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Determinants of Growth in Cement Production in Nigeria

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Abstract

Rapid industrialisation through sector-led industrial policies, prohibitive tariffs and aggressive subsidies has become commonplace in many African countries. In Africa's largest economy, Nigeria, one of the flagship industries cited as a success story of successful industrialisation is the cement industry. However, the Nigerian cement industry manifests certain industry peculiarities such as oligopoly and bulky mass, that is not easily replicable across sectors. The aim of this paper is to isolate the key market characteristics and industry incentives granted to the cement sector so as to identify the most important determinants of the recorded phenomenal growth. Based on previous studies, four industry variables: concentration ratio, capital intensity, installed capacity and demand-supply gap were identified. In addition, four other macroeconomic variables that impacted production costs: financing costs, tax rate, real exchange rate and effective rate of protection; were also tested in the model. Data was obtained for the cement industry from 1980 to 2015 for the cointegration model. The results indicate that tariff protection was the most significant determinant of the growth in cement production. Subsidies, in form of tax holidays and cheaper financing, were only minimally important. The findings of this study underscore the huge cost of supporting the growth of industrialisation in African countries through various instruments.

Keywords: Industrial growth; Industrial production; Industrial policy; Cement industry.

1. Introduction

Many African countries have embarked on rapid industrialisation strategies away from the commodity-led policies of the 1960s and 1970s, for several reasons including improved value-added and minimising commodity shocks (United Nations Economic Commission for Africa, 2016;2017). This renascence of industrial policy is justified given the stagnant share of manufacturing output to GDP in the three decades from 1980 to 2010 (United Nations Economic Commission for Africa, 2016). Accordingly, sector-led industrial policy has become a strong theme in the development plans of several countries, while economic planners look for patterns and trends in the fastest-transforming countries so as to 'discover' the elixir for rapid industrial growth (Austin and Frankema, 2017). While isolated cases of rapid transformation in specific sectors such as Kenya's textiles and garment sector and Nigeria's cement sector have been highlighted in recent literature, these manufacturing successes are highly nuanced, with vast differences from country to country (Tyce, 2019). In addition, the underlying determinants of rapid increase in production often include a combination of trade policy incentives, fiscal subsidies, and industry-specific market structure that may be peculiar to an industry and not easily replicable even within the same country.

This paper focuses on the cement industry in Nigeria that quadrupled its contribution to GDP in the two decades from 1995-2015 while aggregate manufacturing barely increased by 50%, thereby implying an eight-fold growth rate above the manufacturing sector. In the same period, production volumes increased quadrupled from approx. 8.5 million capacity to about 35 million tonnes (Dangote Cement Plc, 2016; Lafarge Africa Plc, 2016). Nuancing qualitative drivers for the sector's growth such as crony capitalism, this research paper investigates the measurable impact of various trade and fiscal policy instruments within the context of a dynamic market structure that has seen concentration ratios rise from 0.6 to 0.9 (Akinyoade and Uche, 2018).

Cement is a binder with adhesive properties used in building and civil engineering construction. In many developing countries like Nigeria, the demand for cement can be described as multi-level, with both direct and indirect demand, mainly from three segments – government, construction companies, and individuals. About 75 percent of cement production is used in ready mixed concrete to be utilised in construction. The remaining 25 percent is used for paving roads or drilling/extractions (Portland Cement Association, 2019). With no perfect substitutes, and low adoption of near-substitutes, there is a growing demand for cement in the short-run (Allevi *et al.*, 2018; Maddalena *et al.*, 2018).

Recognising the strategic role of cement for both residential housing and in the provision of road infrastructure, the Federal Government of Nigeria has provided incentives for the domestic production of cement in the country (Ministry of Budget and National Planning, 2017; National Planning Commission, 2010). Prioritised as a strategic industry in the early 2000's by the Federal Government, a national self-sufficiency plan was articulated between 2000 and 2002 with various trade and fiscal policy incentives focused on backward integration to encourage the construction of large in-country cement manufacturing plants.

The years 2001-2002 were the major intervention period when government introduced co-ordinated incentives to the cement industry through affirmation of the import prohibition and the Backward Integration Programme that provided preferential trade and fiscal incentives to domestic cement manufacturers. A summary of the policy regime for the period 1980-2000/1 relative to the policy regime from 2002-2015 is summarised in the Table 1 below.

Table-1. Policy Thrusts for the Cement Industry in Nigeria-Pre and Post-2001

	1980-2001	2001-2015
TRADE POLICY THRUST	Liberal policy regime for cement with minimal government incentives.	Protective trade regime for cement and key cement inputs with vertical, sector-specific policies starting with the Backward Integration Program and import-prohibition in 2001
-Tariff	Little or no change in tariff rates or tariff structure	Incremental tariff on inputs up to 35 percent on certain inputs
-Quotas	No import prohibition or preferential quotas	Gradated import quota regime, and outright prohibition of bagged cement
Subsidies	No significant subsidies provided to the sector	Subsidy escalation with increasing subsidies for inputs as well as financing subsidies at preferential interest rates for domestic cement manufacturers

Source: Author's annotation of trade regimes from Oyejide *et al.* (2013) 'Study of the Impact of Nigeria's Cement Import Restrictions' DFID Nigeria, Abuja, September 2013.

By 2018, the country claimed to have achieved near self-sufficiency, and commenced exporting to African countries; leading to suggestions by some key government officials to replicate the cement industry success story (Akinyoade and Uche, 2018).

Earlier studies on this subject have focused on the allocative inefficiency of the government interventions and incentives in the cement industry, and the contribution to GDP (Oyejide *et al.*, 2013). However, a missing component in existing literature is the identification of the specific contribution of the tariff incentives as distinct from the financing incentives of tax rebates and direct grants. Beyond identifying the relative impact of tariffs and subsidies, this paper attempts to understand what the key determinants of the growth of the cement industry are.

The rest of this paper quantifies the various trade and fiscal policy incentives granted to the Nigerian cement industry and then conducts an econometric analysis to determine the most significant drivers of the increased cement production; and assess if those factors apply to other identified industries.

2. Literature Review

The increased adoption of 'vertical' sector-focused industrial policies or 'industrial targeting' in African countries has received recent renascence in the literature in recent years (United Nations Economic Commission for Africa, 2016;2017). Much of the theoretical arguments for the focus on manufacturing have been anchored on the infant-industry argument, the success of such protectionist policies in most of the industrialised countries in the world, and the strategic role of manufacturing in driving increased productivity required for economic transformation (Chang *et al.*, 2014). The choice of the specific infant-industry to promote is often based on the theory of comparative advantage, and for many African countries this has been identified as resource-based industries that can serve the domestic as well as the export market (Ministry of Budget and National Planning, 2017; National Planning Commission, 2010; Tyce, 2018). For Nigeria, agro-allied, cement and petrochemicals are therefore identified as a few of the key industries of interest in the country"s industrial policy.

Several authors have analysed the reasons for the apparent success or supernormal growth in the cement industry relative to the aggregate economy, or relative to other infant-industries such as agro-allied and petrochemicals. Mojekwu *et al.* (2013) and Oyejide *et al.* (2013) identified the rapid growth of cement contribution to GDP in Nigeria, while recognising the contributory factor, though not causative factor, of the oligopolistic market structure and the government subsidies. This suggests issues of allocative inefficiency of public finances with Mojekwu *et al.* (2013) stating that "the protectionist policy for the cement industry must have a limit. The industry should be encouraged to grow out of its infancy in order to compete in the global arena". Other authors have attributed this growth largely to "crony capitalism" (Akinyoade and Uche, 2018; Fasan, 2018). All of these studies acknowledge the central role of government, state-led intervention or subsidies in the growth of the Nigerian cement industry. However, most of these studies are either qualitative or macro-economic studies that assess economic impact, rather than quantitative micro-economic studies that focus on the identification of industry drivers.

Some of the recent global industry studies for cement identify capital efficiency, timing of acquisitions, a market-relevant business model, and a cost leadership strategy based on operating efficiency as generic drivers for successful regional cement players as distinct for the global multinationals (Birshan *et al.*, 2015). Other authors including Tamotia and Woods (2017) have identified the increasing supply-demand gap and growing protectionism as possible contributory factors of the growth of the cement industry. Many of these authors distinguish between the drivers of performance of the local or regional players owned largely by indigenous shareholders, and the global cement multinationals headquartered in Europe or America (Birshan *et al.*, 2015). In the entire Africa region, over one-third of the continent's production capacity for cement is based in Nigeria, with a capacity of about 43 million tonnes, about twice of the next country South Africa at 21.4 million tonnes (Edwards, 2017). Other countries in the top 5 league include Ethiopia (15.1 mt) , Kenya (8.9 mt) and Senegal (8 mt). Even though Nigeria was not in the top 10 producing countries as at 2017, the country's largest cement producer Dangote Cement Plc was the 10th largest cement producer in the world and the only African-headquartered company in the top 10 league. Accordingly, there are limited benchmarks on the African continent for Dangote due to its relative domination of cement production in Africa. While many of the large African cement producers have benefitted from some type of consumption stimulation incentives, others have enjoyed elements of implicit subsidies or competed with foreign imports from Asian countries such as Pakistan that were highly subsidised (Dyer and Blair, 2017). A major commonality in most of the published research studies is the relevance of the local market structure and the role of government policy either in stimulating demand or providing implicit subsidies, as determinants of industry performance.

2.1. Scope of Study

This study focuses on cement production in Nigeria. Cement production in Nigeria has historically been oligopolistic even before the country's independence in 1960. Most empirical studies and measures of market structure confirm that the cement industry is one of the most concentrated industries in Nigeria, with very little change over the past six decades (Oyejide *et al.*, 2013). For instance, the 2-firm concentration ratio increased from 59 percent in 1954 to 86 percent in 2012. Over the past 6 decades, this increasing tendency of concentration has resulted in a Stackelberg duopoly with the largest firm controlling approximately 68 percent and 18 percent of total market output respectively as at 2012 (Oyejide *et al.*, 2013). Such a structurally asymmetric industry, i.e., an oligopoly with a HH of .51 and a C-1 of .68 in contrast to a large number of purchasers, has implications for both the input and output markets.

3. Materials and Methods

The study extends the models used by Mojekwu *et al.* (2013) and Oyejide *et al.* (2013). The main modifications to these models is the introduction of the effective rate of protection (ERP) computed from first principles, and the discrete analysis of fiscal policy instruments such as tax and financing subsidies, separate from the effective rate of protection. The alternative method of the computable general equilibrium (CGE) approach is not feasible given the absence of reliable aggregate data as at the time of this study. Following a similar study by Olayiwola and Rutaihwa (2010), the error correction model (ECM) used for estimating a dynamic time-series model, is used as this approach is superior to other non-cointegration estimation techniques such as ARIMA for long-run horizons.

The study utilises a time-series analysis from 1980 to 2015 to understand the changing patterns of the cement industry in Nigeria. Based on prior models of the cement industry by Mojekwu *et al.* (2013) and Oyejide *et al.* (2013), four industry variables that influence the production of cement in Nigeria are measured. These include concentration ratio, capital intensity, installed capacity and demand-supply gap were identified. To identify the key incentives granted to the cement industry, the national development plans and the industrial policy documents of the Federal Government were reviewed for the period 1980 to 2015. Based on a review of these documents and other industry literature and a review of empirical literature, the various incentives granted to the cement industry were also identified and categorised as tax incentives, financing subsidies, and trade protection incentives in the form of import prohibition, prohibitive import tariffs and quotas. Based on the review of the incentives and the macroeconomic environment, four other macroeconomic variables that impacted production costs were included in the model: financing costs, tax rate, real exchange rate and effective rate of protection; were also included in the model.

An output model of cement production as a function of the eight variables is specified as follows:

The specification of the equations in the model is

$P_{VA(t)} = f(CI_{t-i}, FC_{t-I}, ETR_{t-i}, REX_{t-i}, ERP_{t-i}, CONC_{t-I}, DSGap_{t-i}, CAP_{t-i})$

Where:

$P_{VA}(t)$: GDP value-added for cement production in Nigeria in year t

CI*(t-i):* Lagged variables of capital intensity, where *i* =1

FC*(t-i):* Lagged variables of financing cost

ETR*(t-i*: Lagged variables of effective tax rate

REX(t-i): Lagged variables of Real Exchange Rate

ERP(t-i): Lagged variables of Effective rate of protection

CONC(t-i): Lagged variables of concentration ratio. The concentration ratio is the 2-firm concentration measure of industrial structure.

DSGap(t-i): Lagged variables of Demand-supply gap of cement in the country. The demand-supply gap is calculated as the difference in any particular year between estimated demand in the country of Nigeria, and the supply of locally produced cement in that year.

CAP(t-i): Lagged variables of active installed capacity.

3.1. Data Collection and Analysis

Nominal data on the variable variables were obtained from the manufacturing sector database of the Nigeria Bureau of Statistics (NBS, 2017), and the published annual reports of the cement companies. Computations of the ratios for the industry indices are then done from available raw data of the manufacturing firms. Due to limited availability of data, firm-level data had to be computed for individual manufacturing companies over 36 years across all variables, and then aggregated to the industry. For the macroeconomic data, data from the Central Bank of Nigeria and the NBS are used.

Analysis of data was executed using the *eViews* software. Ordinary Least Squares (OLS) estimation was done followed by error correction. Significance was defined as a p value ≤ 0.05.

4. Results

4.1. Trends and Summary Statistics of the Cement Industry in Nigeria

The summary of the indices for cement production in Nigeria are presented in Table 3.1 below, while the indices for tariff and fiscal incentives are presented in Table 3.2.

Table-3.1. Indices of Cement Industry Production in Nigeria

	1980	1985	1990	1995	2000	2005	2010	2015
Cement Industry Gross Sales (*Millions of Naira*)	119	241.7	1,162.70	11,464.87	13,323.16	37,005.54	257,588.46	516,811
Cement Industry Production (*Million of Metric Tons)*	3.5	3.5	3.03	2.61	2.29	2.85	10.11	31
Cement Industry Capital Employed (*Millions of Naira)*	251	318.7	1,109.86	6,918.49	17,324.63	28,755.93	387,933.63	1,317,201.46
Cement Industry Capital Intensity	2.1	1.32	0.96	0.6	1.3	0.78	1.51	2.55
Demand-Supply Gap	0.15	0.243	0.91	1.09	3.33	6.63	5.71	0.01
2-firm Concentration Ratio	0.61	0.625	0.64	0.66	0.67	0.76	0.83	0.92
Installed Capacity (*Million Tons)*	3.69	3.5	3.5	3.01	3	4.6	11	35

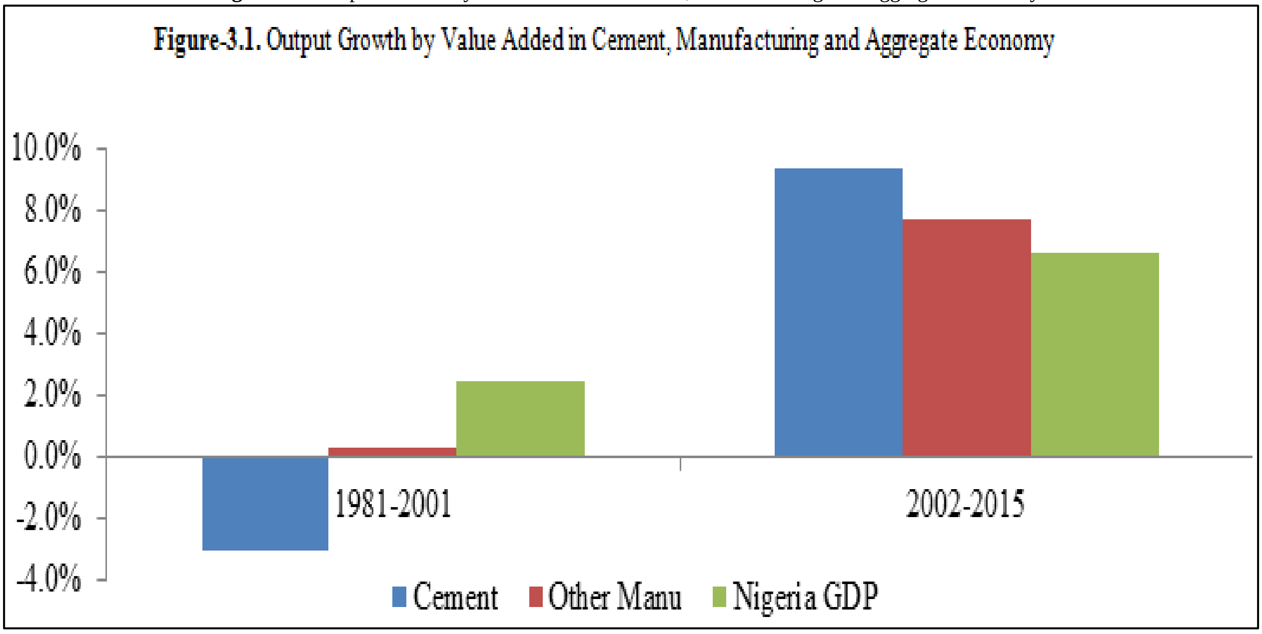
Table-3.2. Indices of Fiscal and Tariff Incentives to the Cement Industry in Nigeria

Year	1980	1985	1990	1995	2000	2005	2010	2015
Cement Industry Financing Cost %	1.05	1.195	0.025	0.257	0.171	0.266	0.107	0.797
Cement Industry Effective Tax Rate %	0.11	3.234	0.365	0.148	0.043	-0.00004	0.084	0.041
Effective Rate of Trade protection	0.29	0.329	0.347	0.544	0.939	1.075	1.634	1.763
Real Exchange rate	100	166.72	24.08	29.21	23.69	29.12	29.75	37.51

From Tables 3.1 and 3.2, the data show the exponential growth of the cement industry from year 2000 coinciding with the increase in tariff protection and tax incentives.

A comparison of the growth in cement production relative to the economy is presented in Figure 3.1.

Figure-3.1. Output Growth by Value Added in Cement, Manufacturing and Aggregate Economy



Source: Author's computations from various annual reports of quoted companies in Nigeria, NSE Fact book (2000-2015).

An interpretation of Tables 3.1 and 3.2 together with Figure 3.1 leads to many observations of patterns in the cement industry. First is that the protected cement sector records higher cumulative average growth rate in output or geometric mean. Second is that the output growth in the protected Nigerian cement industry outstrips output growth in the aggregate economy shortly after the introduction of co-ordinated incentives in 2001-2002.

Summary descriptive statistics for the cement industry is summarised in Table 3.3

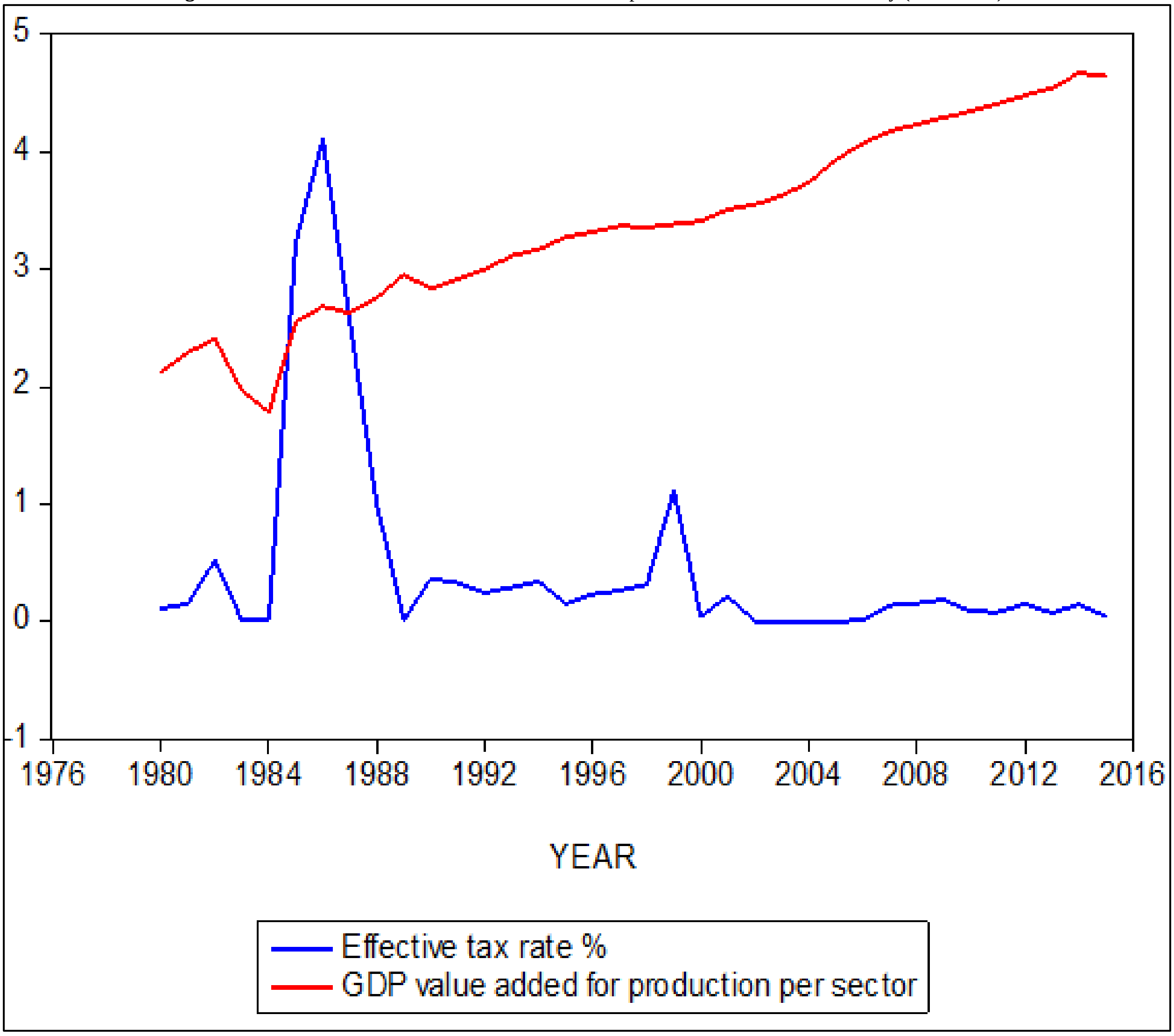
Table-3.3. Summary Statistics of Nigeria's Cement Industry 1980-2015

	CI	ETR1	FC	REX	DSGAP	ERP1	CON1	CAP	PVA
Mean	1.187992	0.462468	0.461200	45.18907	2.742268	0.842936	0.707500	7.0994	7.771895
Median	1.043295	0.150203	0.209040	29.18500	1.839428	0.608609	0.662500	3.5000	7.744805
Maximum	2.548710	4.104400	1.498140	185.9400	6.977000	1.762642	0.921000	35.0000	10.75609
Minimum	0.578130	-4.21E-05	0.025340	16.93000	0.000000	0.270000	0.610000	3.0000	4.108464
Std. Dev.	0.447058	0.920110	0.472486	40.77956	2.558024	0.516241	0.093805	8.9343	1.841717
Skewness	0.970084	2.897188	0.868696	2.245092	0.509360	0.458671	0.884282	2.3916	-0.069631
Kurtosis	3.705573	10.46395	2.139785	7.108005	1.614920	1.657925	2.418830	7.1941	2.097172
Jarque-Bera	6.393133	133.9281	5.637755	55.55619	4.434355	3.964023	5.198368	60.7053	1.251738
Probability	0.040902	0.000000	0.059673	0.000000	0.108916	0.137792	0.074334	0.0000	0.534797
Sum	42.76770	16.64883	16.60321	1626.807	98.72165	30.34570	25.47000	255.5800	279.7882
Sum Sq. Dev.	6.995137	29.63107	7.813507	58204.04	229.0220	9.327676	0.307977	2793.7490	118.7172
Observations	36	36	36	36	36	36	36	36	36

From Table 3.3 on the summary descriptive statistics of the variables analysed, all the indices for the incentives (financing, tax rate and effective rate of tariff protection) are positively skewed reflecting faster growth in incentives recent year. The real exchange rate REX was very volatile during the estimation period largely due to the drastic foreign exchange devaluation. This is noteworthy given that the capital machinery and equipment are almost entirely imported while some inputs such as gypsum were also imported. The Jacque-Berra test statistic for normal distribution equally show that FC, LPVA, DSGAP, and ERP are normally distributed at 5 percent level of significance, while LP, CI, ETR, and REX are not normally distributed at 1 percent, 5 percent, 1 percent and 1 percent respectively. These observations are expected given the several interventions in the Nigerian foreign exchange market during the period under review that affected the real exchange rate, RER. Likewise, the several fiscal incentives offered to the cement industry at different intervals affected the tax rate, hence the high kurtosis of the effective tax rate, ETR.

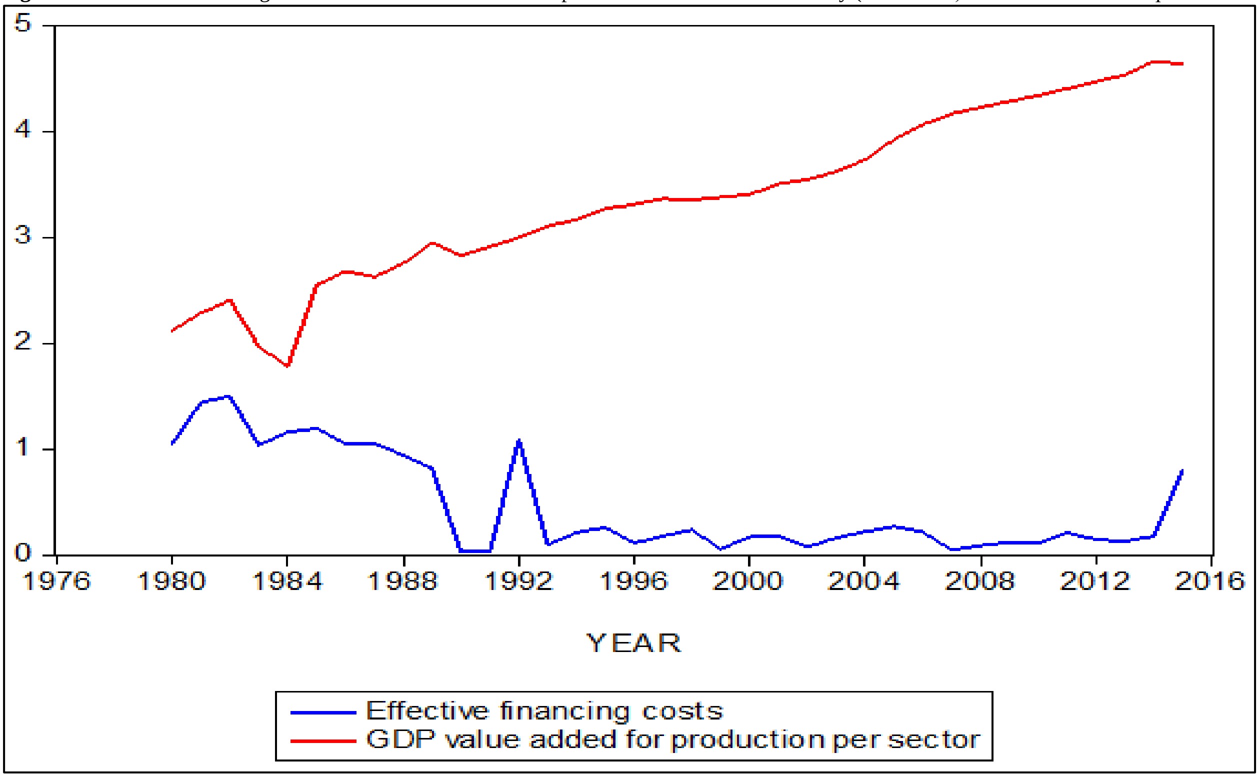
A trend analysis in Figures 3.2 and 3. Confirm an inverse relationship between both subsidy elements, that is effective tax rate and financing cost, with production value added.

Figure-3.2. Effective tax rate % and GDP value added of production in the cement industry (1980-2015)



Source: Author's computations

Figure-3.3. Effective financing costs % and GDP value added of production in the cement industry (1980-2015) Source: Author's computations



4.2. Estimating the Error Correction Model (ECM) for Cement Production in Nigeria

Following Mojekwu *et al.* (2013), the output growth model for cement is estimated first using OLS parameter estimation. The result of the OLS parameter estimation is indicated below in Table 3.4. The purpose of the OLS estimation is to detect if there is spurious regression. The results show that the R squared is less than the DW statistic hence we reject the hypothesis of spurious regression.

Table-3.4. OLS Parameter Estimation of Cement Production Model in First Difference

Value Added Output Model				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
CI	-0.477884	0.265139	-1.802392	0.0827
FC	-0.474933	0.255738	-1.857103	0.0742
ERP	1.798891	0.823324	2.184913	0.0378
CONC	14.18912	5.436946	2.609759	0.0146
DSGAP	-0.107621	0.069512	-1.548247	0.1332
CAP	-0.686640	0.447126	-1.535673	0.1363
REX	-0.283574	0.156611	-1.810691	0.0813
ETR	0.162209	0.082754	1.960148	0.0604
Constant	8.793554	4.638100	1.895939	0.0687
R-Square= 0.965274		**Adj.R-Square**= 0.954985		
F-Statistics= 93.81468	P-**Value**= 0.000000	DW = 1.530627		

Note: ***, ** and * denote the rejection of the null hypothesis at 1 % , 5% and 10% significance level.
Source: Author's computations using E-views 10.

Further, the ADF test was used to examine the null hypothesis that a unit root is present in the time series dataset. The result is shown in Table 3.5

Table-3.5. Preliminary ADF Test Result in Cement Production Model.

Value Added Output Model			
Variable	ADF Statistics	Critical Value	
	@ Constant and Trend	1%	5%
Residual	-7.305545**	-4.28458	-3.562882

** and * denote the rejection of the null hypothesis at 1 % significance level.
Source: Author's computations using E-views 10.

Based on the ADF test of the model and the rejection of the null hypothesis, this indicates that though the variables are stochastic individually, combining them causes them to be stationary in the long-run. Presents the results of the ADF unit root tests for the entire model.

Table-3.6. Unit Root Test Results for the Cement Production Model

Variables	Augmented Dickey Fuller (ADF), Phillps- Perron		
	Constant	**Constant and Trend**	**Remark**
CI	-3.595777**	-4.393534***	I(1)
FC	-7.331118***	-8.188246***	I(1)
REX	-6.993426***	-7.000299***	I(1)
ETR	-4.627453***	-4.565270***	I(1)
PVA	-5.866954***	-5.774672***	I(1)
ERP	-7.446553***	-7.579290***	I(1)
CONC	-5.506620***	-5.491917***	I(1)
DS	-4.369638***	-4.717860***	I(1)
CAP	-4.023347***	-5.010220***	I(1)

**** and ** denote the rejection of the null hypothesis at 1 % and 5% significance level.*

Source: Author's computations using E-views 10.

Table 3.6 above tests for the mean-reversion of all the variables and clearly indicates that all the variables are mean reverting at first difference. Having established the integration of the series of the same order *I* (1), the Johansen test for integration is conducted using the trace statistic and the maximum eigenvalues as depicted in Table 3.7.

Table-3.7. Result of Johansen Cointegration

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
r = 0	r = 1	0.917262	237.0882	125.6154	0.0000
r ≤ 1	r = 2	0.855561	152.3576	95.75366	0.0000
r ≤ 2	r = 3	0.695382	86.57101	69.81889	0.0013
r ≤ 3	r = 4	0.534844	46.15528	47.85613	0.0716
r ≤ 4	r = 5	0.298650	20.13231	29.79707	0.4139
r ≤ 5	r = 6	0.209196	8.070876	15.49471	0.4579
r ≤ 6	r = 7	0.002670	0.090918	3.841466	0.7630
Null Hypothesis	**Alternative Hypothesis**	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
r = 0	r = 1	0.917262	84.73053	46.23142	0.0000
r ≤ 1	r = 2	0.855561	65.78662	40.07757	0.0000
r ≤ 2	r = 3	0.695382	40.41573	33.87687	0.0072
r ≤ 3	r = 4	0.534844	26.02297	27.58434	0.0781
r ≤ 4	r = 5	0.298650	12.06144	21.13162	0.5416
r ≤ 5	r = 6	0.209196	7.979958	14.26460	0.3808
r ≤ 6	r = 7	0.002670	0.090918	3.841466	0.7630

The normalized co-integrating coefficients for the identified vectors for error correction are presented in Table 3.8

Table-3.8. Cointegrating Coefficients Normalised on Cement Production Model

Variable	Coefficients	Standard errors
CI	0.288644	0.09448
FC	-2.362797	0.14243
CON	10.69615	1.13592
ERP	0.738990	0.26735
ETR	0.033773	0.04143
REX	0.007607	0.00190

Source: Extracts from E-Views 10.

Estimating the vector error correction model (VECM) requires combining differenced data and lagged differenced data of the chosen variables in the VAR model. The results of the long-run vector error correction model are indicated in Table 3.9, and these explain the long-run relationships between the explanatory variables and cement production in Nigeria.

Table-3.9. Vector Error Correction Model for Cement Production

Variable	D(PVA)	D(CI)	D(FC)	D(CON1)	D(ERP)	D(ETR)	D(REX)
Error Correction Term	-0.631404	0.051595	0.309226	0.004634	-0.061666	-0.782809	-28.69636
Standard error	(0.12851)	(0.19750)	(0.13206)	(0.00176)	(0.08768)	(0.22378)	(16.3102)
t-statistic	[-4.91335]	[0.26125]	[2.34155]	[2.63273]	[-0.70333]	[-3.49808]	[-1.75941]

Note: Standard errors in ( ) & t- statistics in [ ].
Source: Extracts from E-Views 10.

Having reached conclusions on the inherent long-run relationships, the results of the VECM of short run dynamics of trade are presented in Table 3.10.

Table-3.10. Short-run Dynamic Estimates of VECM Normalised on Production Value-Added

Parameters	Coefficient	Standards Error	t-Statistic
Δ (lnPVA)(-1)	-0.632825	0.22041	-2.87113
Δ CI(-1)	-0.793538	0.30266	-2.62189
Δ FC(-1)	0.604823	0.19677	3.07373
Δ CON(-1)	-17.39175	14.0087	-1.24149
Δ ERP(-1)	1.052907	0.39592	2.65938
Δ lnETR(-1)	0.071690	0.14562	0.49230
Δ lnREX(-1)	0.006819	0.00267	2.55163
ECM (-1)	-0.270794	0.05696	-4.75426
Adjusted R^2=0.77 F = 8.309839			

Source: Extracts from E-Views 10.

The negative and statistically significant coefficient of the error term confirms that the variables are indeed cointegrated. The magnitude of the error-correction term reveals the change in real PVA per period that is attributable to the disequilibrium between the actual and equilibrium levels. The reported speed of adjustment is low as it indicates that about 27.08 percent of the short-run disequilibrium in the cement industry adjusts to the long-run equilibrium level of PVA every year in Nigeria. Furthermore, the adjustment coefficient being statistically significant implies that the disequilibrium in PVA would be normalised in about four years.

The model has a good fit given an adjusted R-squared of 0.77, which implies that about 77 percent of the total variations in the production value added, is explained by the Effective Rate of Protection and other explanatory variables.

4.3. Variance Decomposition

Total variance in the dataset could be decomposed into two components namely variance attributable to known and unknown sources. The forecast error variance decomposition (FEVD) or variance decomposition is used in the interpretation of the fitted VAR model. The variance decomposition indicates the amount of the forecast error variance of each of the variables that can be explained by exogenous shocks to the other variables. Variance decomposition therefore provides information on the relative importance of changes in the value of each variable in the VAR. It also provides the proportion of "the movements in the dependent variables that are due to their 'own' shock, versus shock to the other variables" (Olayiwola and Rutaihwa, 2010). In this analysis of variance decomposition, a ten-year forecasting horizon is employed given the relatively long three to five-year cycle for completion of a new cement plant.

Table-3.11. Variance Decomposition for Cement Production Value Added

Period	S.E.	PVA	CI	FC	CON1	ERP	ETR	REX
1	0.1873	100.0000	0.0000	0.0000	0.0000	0.0000	0.000000	0.000000
2	0.436	83.759	1.691	1.009	6.319	0.960	3.341	2.920397
3	0.579	72.0857	9.553	4.400	7.542	0.733	4.028	1.658965
4	0.622	73.722	9.258	3.991	6.888	0.676	3.963	1.499823
5	0.670	75.218	8.164	3.445	7.228	0.600	3.803	1.542263
6	0.704	74.426	7.495	3.142	8.365	0.547	3.989	2.037266
7	0.720	74.022	7.517	3.062	8.717	0.539	4.028	2.114599
8	0.744	74.553	7.105	2.862	8.603	0.566	3.953	2.358710
9	0.795	74.942	6.992	2.650	8.676	0.518	3.883	2.339403
10	0.841	74.842	7.213	2.674	8.672	0.493	3.908	2.198285

Source: Extracts from E-Views 10

Based on the data in Table 3.11, a one standard deviation shock to production value added in forecast year 2 accounts for 83.76 percent of the variation compared to a lower 74.84 percent variation in forecast year 10. Similar explanations can be provided for all the other variables. Strikingly, the data in Table 3.10 indicate that while most of the variables record decreasing impact on the variation of production value added as we approach year 10, the concentration ratio, is the only variable that shows a fairly steady impact on the variation in production. Capital intensity on the other hand shows a dramatic increase from 1.7 percent in year 1 to 7.2 percent in year 2. From the analysis, the indicators of fiscal incentives (financing and tax incentives) account for more variation in value added compared to effective rate of protection. This observation is indeed justified given the relative ease of adjusting fiscal policy incentives on an annual basis in Nigeria.

Strikingly, a notable observation from the analysis of variance decomposition is that the concentration ratio still accounts significantly for the variation in production for the entire ten-year horizon. Interpreting the variance decomposition together with the earlier analysis on the co-integration and error correction therefore indicates that the high level of duopolistic concentration in the Nigerian cement industry at over 90 per cent is one of the most significant determinants of both the nominal quantum of production and the variations therein. Invariably, this finding has major implications on the applicability of effectiveness of the trade protection measures to industries with less concentrated market structures.

5. Discussion

The trend analysis and the error correction model validate the abnormal growth of the cement industry in Nigeria relative to the manufacturing sector and relative to aggregate GDP. The eight-fold growth in cement's contribution to GDP in addition to the nominal growth in production in the period surveyed from 1980 to 2015, en route to self-sufficiency and export of cement in Nigeria appear to be an *apparent* success story in import substitution.

The analysis of the drivers of this remarkable growth provide us with the relative impacts or contributions of the various incentives and the industry characteristics to this growth. From the results of the error correction model in section 3.2, and the variance decomposition model in section 3.3, the concentration ratio and effective rate of protection are the two key variables in terms of magnitude that have a significant positive impact on production. These findings reinforce the outcomes of the trend correlation analysis conducted in section 3.1 that suggest that the noticeable upswing in the production volumes of cement in Nigeria were driven by the increased trade protection reinforced by fiscal incentives with a net impact on reducing the financing cost of cement manufacturers.

The significant positive impact of the concentration ratio on the production volumes is particularly of notable significance for industrial policy in Nigeria for several reasons. First, the efficacy of the trade and fiscal incentives may be of limited impact in an industry with a diffuse market structure due to co-ordination problems and challenges with implementing such incentives in an industry with too many players. A second factor is the welfare risk that is attendant with an oligopoly controlling both production and pricing of a homogenous good. The third factor is the cost to the taxpayer of driving increased production volumes toward self-sufficiency in a Stackelberg-type oligopolistic industry where the increased production does not translate to reduced pricing for the consumer. Oyejide *et al.* (2013), has for instance noted that the increasing price trend in the cement industry despite geometric increase in domestic supply, attributing this phenomenon to the oligopolistic concentration in the industry. The correlation between ERP and concentration ratio suggests that the trade protection by the Federal Government did not only positively affect production volumes but also exacerbated the oligopolistic structure of the industry.

However, some of the other incentives while contributory may not have had a significant role to play in boosting cement production in Nigeria. For instance, real exchange rate is not significant in the short run, though it impacts GDP value added of production in the cement industry inversely. The supply gap in the industry, a gap that is typical of many commodities in a large growing economy with the seventh largest population in the world, is also a contributory factor though it does not suffice to explain the phenomenal growth in cement production. Other similar products, for instance in agriculture and energy, with similar supply shortages have not recorded such phenomenal growth.

Overall, the most significant variable on production growth is the effective rate of tariff protection (ERP) which included import prohibition of bagged cement into the country since the early 2000s. Notable in the package of incentives is the preferential duty-waivers given to the cement industry to import machinery, equipment and spare parts on a duty-free basis and up to five years tax holidays. These incentives allow the cement manufacturers to employ modern technology. The firms utilise the pre-calciner rotary kiln with electrostatic precipitators, leading to a more energy-efficient process than the conventional dry kiln process (Dangote Cement, 2015). The second is the set of fiscal subsidies for energy feedstock into the cement plants, including concessional pricing and special allocation of low-pour fuel oil (LPFO), de-linking the price of gas for cement production from the price of LPFO, and granting of duty-free importation of LPFO during acute domestic shortage of cement. The third is the restricted import-licensing regime to only six companies with local production that increased the imperfect competition in the market and enabled the larger producers to control price. As a result, the cement industry benefited from both the efficiency gains of new technology as well as higher sales value per output in a fiscal regime of subsidised costs and low effective tax rates.

The statistical significance of the effective rate of tariff protection and the concentration ratio are however highly nuanced, and have implications for industrial policy. These implications would be examined in the final and concluding section.

6. Conclusions

This study examined the determinants of increased production of a key industry in the Nigerian economy that contributes 1% of the nation's GDP and 10% of the entire manufacturing sector's output. The objective of this research is to identify the most significant incentives for industrial growth in a large economy and assess if those incentives could be applied to other industries or sectors of the economy to accelerate Nigeria's industrialisation. The results of the analysis show that the high tariff protection reflected in a high effective rate of protection (ERP) together with the fiscal subsidies that reflected in lower financing costs (FC) and tax rates (ETR) contributed to this geometric growth in cement production. However, despite this industrial success in success, the analysis also indicate that the effectiveness of the incentives was within the context of a highly concentrated duopolistic industry with a 2-firm ratio of above 0.90. Secondly, the industry has a homogenous product with derived demand and also a bulky mass with relatively low unit value hence making smuggling across the borders cumbersome due to the heavy weight, and not lucrative due to the low unit value. Due to these two reasons, an application of the same incentives may not yield the same positive results in industries without the market structure and product structure of the cement industry. This has major implications for the agricultural sector where Nigeria has similar economic objectives of achieving food self-sufficiency in the short to medium-term using such incentive structures (Ministry of Budget and National Planning, 2017).

Noteworthy to the achievement of the geometric increase in cement production in Nigeria is the duopolistic market structure that minimises co-ordination failure in the granting of incentives. In contrast to the successful use of the tariff and industrial incentives in the cement industry to achieve self-sufficiency, authors such as Dorosh and Malek (2016) have observed that similar incentives and increased trade protection has not substantially decreased rice imports to Nigeria. This divergence in policy outcomes may be linked to differences in market structure and type of product. This policy gap, as defined by Bartolini (2012) would be more prominent the higher the degree of sectoral fragmentation. The application of direct subsidies in fragmented industries is prone to more abuse by the beneficiary company likewise the accounting treatment. This viewpoint aligns with empirical studies such as Modebe *et al.* (2014) that find significant levels of abuse in industrial incentives purportedly granted. Overall, the overarching implication of the twin factors for the divergence between the policy outcomes in cement and in agriculture is that the Federal Government of Nigeria would need to conduct more detailed studies on optimal tariff for a protected industry taking into cognisance the industry structure before imposing tariffs merely to achieve short-term objectives.

In summary, this study has identified the key determinants for the geometric increase in cement production, apart of course from the factor of crony capitalism cited by some authors. Notwithstanding the outcomes in the cement industry, the findings also indicate that the trade policy restrictions and incentives on the cement industry may not necessarily yield similar results in other industries.

An alternative explanation could be that the financing subsidies granted have been relatively little in magnitude hence of minimal impact to induce plant expansion in a capital intensive industry by equity investors. Either explanation for the relative insignificance of the subsidies to induce industrial growth would warrant a close review by the government's industrial policy planners on the allocative efficiency of the production subsidy regime, to determine if this is an optimal use of government revenue. The second major implication is that while tariff protection appears to be effective in both the short and long-run horizons to stimulate industrial growth, Nigeria's accession to the World Trade Organisation rule would limit the wide-scale application of such tariff protection to other industries. Indeed, given the imminence of the African Continental Free Trade Area, this flexibility on protective tariffs may only be feasible for about 10 per cent of the country's products. Given the limitation on the wide-scale roll-out of tariff protection to other industries, no matter how successful it has been in the cement industry, it is imperative that the government address the root causes of the inefficiencies or ineffectiveness of the subsidy regime. This study has confirmed the findings of several other studies on the need for radical reform of the subsidy regime. This reform would be critical before rolling-out the incentives granted to the cement industry to other manufacturing industries.

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