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**THE EFFECT OF EXPORT
EARNINGS FLUCTUATIONS
ON CAPITAL FORMATION
IN NIGERIA**

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AFRICAN ECONOMIC RESEARCH CONSORTIUM 

CONSORTIUM POUR LA RECHERCHE ECONOMIQUE EN AFRIQUE

The effect of export earnings fluctuations on capital formation in Nigeria

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Abstract

This study explored the association between export earnings fluctuations and capital formation in Nigeria. Using a reduced form equation built around the flexible accelerator model and adopting a cointegration technique, it discovered that the current level of export earnings fluctuations adversely impinges on investment (that is, the change in capital stock) in the short run.

1. Introduction

The centrality of trade to economic growth and development is now beyond dispute. With the evolution of development economics since the 1950s, a vast body of knowledge has accumulated assigning a phenomenal role to trade in the development process.

The neoclassical economists, for example, drawing on historical evidence from the nineteenth century, likened trade to an "engine of growth" (Nurske, 1961). This characterization of the relationship between trade and development was modified a decade later by Kravis (1970), who dubbed trade the "handmaiden of growth". However, the perception of the inexorable link between trade and growth is no longer exclusively neoclassical; it is now endorsed by economists of almost all persuasions. It is widely acknowledged, for example, that development requires modern technological inputs often embodied in imported capital goods; nevertheless, exports, especially of manufactures, remain particularly crucial to the precipitation and perpetuation of growth (see Asher, 1970; Emery, 1968).

But the capacity of trade to engineer growth in developing countries has increasingly been undermined by the debilitating effects of fluctuations in export earnings. Developing countries export mainly primary products, which are characterized by lower price and income elasticities of demand and supply than manufactured products. Moreover, a limited number of commodities (in some cases only one or two) constitutes total exports, exposing the countries to the vagaries of a highly volatile international economic environment. Finally, the direction of trade is concentrated in favour of developed countries, and cyclical movements in these countries are promptly transmitted to less developed countries.

Since developing countries import most of their capital goods and because technical progress in these countries tends to be of the embodied variety, sustained ability to import, which is partly a function of stable export earnings, is crucial to sustained economic growth. Even when imports are not emphasized as a source of technical progress, it is still the case that developing countries import most of their crucial production inputs. Decreased export earnings or fluctuations in export earnings imply inability to import these inputs or inability to import them at the time when needed during the production process. Therefore, stability and growth of export earnings will have a strong impact on economic growth.

The objective and rationale of the study

The purpose of the study is to explore the association between export earnings fluctuations and capital formation in Nigeria. In doing so, the study presents three novelties. First, the standard transmission channels of fluctuations in export earnings on growth—hypothesized to deter investment—and the transmission channel of the permanent income literature—hypothesized to ease investment—are taken into account simultaneously within an integrated theoretical setting and not, as has generally been done, within an ad hoc specification. Second, the focus is on the link between fluctuations in export earnings and the formation of capital, which is more direct. Third, the relationship is tested in a country approach method as opposed to the usual cross-country analyses.

Policy relevance

The empirical relationship between fluctuations in export earnings and investment in Nigeria is still foggy. As a result, the findings of the study are expected to have profound implications for policy. For example, if export fluctuation were confirmed to retard capital formation in Nigeria, this would dramatize the desirability of accumulating foreign exchange reserves to smooth fluctuations in export earnings in the short run. These findings could also serve to bolster current efforts at trade and exchange rate liberalization as a mechanism for mitigating fluctuations in export earnings in the long run.

2. Exports and investment connection: Historical evidence

Although Nigeria's oil earnings were becoming significant in the late 1960s, the civil war of 1967–1970 prevented effective and full exploitation of the oil resources. As such, the historical analysis focuses on three subperiods, 1973–1978, 1979–1985 and 1987–1995.

1973–1978

Table 1 shows that real export earnings rose from ₦362 million in 1973 to ₦585 million in 1974. The export earnings index rose from 33 in 1973 to 53 in 1974. This increase was in response to the terms of trade shocks occasioned by the dramatic rise in oil prices in 1973/74. The terms of trade index during this period rose from 21 in 1973 to 51 in 1974 (see Oyejide, 1997).

Part of the domestic windfall was invested, so that between 1974 and 1978, investment increased massively. Table 1 shows that real investment increased from ₦396 million in 1973 to ₦670 million in 1977, while the index of investment rose from 127 in 1973 to 215 in 1977 (see also figures 1 and 2).

1979–1985

The fall in the quantity and price of oil exports in 1978 resulted in a decline in real export earnings from ₦564 million in 1977 to ₦520 million in 1979. The rise in oil prices in 1979 and 1980 came to the rescue, with real export earnings soaring to ₦644 million in 1980. But beyond 1980, the real export earnings of Nigeria declined. For instance, as shown in Table 1, real export earnings plummeted from ₦644 million in 1980 to ₦261 million in 1983. Correspondingly, the export index dropped from 59 in 1980 to only 24 in 1983. The drop in real export earnings between 1980 and 1983 could be accounted for by Nigeria's crude oil exports, whose volume was cut in half (see Gelb, 1988).

During this period, also, real investment dropped significantly. Table 1 shows that real investment declined from ₦499 million in 1980 to ₦121 million in 1984, while the investment index declined from 160 in 1980 to 39 in 1984. The political change in Nigeria from military to civilian government is a major factor in the drop in investment. During this period, there was a shift in emphasis from investment to consumption. Imports were

cut through licensing, increased duties and the introduction of an import deposit scheme. In 1981, import licensing became more restrictive while inflation rose to more than 20%.

1986–1995

A major feature of this period was the implementation of the structural adjustment programme. Real export earnings surged from ₦350 million in 1986 to ₦1,098 million in 1990. The increases were the result of the combined improvement in oil and non-oil exports during the period. Real export earnings declined to ₦1,024 million in 1991 but rose again to ₦1,051 million in 1992 as a result of the increase in the price and volume of oil exports occasioned by the Gulf War. After 1992, real export earnings began to drop.

Real investment began to rise after 1986, a trend that continued until 1990. However, as Table 1 shows, the level of investment from the mid 1980s to early 1990s does not compare favourably with investment levels in the 1970s. While the investment index was in triple digits in the 1970s, it was double-digit in the 1980s and early 1990s.

Nigeria depends heavily on imported capital goods and raw materials to run her local industries. On an annual average, imported capital goods and raw materials accounted for 38% and 30%, respectively, of total imports between 1970 and 1994. This implies that about 68% of total imports of the country is used to service local industries. As a result, fluctuations in export earnings can be expected to undermine the capacity of the country to import these critical inputs at crucial moments.

Table 1: Nigeria's export earnings and domestic investment

Period	Real export earnings		Real investment	
	Value (million naira)	Index (1990=100)	Value (million naira)	Index (1990=100)
1972	369	34	363	117
1973	362	33	396	127
1974	585	53	319	103
1975	409	37	472	152
1976	490	44	635	204
1977	564	51	670	215
1978	400	36	561	180
1979	520	47	468	150
1980	644	59	499	160
1981	457	42	464	149
1982	332	30	381	123
1983	261	24	250	80
1984	270	25	121	39
1985	320	29	141	45
1986	350	32	217	69
1987	583	53	179	57
1988	483	44	145	47
1989	621	57	197	63
1990	1098	100	311	100
1991	1024	93	300	96
1992	1051	96	301	97
1993	902	82	335	108
1994	687	63	281	90
1995	577	53	270	87

Source: Computation based on data culled from International Financial Statistics of the IMF, 1996 Edition.

Figure 1: Real export earnings and investment in Nigeria

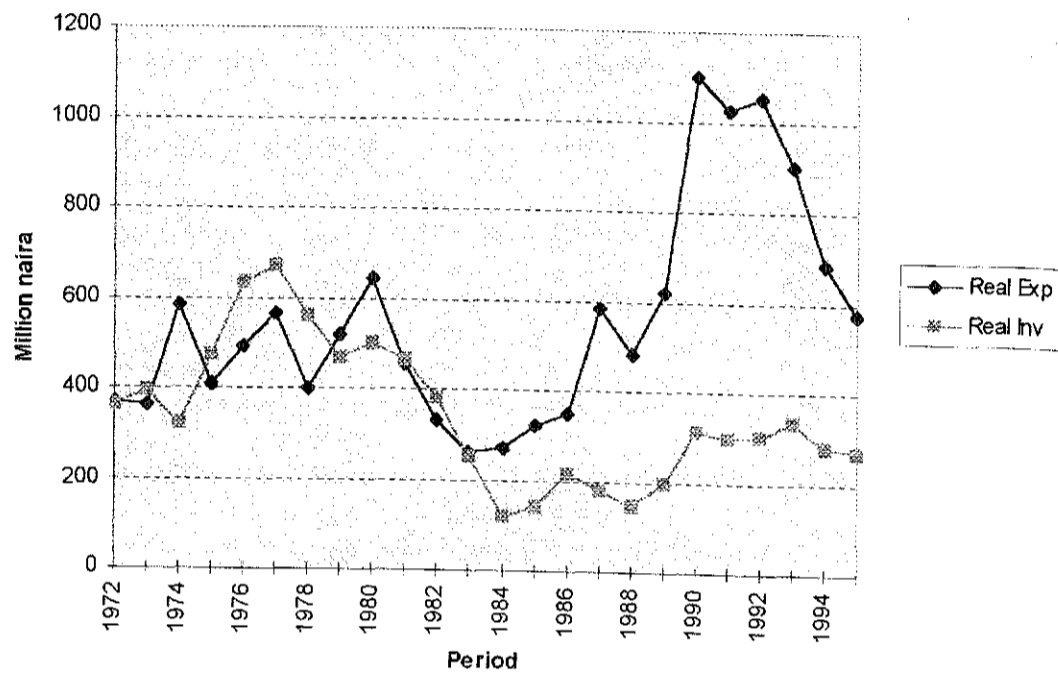
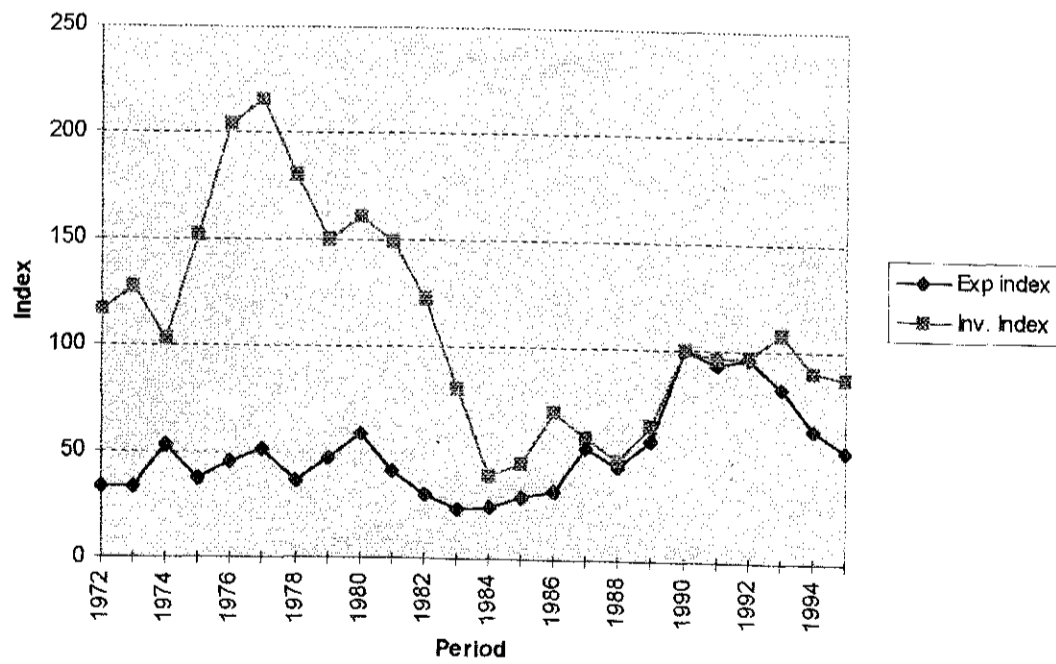


Figure 2: Nigeria's real export earnings and investment index



3. Review of the literature

Theoretical review

Keynes (1936) was the first to call attention to the existence of an independent investment decision in the economy. He observed that investment depends on the prospective marginal efficiency of capital relative to some interest rate that reflects the opportunity cost of the invested funds.

After Keynes, the evolution of investment theory was linked to simple growth models. These models gave rise to the accelerator theory, which makes investment a linear proportion of changes in output. The flexible accelerator model is a more general form of the accelerator model.

Other investment theories include the neoclassical model developed by Jorgenson (1967) and Jorgenson and Hall (1971) and the "Q" theory associated with Tobin (1969). The notion of irreversibility in investment has also been given considerable attention in the investment literature (see Pindyck, 1988; Bertola and Caballero, 1990). Finally, the financial intermediation theory associated with McKinnon (1973) focuses on the role of financial deepening and high interest rates in stimulating growth in developing countries.

Empirical review

Direct empirical investigation of the relationship between export earnings fluctuations and investment is scanty in the literature. Rather, the literature is saturated with empirical work on the connection between export earnings fluctuations and economic growth, which is more indirect.

The findings of the studies on the relationship between fluctuations in export earnings and economic growth can be categorized into three.

One category of scholars finds a negative association between export instability and economic growth, stressing the negative consequences of the former on output through the induced uncertainty in long-term planning as well as through shortages of inputs at critical times during the production process (e.g., Kenen and Voivodas, 1973; Glezakos, 1984; Stordel, 1990; Gyimah-Brempong, 1991). The works of Stordel (1990) and Gyimah-Brempong (1991) are of particular relevance.

Gyimah-Brempong (1991) conducted his study for a cross sample of 34 sub-Saharan African countries during the 1960–1986 period. Using a neoclassical growth equation

with export growth and an export earnings fluctuations index as additional explanatory variables, and adopting three different indexes of export earnings fluctuations, he found that the coefficients of the fluctuation indexes were significantly negative, thus confirming the negative impact of export earnings fluctuations on the growth rates of the sub-Saharan African economies. The limitation of this study, however, is that it is cross-sectional.

Stordel (1990) focused on the direct relationship between export earnings fluctuations and capital formation (the major determinant of economic growth) using a country-specific approach for 12 developing countries during the period 1963–1983. Export earnings fluctuation was found to directly harm investment in 7 of the 12 developing countries examined. It was particularly significant for the countries characterized by a small domestic market and a strong dependence on exports of very few primary commodities or unprocessed goods.

Another class of contributors finds a positive relationship between export earnings fluctuations and economic growth. The premise here is that developing countries respond to export earnings fluctuations by cutting back consumption. This process, if repeated over a considerable period of time, increases savings and hence the rate of investment (see Savvides, 1984).

The third group of scholars finds no significant relationship between export earnings fluctuations and economic growth. They argue that developing countries are able to anticipate fluctuations in export earnings and therefore institute contingency plans to cushion such fluctuations; hence fluctuations in export earnings have no appreciable effect on economic growth (see Coppock, 1960; MacBean, 1966; Obidegwu and Nziramasanga, 1981).

Coppock (1960) was the first to examine the relationship between export earnings fluctuations and economic growth. His results show no correlation between export earnings fluctuations and gross national product (GNP). He also surmised that the degree of fluctuations in export earnings is greater in developed than in developing countries. This conclusion was also reached by MacBean (1966).

Two major flaws are inherent in the work of Coppock. First, his fluctuation index is considered a random estimate. Second, by using total GNP growth rates rather than per capita growth rates, he introduced an upward bias into the rates of the developing countries.

MacBean's (1966) findings are similar to those of Coppock. However, he did not give attention to the connection between investment and export earnings fluctuations.

Deaton and Miller (1996) note that the policy implications of trade shocks (which are in most cases temporary) experienced by sub-Saharan African countries have been the subject of debate for decades (see Gavin, 1993). A prime concern has been whether temporary shocks induce an efficient savings response. Collier and Gunning's (1995) conclusion is in the affirmative.

Oyejide (1997) characterized Nigeria's oil boom experience as a mixture of positive and negative shocks. The positive elements of the shocks came in 1973/74 and 1979; they were mild and short-lived. The negative shock occurred during 1977/78 and again in 1978/79. This shock was deeper and much more long lasting. The author observed that the government viewed the 1973/74 trade shock largely as a permanent phenomenon up to around 1977. However, the sharp decline of oil revenue between 1976 and 1978

provided an important lesson of experience that forced government to give some recognition to the short-lived nature of the oil boom phenomenon. According to the author, "reference to a 'wasting asset' and the need to transform its resources into some 'permanent' forms by quickly expanding the economy's productive capacity and building up its infrastructures are important clues to the gradually changing perception of the trade shock and resulting oil boom as temporary events which were generating windfall incomes that if wisely expended could create a future stream of permanent income" (Oyejide, 1997:123).

Deaton and Miller (1996) established that increase in export prices significantly raised output in the year of the shock. However, such gains were discovered not to be persistent in the post shock period because they did not reflect increases in the capital stock.

4. Methodology

Measurement of export earnings fluctuation index

A number of statistics have been used to measure export earnings fluctuations. An approach known as the least square method involves fitting a function of time to export earnings (see Naya, 1973). Another approach is the log variance method. This approach closely approximates the average year-to-year percentage variations in earnings from exports of goods and services adjusted for a constant percentage trend. The index equals the antilog of the square root of the logarithmic variance of the series. In this method, the expectation component is determined exclusively by the first and last observation. A major weakness of this approach is that the index is highly sensitive to the particular period chosen by the researcher. The complexity of the method is another inherent flaw.

The moving average method is yet another technique that has been widely used in the literature. It involves finding a moving norm or trend that yields deviations from a trend that appropriately balance over a short period of time (see Fleming et al., 1963; MacBean, 1966).

This study used the standard normalization combined with a moving average approach. Export earnings fluctuation (F) is derived applying the following formula:

$$F_t = \frac{X_t - X_{4_j}}{\sigma_{4_j}}, \text{ with } X_{4_j} = \frac{1}{4} \sum_{j=t-3}^t X_j \quad (1)$$

where X is the export earnings and σ_{4_j} is the standard deviation of the export earnings of a four-year period. The advantage of this method is that it distinguishes between rise and fall, temporary and permanent, and stochastic and predictable changes, all relative to the most recent experience in the indexes obtained. (See Appendix A for definitions of variables.)

Model specification

The shortcomings attendant on the application of the strict version of the neoclassical investment model as outlined by Jorgenson (1967) and Hall (1977) are abundantly demonstrated in the literature (see Galbis, 1979; Wai and Wong, 1982). Consequently, a

modified version that draws substantially on the works of Blejer and Khan (1984), Stordel (1990), and Sundararajan and Thakur (1980) is adopted in this study.

First, a partial adjustment function for capital stock is specified:

$$\Delta K_t = \beta_t (K_t^* - K_{t-1}) \quad (2)$$

with $K_t^* > K_{t-1}$;

But $\Delta K_t = 0$ when $K_t^* \leq K_{t-1}$.

where ΔK_t is the net investment, K_t^* is the desired capital stock, K_{t-1} is the capital stock of the economy at the beginning of period t , and β_t is the adjustment coefficient or speed of adjustment.

The desired capital stock and the adjustment coefficient are both endogenously determined. The desired capital stock equation is specified as follows:

$$K_t^* = d_1 + d_2 r_t + d_3 Q_t^* + d_4 F_t \quad (3)$$

$$(d_2 \leq 0, d_3 > 0, d_4 < 0)$$

where r_t is the real interest rate, Q_t^* is the expected output and F_t stands for the export earnings fluctuation index.

Equation 3 indicates that the desired capital stock is an increasing function of the expected output. This occurs because a rise in expected output can only be met by the procurement of additional inputs and hence an increase in the desired capital stock. An increase in interest rate, by raising the cost of capital, discourages investment thereby engendering a decline in the desired capital stock. This implies that the relationship between interest rate and the desired capital stock is inverse. In Nigeria, the influence of official interest rates on the desired capital stock is expected to be negligible because of the large discrepancy between the relatively high rates of return on investment and the interest rates on loans, which are kept artificially low by the monetary authorities (see Blejer and Khan, 1984). Finally, rises (falls) in export earnings fluctuations by lowering (increasing) returns induce a smaller (larger) desired capital stock (see Caballero and Pindyck, 1992).

There is a variety of ways to generate the expected output. Prominent among these are the adaptive expectation approach (see Cagan, 1956) and the general distributed lag method (see Bischoff, 1969) in which expected output is related to its past values, so that:

$$Q_t^* = a_0 + \sum_{i=1}^n b_i \text{Log} Q_{t-i} \quad (4)$$

where Q^* is the expected output and Q is actual output proxied by GDP. This study adopted the latter approach as several studies conducted on Nigeria using this approach

obtained robust results (see Egwaikhide et al., 1995). The lag period was limited to two years because of the shortness of the study period.

In line with Coen (1971), β varies systematically with economic factors that influence the ability of investors to achieve the desired level of capital stock. Export earnings fluctuation is postulated as one of such factors and the channel of transmission is easy to apprehend. Variations in the levels of export earnings fluctuation induce a slowdown or speed up of the adjustment process. For example, when there is a rise in export earnings fluctuations, investors become more cautious before making decisions, trying to obtain more information. This involves time and money, thus slowing down the process of adjustment. Therefore, the direct influence of export earnings fluctuations on the speed of adjustment is adverse.

The availability of financing is also an important factor influencing the coefficient of adjustment. The consensus in the literature is that the quantity rather than the cost of financial resources is one of the principal constraints to investment in developing countries (see McKinnon, 1973). In these countries, investment is financed predominantly through domestic savings because of the rudimentary nature of capital markets (see Bhatt and Meerman, 1978; Mweha, 1996).

Given the foregoing postulates, the coefficient of adjustment is expressed as a function of domestic savings (S_t) and export earnings fluctuation (F_t). This relationship is represented as follows:

$$\beta_t = \gamma + \frac{1}{K_t^* - K_{t-1}} (\eta S_t + \delta F_t) \quad (5)$$

$$(\eta > 0; \delta < 0)$$

The reduced form equation estimated (see Appendix B for derivation) is as follows:

$$K_t = \gamma d_1 + \gamma d_2 r_t + \gamma d_3 Q_t^* + (\gamma d_4 + \delta) F_t + (1 - \gamma) K_{t-1} + \eta S_t \quad (6)$$

Equation 6 was disaggregated into its public and private components and experimented with as follows:

$$GK_t = \gamma d_1 + \gamma d_2 r_t + \gamma d_3 Q_t^* + (\gamma d_4 + \delta) F_t + (1 - \gamma) GK_{t-1} + \eta GS_t \quad (7)$$

where GK is public capital stock and GS is public savings.

$$PK_t = \gamma d_1 + \gamma d_2 r_t + \gamma d_3 Q_t^* + (\gamma d_4 + \delta) F_t + (1 - \gamma) PK_{t-1} + \eta PS_t \quad (8)$$

where PK is private capital stock and PS is private savings.

Estimation technique

A time series approach was adopted in order to avoid potentially spurious results emanating from the non-stationarity of the data series and to analyse the short-run dynamic structure of the relationship. Engle and Granger (1987) suggest a two-step approach. First, the existence of a cointegrating relationship among the variables in equations 6, 7 and 8 is determined by standard cointegration techniques. If the variables are cointegrated, stable long-run relationships can be estimated using standard ordinary least squares (OLS) techniques. Second, the information in the error terms of the long-run relationships is used to create dynamic error correction models. The Micro TSP Econometric Views (E-View) 1994 software was used for estimating the models.

Sources of data

The data, which cover 1960–1995 for the aggregate model and 1973–1995 for the disaggregate models, were sourced in the main from international publications for consistency reasons. Data on export earnings, savings and gross domestic product derive from the International Financial Statistics of the International Monetary Fund (IMF), while series on public and private investment were obtained from the International Finance Corporation publications of the IMF. Data on gross fixed capital formation were culled from the World Tables of the World Bank.

Gross domestic product in constant 1990 prices was used for real output. Annual export earnings deflated by the GDP deflator served as real exports, while real savings was defined as nominal domestic savings deflated by the GDP deflator. Real short-term interest rate was derived by subtracting inflation from the nominal interest rate on loans. Investment series were generated by deflating the gross fixed capital formation by the import deflator. Capital stock was computed using the deflated investment series and defined as the sum of previous gross investment minus the replacement investment. Replacement investment was calculated assuming an annual depreciation rate of the capital stock of 10%.¹

5. Empirical results

Unit root tests

All variables are in log form except real interest rate and the export earnings fluctuation index, which have negative values. Table 2 lists the unit root test results. The table shows that capital stock (K), expected output (Q^*), savings (S) and interest rate (R) are $I(1)$; that is, they are stationary only at their first difference. However, the export earnings fluctuation index (F) is an $I(0)$, being stationary at its level.

Table 2: Unit root test statistics

Variables	ADF test
LogK	-1.87
Δ LogK	-4.08
LogGK	-1.75
Δ LogGK	-3.22
LogPK	-2.21
Δ LogPK	-4.21
LogQ*	-1.49
Δ LogQ*	-3.38
F	-3.10
LogS	-2.39
Δ LogS	-3.81
LogGS	-2.20
Δ LogGS	-4.54
LogPS	-1.98
Δ LogPS	-5.21
R	-2.19
Δ R	-3.89

Note: ADF critical value of the series is -2.97.

F , as an $I(0)$, was not included in the cointegration analysis because by definition an $I(0)$ is not expected to have a long-run relationship with $I(0)$ series (see Adams, 1992; Taylor, 1993).

Table 3 presents the results of the Johansen cointegration tests for the aggregate capital stock. The table shows that the variables are cointegrated as indicated by likelihood ratios that are greater than the critical values at both 1% and 5% levels, respectively.²

Table 3: Johansen cointegration test results

Sample:	1970 1995			
Included Observations:	26			
Series:	LogK, LogQ*, LogS and R			
Eigenvalue	Likelihood ratio	5% critical value	1% critical value	Hypothesized no of CE(s)
0.60	77.78	68.52	76.07	None**

**denotes rejection of the hypothesis at 5%(1%) significance level.
LR test indicates 1 cointegrating equation at 1% significance level.

Long-run capital stock regression results

With cointegration confirmed for the aggregate capital stock model, the long-run model was estimated. The results, which are contained in Table 4, confirm the negative association between interest rate and the capital stock. However, this association is not statistically significant. Furthermore, the magnitude of the interest rate's impact on aggregate capital stock is very small. This may be due to the large discrepancy prevailing between the relatively high rates of return on investment in Nigeria and the interest rates on loans, which are kept artificially low by the monetary authorities.

Table 4: Long-run aggregate capital stock model estimates

Modelling Log(K) by OLS Sample: 1970–1995		
Variable	Coefficient	t-value
Constant	14.1487	9.7161***
LogQ*	0.7800	3.5701***
LogS	0.0069	1.9430*
R	-0.0001	-0.6064

AdjR² = 0.65 F = 7.124(0.0008) σ = 0.1034 DW = 1.92
Schwarz information criterion = -4.125

The positive effect of savings and output on the capital stock in the long run, as amplified in the development literature, is confirmed by the results of this study. Output has a strong positive impact on the capital stock during the period under investigation. Its impact was also found to be statistically significant. The impact of savings on aggregate capital stock was not discovered to be highly significant in the long run.

Though cointegration tests could not be carried out for the disaggregated models because of an insufficient number of observations, the long-run models for private and public capital stock were nonetheless estimated. The results, which are contained in Appendix C, tables C1 and C2, indicate that output, savings and export earnings fluctuations affect private and public capital stock in Nigeria. The impact of savings on private capital stock is significant in the long run, but the impact on public capital stock is not.

Short-run capital stock regression results

With confirmation that the residuals from the cointegration regression are stationary (see Figure 3), the dynamic version of the long-run model was specified with the residuals from the cointegration regression as the error correction term (EC). An overparameterized error correction model was first estimated. Theory dictates that as many lags as possible should be included in the overparameterized model. However, greater consideration was given to the optimal lag rule for the series. The optimal lag was determined by minimizing the Akaike info criterion. By this criterion, the optimal lag was discovered to be one period. Furthermore, the shortness of the period of observation and the need to have sufficient degrees of freedom preclude the inclusion of longer lag periods.

Statistics and economic theory provided the guide to the parsimonious model. Accordingly, variables whose signs did not conform to economic expectations and those that had low t-statistics were construed to be zero.

The diagnostic tests for the overparameterized and parsimonious models, which are contained in tables 5 and 6, show that the AR test for autocorrelated residuals, the ARCH test for heteroscedastic errors and the Jarque–Bera normality tests for the distribution of the residuals are not significant as indicated by the levels of significance in parentheses. The tables also reveal that the Schwarz criterion (SC) declined from -7.26 in the overparameterized model to -8.24 in the parsimonious model.

Figure 3: Long-run model residuals

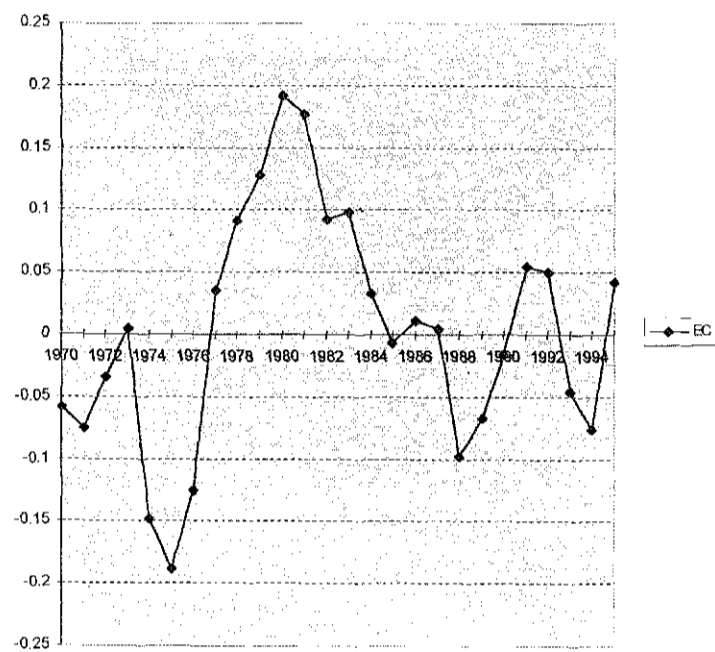


Table 5: Short-run overparametrized model estimates

Modelling $\Delta \text{Log}(K)$ by OLS Sample: 1970-1995		
Variable	Coefficient	t-value
Constant	0.0001	0.0341
$\Delta \text{Log}K(-1)$	0.1635	2.7346***
ΔR	-0.0006	-2.0502**
$\Delta R(-1)$	0.0002	0.7045
$\Delta \text{Log}S$	0.0001	0.0028
$\Delta \text{Log}S(-1)$	-0.0030	-0.0990
$\Delta \text{Log}Q^*$	-0.0165	-0.3094
$\Delta \text{Log}Q^*(-1)$	0.2150	2.1818**
F	-0.0471	-2.4805**
F(-1)	0.0358	0.0884
EC(-1)	-0.5173	2.4205**

Adj R² = 0.756 F = 2.91(0.0787) σ = 0.016 DW = 2.15
Schwarz information criterion = -7.2654

Diagnostic tests:
Normality [Chi²(1)] = 1.38(0.78)
ARCH 1 F[1,24] = 2.37(0.78)
AR 1-2 F[2,24] = 2.34(2.45)

Table 6: Short-run parsimonious model estimates

Modelling $\Delta \text{Log}(K)$ by OLS Sample: 1970–1995		
Variable	Coefficient	t-value
Constant	-0.0008	-0.2605
$\Delta \text{Log}K(-1)$	0.5033	4.6847***
ΔR	-0.0001	-0.2802
$\Delta \text{Log}S(-1)$	0.0057	0.6062
$\Delta \text{Log}Q^*(-1)$	0.1780	5.9049***
F	-0.0590	-2.9040***
$EC(-1)$	-0.4512	-5.9632***

Adj $R^2 = 0.546$ $F = 12.41(0.0000)$ $\sigma = 0.012$ $DW = 2.12$
 Schwarz information criterion = -8.24

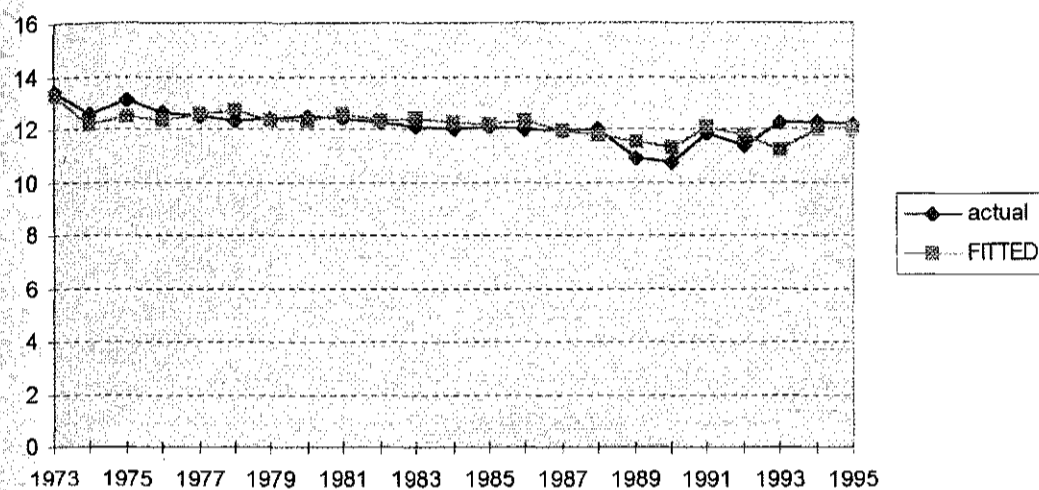
Diagnostic tests:
 Normality [$\text{Chi}^2(1)$] = 1.78(0.87)
 ARCH 1 $F[1,24] = 0.13(0.98)$
 AR 1-2 $F[2,24] = 1.20(1.32)$

Figure 4 shows that the parsimonious aggregate model tracks the data well over the sample period. Table 6, which presents the results of the parsimonious model, indicates that in the short run, expected output, savings and export earnings fluctuation affect investment (i.e., change in K). Specifically, expected output has a significantly positive impact on investments while the impact of savings is non-significant. Moran (1983) and Ghosh and Ostry (1994) had earlier reached a similar conclusion.

Though F is an $I(0)$, it may have a significant impact on investment, hence the inclusion of the variable in the short-run model (see Adams, 1992; Taylor, 1993). Table 6 shows that export earnings fluctuations affect investment in Nigeria in the short run. The impact is adverse and highly significant. The magnitude of the coefficient is 0.059, which compares with results obtained from similar studies for Africa and the developing countries in general. For example, Gyimah-Brempong (1991) obtained magnitudes of between 0.072 and 17.57, depending on the export earnings fluctuations index used. It should be noted that it is the current level of export earnings fluctuations that influences investment.

The structural models (equations 3 and 5) indicate that export earnings fluctuations affect the capital stock adversely through the desired capital stock and the speed of adjustment. In Equation 5, savings and export earnings fluctuations are the two critical variables determining the speed of adjustment. Friedman's theory of savings postulates that fluctuations in the stream of income affect the propensity to consume by requiring additional savings to cope with unexpected low incomes (see Friedman, 1957). Thus, the higher the fluctuations in the stream of income, the higher the propensity to save. Friedman's theory may not hold in developing countries like Nigeria, however, where incomes are below or at best at subsistence levels (see Ghosh and Ostry, 1994). This implies that savings may at best remain constant in response to fluctuations in earnings.

Figure 4: Parsimonious aggregate results graph



Given this premise, increases in export earnings fluctuations should slow the speed of adjustment. A rise in export earnings fluctuations causes the desired capital stock to plummet in Equation 3. The aggregate impact is a decline in net investment in Equation 2.

The coefficient of the error correction term [EC(-1)] indicates the speed at which aggregate investment adjusts in the long run to its main driving force. Table 6 shows that the variable is well defined. It is negative and highly significant.

Tables C3 and C4, and C5 and C6 (Appendix C) present the results of the overparameterized and parsimonious private and public capital stock models. The SC also declined from -5.69 and -4.35, respectively, in the overparameterized private and public capital formation models to -6.38 and -6.24, respectively, in the parsimonious models. These declines indicate model parsimony.

The results of the short-run parsimonious error correction models for the private and public capital stock contained in tables C4 and C6, respectively, reveal that savings and output affect capital formation in both sectors. However, while private savings have a significant impact on capital formation in the private sector, public savings do not significantly affect public capital formation. The tables also reveal that export earnings fluctuations adversely affect capital formation in both sectors. The impact is relatively larger in the public sector, however.

While the results of the private and public capital stock models are appealing, they should be taken with some caution. This is particularly the case as diagnostic tests could not be carried out because of the considerable loss in degrees of freedom arising from the calculation of capital stock in both sectors. This is in addition to the small sample size from which the results were obtained.

6. Policy lessons and conclusion

Given that export earnings fluctuation was found to adversely affect investment in the short run, it appears that export stabilization schemes are likely to stimulate investment by minimizing the debilitating effect of fluctuations in export earnings in the short run. However, it should be noted that the impact of such stabilization schemes on investment is not anticipated to be very large as a result of the small magnitude of the coefficient on export earnings fluctuations. The small extent of the reaction of investment to export earnings fluctuations in the short run suggests that other policy instruments could have a larger investment stimulating effect. It appears that a change in the official interest rate has no effect on investment. However, fiscal policy instruments may have the largest impact on investment, under the assumption that they affect output directly.

Finally, the small sample size on which the results are based implies that the policy lessons are suggestive and therefore should be taken with some caution.

Notes

1. The entire study period for the aggregate (Equation 6) and disaggregated (Equations 7 and 8) models is 1960–1995 and 1973–1995, respectively. However, the regression period for Equation 6 is 1970–1995, while that of equations 7 and 8 is 1983–1995. This is due to the 10% rate of capital stock depreciation applied in the study.
2. Cointegration tests could not be carried out for the disaggregated models because of insufficient number of observations.

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Appendix A: Definition of variables

β	-	Adjustment coefficient
F	-	Export earnings fluctuation index
K	-	Aggregate capital stock
GK	-	Public capital stock
PK	-	Private capital stock
K*	-	Desired capital stock
Q*	-	Expected output
r	-	Real interest rate
S	-	Domestic savings
GS	-	Public savings
PS	-	Private savings
X	-	Export earnings

Appendix B: Reduced form equation derivation

$$\Delta K_t = \beta_t(K_t^* - K_{t-1}) \quad (1)$$

$$\Delta K_t = K_t - K_{t-1} \quad (2)$$

$$K_t^* = d_1 + d_2 r_t + d_3 Q_t^* + d_4 F_t \quad (3)$$

$$\beta_t = \gamma + \frac{1}{K_t^* - K_{t-1}} (\eta S_t + \delta F_t) \quad (4)$$

From equations 1 and 2:

$$K_t - K_{t-1} = \beta_t(K_t^* - K_{t-1}) \quad (5)$$

$$K_t = K_{t-1} + \beta_t(K_t^* - K_{t-1}) \quad (6)$$

Substituting β_t in Equation 4 into Equation 6:

$$K_t = K_{t-1} + \left[\gamma + \frac{1}{K_t^* - K_{t-1}} (\eta S_t + \delta F_t) \right] (K_t^* - K_{t-1}) \quad (7)$$

$$K_t = K_{t-1} + \gamma(K_t^* - K_{t-1}) + (\eta S_t + \delta F_t) \quad (8)$$

$$K_t = \gamma K_t^* - \gamma K_{t-1} + \eta S_t + \delta F_t + K_{t-1} \quad (9)$$

Substituting K^* in Equation 3 into Equation 9:

$$K_t = \gamma(d_1 + d_2 r_t + d_3 Q_t^* + d_4 F_t) - \gamma K_{t-1} + K_{t-1} + \eta S_t + \delta F_t \quad (10)$$

$$K_t = \gamma d_1 + \gamma d_2 r_t + \gamma d_3 Q_t^* + \gamma d_4 F_t + (1 - \gamma) K_{t-1} + \eta S_t + \delta F_t \quad (11)$$

$$K_t = \gamma d_1 + \gamma d_2 r_t + \gamma d_3 Q_t^* + \gamma d_4 F_t + \delta F_t + (1 - \gamma) K_{t-1} + \eta S_t \quad (12)$$

$$K_t = \gamma d_1 + \gamma d_2 r_t + \gamma d_3 Q_t^* + (\gamma d_4 + \delta) F_t + (1 - \gamma) K_{t-1} + \eta S_t \quad (13)$$

Appendix C: Results of disaggregated models

Table C1: Long-run private capital stock model estimates

Modelling Log(PK) by OLS Sample: 1983–1995			
Variable	Coefficient	t-value	
Constant	5.1257	2.6981**	
LogQ*	1.3225	2.5941**	
LogPS	0.5874	1.9643*	
R	-0.0726	-0.6548	
AdjR ² =0.66 F=11.54(0.010) σ =0.25 DW=1.69 Schwarz information criterion = -2.584			

Table C2: Long-run public capital stock model estimates

Modelling Log(GK) by OLS Sample: 1983–1995			
Variable	Coefficient	t-value	
Constant	12.9877	3.1351***	
LogQ*	2.3297	2.5441**	
LogGS	0.3214	0.2683	
R	-0.0656	-0.9788	
AdjR ² =0.63 F=15.65(0.010) σ =0.48 DW=2.19 Schwarz information criterion = -1.054			

Table C3: Short-run overparameterized model estimates

Modelling $\Delta \text{Log}(\text{PK})$ by OLS Sample: 1983–1995		
Variable	Coefficient	t-value
Constant	0.2541	0.0258
$\Delta \text{LogPK}(-1)$	0.2546	1.9856*
ΔR	-0.5874	-1.9961*
$\Delta R(-1)$	-0.0025	-0.2580
ΔLogPS	0.0698	2.7554**
$\Delta \text{LogPS}(-1)$	-0.1541	-0.3850
ΔLogQ^*	0.0287	1.9870*
$\Delta \text{LogQ}^*(-1)$	-0.0975	-0.2590
F	-0.0049	-1.8918*
F(-1)	-0.0825	-0.5899
EC(-1)	-0.6853	-1.8975*

Adj R²=0.87 F=10.2(0.001) σ =0.497DW=2.18
Schwarz information criterion = -5.69

Table C4: Short-run parsimonious model estimates

Modelling $\Delta \text{Log}(\text{PK})$ by OLS Sample: 1983–1995		
Variable	Coefficient	t-value
Constant	0.0878	0.5485
$\Delta \text{LogPK}(-1)$	0.9873	2.1547**
ΔR -0.0023	-1.5820	
$\Delta \text{LogPS}(-1)$	0.0547	1.9875*
$\Delta \text{LogQ}^*(-1)$	0.6880	2.3001**
F	-0.0158	-2.4850**
EC(-1)	-0.5102	-2.4289**

Adj R²=0.476 F=2.1(0.101) σ =0.482DW=1.96
Schwarz information criterion = -6.38

Table C5: Short-run overparameterized model estimates

Modelling $\Delta \text{Log}(\text{GK})$ by OLS Sample: 1983–1995			
Variable	Coefficient		t-value
Constant	0.0632		0.2461
$\Delta \text{LogGK}(-1)$	0.2147		1.9742*
ΔR	-0.0580		-1.6261
$\Delta R(-1)$	-0.0009		-1.9806*
ΔLogGS	0.0006		0.2354
$\Delta \text{LogGS}(-1)$	0.0204		-0.4360
ΔLogQ^*	0.0431		1.9819*
$\Delta \text{LogQ}^*(-1)$	0.4561		0.4321
F	-0.0310		-2.5431**
F(-1)	-0.0042		-0.7861
EC(-1)	-0.5321		-1.9172*

Adj R² = 0.76 F = 4.78(0.1032) $\sigma = 0.2617$ DW = 2.18
Schwarz information criterion = -4.35

Table C6: Short-run parsimonious model estimates

Modelling $\Delta \text{Log}(\text{GK})$ by OLS Sample: 1983–1995			
Variable	Coefficient		t-value
Constant	-0.0538		-0.3460
$\Delta \text{LogGK}(-1)$	0.6214		2.1483**
ΔR	-0.0321		-0.9624
$\Delta \text{LogGS}(-1)$	0.4976		0.7132
$\Delta \text{LogQ}^*(-1)$	0.2630		1.9210*
F	-0.0516		-1.9325*
EC(-1)	-0.4691		-2.1432**

Adj R² = 0.556 F = 10.42(0.056) $\sigma = 0.412$ DW = 2.09
Schwarz information criterion = -6.24

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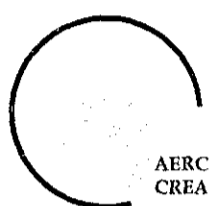
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