Factors Affecting Capacity Utilization Decisions in Nigeria: A Time Series Analysis

Mojekwu, J. N.
Department of Actuarial Science and Insurance
University of Lagos, Akoka, Lagos. Nigeria
Tel: 234-803-306-3363 E-mail: jnmoj@yahoo.com

Iwuji, I. I.
Department of Business Administration,
University of Lagos, Akoka, Lagos, Nigeria
Tel: 234-805-119-7460 E-mail: iwujiifeanyi@yahoo.co.uk

Received: July 11, 2011 Accepted: September 8, 2011 Published: January 1, 2012
doi:10.5539/ibr.v5n1p157 URL: http://dx.doi.org/10.5539/ibr.v5n1p157

Abstract

This study examined the impact of some macroeconomic variables and power supply on the performance of the Nigerian manufacturing sector, using ex-post facto research design. Secondary data were sourced from Central Bank of Nigeria (CBN) statistical bulletin (2009) and other publications. The main findings of the study were that power supply had positive and significant impact on capacity utilization while inflation rate and interest rate had negative impact on capacity utilization. However, the impact of interest rate was significant at 5% level while lending rate was insignificant. Time series data were analysed with the aid of e-views 5.0 econometric computer package using least square multiple regression technique. The regression model explained 88.54% of the variation in capacity utilization, after correcting for linearity, normality, auto-correlation and heteroscedascity. The study recommended that the ongoing privatisation of Power Holding Company of Nigeria should be pursued with vigour and that the policy thrust of single digit inflation and lending rates by CBN should be sustained. The government should also put in place monetary and fiscal policies to create an enabling environment for the manufacturing sector, thereby giving a boost to the economy as a whole.

Keywords: Nigerian manufacturing sector, Capacity utilization, Multiple regression, Autoregressive Model, Co-integration

I. Introduction

The problem of the Nigerian Manufacturing sector started in 1970s which corresponded with sharp increase in the international oil price. The government responded with the import substitution strategy aimed at increasing domestic production. There was huge investment in state owned enterprises. The contribution of manufacturing to GDP rose from 2% in 1957 to 7% in 1967. Like in most countries in Africa, the import substitution strategy failed to generate income and employment growth. (Soderbom & Teal, 2002). Following the fall in oil prices in late 1970s and early 1980s the economy went into rapid decline. To avert catastrophic collapse of the economy, the government introduced tough budgetary and fiscal measures, involving deregulation of foreign exchange market, abolition of import licenses, and devaluation of the naira. The effect of these policy measures were nothing to cheer about as the economy took further steps backward, with its attendant miseries on the populace. To stimulate domestic production the structural adjustment programme (SAP) was initiated in 1986. SAP brought with it escalation in exchange rate resulting in high cost of raw materials and spare parts. The SAP programme ended up being a failure. The harsh economic situation triggered a chain reaction, such as high cost of production, scarcity of raw materials and spare parts and huge inventory of unsold goods due to low purchasing power. All these factors impacted negatively on capacity utilisation. (Banjoko, 2002).

Current governmental programmes aimed at reversing the economic trend are National economic empowerment and development (NEEDS) and vision 2020, which according to the proponents will put Nigeria among the first twenty (20) developed economies by the year 2020. It is against this background that it becomes imperative to access the effects of power supply and some macroeconomic variables on capacity utilization of the Nigerian manufacturing industry, thereby providing policy recommendations to the policy makers. The objectives of the study are:

- To assess the impact of power supply on capacity utilization of the Nigerian Manufacturing industry.
- To evaluate the effects of inflation rate on capacity utilization of the Nigerian Manufacturing industry.
- To examine the relationship between capacity utilization rate and interest rate in Nigerian Manufacturing industry.

In order to achieve the above objectives, the following hypotheses were proposed for testing.

- Power supply will not have significant effect on capacity utilization decisions in Nigeria.
- Inflation rate will not have significant effect on capacity utilization decisions in Nigeria.
- Interest rate will not have significant effect on capacity utilization decision in Nigeria.

2. Literature Review

According to Slack et al (2007) capacity utilization is defined as the ratio of actual output to design capacity, symbolically it is expressed as:

$$CU = A_c \quad *100/\ D_c \qquad (1)$$

Where CU = Capacity Utilization, A_c = Actual output, D_c = Design capacity

Design capacity is the capacity the technical designers have in mind when the operation was commissioned. It is hardly achievable in real life due to both planned and unplanned stoppages. The planned stoppages include set up, preventive maintenance, no work scheduled, quality sampling checks, shift change times etc. The unplanned stoppages include equipment breakdown, quality failure investigation, material stock outs, labour shortages and waiting for materials. The planned stoppages are unavoidable, while the unplanned are avoidable. In computing the actual output, both planned and unplanned stoppages must be deducted from the design capacity.

The influence of some macroeconomic factors as predictors of capacity utilization has been well documented by scholars (Eniola, 2009; Adenekan 2010). The macroeconomic variables identified include; inflation rate, real exchange rate real loans and advances, ratio of import of manufactures to GDP , ratio of federal government expenditures to GDP and ratio of foreign direct investment on GDP.

2.1 Power Supply

The work of Siyan and Ekhator (2001) gave an insight into the gross inefficiency that characterized most public enterprises like the National Electric Power Authority (NEPA) now Power Holding Company of Nigeria (PHCN). The study revealed that the installed capacity of NEPA in the 1980s was 6000MW but by 1990, the available installed capacity dropped to less than 2000MW and has continued to drop since then. Some of the plants which were available in 1980s were no longer available by 1990. The main reasons for the continued drop being inefficiency and corruption (see appendix 1). Table 1 shows that, in 1980 there were a total of 76 installed units with total capacity of 6000MW, but by 2001 only 22 units were available with total capacity of 2716.6MW and actual capacity generated being 2278MW. There was 338.6MW of generation loss from available capacity. At Sapele station for example only two (2) generating units were available in 2001 out of the ten (10) installed in 1980. Available capacity was 360MW in 2001 while actual available capacity was 253MW representing a generating loss of 107MW.

Insert Table 1 Here

2.2 Interest Rate

When banks lend money to a manufacturer, they use depositor’s money. The interest charged, which currently is about 25% of the principal is made up of two components, 5% to depositors and 20% to cover bank overhead and profit. If this interest is too high as is the case in Nigeria, production cost will also increase and impact negatively on capacity utilization. The negative impact of lending rate is well established in literature.

2.3 Inflation Rate

According to Umo (2007), inflation can be defined as a generalized increase in the level of prices sustained over a long period of time. From, the definition, inflation is a macroeconomic phenomenon and does not refer to specific products whose prices may fall or rise during the period under consideration. In other words, it refers to the aggregate or basket of goods. It is measured as a ratio of the increase in aggregate price and aggregate price at the base period. It is usually expressed in percentage.

Eniola (2009) reported that Exchange rate, Inflation rate, Imports Federal capital expenditure, foreign direct investment (FDI) and Real loans and advances accounted for 50 percent variation in capacity utilization. Out of the six variables only inflation rate had a negative impact on capacity utilization while the other five had positive impact. The finding also revealed that there was a very strong positive and significant relationship between imported manufactures and capacity utilization, showing that Nigeria is highly important dependent. From the study 1percent change in imported manufactures resulted in 18.33 percent increase in capacity utilization, indicating that Nigeria is highly important dependent.

3. Data and Methodology

The study method used is ex-post facto design using 1981 – 2009 data sourced from CBN statistical bulletin and other publications to access the impact of power supply, inflation rate and interest rate on capacity utilization rate.

The data analysis was carried out using ordinary least square (OLS) multiple regression technique. Log transformations of the variables were carried out to improve linearity.

Insert Table 2 Here

3.1 Model Specifications

The following model specifications which were estimated with the aid of e-views 5.0 statistical package are as follows.

Model 1 – At level:

$$\text{Log}(cu_t) = \beta_1 + \beta_2 \log(elec_t) + \beta_3 \log(inf_t) + \beta_4 \log(int_t) + \mu_t \quad (2)$$

Model 2 – including one period lags of variables as independent variables

$$\text{Log}(cu_t) = \beta_1 + \beta_2 \log(elec_t) + \beta_3 \log(inf_t) + \beta_4 \log(int_t) + \beta_5 \log(cu(-1)) + \beta_6 \text{logelec}(-1) + \beta_7 \log(inf(-1)) + \beta_8 \log(int(-1)) + \mu_t \quad (3)$$

Model 3 – Auto regressive (AR) model

$$\text{Log}(cu_t) = \beta_1 + \beta_2 \log(elec_t) + \beta_3 \log(inf_t) + \beta_4 \log(int_t) + \mu_t \quad (4)$$

$$\mu_t = \mu_{t-1} + e_t \quad (5)$$

Where cu = capacity utilization (%), elec = Electricity generated in megawatts,

inf = inflation rate(%), int = interest rate (%), and t = time period. To diagnose and control the assumptions of the regression modeling the following tests were carried out on the variables as well as the residual. Normality, Augumented Dickey-fuller (ADF) Unit root test, Breusch-Godfery LM test for serial correlation of the residuals and Autoregressive conditional Heteroscedasticity (ARCH) test for non-constant variance of the error term. The e-views 5.0 outputs is as shown in table 3.

The corresponding Substituted Coefficients for models 1, 2, and 3 respectively are shown below:

$$\text{Log}(cu) = 1.517555446 + 0.4326251015*\text{Log}(elec) - 0.01953631977*\text{Log}(inf) - 0.3282804849*\text{Log}(int) \quad (6)$$

$$\text{Log}(cu) = -0.3753031584 + 0.06881104735*\text{Log}(elec) - 0.01503188026*\text{Log}(inf) + 0.1878999709*\text{Log}(inf) + 0.8005849346*\text{Log}(cu(-1)) + 0.05990645918*\text{Log}(elec(-1)) - 0.04458446685*\text{Log}(inf(-1)) - 0.08792852816*\text{Log}(int(-1)) \quad (7)$$

$$\text{Log}(cu) = 2.562322934 + 0.09154993813*\text{Log}(elec) + 0.005186872855*\text{Log}(inf) + 0.1366020106*\text{Log}(int) + [AR(1) = 0.8105415303] \quad (8)$$

4. Discussion

From the ADF tests only log (inf) is stationary at I (0) level of integration or differencing and 5% level of significance, while Log (cu), log (elec), and log (int) are non-stationary. The unrestricted co-integration Rank test (trace) result indicates two co-integrating equations at 0.5 levels. The implication of this though the series are individually non-stationary, they are co-integrated. Model 1, therefore is not spurious or nonsense. (Gujarati, 1999; Alao, 2010; Hossain, 2009; Nahmias, 2001; Engle and Granger, 1987). Model 2 and 3 are an improvement over model 2 and 3 by including one period lags or the error term respectively as independent variables. This addressed the problems of serial correlation, stationarity, heteoscedasticity etc .From table 3, it is evident that models 2 and 3 showed drastic improvement in all dimensions over model 1, including Dubin-watson statistic for serial correlation, coefficient of determination which measures the variation in log (cu) explained by the the model, Standard error which measures the error of forecast of the model, and other indicators. The coefficient of determination improved from 29.9% for model 1 to 84.5% and 82.7% for models 2 and 3.respectively.

Insert Table 4 & Table 5 Here

From the substituted coefficients for model 1, an increase of 1 unit of log (elec) that is, e1= 2.72 megawatts generated will be accompanied by an increase of

$e^{0.432526}$ = 1.54% in capacity utilization holding other variables constant.

The overall impact of the three models is significant as measured by Prob (F-statistics). In practice it is possible to have a situation where the variables have significant impact individually but when taken together the impact might be low as a result of high interaction or correlation among the variables.

From the Wald test electricity supply has a significant positive impact on capacity utilisation at 5% level of significance, while inflation rate and interest rate have negative impact. The impact of interest rate is significant at a p-value of 0.0212 and 0.039 for F-Statistics and x^2 statistic respectively. The impact of inflation is negative as expected but not significant at 5% level. The effect of interest rate being negative is expected because it has direct relationship with high production cost which lowers capacity utilization. The effect of electricity is understandable because when the machines are idle production shutdown.

5. Conclusion

It is strongly recommended that PHCN should be privatized without further delay. The issue of improved power supply as a strategy aimed at boosting o capacity utilization of the manufacturing sector and the economy as a whole cannot be emphasized. A situation where PHCN had an installed and available capacity of 6000MW in 1980 but is struggling to generate 1500MW of electricity in 2011 is by all known standards an abysmally poor performance. Borrowing from the experience of China where power generation is decentralized the independent power supply strategy has to be vigorously pursued. In addition to hydroelectricity the time has come for us to consider in our National strategic plans, other options in addition to gas as source of power for the turbines. The alternative sources include the use of coal, wind, bio-fuel and solar energy.

The present policy of CBN to keep inflation and interest rate at single digit level should be vigorously pursued. The study clearly shows that both variables impact negatively on capacity utilization.

The government should always consider the findings and recommendations of researchers and captains of industry in crafting policies.

The government should also constitute a committee where all stakeholders including manufacturers will be fully represented. The committee should be headed by the Head of State so that the committee's recommendations could have an eye on implementations against what obtained in the past where committee recommendations had no executive backing.

The government should also set specific targets for the manufacturing sector in the implementation plan of vision 2020. For example there is no reason capacity utilization should not increase from present level of 35% to 65% by 2015. This is achievable if the present level of power generation of 1500MW is increased to 15,000MW by 2015.

From the findings and policy recommendations, the role of the government in cushioning the effects of epileptic power supply and other macroeconomic variables on capacity utilization cannot be overemphasized. The government should put in place appropriate macroeconomic policies to improve the performance of the manufacturing industry. This is important if the noble objective of vision 2020 of Nigeria being counted among the first twenty industrialized economies of the world by the year 2020 is to be realized.

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Table 1. Power Stations in Nigeria and their Generation Capacities

S/N	Station	Installed unit	Available unit	Installed Available Unit (MW)	Actual Capacity Generated (MW)	Generation Loss (MW)
1	Kanji	8	3	260	186	74
2	Jebba	6	4	385.6	269	16.6
3	Shiroro	4	2	450	425	25
4	Egbin	6	3	880	825	57
5	Sapele	10	2	360	253	107
6	Afam	18	3	40	30	101
7	Delta	20	3	320	291	29
8	Ijora	3	1	20	0	20
9	Calabar	1	1	1	1	0
	Total	76	22	2716.6	2278	338.6

Source: Daily Broadcast, national Control Centre, Oshogbo, 2000 as Reported by Siyan and Ekhator (2001)

Table 2. Annual Capacity Utilization Rates, Electricity Generation, GDP, Inflation and Interest Rates

Year	MANUFACTURING CAPACITY UTILIZATION RATE (%)	ELECTRICITY GENERATION IN MEGAWATTS (MW)	GROSS DOMESTIC PRODUCT AT 1990 BASIC PRICES (MILLIONS OF NAIRA)	INFLATION RATE (%)	INTEREST RATE LEADING (%)
Obs	CU	ELEC	GDP	INF	INT
1981	73.30000	1603.800	251052.3	20.90000	10.00000
1982	63.60000	1775.400	246725.6	7.700000	11.75000
1983	49.70000	1707.200	230380.8	23.20000	11.50000
1984	43.00000	1804.800	227254.4	39.60000	13.00000
1985	38.30000	2038.400	253013.3	5.500000	11.75000
1986	38.80000	1331.800	257784.4	5.400000	12.00000
1987	40.40000	1393.200	255997.0	10.20000	19.20000
1988	42.40000	1404.200	275409.6	38.00000	17.60000
1989	43.80000	1518.800	295090.8	40.90000	24.60000
1990	40.30000	1656.000	472648.7	7.500000	27.70000
1991	42.00000	1656.000	328644.5	13.00000	20.80000
1992	38.10000	1847.000	337288.6	44.50000	31.20000
1993	37.20000	1874.800	342540.5	57.20000	36.09000
1994	30.40000	2013.600	345228.5	57.00000	21.00000
1995	29.30000	1981.400	352648.6	72.80000	20.79000
1996	32.50000	2025.000	367218.1	29.30000	20.86000
1997	30.40000	2012.800	377839.8	8.500000	23.32000
1998	32.40000	1881.800	388468.1	10.00000	21.34000
1999	34.60000	1906.400	393107.2	6.600000	27.19000
2000	36.10000	1944.400	412332.0	6.900000	21.55000
2001	42.70000	2278.100	431783.1	18.90000	21.34000
2002	54.90000	2250.200	451785.6	12.90000	29.70000
2003	56.50000	2397.800	495007.1	14.00000	22.47000
2004	55.70000	2762.300	527576.0	15.00000	20.62000
2005	54.80000	2687.100	561931.4	17.90000	19.47000
2006	53.30000	2650.200	595821.6	8.200000	18.70000
2007	53.38000	2789.100	634251.1	5.380000	18.36000
2008	53.84000	2845.900	672202.6	11.60000	18.74000
2009	54.30000	2900.300	716949.7	12.40000	22.90000

Source: Central Bank of Nigeria Statistical Bulletin (2009)

Table 3. Model Representation of the Equations - Empirical Results

Statistics	**Model 1**	**Model 2**	**Model 3**
Adjusted R-squared	0.215072	0.885447	0.826892
R-squared	0.299172	0.845354	0.796786
S.E. of regression	0.212185	0.087050	0.099787
Sum squared resid	1.125561	0.151553	0.229021
Log likelihood	5.961484	33.33606	27.55575
Durbin-Watson stat	0.548864	1.668933	1.115099
S.D. dependent var	0.239497	3.753121	3.753121
Mean dependent var	3.771792	0.221359	0.221359
Akaike info criterion	0.135275	1.809719	1.611125
Schwarz criterion	0.053318	1.429089	1.373231
F-statistic	3.557359	22.08457	27.46627
Prob(F-statistic)	0.028544	0.000000	0.000000

Table 4. Augmented Dickey-Fuller (ADF) Unit Root test Statistics Summary Based on Mackinnon (1996) Critical Values.

Variable	Log a	Log (elec)	Log (mf)	Log (int)
t-statistic	-2.1532	-0.8091	-3.5799	-2.6187
p-values	0.2268	08010	0.0132	0.1012
Level of integration	I(0)	I(0)	I(0)	I(0)

Table 5. Unrestricted Co integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.675990	62.63667	47.85613	0.0012
At most 1 *	0.532792	32.20822	29.79707	0.0259
At most 2	0.340369	11.66173	15.49471	0.1739
At most 3	0.015716	0.427700	3.841466	0.5131

Trace test indicates 2 co integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 6. WALD Coefficient Test Results

Variable	C	Log (Elec)	Log (Inf)	Log (Int)
Coefficient	1.5176	0.43265	-0.0195	0.3283
Probability of F Statistics	0.2933	0.0307	0.7170	0.0212
Probability of Chi-Square	0.2830	0.2220	0.7148	0.0139