TEP_t)	0.4417	0.5260
Sigma square Gamma (δ^2)	0.5351 (2.425)**	
Gamma (λ)	0.4171 (2.415)**	
Log-Likelihood	-0.4425	
LR Test	15.4047	

Note: Asterisk *, ** and *** represent 10%, 5% and 1% significance levels respectively. Variables are as defined in equations (4).

The empirical result revealed that land price (PLP_t) and depreciation cost (RPK_t) have negative relationship with the total variable cost in the sugar industry in Nigeria. On the other hand, the wage rate of production workers (WPW_t) and price of other inputs is positively related to the total variable cost in the industry.

4.3 Estimated Indices of Economic Efficiency

In all the observations, the economic efficiency was less than unity with an average value of 41.80 %. It is important to note that the mean value of the cost efficiency indices for the industry in the study period gives an indication of how dispersed the annual total variable cost of the industry is in terms of cost efficiency. Thus a low mean value indicates that, in most years the industry is relatively distant from the most cost efficient year (in terms of cost efficiency). Given the mean value, it implies that the industry had relatively low level of economic efficiency. Economically it means that, the average purchasing cost of factors of production was about 58.20 % above the cost frontier. This result indicates that the industry had economic efficiency gap or excess economic efficiency (cost efficiency) of 58.20 % which could have been achieved by improving the financial and resource base of the industry given the technology endowment of the sub-sector *citeris paribus*. Overall, these findings suggest that there is considerable capacity for cost efficiency improvement in the

industry. It was also observed that, cost inefficiency (1-cost efficiency index) seems to diminish in years that the industry has reasonable subvention from the government. The result suggests that, there was an insufficient financial resource to acquire optimal production factors in the industry in most years during the study period.

4.4 Trend in Economic Efficiency of the Sugar Industry in Nigeria

The estimated trend equation for the economic efficiency indices in the sugar industry in Nigeria is shown in Table 4.

The result indicates that the index of economic efficiency in the Nigerian sugar industry was not significantly related to time in the study period. This means that the fluctuation in the economic efficiency was not influenced by time factor.

Table 4. The Linear trend equation for the economic efficiency indices

variable	coefficient	standard error	t-value	p-value
Constant	0.381	0.044	8.720	0.000***
Time	0.002	0.002	0.972	0.337
Schwarz C. = -40.93 Hannan-Quinn = -43.89 F-cal 0.945 R-square = 0.024 Akaike information C. = -44.31 Rho = -0.052 Durban Watson = 2.10				

*Note: Asterisk ***represents 1% significance level.*

Fig. 1 shows the graphical representation of the trend in the estimated economic efficiency (cost efficiency) indices of the sugar industry in Nigeria for the period 1971 to 2010. The economic efficiency index increases from 37 % in 1971 to around 73 % in 1972 probably due to increase in the federal government subvention to the industry arising from the oil boom of early 1970s [23]. In the period 1973 to 1980, the industrial policy of import substitution was overwhelmingly protective. However, the deliberate policy of maintaining an overvalued exchange rate for the naira and the protective tariff system created a weak and drowsy manufacturing sector that was unwilling to compete with the foreign counterparts and developed new ideas.
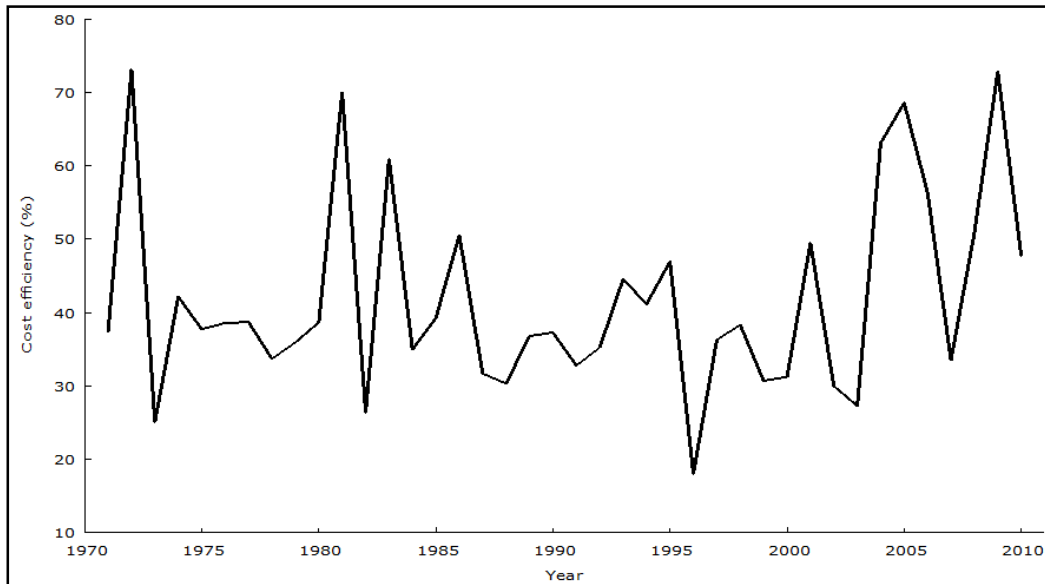
Fig. 1. Trend in economic efficiency in the sugar industry in Nigeria

However, the sugar industry during this period was able to integrate most it operations backward through the local sourcing of raw materials. In this period, the trend in economic efficiency exhibited an average downward trend. This could be attributed to increase in the volatility in some key macroeconomic variables during the period. The policy of import substitution pursued in Nigeria in the period 1981 to 1985 was characterized by high levels of protection, fluctuating tariff structures, and ban of import of selected finished goods. Budgetary allocation to the real sector was quite low and direct government policy to support productive activities were unavailable. In this period, trade policy with respect to the real sector focused on promoting domestic produced raw materials [47]. By the end of 1985, the Nigerian economy was highly protected with an average unweighted nominal rate on imports of above 30 percent and individual tariffs were adjusted frequently, often on an ad-hoc basis. The oil shocks and the debt crisis during this period affected subventions to the sugar industry by the federal government. As a consequence, the indices of economic efficiency during this period assumed an average downward trend. The adoption of the Structural Adjustment Programme (SAP) in 1986 lead to the implementation of diverse liberalization measures including a sizeable devaluation and partial liberalization of the trade policies. During SAP era (1986 to 1993), the sugar industry focused on sourcing of raw materials in the domestic market. However this attempt was constrained by increase volatility in macroeconomic variables and insufficient funding of the sub-sector. The economic efficiency rose from 37 % in 1990 to 44 % in 1993 following the recapitalization of the industry by African Development Bank and African Development Fund in 1989 and 1991 respectively.

In the post Structural Adjustment Programme (SAP) period (1994 to 2010), trade policy had de-emphasized protection and import substitution and focused on export promotion [48]. Nigeria's adoption of trade liberalization led to a significant fall in import tariff. Incidences of tariff escalation and tariff peaks also declined. All of these work together to stifle much needed funds required by the real sector for working capital and investment financing. The economic efficiencies during this period (1994 to 2010) assumed undulating trend following the uncertainties that crowded the industry. Between 2002 and 2008, all the four sugar firms

in Nigeria were partly privatized and the process of recapitalization by the co-investors was rather sluggish. Most of the sugarcane plantations were destroyed prior to privatization; government subventions to the sub sector were terminated and most capital equipment depreciated [49]. In addition, the pressure on domestic sugar firms generated by increasing domestic demand causes an upsurge in raw and refined sugar imports. Domestic production was less than 4 % of the total sugar consumption in the period 2004 to 2008 [50]. Increased in the sugar import in the country during the period (1994 to 2010) reduces competition in the domestic sugar industry, hence the indices of economic efficiency decline during 1995 to 2004. In the period 2005 to 2010, there were traces of improvement in the efficiencies in the industry following attempts by the co-investors to recapitalize the sub sector. The index of economic efficiency rose from 63 % in 2004 to 68 % in 2005, and 72 % in 2009.

4.5 Determinants of Economic Efficiency in the Sugar Industry in Nigeria

Table 5 presents the result of the estimation of the various functional forms of economic efficiency equation in the sugar industry in Nigeria. The result of the diagnostic tests and the number of significant explanatory variables present in each functional form favored the semi-log form as the lead equation. The R^2 for the lead equation explains 68.70 % of the total adjusted variations in the sugar industry's economic efficiency. The F-statistic of 3.917 is significant at 1 % probability level, indicating that the R^2 is significant and this implies that the equation had goodness of fit. The Durbin-Watson value of 2.08 indicates that autocorrelation is not a serious problem in the selected equation.

As revealed in Table 5, the coefficient of sales growth (SG_t) is statistically significant at 1 % probability level and is positively related to the economic efficiency in the sugar industry in Nigeria. This relationship indicates that increase in the sales growth increases the economic efficiency in the industry. This implies that 1% increase in the sales growth will increase economic efficiency by 0.019 %.

Also the coefficient of the real expenditure on research and training in the sugar industry (ERT_t) had a significant negative relationship (at 10 % probability level) with the economic efficiency. The result implies that as the expenditure on research and training in the industry increases, the industry's economic efficiency decreases. This means that one million naira increase in the research and training expenditure in the industry would result in 0.035 units decrease in the economic efficiency of the industry. The result is against *a priori* expectation; but I believe it could be explained partly by the quality of researches and trainings available in the industry. Corruption practices among administrative or management staff in the industry could also be responsible for this result. However, the finding agrees with the results reported by Albert [28] in Spain and Badunenko [33] in Germany.

The coefficient of the real exchange rate (RER_t) exhibited a significant negative effect (at one percent level) on the economic efficiency of the sugar industry in Nigeria. The finding implies that a unit increase in the real exchange rate of naira for US dollar will lead to 0.002 units decrease in economic efficiency of the sugar industry. The result suggests that the exchange rate policy adopted by the federal government of Nigeria impacted negatively on the economic efficiency of sugar industry in Nigeria. Similar result had been reported by Adewuyi [24] in Nigeria.

In addition, the slope coefficient of capital to labour ratio (K_t/L_t) was statistically significant at one percent level and positively related to the sugar industry's economic efficiency. The result implies that 10 % increase in the capital to labour ratio will increase economic

efficiency by 1.16 %. The result suggests that economic efficiency in the sugar industry could be enhance if the change in the capital base of the sub-sector is greater than the same proportional increase in the workforce. The result is in line with the findings reported by Chirwa [27] in Malawi, Alvarez and Gustavo [31] in Chile.

Furthermore, the coefficient of the physical capacity utilization rate ($PCUR_t$) was statistically significant at 5 % level and negatively correlated to the economic efficiency in the sugar industry in Nigeria. This relationship shows that increase in the physical capacity utilization rate decreases the economic efficiency in the sugar industry in Nigeria. The result indicated that one percent increase in the physical capacity utilization rate in the industry will decrease the economic efficiency by 44.80 %. The result is as expected, as increase in production would increase the total variable cost of the industry.

In assessing the elasticity of some explanatory variables in the model; result of elasticity estimation presented in Table 6 revealed that, economic efficiency in the sugar industry in Nigeria had inelastic association with respect to the industry's sales growth (SG_t), expenditure on research and training (ERT_t), real exchange rate (RER_t) and capital to labour ratio (K_t/L_t). This implies that 10 % change in these variables would produce less than equivalent 10 % change in the economic efficiency of the industry.

On the other hand, economic efficiency in the industry had elastic correlation with respect to the physical capacity utilization rate. This means that a unit change in the physical capacity utilization rate in the industry will lead to more than equivalent unit change in the economic efficiency of the industry in the same period. This result perhaps explained the extent of the obsolete capital resources in the industry.

4.6 Assessment of the Performance of the Sugar Industry in the Import Substitution Period (1970-1985) and Liberalization Period (1986-2010) in Nigeria

In assessing the performance of the sugar industry in the two distinct industrial policy periods in Nigeria; economic efficiency was descriptively analyzed and compared in the period of import substitution and period of liberalization. The level of economic efficiency achieved in the sugar industry was higher during years of import-substitution than liberalization (Table 7). This is suggested by the higher maximum and average value of 73.07 % and 42.16 % respectively for the economic efficiency during the period of import substitution compared to lower maximum and average value of 72.84 % and 41.65 % respectively during the liberalization period.

Table 5. Economic efficiency equations in the sugar industry in Nigeria

Variable	Linear	Exponential	Semi-log (L)	Double- log
Constant	1.067 (3.70)***	0.539 (0.79)	-0.163 (-0.16)	-2.82 (-1.12)
$SIMP_t$	-1.49e-006 (-0.948)	-2.07e-006 (-0.56)	-0.023 (-1.14)	-0.041 (-0.18)
$INFL_t$	1.93e-005 (0.013)	0.0003 (0.09)	0.021 (0.76)	0.033 (0.48)
SG_t	0.002 (3.33)***	0.005 (3.04)***	0.019 (3.42)***	0.039 (2.72)**
ERT_t	-0.0002 (-0.89)	-0.0006 (-1.06)	-0.035 (-1.86)*	-0.087 (-1.87)*
RER_t	-0.002 (-1.08)	-0.004 (-1.11)	-0.081 (-3.04)***	-0.167 (-2.52)**
RWS_t	0.0003 (0.97)	0.0008 (1.00)	-0.009 (-0.13)	-0.002 (-0.01)
FS_t	3.32e-005 (0.16)	0.0002(0.33)	-0.0008 (-0.36)	-0.003 (-1.49)
Kt/L_t	4.58e-008 (2.23)**	1.12e-007 (2.29)**	0.116 (4.46)***	0.252 (3.89)***
$GGDP_t$	0.0003 (1.19)	0.0006 (0.94)	-0.0006 (-0.19)	-0.002 (-0.23)
OTR_t	0.004 (2.03)*	0.009 (1.96)*	0.051 (1.34)	0.137 (1.44)
PXR_t	-0.080 (-0.48)	-0.168 (-0.42)	-0.0002 (-0.004)	-0.009 (-0.005)
HC_t	-3.26e-005 (-0.41)	-5.04e-005 (-0.27)	-0.133 (-1.23)	-0.217 (-0.808)
$PCUR_t$	-0.756 (-2.41)**	-0.766 (-2.37)**	-0.448 (-2.26)**	-1.00 (2.03)**
D_1	-0.0260 (-0.36)	-0.076 (-0.45)	0.157 (1.35)	0.289 (1.00)
R^2	0.578	0.545	0.687	0.629
F-Statistic	2.442**	2.137**	3.917***	3.039***
DW-test	2.38	2.47	2.08	2.22
Normality test	16.801 (0.0002)***	10.615 (0.0050)***	3.962 (0.0079)***	2.526 (0.2828)
Hetero-test	21.870 (0.7439)	28.553 (0.3829)	31.176 (0.2640)	24.188 (0.6199)
RESET–test	1.468 (0.2374)	3.7673 (0.0641)*	0.729 (0.4018)	0.009 (0.9216)

Note: *Asterisk *, ** and ** represent 10%, 5% and 1% significance levels respectively. Variables are as defined in equation (5). L means the lead equation*

Table 6. Elasticity values of significant variables that affect economic efficiency in the sugar industry in Nigeria.

Variable	a (average value)	b (marginal value)	Elasticity value (b/a)
Sales growth (SG_t)	10.195	0.463	0.045
Expenditure on training and research (ERT)	0.157	-0.013	-0.084
Real exchange rate (RER_t)	0.741	-0.144	-0.194
Capital to Labour ratio (K_t/L_t)	0.034	0.009	0.278
Physical capacity utilization rate (PCUR)	3.603	-3.862	-1.072

*Note: Parameters are estimated at the mean value of variables. **Functional form is semi-log.***

Table 7. Comparing economic efficiency in the sugar industry during periods of import-substitution and liberalization in Nigeria

Indicators	Import substitution period (1971-1985)	Liberalization Period (1986-2010)
Minimum value (%)	25.07	18.02
Maximum value (%)	73.07	72.84
Mean value (%)	42.16	41.65
Coefficient of variability (%)	33.96	32.13
Excess efficiency (%)	57.84	58.35
Average growth rate (%)	14.01	8.67

***Source:** Computed by author.*

The values of coefficient of variability in the sub-periods suggest that fluctuation in the economic efficiency in the sugar industry was more during import-substitution period than the liberalization period. Comparing the values of excess efficiency in the sub-periods, the industry had more excess efficiency in the period of import substitution than liberalization. This implies that, the industry was more economically efficient in resource use during the period of liberalization than the import-substitution period. The growth rate in economic efficiency in the industry was higher during the import-substitution period than the liberalization period. Based on the descriptive analysis, we conclude that the industrial policy of the import substitution period had a more stimulating influence on the sugar industry's economic efficiency than the liberalization period. This result satisfies the *a priori* expectation because sugar industry in the country was totally owned and managed by the federal government prior to privatization in late 1990s. Sugar industry was therefore one of the means by which the federal government used to manifest the concept of import substitution in the country. This result is however contrary to the research finding of Adewuyi [24] in Nigeria. He confirmed a positive relationship between efficiency indices in the manufacturing sector and trade policy reform period.

5. SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

Sugar industry data and macro-economic data from 1970 to 2010 were used to analyze the economic efficiency in the sugar industry in Nigeria. The estimation of the Cobb-Douglas stochastic cost function for the sugar industry generated diagnostic tests that confirm the relevant of the specified model. Following the result of the estimated sugar industry cost function, it was revealed that, land price (PLP_t) and depreciation cost (RPK_t) have negative relationship with the total variable cost while the wage rate of the production workers (WPW_t)

and the price of other inputs had positive relationship. Economic or cost efficiency for the sugar industry was also generated from the stochastic cost function using Frontier 4.1 software. The descriptive analysis of the economic efficiency indices in the industry revealed that the indices displayed minimal fluctuations that were invariant with time. The cost efficiency indices had an average value of 41.80 % and excess economic efficiency of about 58.20 %. The fluctuation in the estimated indices in some years in the study period was consistent with some of the industrial and macro-economic policies implemented by the federal government of Nigeria. The study also analyzed the determinants of economic efficiency in the industry. The empirical results revealed that economic efficiency in the sugar industry had significant positive relationship with the industry's sales growth and capital-labour ratio. On the other hand, the industry's expenditures on research and training, physical capacity utilization rates and the real exchange rate of naira for US dollar impacted negatively on the economic efficiency of the industry.

Based on the findings, it was recommended that a special policy instrument under the deregulation of exchange rate context should be set up to specifically address the issue of foreign exchange constrains to genuine industrialists in the sugar industry. Also, capital intensive method of production should be adopted as a means of promoting economic efficiency of resource use in the industry. Furthermore, effective marketing policy on the industry manufactures is strongly recommended as this will stimulates sale growth and economic efficiency in the industry. Government should increase budgetary allocation to the Sugarcane Research Development and Training Center to intensify its activities in areas of manpower development, information dissemination on improved varieties of industrial sugarcane to farmers and sugar firms in the country. Finally, the industrial policy package for the industry during import substitution period should used as a basis for promoting or regulating the economic efficiency in the industry in Nigeria.

The study has recognized the important of the sugar industry in the economic development strive of Nigeria. I strongly believed that if all potentials in the sugar industry are well harness, it will influence the country's labour market and contributes to the country's Gross Domestic Product growth. This situation can be achieved if factors that affect the performance of the sub sector are identified and address appropriately. The economic efficiency of the industry is one of such performance indicator that require a careful study because it is affected by diverse factors ranging from firm related factors to environmental and macro-economic fundamentals. This research has identified some of these factors and also provided empirically, evidence based policy recommendations needed to tackle the low economic efficiency in the industry. Hence, these empirically based policy recommendations are crucial for the needed sustainable growth in the sugar industry in Nigeria. It is hoped that the policy recommendations in this study will guide our policy makers on issues related to economic efficiency in the sugar industry and other industries in the manufacturing sector in Nigeria.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. National Sugar Development Council of Nigeria (NSDC). A Publication of the federal ministry of Industry Abuja (FMI), Nigeria (2003); (2010) and (2011). Nigerian Financial Business News, Dec., 2010. Retrieved 13–12–2010. Available: www.thenigeriabusiness.com/.
2. Ayayi DD. Spatial Patterns of Production Sub-contracting in Nigeria. Nigerian Journal of Economics and Social Studies (NSESS). 1988;42(1):95–111.
3. Emmanuel OE. Macroeconomic environment and Agricultural sector growth in Nigeria. World journal of Agricultural Sciences. 2008;4(6):781–786.
4. Siyanbola T, Olasupo A, Adebayo A, Wakeel I, Olukemi L and Omolara Q. Protecting the poor from Macroeconomic shocks in Nigeria An empirical investigation and policy options. A publication of the global development Network; 2005.
5. Central Bank of Nigeria (CBN), Statistical Bulletins; 2008. http/www.cbn.org/out/publications Central Bank of Nigeria statistical Bulletin, 2011. Retrieved 03 –10 – 2012.
6. Akpan SB, Ini-mfon VP, Glory E. and Daniel E. Agricultural Productivity and Macro-Economic Variable Fluctuation in Nigeria. International Journal of Economics and Finance. 2012;4(8):114 –125.
7. Isola, WA. Market reform and de-industrialization in Nigeria: 1986 – 2003. Essays on Economic Development. MPRA paper no. 1025,2006. http:// mpra.ub.uni-muenchen.de/ 1025/; 2006.
8. Central Bank of Nigeria Statistical Bulletin of Central Bank of Nigeria. http/www.cbn.org/out/publications Central Bank of Nigeria statistical Bulletin, 2006. Retrieved 11– 03 – 2013.
9. Akpan SB, Obasi OU, CE O, Daniel EJ. Empirical Relationship among Technical Efficiency, Macroeconomic Variables and Industrial policy Regimes: A case study of Sugar Industry in Nigeria. International Journal of Economics and Management Sciences. 2012;1(10):01–11.
10. Anyanwu JC, Oyefusi AO, Dimowo FA. The Structure of the Nigerian Economy (1960–1997). Onitsha Joanee Educational Publisher; 1997.
11. Busari LD, Misari SM. Sugar and sugarcane in Nigeria. A Publication of NCRI in Nigeria; 1996.
12. Federal Ministry of Industry Abuja (FMI), Nigeria. "National Sugar Policy". A Publication of National Sugar Development Council of Nigeria; 2003.
13. African Development Bank Document (ADB); 2000.
14. African Development Fund (ADF). Operations Evaluation documents; 2000.
15. Olomola AS. Competitive commercial Agriculture in Africa study (CCAA), Nigeria case study. A final report submitted to the Canadian International Development agency (CIDA) and the World Bank; 2007.
16. Nigerian Financial Business News, Dec. 2010. Retrieved 18– 03 – 2013. Available: www.thenigeriabusiness.com/.
17. Central Bank of Nigeria Statistical Bulletin of Central Bank of Nigeria. http/www.cbn.org/out/publications Central Bank of Nigeria statistical Bulletin, 2011. Retrieved 11– 03 – 2013.
18. Nwaobi GC. The Nigerian Sugar Industry (1960- 1987). 0501001, Econs WPA; 2005.
19. Michael David. USDA foreign Agricultural service on sugar imports in Nigeria; 2010.
20. Bitros GC. Firm ownership and economic efficiency. A publication of Athens University of Economic and Business; 2002.
21. Onn FC. Small and medium industries in Malaysia: Economic efficiency and entrepreneurship. The developing economies. 1990;XXVIII:152–179.

22.   Ogun O. Nigeria's Trade Policy During and After the Oil Boom: An Appraisal, University of Ibadan; 1987.
23.   Soludo CC, Adenikinju AF. Economic Policy and Total Factor Productivity in Nigeria's Manufacturing Sector, Final Report Submitted to the Development Centre, OECD, Paris; 1996.
24.   Adewuyi AO. Trade Policy Reform and Technical Efficiency in Nigerian's Manufacturing Sector. A paper Prepared for the African Econometrics Society (AES) Conference at Nairobi, Kenya; 2006.
25.   Alam MS, Morrison AR. A Trade Reform Dynamics and Technical efficiency: The Peruvian Experience. The World Bank Economics Review. 2000;14(2):309–330.
26.   Njikam O. A Trade Reform Efficiency in Cameroonian Manufacturing Industries A Final report presented at November – December 2000 AERC Workshop.
27.   Chirwa EW. A Structural Adjustment Programme and Technical efficiency in Malawian Manufacturing Sector. A project sponsored by the African Development Bank; 2000.
28.   Albert MG. The determinant of efficiency: The case of the Spanish industry. Applied economics. 2000;34(15):1941–1948.
29.   Djankov S, Murrell P. Enterprise restructuring in transition; a quantitative survey. Journal of Economics Literature. 2002;40:739–792.
30.   Admassie A. Technical Efficiency of Small- and Medium- Scale Enterprises: Evidence from a Survey of Enterprises in Tanzania, Eastern Africa Social Science Research Review. 2002;18(2):1–29.
31.   Alvarez R, Gustavo C. Determinants of technical efficiency in small firms. Small Business Economics. 2003;20:233–244.
32.   Badunenko O, Stephan A. The Potential determinants of German Firms Technical Efficiency Using Industry Level Data. A Publication of European University, Viadrina, Faculty of Economics, Germany; 2004.
33.   Badunenko O, Michael F, Adreas S. What determines the technical efficiency of a firm? The importance of industry, location and size. A research project sponsored by German Institute for economic research and German statistic office in Wiesbaden; 2006.
34.   Faruq HA, David TY. The Determinants of Technical Efficiency of Manufacturing Firms in Ghana. Global Economy Journal. 2010; Volume 10, Issue 3. Article 7. Available: http://www.bepress.com/gej/vol10/iss3/7.
35.   Niringiye A, Luvanda E, Shitundu J. (2010). Firm Size and Technical Efficiency in East African Manufacturing Firms. Current Research Journal of Economic Theory. 2010;2(2):69–75.
36.   Chu S, Kaliappa K. Impact of trade liberalization on technical efficiency of Vietnamese manufacturing firms. Paper for presentation at the Conference on "Frontier Issues in Technology, Development and Environment" organized by the Madras School of Economics and the Forum for Global; 2010.
37.   Ray S. Economic reforms and efficiency of firms: the Indian manufacturing sector in the nineties. A paper presented at the Institute of economic growth, University of Delhi, India; 2003.
38.   National Population Commission (NPC), 2006 National Census Data. Retrieved 10 – 12–2010. Available: www.population.gov.ng/.
39.   Lafiagi MS. Towards Self-Sufficiency in Sugar Production in Nigeria. Memo Submitted to Federal Ministry of Commerce and Industry. 1984;1–46.
40.   Battese GE, Coelli TJ. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. Empirical Econ. 1995;20:325–332.

41. Ogundari K, Ojo SO. Economic efficiency of small scale food crop production in Nigeria; A stochastic frontier Approach. Journal of Social Sciences. 2007;14(2);123130.
42. Aigner D, Lovell, Schmidt P. Formulation and estimation of stochastic production function models. Journal of Econometrics. 1977;6:21–37.
43. Koutsoyiannis A. Theory of Econometrics Second edition. Macmillan Press Limited London, UK; 1977.
44. Ogundari K, Ojo SO, Ajibefun IA. Economics of scale and cost efficiency in small scale maize production. Empirical evidence from Nigeria. Journal of Social Sciences. 2006;13(2):131–136.
45. Battese GE, Broca SS. Functional forms of stochastic frontier production functions and models for technical inefficiency effects. A comparative study for wheat farmers in Pakistan" Journal of productivity Analysis. 1997;8(4):395–414.
46. Anyanwu JC, Oyefusi AO, Dimowo FA. The Structure of the Nigerian Economy (1960–1997). Onitsha Joanee Educational Publisher; 1997.
47. Fine J. Implementing Trade Policy in Nigeria: Findings and Recommendations", Chemonics; 2001.
48. Adenikinju A. African Imperatives in the New World Trade Order Country Case Study of the Manufacturing Sector: Nigeria. Final Report Submitted to the AERC, Nairobi, Kenya; 2003.
49. Savannah Sugar Company limited (SSC). Production Data for Savannah Sugar Company Ltd., Numan. 1983–1999;2010.
50. Central Bank of Nigeria (CBN), Statistical Bulletins; 2010. http/www.cbn.org/out/publications Central Bank of Nigeria statistical Bulletin, 2011. Retrieved 03 –10 – 2012.