Capital-Labour Substitution and Banking Sector Performance in Nigeria (1960-2008)

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This study examines productivity in the banking sector by way of estimating two major production functions known in the economic literature. The result obtained from the ordinary least square (OLS) estimates shows that substitution parameters a and β (substitution parameters for capital and labour, respectively) confirms the a priori expectation that the duo of a and β are positive values of less than one. The addition of the values of a and β is greater than one, which indicates that as the banking sector doubles its inputs in terms of capital and labour, the output in terms of deposit will be more than doubled. The substitution parameters in the Constant Elasticity of Substitution Production Function were equally positive, which supports the theory. The speed of adjustment for the two models are reasonably good as any deviation from equilibrium is to be adjusted back in the long run. In the final analysis, the study supports economic theory on the specification of both Cobb-Douglas and Constant Elasticity of Substitution production functions.

I. Introduction

C apital-Labour substitution is an attempt at the estimation of production function. Estimating production function is an exercise that involves determining the productivity of a particular sector or the entire economy. Productivity is a term used to describe the contribution of factor inputs in the production process. In some sense, it is often used synonymously with performance evaluation of those inputs, especially labour. The more reason why some governments have in their structure of executive arm, the ministry of labour and productivity. The government of Nigeria even went as far as establishing a parastatal called the National Productivity Centre. This parastatal has been saddled with the responsibility of conducting productivity research into virtually all human endeavours, with the aim of advising the federal government on various policy issues that can better the lot of the nation, that is, productivity in a broader sense as it encompasses socio-political and economic activities.

The word "productivity" is bereft of a universally accepted definition; there are several ways in which productivity can however, be understood. According to Tybout (1992), productivity is the ratio between output and input of resources. Put simply, it is the arithmetic relationship between the amount produced and the amount of resources used in the course of production. This point is buttressed by Siegel (1980), who defined productivity as a family of ratios of output quantity to input quantity". These definitions, and various others, form the basis for which this research paper is built on. Zeroing down to the main thrust of this paper, an econometric estimation of aggregate production functions of commercial banks in Nigeria, productivity will be narrowed to purely economic phenomenon. There is a vast body of literature on the estimation of production function. From the works of eminent scholars like Solow (1957), Kendrick (1961), Stigler (1958), Fisher (1969), to the new writers like Oaikhena (1997), Iyoha (2000), Ekanem and Oyefusi (2000), Ekanem (2002) and so on, productivity and production functions have been examined in various sectoral dimensions, including the manufacturing sector, the brewing industry and the banking sector.

Thus, if the level of productivity determines a nation's economic growth and development, an examination of the productivity of commercial banks in Nigeria is an exercise worthy of venturing into. This is because the financial sector of the economy plays a key role in the whole process of economic development. Moreover, it is an indisputable fact that the productivity of other sectors of the economy depends on the effectiveness and efficiency of the financial sector (Coker and Balogun, 2002). This apparent manifestation of the growing importance and influence of the banking sector in propelling the Nigerian economy elicits the need to estimate the production function of the banks.

This research paper evaluates the performance of commercial banks in Nigeria with a view to determining the factors that are giving strength to these banks and how they are able to sustain the performance in this era of stiff competitive banking environment. Efforts will be made to see what information technology has done to boost banking performance in this era of e-banking and on line services.

The specific objective of this research work is to estimate both the Cobb-Douglas and Constant Elasticity of Substitution production functions of commercial banks in Nigeria. Specifically, the paper will: first find out which of the inputs of the banks contribute more to output, and second, explain the type of returns to scale that is applicable to the commercial banks in Nigeria.

Estimating production function can be done on any sector. However, this research work concentrates on the banking sector. The period covered by the research work is 1960-2008.

II.   Literature Review

Douglas (1934) and Solow (1957) in their study on capital-labour substitution concluded that labour is the single most important factor of production in a certain subtle sense. Both labour and capital are needed in production: take away capital, or alternatively all labour, and you will be left with negligible total product. But they found that a one percent increase in labour seems to increase output about three times as much as would a one percent increase in capital. This largely corresponds with the widely known fact that wages are about three-fourth of the share of property incomes.

In their own view about productivity growth, Grossman and Helpman (1989) ascertained that productivity growth is driven by private sector research and development, which results in new intermediate goods that enhance final good productivity and also contribute to public knowledge. Entrepreneurs in the research and development sector sell blueprints for income, and the rate of increase in the stock of blueprints determines the rates of productivity growth.

Tybout (1992) asserts that it is a mistake to think of productivity growth as an *orderly shift in* the production function of the representative plant. To him *gradual* processes of technological diffusion or the displacement of inefficient plant are what matters. Trade orientation may from this process pass through many channels. Exposure to increased foreign competition is found to be associated with improvement in the average level of technical efficiency, reduction in the cross-plant dispersion in technical efficiency, and reduction in plant size. However, his preliminary work suggests no clear link between trade policies and patterns of entry and exit.

Westbrook and Tybout (1993) exploited plant-level panel data from Chile to provide new evidence on the empirical significance of econometric study of manufacturing sectors. Particularly, emphasis is given to econometric problems induced by the presence of unobservable plant heterogeneity, measurement error, and selectivity. An analysis of the results suggests that estimates based on Generalized Method of Moment (GMM) estimators that pool long differences (which eliminate heterogeneity effects) are robust to measurement error in the capital stock, heterogeneity and selectivity. Returns to scale for three-digit industries are fairly distributed over the plausible range of 0.8 to 1.2 and none is

statistically significantly different from constant returns. Similar result's hold for the four-digit industries for which sufficient data are available. Although general expansion of the manufacturing industry cannot be expected to yield strong plant-level scale economies, their results do not rule out scale economies from other sources such as the spreading of start-up costs and external returns to scale.

Analyzing productivity in sectors, one concept that has come to stay in the discussion on productivity is the total factor productivity (TFP). Defined as the elasticity of output with respect to time, there exists a lot of literatures on TFP. As a first step in researching the trade – productivity link, Pack (1988) writes that "comparisons of Total Factor Productivity among countries pursuing different international trade orientations do not reveal systematic differences in productivity growth in manufacturing sector". However, Chenery,et al (1986) and Balassa (1985) have found a positive association between TFP growth and openness. Second, after reviewing studies based on within – country temporal correlations, Pack (1988) and Havyrlyshyn (1990) both concluded that there is no strong evidence linking productivity and openness. Nevertheless, some studies do find a positive association between export growth and productivity (for example, Krueger and Turner (1982); Nishimizu and Robinson (1984); Nishimizu and Page (1991) find that other dimensions of policy-notably the degree of government intervention significantly influences the relation between trade and productivity.

Works on productivity and production functions in Nigeria have been going on for about five decades now. With the traces of skeletal work on the topic then, it has reached a climax of sort with the establishment of the National Productivity Center by the Buhari Administration. With the establishment of the Center, an encyclopedia of sort that comprises of various works on productivity had been prepared, with its first edition that came out in year 2002. In the Nigerian context, works on productivity include Liedholm (1964), Oaikhena (1997), Iyoha (2000), Ekanem and Oyefusi (2000), Ekanem (2000), Osagie and Odaro (1975), Ajayi (2002), Jekelle (1987), Akinnusi (1987), Uruestone (1987), Adekoya (1987), Komolafe (1987 and, Usman (1987).

Liedholm (1964) was perhaps the first work to be done on productivity in Nigeria. In the work an attempt was made at finding out between labour and capital, which input contributed more to the output of major industries in Eastern Nigeria. In the said work, it was found that labours' contribution to the output of the selected manufacturing industries was larger than that of capital. This position was confirmed by Osagie and Odaro (1975).

In a similar vein, Osakwe (1976) using time data carried out the same analysis for ten different manufacturing industries and derived estimates of labour and capital and arrived at coefficients similar to that obtained by Liedholm in 1964. For seven of the ten industries, the estimated capital elasticity (coefficients) carried negative signs contrary to a priori expectations, while for the remaining five industries whose capital coefficients were positively signed; the estimates did not pass the necessary significance test.

Oaikhena (1997) used the CES production function to obtain estimates for the Brewing Industries in Nigeria using time series data from 1975 to 1994. The industry's output and factor inputs were proxied by industry's turnover, monetary value of fixed assets and expenditures on salaries and wages, respectively. The model was estimated separately for the major brewing firms in Nigeria and then for the firms together using the OLS method. The results obtained were, however, not impressive both at the individual and aggregate levels. The results indicate the presence of positive serial correlation, the coefficients of determination were low, except for one of the firms and the distribution parameter estimate yielded extreme returns to scale and was shown to be increasing. Again, while for the individual firms the substitution parameter indicates little scope for factor substitution the scope was shown to be higher for the industries combined. Consequently, the Cobb-Douglas form of production function was estimated for the same period using the same data. Even though the estimates yielded better results the returns to scale parameters were not consistent.

Ekanem and Oyefusi (2000) estimated the Cobb-Douglas and the CES production functions for the manufacturing industry in Nigeria for the period 1980-1997, taking into consideration the phenomenon of idle capacity that has characterized the industry in recent times. The results of the models when compared with the work of Liedholm (1964) and Osagie and Odaro (1975) gave satisfactory results in terms of goodness of fit. Of the two production functions estimated, the Cobb-Douglas Production Function performs better considering all the relevant econometric test criteria. This then showed that the Cobb-Douglas Production Function gives a better explanation of the aggregate production process in the manufacturing industry in Nigeria for the period studied.

Ekanem (2002) provides estimates of Total Factor Productivity for the banking industry in Nigeria for the period 1986-2000. The methodology in the work involved the use of the Growth Accounting Model based on aggregate production functions. In the study, the most appropriate production function that describes the production process of the industry in Nigeria was found to be the Cobb-

Douglas. The parameters of the estimated Cobb-Douglas function were used to calibrate the Growth Accounting Model. The results showed that measured aggregate output grew at an average annual rate of 4.29%, while Total Factor Productivity grew at an average annual rate of 3.33%. The study analyzed that TFP provided 78% of the recorded growth in the industry during this period.

When the time span was broken into sub-periods to permit a closer look at the productivity trends in the industry, it was found out that TFP accounted for 72% of industry growth in the period 1986-1990. For the period 1991-1996 TFP accounted for 70% of the industry growth. For the final period, 1996-2000 TFP accounted for 82.5% of industry growth. The study equally shows that the banking industry in Nigeria has expanded rapidly in recent years, with TFP rising sharply since 1996. This strong aggregate performance and well-documented investment in research, manpower development and information technology gives an encouraging signal to the emergence of a sustainable growth in the industry in Nigeria.

Iyoha (2000) made an attempt to undertake a growth accounting exercise for Nigeria using data for 1960-1997. The aim of the exercise was to breakdown economic growth into components associated with changes in factor inputs (capital and labour). The paper used the standard primal growth accounting framework. Estimates of Total Factor Productivity (TFP) were obtained for the entire period and for four sub-periods namely 1961-1970, 1971-1980, 1981-1987, and 1988-1997. The average annual growth rate of real GDP for the entire period was 3.7%. Growth in factor inputs was at the rate of 2.55%, while growth in TFP was 1.1%. In effect TFP growth accounted for 30.3% of aggregate real GDP growth during the period. TFP growth was especially rapid during the first decade. Out of total real GDP growth of 5.07%, TFP growth was 4.6%. The conclusion is that during 1961-1970 period, TFP growth accounted for over 92% of average growth in real GDP. TFP performance deteriorated during 1971-1987. It recovered somewhat during the last decade when TFP growth was 2.1%, compared with an average real GDP growth of 4.7%. Thus, during the 1988-1997 period, TFP growth accounted for 43% of aggregate real GDP growth.

The paper equally made an attempt at identifying the causes or determinants of productivity growth in Nigeria. Attention was particularly centered on the last decade of the research period. It was found that the economic and market reforms undertaken under SAP which entailed deregulation of the foreign exchange system, trade policies, the financial system and agricultural policies have played a significant role in enhancing productivity performance. The study

concluded by advising that investment needs be encouraged and increased to raise the overall rate of economic growth in the years ahead.

Coker and Balogun (2002) attempt to analyze the impact of the role of the financial sector on the Nigeria economy. In their concluding remarks, they posit that in the years ahead, with increasing deregulation and globalization and the keen competition to survive, financial sector operators have to be more resourceful and sophisticated. In particular they should try to keep their institution healthy and strong by adopting prudent measure, relying increasingly on self-deregulation, applying advanced technology in providing financial services and above all developing customer-friendly strategies. They equally postulate that to stimulate and protect the intermediation role of the financial institution (operators) in Nigeria, the regulator (CBN) has to sustain a number of recent measures that have proved effective. These include enforcing compliance with regulations and ethics of financial services and providing early warning signals through effective supervision and prudential regulatory measures.

In her contribution, Ajayi (2002) examines how productivity improvement strategies and incentive schemes could act as policy instruments to the enhancement of higher productivity among individuals, organization, economic sectors and nations. The study thus, revealed that productivity levels in the national economy could be increased by various techniques of productivity improvement. Among these, motivation of employee through productivity incentive scheme is known to have a far-reaching effect on the productivity of the workforce. This is so because each productive incentive scheme takes into consideration employees' needs and potentials, circumstances of the work system as well as the level of technology applicable. The paper finally proffered some policy recommendations to be adopted in enhancing productivity growth. Principal among these recommendations is the installation of productivity improvement strategies and incentives scheme in all sectors of the economy.

Coming to the application of productivity in Nigeria, Komolafe (1987) looked at productivity as the positive contribution of the citizen to the multi-farious needs of his community, state or nation. The paper looked at, among other things, possible ways of improving productivity in a developing nation like ours. He concluded that Nigeria's means of production could only be reliable if they originate from the country. People should be mobilized to produce their own tools. Incentives should be created by stepping up measures in banning or limiting importations. Necessary financial and moral support should be given to indigenous entrepreneur. Government should honour and reward sincere and original efforts

in technology. Government should ban or limit external borrowing to the minimum so that hard earned foreign exchange can be utilized to promote the local production of our needs.

In his own attempt at examining the role of government in promoting increased productivity on Nigerian farms, Adekoya (1987) examined the concept of productivity as a measure of how well resources are brought together in a farm firm and utilized for accomplishing a set of results. The paper finally argued that government's involvement in manpower development is a means of increasing productivity on Nigerian farms; and that the Directorate for Foods, Roads and Rural Infrastructure will need to introduce community development programmes which require the active participation of women and the elderly in the implementation of such programmes.

The literature on productivity will be incomplete without mentioning the aspect of productivity and public service in Nigeria. Jekelle (1987) tries to examine the issue of productivity as it affects public service in Nigeria. He was moved by the general apathy people feel about the Nigerian civil service. The sector has been accused of corruption, ineptitude, indolence, rigidity, and general laziness, low productivity e.t.c. despite occupying a dominant position in the Nigerian economy. So the paper examines low productivity in the public service with particular reference to how employment policies relate to level of productivity.

The paper reveals that the major cause of low productivity in Nigeria has to do with selection and placement procedures. That the federal government in its characteristics manner of trying to maintain the unity of the nation brings in a lot of sentiment in the recruitment process all in the name of federal character. Though Jekelle (1987) did not find anything wrong with that except that he contends that it does not have legal backing. He, however, frowned at its implementation. Also, low productivity is prevalent in the county because rather than allow merit and qualification to be the determinants and basis for selection, it has been other factors like nepotism, tribalism, and favoritism e.t.c. The paper finally recommends, among other things, improvement of the content of selection interviews by looking beyond educational qualifications and work experience of the candidates. Interviews should be restructured to reflect real work job situation. This will lead to logical matching of men with jobs. The paper as a policy views the issues of examining the examiners by knowing the quality of products they are turning out. With this productivity as a problem would have been handled from the root.

III.   Theoretical Framework

Production is the act of creating utility. This means that production is not complete until the goods produced finally reach the consumers (Mansfield, 1985). A production function is a function that specifies the output of a firm, an industry, or an entire economy for all combinations of inputs (Wikipedia). It is the technical relationship between the inputs and the outputs.

There are several ways of specifying the production function. In a general mathematical form, a production function can be expressed as:

$$Q = f(X_1, X_2, X_3, ..., X_n) \qquad (1)$$

where:

Q = quantity of output

$X_1, X_2, X_3, ..., X_n$ = factor inputs (such as capital, labour, land or raw materials). This general form does not encompass joint production. That is, a production process, which has multiple co-products or outputs. At the advanced stage of microeconomics, all the inputs in a typical production process are subsumed into two major inputs; the fixed inputs (often denoted by K) and the variable inputs (often denoted by L). So many types of production functions are obtainable in the theoretical literature. They include the two popular ones namely the Cobb-Douglas Production Function and Constant Elasticity of Substitution production function. Other less popular ones are the Quadratic production function and Transcendental Logarithmic production function.

The Cobb–Douglas functional form of production functions is widely used to represent the relationship of an output to inputs. It was proposed by Knut Wicksell (1851–1926), and tested against statistical evidence by Charles Cobb and Paul Douglas in 1900–1928.

A typical Cobb-Douglas production function is of the form :

$$Q = AL^\alpha K^\beta, \qquad (2)$$

where:

Q = total production (the monetary value of all goods produced in a year)

L = labor input

K = capital input

A = total factor productivity or efficiency parameter.

α and β are the output elasticities (substitution parameters) of labor and capital, respectively. These values are constants determined by available technology.

Output elasticity measures the responsiveness of output to a change in the levels of either labor or capital used in production, ceteris paribus. For example if a = 0.15, a 1% increase in labor would lead to approximately a 0.15% increase in output.

Further, if:

$$a + \beta = 1,$$

the production function has constant returns to scale. That is, if L and K are each increased by 20%, Y increases by 20%. If

$$a + \beta < 1,$$

returns to scale are decreasing, and if

$$a + \beta > 1$$

returns to scale are increasing. Assuming perfect competition, a and β can be shown to be labor and capital's share of output.

For Constant elasticity of substitution (CES) function: the original specification is of the form

$$Q = A[aK^\rho + (1-a)L^\rho]^{1/\rho} \tag{3}$$

$\rho = 0$ corresponds to a Cobb–Douglas function, $Q = AK^a L^{1-a}$.

The variables and the parameters are explained under Cobb-Douglas production function.

The Translog production function is a generalization of the Cobb–Douglas production function. The name Translog stands for 'transcendental logarithmic'. The three factor Translog production function is:

$$Q = f(K, L, M),$$

where L = labor, K = capital, M = materials and supplies, and Q = product. This is specified in a general form as:

$$\ln Q = \ln(A) + a_K \ln(K) + a_L \ln(L) + a_M \ln(M) + b_{KK} \ln(K)\ln(K) + b_{LL} \ln(L)\ln(L) + b_{MM}\ln(M)\ln(M) + b_{KL} \ln(K)\ln(L) + b_{KM} \ln(K)\ln(M) + b_{LM}\ln(L)\ln(M) \tag{4}$$

III.1   Research Methodology and Model Specification

The methodology used for this research are Cointegration and Error Correction Model. The choice of the econometric technique is borne out of the fact that the data used is time series data that is prone to autocorrelation. Once the

causal relationship between the dependent variable of output and its determinants (capital and labour) is established, then the issue of stationarity or otherwise of the data will be determined.

Two models are specified for the study, the Cobb-Douglas production function and the Constant Elasticity of Substitution production function. The general form of the Cobb-Douglas production function for two factors as applied in this study is:

$$Q = AK^{\alpha}L^{\beta} \tag{5}$$

While that of CES Production Function is of the form

$$Q = \gamma[(1-\delta)K^{-\rho} + \delta L^{-\rho}]^{-\upsilon/\rho} \tag{6}$$

Equation 5 is not a convenient form for direct estimation by least squares methods; it is therefore usually converted into a logarithmic form:

$$logQ = logA + \alpha logK + \beta logL + u \tag{7}$$

so that the residual u is added in the multiplicative form e^{u}.

A priori expectation suggests that both α and β are greater than zero but less that one. That is

$0<\alpha<1$ and $0<\beta<1$. In the case where constant returns to scale is present, then $\alpha+\beta=1$. Alternatively, constant returns to scale may be imposed by putting $\beta= 1-\alpha$ so that (5) can be rewritten as:

$$Q = AK^{\alpha}L^{1-\alpha}e^{u} = A(K/L)^{\alpha}Le^{u}$$
or
$$Q/L = A (K/L)^{\alpha} e^{u}$$

and taking logarithms of both sides gives

$$logQ/L = logA + \alpha log(K/L) + u \tag{8}$$

This second form avoids multicollinearity between logK and log L and also reduces heteroscedasticity if the variance of K is correlated with L (Wynn and Holden 1974).

The CES function is not easy to estimate directly like that of the Cobb-Douglas function. Estimation of the CES function has, therefore, generally been limited to either examining whether the condition for profit maximization are satisfied or making some approximation to the function. In this study, we make use of Kmenta (1967) approximation to CES cited in (Wynn and Holden, 1974). The approximation with the use of Taylor's expansion series gives:

$$\text{Log}(Q/L) = \log\gamma + (\upsilon-1)\log L + \upsilon(1-\delta)\log(K/L) - 0.5\upsilon\delta\rho(1-\delta)[\log(K/L)^2] + \upsilon \tag{9}$$

The equivalent equation for the Cobb-Douglas function is found by rewriting 3 as follows:

$$\text{Log}(Q/L) = \log A + (\beta-1+a)\log L + a\log(K/L) + \upsilon \tag{10}$$

Thus equations 9 and 10 form our structural equations and the result of the estimated equations are presented in the section that follows.

IV.   Empirical Results

This section focuses on the empirical relationship between the inputs (labour and capital) and the output. The data used is for the period 1960-2008 spanning 49 years. It is a time series data that is prone to autocorrelation. To avoid that, unit root test was conducted based on Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) to test for the stationarity or otherwise of the variables in the model.

IV.1   Unit Root Test

The table below shows the result of the ADF conducted on all the variables[1]. The test shows that two of the variables have unit roots i.e. the variables are non-stationary. Stationarity was however obtained by differencing the variables. The result is as tabulated.

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[1] Bank deposit was used to proxy output, wages, salaries and management remuneration was used to proxy labour, while expenditure on fixed assets was used to proxy capital.

Table 1: Augmented Dickey Fuller for Unit Root Test (1960-2008)

Variables	At levels	1st Difference	Order of Integration
Ln(Q/L)	-1.48404	-6.489555*	I(1)
Ln (L)	-0.85860	-7.390741*	I(1)
Ln (K/L)	-4.45824*	-7.08439	I(0)
Ln (K/L)^2	-3.098394**	-7.10405	I(0)

Source: Own Computation using E-Views 4.1
Critical values at 1%, 5% and 10% respectively are -3.5778, -2.9256 and -2.6005
*Significance at 1%, **Significance at 5%

From the above table, two of the variables [ln (Q/L and ln (L)] have unit roots. The variables are, however, made stationary by differencing. While the ln (K/L) and ln (K/L)^2 are integrated of order 0, that of ln(Q/L) and ln(L) are integrated of order one.

Table 2: Phillips-Perron for Unit Root Test (1960-2008)

Variables	At levels	1st Difference	Order of Integration
Ln(Q/L)	-2.581751	-11.0526*	I(1)
Ln (L)	-0.9825	-7.390741*	I(1)
Ln (K/L)	-4.511247*	-11.80830	I(0)
Ln (K/L)^2	-4.528596*	-11.83654	I(0)

Source: Own Computation using E-Views 4.1
Critical values at 1%, 5% and 10% respectively are -3.5713, -2.9228 and -2.5990
*Significance at 1%, **Significance at 5%

The Phillips-Perron result in table 2 above follows the same pattern as that of the Augmented Dickey-Fuller. The PP confirms non-stationarity of two of the variables under consideration. The differenced values of the variables are as shown above. Ln (Q/L) and Ln(L) are integrated of order one, while ln(K/L) and ln (K/L)^2 are integrated of order 0. This goes to confirm that ADF and PP hardly gives different result when testing for unit root. The minor difference noticed however is that the I(0) of Ln(K/L)^2 is significant at 5% for ADF, it is significant at 1% for PP.

IV.2   Co-integration Test
Having established the existence of unit root in the variable, co-integration tests were conducted on the two models of Cobb-Douglas and CES Production

function using the Johansen co-integration test. The result shows that whereas co-integrating relationship can be established for the Cobb-Douglas Production Function, that of CES cannot be established because the relationship that exists is near singular matrix. The result of the test is as shown in the table below:

Table 3: Johansen Co-integration Test

Sample: 1960 2008
Included Observation: 47
Test Assumption: Linear Deterministic Trend in the Data
Series: Ln(Q/L) Ln(L) Ln(K/L)
Lag Interval: 1 to 1

Eigenvalue	Likelihood Ratio	5% Critical Value	1% Critical Value	Hypothesised No of CEs
0.267923	49.16507	29.68	35.65	None**
0.080267	24.507214	15.41	20.04	At most 1**
0.012152	4.574643	3.76	6.65	At most 2*

Source: Own Computation
Notes *(**) denotes the rejection of the hypothesis at 5%(1%) level of Significance

From the above result, it can be confirmed that commercial banks output and the inputs represented by labour and capital are subject to an equilibrating relationship and positively related to each other in the long run.

**Table 4: Ordinary Least Square Regression Result for
Cobb-Douglas Production Function**

Dependent Variable is the natural logarithm of (Q/L)

Variable	Coefficient	Std Error	t- statistic	Prob
Constant	0.981865	0.444083	2.210994	0.0320
Ln (L)	0.058163	0.028564	2.036207	0.0475
Ln (K/L)	0.924686	0.124166	7.447145	0.0000
R- Squared		0.583051	Mean dependent var	4.484082
Adjusted R-Squared		0.564923	S.D. dependent var	0.853561
S.E. of regression		0.563012	Akaike info criterion	1.748238
Sum squared resid		14.58119	Schwarz criterion	1.864064
Log Likelihood		-39.83183	F-statistic	32.16267
Durbin-Watson Stat		0.277436	Prob(F-statistic)	0.000000

Source: Own Computation

The above result can be expressed in linear form based on equation 6 as follows:

$$Ln(Q/L) = 0.982 + 0.058Ln(L) + 0.92Ln(K/L) \qquad (11)$$
$$(2.21) \quad (2.04) \qquad\qquad (7.45)$$

The above equation shows a positive relationship between the output and the inputs which conforms with the a priori expectation of $0<\alpha<1$ and $0<\beta<1$. α from the result is 0.92 while β is 0.14, which confirms the existence of increasing returns to scale in the production function. The R squared which is the explanatory power of the model is reasonably high at 58%. This means that 58% of the variations in output are explained by the inputs of labour and capital. Reported in parenthesis are the t statistics of the explanatory variables which of course are significant both at 5% and 1% level of significance going by the rule of thumb that gives significance to t- statistic of greater than 2. Although the Durbin- Watson is low at 0.28, it only confirms the existence of unit root which had been taken care of in the unit root test above. The F statistic is equally good at 32.16, which suggests that all the independent variables put together belong to the model.

Table 5: Ordinary Least Square Regression Result for C.E.S. Production Function

Dependent Variable is the natural logarithm of (Q/L)

Variable	Coefficient	Std Error	t- statistic	Prob
Constant	1.058838	0.468010	2.262425	0.0285
Ln (L)	0.059943	0.028954	2.070272	0.0442
Ln (K/L)	-9.325347	18.27854	-0.510180	0.6124
Ln (K/L)^2	5.111672	9.115260	0.560782	0.5777
R- Squared	0.585945		Mean dependent var	4.484082
Adjusted R-Squared	0.558341		S.D. dependent var	0.853561
S.E. of regression	0.567254		Akaike info criterion	1.782090
Sum squared resid	14.47999		Schwarz criterion	1.936524
Log Likelihood	-39.66121		F-statistic	21.22707
Durbin-Watson Stat	0.255299		Prob(F-statistic)	0.000000

Source: Own Computation

The above result can be expressed in linear form based on equation 10 as follows:

$$Ln(Q/L) = 1.06 + 0.06Ln(L) - 9.323Ln(K/L) + 5.11Ln(K/L)$$
$$(12) \quad\quad (2.26) \quad\quad (2.07) \quad\quad (-0.51) \quad\quad\quad (0.56)$$

The R^2 in this model is 59%, which means that 59% of the variation in output is explained by the independent variable. The estimated substitution parameters in this model are all positive
(γ= 1.06, υ=1.06, δ= 9.80 and ρ=0.11) which conforms with a priori expectation. The F statistic of 21.23 has taken care of whatever inconsistencies that may have been noticed in the t-statistics.

IV.3   Error Correction Model

In order to establish the long run relationship between the dependent variable and the independent variables of the two models, equations 9 and 10 can be transformed into an econometric model under the ECM framework as follows:

$$dLog(Q/L) = \varphi_0 + \varphi_1 \sum_{i=0}^{m} d\log L + \varphi_2 \sum_{j=0}^{m} d\log(K/L) - \varphi_3 \sum_{s=0}^{m} d\log(\frac{K}{L})^2 + \varphi_4 ECM(-1) + U_t$$

$$(13)$$

The equivalent equation for the Cobb-Douglas function is found by rewriting 7 as follows:

$$dLog(Q/L) = \Omega_0 + \Omega_1 \sum_{i=0}^{m} dlogL + \Omega_2 \sum_{j=0}^{m} dlog(K/L) + \Omega_3 ECM(-1) + \varepsilon_t$$

$$(14)$$

d in the equations stand for first differencing, while ECM is the error correction term for the ECM models. The significance of the ECM in the model is to indicate how disequilibrium in output can be adjusted in the short -run. The results of the ECM for the two models are presented in the table below:

Table 6: Parsimonious Error Correction model for Cobb-Douglas Production Function

Dependent variable is dLn(Q/L(-1),2)

Variables	Coefficient	Std Error	t- Statistic	Prob
dLn(L(-1),2)	-0.941607	0.038018	-24.76733	0.0000
dLn(K/L(-1))	0.047774	0.030529	1.564863	0.1251
ECM(-1)	-0.300046	0.091669	-3.273167	0.0021
Constant	-0.000708	0.025620	-0.027619	0.9781

Source: Author's Computation

As stated earlier, the significance of ECM is to indicate how the departure from the long run disequilibrium is corrected in the short-run. To do this, the coefficient of the ECM was estimated. In the above table the coefficient of ECM is -0.30, which is a reasonably good adjustment process. The speed of adjustment which

is significant at both 5% and 1% suggests that about 30% of the disequilibrium in the previous year's shock adjusts back to the long run equilibrium in the current year.

Table 7: Parsimonious Error Correction model for C.E.S. Production Function

Dependent variable is dLn(Q/L(-1),2)

Variables	Coefficient	Std Error	t- Statistic	Prob
Constant	-0.000112	0.025862	-0.004334	0.9966
dLn(L(-1),2)	-0.940149	0.038459	-24.44541	0.0000
dLn(K/L(-1))	-5.536681	4.774698	-1.159588	0.2529
dLn((K/L)²(-1))	2.807003	2.378962	1.179928	0.2448
ECM(-1)	-0.283357	0.097256	-2.913505	0.0058

Source: Author's Computation

Following from the same explanation, the speed of adjustment in the C.E.S. Production function is 28%. This means about 28% of the disequilibrium in the previous year's shock is adjusted back to the long run equilibrium in the current year. The ECM for this model is equally significant at both 5% and 1%.

V.   Conclusion and Policy Implications

This study examined productivity in the banking sector by way of estimating two major production functions known in the economics literature. The study made use of time series data spanning forty-nine years, from 1960 to 2008, and because of serial/autocorrelation that is normally associated with time series data, co-integration econometric technique was adopted. The unit root test conducted confirms the existence of non-stationarity in some of the data. This was, however, corrected after first differencing to avoid spurious result at the end of the study.

The result obtained from the OLS estimates shows that substitution parameters, a and β support economic theory of the duo being positive values of less than one. The addition of the values of a and β is greater than one which indicates that as the banking sector doubles its inputs in terms of labour and capital, the output in terms of deposit will be more than doubled. The substitution parameters in the Constant Elasticity of Substitution Production Function were equally positive and supports economic theory. The speed of adjustment for the two models are reasonably good; any deviation from equilibrium is to be adjusted back in the long run.

Finally, the study supports economic theory in the specification of both the Cobb-Douglas and Constant Elasticity of Substitution production functions. The study, therefore, recommends for commercial bank operators that for increased productivity in terms of more deposit, more units of both labour and capital should be employed.

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