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AN ECONOMETRIC ANALYSIS OF NIGERIA'S EXPORT DEMAND*

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I. SOME GENERAL CONSIDERATIONS

Studies of the demand for exports of any country or territory are essential for a number of reasons which are particularly relevant in problems of international economic policy. In this connection, the problem of the stability of exchange rates first comes to mind. This is concerned with whether or not a country, more specifically an under-developed, primary producing country at that, can improve its balance of payments position either by export diversification or by devaluation or both. Secondly, there is the problem of which commercial policy a country could adopt, in an ideologically partitioned world, with respect to diversifications in export destinations (through tapping the hitherto untapped communist block sectors of the world market or through the determination of the optimum rate of tariff and/or subsidy). Thirdly, there is the issue of improving government revenue and foreign exchange earnings. Lastly, the need to offer advice on the problems raised above coupled with efforts to plan and implement development schemes presupposes the need for fairly precise and dependable quantitative information on the relevant elasticities of demand for and supply of exports.[1]

The present article attempts to estimate the relevant parameters of Nigerian export demand, especially for individual commodities of the export trade. Such estimates will throw useful light on three issues noted above.

In the remaining part of the study, section II discusses the nature of Nigeria's export trade with broad emphasis on the composition of exports, export earnings, their fluctuations and the need for export diversification. Section III discusses the relevant parameters of export demand which need estimation; it also examines their usefulness. The sources of data and methodology adopted for the study are considered in section IV. A discussion of the empirical results follows in section V, while the last section contains the summary and conclusions.

II. STRUCTURE OF NIGERIA'S EXPORT TRADE

Nigeria's export trade is largely made up of primary products. Of these products, agricultural crops constitute about 70 per cent by value. These crops include cocoa, groundnuts (nuts and oil), oil palm produce (kernels and oil), cotton, plantain and bananas, and rubber. Most of these products are handled by marketing boards. Animal products include cattle hides and skins (of goats, sheep and reptiles). Mineral products include such non-ferrous ores as tin ore, columbite, etc., and coal and petroleum. Export of petroleum is recent but

* We are grateful to Professor Andrzej Brzeski of the Department of Economics, University of California, Davis for helpful comments on earlier drafts of a research paper from which this article was extracted.

1. R. J. Ball, and Pamela S. Drake, "Export Growth and the Balance of Payments," *Manchester School*, Vol. 30, 1962, pp. 105-119.

is rapidly expanding. Among forest products wood as raw material in the form of logs and sawn timber is the major item of exports.

With efforts at export diversification, many more agricultural products are entering the export trade. New additions include copra, soyabeans, beniseed, grape fruit and lemons, coffee, ginger, gum arabic, kapok, pepper and chillies piassava and shea-nuts.

Nigeria derives a very substantial part of its gross domestic product from its export trade. The value of exports during the period 1948-64 has shown an upward trend (with minor oscillations) from the "low" of $251.75 million in 1948 to the all time "high" of $601.02 million in 1964. Export duty and/or taxes showed greater fluctuations during the 17-year period varying between the low of $29.32 million and a high of $59.64 million. The violent fluctuations that characterized export prices during this period have not been so seriously reflected in export earnings. This is due to increases in the quantity of exports as well as improvements in the quality of produce.[2]

III. PARAMETERS OF EXPORT DEMAND

Our main hypothesis is that the demand for Nigerian exports is affected by a host of variables other than their respective prices and/or the terms of trade. These variables include competitors' supply of produce, the rate and/or level of inventory in the importing countries, the index of industrial production in the purchasing countries, the taste pattern of buyers, the role of substitute and/or synthetics (partial or total), the barriers to trade (both natural and artificial), the extent or role of foreign loans floated by Nigeria abroad, etc. It is our contention, following Kaliski[3] that:

> "Movements in these shift parameters would not matter greatly if they were not associated with or correlated to movements in the prices or the terms of trade variable. Such 'random' movements would, to be sure, reduce the precision with which one can estimate the effects of prices on the quantities sold, but they would not affect the expected value or meaning of one's estimates."

One of the most important reasons for wanting to estimate the parameters of export demand is, therefore, to obtain the relevant elasticities and/or flexibilities. These elasticities and flexibilities are useful in measuring the rate of growth of exports, which, in itself, has a two-fold importance. The first stems from the future behaviour of exports as a pointer to the likely outcome of balance of payments position. This situation indirectly governs the rate of growth of output which planning authorities consider safe for economic growth. Secondly, the rate of growth of exports has a direct effect on aggregate growth of output through an impact of the multiplier mechanism. For developing countries like Nigeria, these two-fold benefits necessarily indicate that future rate of growth of output could become, more and more, inextricably intertwined with export prospects.

2. Federal Office of Statistics : Annual Abstract of Statistics, Government Printer, Lagos, 1960-1966 series.

3. S. F. Kaliski, "Some Recent Estimates of the Elasticity of Demand for British Exports," *Manchester School*, Vol. 29, 1961, pp. 23-42.

This contention does not ignore the hypothesis that the foreign sector becomes less important as a country develops. It is our belief that this hypothesis is only valid when a developing country has reached Rostow's stage of "the drive to maturity"[4]

The elasticity of demand for the exports of a single country, say Nigeria, will depend for its magnitude on three positions. The first position is that offered by the case whereby Nigeria possesses a world monopoly of a particular commodity. In this extreme case, which does not exist in practice (at least for Nigeria), the country will simply face the downward sloping demand curve in the world market. The second is the case of a demand curve of perfect elasticity where Nigeria's production and export would be a very negligible percentage of the export market, as in the case of soyabeans. A third case is where Nigeria supplies a significant proportion of the export market as is the case with cocoa, palm oil, palm kernels, groundnuts, etc. This position lies between the two previous extremes. The resulting price elasticity of demand for the exported commodities will be greater than the price elasticity of export demand for the commodity in general by an amount that depends on the proportion of the market supplied by Nigeria, and on the price elasticity of supply in other countries.

The relevant elasticities usually considered in export demand analyses are price elasticity of export demand, elasticity of export supply, the exchange elasticity of export demand, and the elasticity of export receipts.[5]

To explain these elasticities, let us define the export price in foreign currency for any given commodity as p, the amount exported as Q, the total world demand as D, the quantity supplied by other countries besides Nigeria as S*, and elasticity as E. Then we have the relation

$$\frac{dQ}{dp} = \frac{dD}{dp} - \frac{dS^*}{dp} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

This in terms of elasticities becomes,

$$E_{Qp} = \frac{D}{Q} E_{Dp} - \frac{S}{Q} Es^*p \ldots\ldots\ldots\ldots \quad (2)$$

where E_{Dp} is the price elasticity of demand in the export market, E_{Qp} is the price elasticity of export demand for Nigeria's given product, and E_{s^*p} is the price elasticity of supply in the competing countries. Thus equation 2 shows that the price elasticity of export demand for any given product of Nigeria will depend on the share of Nigeria in the export market of a given commodity and on the elasticity of supply in the competing countries as well as on the elasticity of demand for the commodity in the export market.

Horner[6] indicates that equation 2 will require further interpretation and some change before it can be used in empirical estimates. The demand term

4. W.W. Rostow: The Stages of Economic Growth, The Cambridge University Press, London, 1960, pp. 59-72.

5. Murray C. Kemp: The Pure Theory of International Trade, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, U.S.A., 1964, p. 324.

6. F. B. Horner, "Elasticity of Demand for Exports of a Single Country," *Review of Economics and Statistics*, Vol. 34, 1952, pp. 326-342.

$\left(\frac{D}{Q}EDp\right)$ and the supply term $\left(\frac{S^*}{Q}E_{s^*p}\right)$ can be divided into as many consuming and producing countries as there are. For example, the home market of each of the competing suppliers can be represented by a separate demand term in preference to interpreting their supply terms as relating to net exports only. Furthermore, he contends that the influence of important market frictions such as transport costs and trade restrictions (like tariffs, subsidies, export taxes, etc.) should be accounted for. Suppose t represents the specific tariff and transport cost per unit, and t* is the specific tariff and transport cost per unit between the competing country and the importing country. To take account of tariffs and transport costs, Horner indicates that equation 2 can be rewritten in a different form as:

$$E_{Qp} = \frac{D}{Q}\frac{P}{p+t}E_{Dp} - \frac{S^*}{Q}\frac{P}{p+t-t^*}E_{s^*p} \quad \ldots\ldots(3)$$

The exchange elasticity of export price represents the change in foreign price that is associated with a given change in exchange rate. Let p be the export price in foreign currency as previously defined, p* the export price in the domestic currency (say, £N), and r the exchange rate (defined as the price of foreign currency in Nigerian units). Then p* will be equal to rp. Furthermore, let export supply be x. The change in x and the change in Q with respect to variations in the exchange rate (r) may be said to be equal. Thus we have:

$$\frac{dx}{dp^*} \cdot \frac{dp^*}{dr} = \frac{dQ}{dp} \cdot \frac{dp}{dr} \quad \ldots\ldots\ldots\ldots \quad (4)$$

The equation 4 may be rewritten in terms of elasticities as follows (since $p^* = rp$):

$$E_{pr} = \frac{E_{xp^*}}{E_{Qp} - E_{xp^*}} \quad \ldots\ldots\ldots\ldots\ldots \quad (5)$$

where E_{xp^*} is the elasticity of export supply with respect to export price in the domestic currency. The elasticity of export receipt may be defined as the result of movements in price and quantity. In other words, it is a summation of the elasticities of export price and export demand. This may be rendered as follows :

$$E_{Rr} = E_{pr} + E_{Qr} \quad \cdots\cdots\cdots(6)$$

There will be an expression like the one in equation 6 for every commodity exported. Aggregation will be a simple matter in this case, since it will only refer to money values. We only need to add the elasticities of export receipts for individual commodities, each weighted by its share in total export receipts. No index number problem would be encountered in such an exercise. The exchange elasticity of total export receipts may be mathematically rendered as :

$$E\left(\Sigma R^i\right)r = \frac{d\Sigma Ri}{dr}\frac{r}{\Sigma Ri}\Sigma\frac{Ri}{\Sigma Ri}E_{Rr} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

for $i = 1, 2, \ldots, n$

The significance of equations 5 and 7 in export demand analysis lies in the fact that knowledge of the values of the components of E_{pr} and E_{Qr} makes it relatively easy for planners and analysts to determine whether devaluation of the currency will improve or worsen the balance of payments on the export side.

IV. METHODOLOGY AND SOURCES OF DATA

A study of the structure of commodity trade indicates the existence of causal relationships of supply and demand. Hence, in any empirical analysis, the most logical approach is one that uses a system of simultaneous equations.[7] But under certain simplifying assumptions, a single equation ordinary least square (OLS) method could be used with satisfactory results.

The statistical derivation of *ex-post* export demand functions attempted here assumes that a "routine" of demand exists so that the relations remain stable instead of being unduly disturbed by changes due to omitted variables. It also assumes that this routine can be revealed due to the availability of numerous observations capable of giving a series of equilibrium points. Lastly, it is assumed that the major shift variables are measurable and are included in the analysis.[8] Since changes in export prices in world commodity market have been such as to materially affect the balance of payments as well as the quantity exported, the measurable elasticities are the price elasticity of demand in the market of the consuming countries and the income elasticity of demand.[9] The elasticities of supply in Nigeria and in the competing countries are assumed given, since an accurate estimation of supply function is difficult due to data limitations.

If several explanatory variables moved independent of one another (*i.e*, if they were orthogonal variables), simple regression procedure would be sufficient in estimating the effects and influences. Under such a favourable situation, which hardly exists with time-series data, each explanatory variable would be allocated its "true" influence. Since the explanatory variables are not orthogonal, a multiple regression analysis technique is employed. A consideration of all the possible explanatory variables is impossible due to the limited degrees of freedom and to the fact that no practical technique could include all of them.

The least squares multiple regression technique adopted in this study is of the following form :

$$Q = f(P, K, X, Y, I, T, U) \quad .. \quad .. \quad .. \quad (8)$$

where Q is the quantity of the particular commodity exported by Nigeria, P is the price of the exported commodity in dollars per given unit weight, K is the measure of export control as typified by export taxes, X is the quantity exported by competing countries, Y is the real income of importing countries (which is

7. A.R. Bergstrom, "An Econometric Study of Supply and Demand: New Zealand's Exports," *Econometrica*, Vol. 23, No. 3, July, 1955, pp. 258-276.

8. J. Foytick, "Demand Characteristics for Selected Fruits in Honolulu, Hawaii 1947-1961," *Agricultural Economics Bulletin*, 24 December, 1964, University of Hawaii, pp. 19-23.

9. Raymond E. Zelder, "Estimates of Elasticities of Demand for Exports of the U. K. and the U.S. 1921-1938," *Manchester School*, Vol. 26, No. 1, January, 1958, pp. 37-47.

a mean real income for U.K., U.S.A., France, West Germany, and Japan), I is the mean index of industrial production (in the five countries listed under real income), T is the trend factor measured in years, and U is the error term assumed to have zero mean and constant variance.

The quantity exported, Q, is taken as the dependent variable because the empirical study is designed to "explain" fluctuations in quantities of the various commodities. This choice of Walrasian demand function does not attempt to imply that causation necessarily flows from price (P) to quantity than conversely. An examination of the commodity market structure suggests this choice as the usual type of cause and effect connection. Since the export price is given, the quantity exported is then dependent on the given price instead of the reverse. Direct allowance is also made for purchasing power, as measured by the mean disposable income (Y_d) of the chief importing countries. We have not assumed that "income" effect is reflected by the evolutionary changes included under "year" or trend (T) variable because the procedure is contrary to that often adopted and hence seems unjustified.

The trend variable (T) is included separately to take account of changes in technology/techniques of industrial processing of these commodities, such as the use of substitutes and/or synthetics, the degree of blending, etc. The inclusion of the index of industrial production (for manufactures, I) seems a little unjustified in the sense that it is industries' "census value added" component of the gross domestic product (GDP). In this sense, I variable may be said to be part and parcel of the income variable, and may not necessarily appear with Y_d as separate variables in the same equation. Our justification is that in attempts to find a "common" proxy variable for annual changes in industrial production, this index comes closest to the "ideal" variable. Inventory changes or depletion rate index of imported raw materials in store would have been the "ideal" variable, but this is not available in all cases.

The variables Y_d, I, and T may be said to be intercorrelated. This possibility of the existence of multicollinearity may produce large standard errors of the coefficients and thus head to unreliable estimates of the regression coefficients from the sample. The correlation matrix of the variables will be used to test the existence of multicollinearity following the constraint of $r_{YI} > 0.8$ imposed by Heady and Dillon.[10] The variables K and X are included as "proxies" for measuring the effects of restrictions on commodity exports. They are justified in the sense that international trade is *not* "restriction-free."

The form of equation adopted is based on fitting several alternative forms and of selecting that functional form which gives the "best fit" from among linear, curvilinear (second degree polynomial), Cobb-Douglas (or linear in logarithm), and exponential forms. Given the limitations and assumptions, the validity of the partial regression coefficients obtained from the study will largely depend on the independence of the error terms of the regression equation. In this connection, test for serial correlation using the Durbin-Watson[11] test statistics has been

10. E. O. Heady, and J. L. Dillon : Agricultural Production Functions, Iowa State University Press, Ames, Iowa, U.S.A., 1961, pp. 134-136.

11. J. Durbin, and G. S. Watson, "Testing for Serial Correlation in Least Squares Regression: I," *Biometrika*, Vol. 37, 1950, pp. 409-428; and "Testing for Serial Correlation in Least Squares Regression : II," *Biometrika*, Vol. 38, 1951, pp. 159-178.

undertaken. In cases where the test statistics are "inconclusive," the Theil-Nagar test[12] was used as a basis for the adjustment of the upper values of the Durbin-Watson test statistics.

The sources of data for the variables include the United Nations publications and official publications of the Government of Nigeria.[13] The annual series are for the period 1948-1964, thus omitting the two antebellum years (1965 and 1966) because of the stringent and restrictive trade measures imposed on foreign trade. As much as possible, actual data have been used in preference to indices, with the only exception of variable I. This preference for actual data is due to the fact that adjustors may introduce "distortions and spuriousness" into the relations, apart from the difficulty of making sure that the differences in the results often claimed for the use of adjustors are not secured merely as a by-product of the method of adjustment used.[14] Furthermore, errors in data constitute one of the most serious limitations in making forecasts from parameters obtained in any empirical analysis, especially those that use time-series data. It should be noted, of course, that the carefulness with which foreign trade data have been assembled in Nigeria (as in other developing countries), the efficient handling of the movement of exports by a State monopoly (the Marketing Board), and the nearly complete absence of smuggling in export transactions lead us to conclude that errors in data are *not* significant.

V. RESULTS OF ESTIMATING EQUATIONS

The four basic functions mentioned under methodology formed the basis for combining the six explanatory variables in many different forms. It was, however, decided to restrict our choice of estimating equations to those in which only the six explanatory variables are included for three chief reasons. Firstly, this is to prevent a drastic reduction in the degrees of freedom since only 17 observations were used in each regression (1948-1964). Secondly, even though an inclusion of the squared term of some of the variables such as P, T and K, improved the fit through higher R^2, this improvement is very small and the variables themselves become statistically insignificant with large sampling variances. It was, therefore, considered not worthwhile including the squared terms of the variables. Consequently, we are left with three functions, the linear, the power and the exponential.

(*a*) *Linear Function*

The results of the estimating equations for the linear function are shown as equation 9 (*i.e.*, equations 9.1 to 9.13) in Table I. The variables are as defined earlier under methodology and sources of data (section IV), while R^2 is the coefficient of multiple determination, d^+ is the calculated Durbin-Watson test statistic, and the figures in parentheses are the standard errors of regression coefficients. A blanket criterion adopted for testing the significance of the regression

12. H. Theil, and A. L. Nagar, "Testing the Independence of Regression Disturbances," *Journal of American Statistical Association*, Vol. 56, 1961, pp. 793-806.

13. United Nations : Yearbook of International Trade Statistics; Demographic Yearbook. Yearbook of National Accounts Statistics; Statistical Yearbook. Annual Series for 1956, 1960, 1964, and 1966.

14. J. Foytik, "Characteristics of Demand for California Plums," *Hilgardia*, Vol. 20, No. 20, April, 1951, pp. 407-527.

TABLE I—EXPORT DEMAND EQUATIONS : REGRESSION RESULTS USING LINEAR FUNCTION WITH QUANTITY OF EXPORT (Q) AS DEPENDENT VARIABLE

Equation 9		R^2	Constant term	P_t	K_t	X_t	Y_t	I_t	T	d+
9.1	Cocoa	.8687	—88.4667	—.0967 (.0452)	.4175 (.8291)	—.0634 (.0779)	.9466 (.4234)	.0995 (.3156)	—9.5911 (6.3936)	1.68r
9.2	Banana	.7673	244.4777	.4755 (.5104)	.5220 (.3698)	—.0074 (.0188)	—.8393 (.2555)	.4992 (.2366)	13.3728 (5.8398)	2.47
9.3	Cotton	.7820	106.1204	—.0098 (.1627)	.1643 (.2646)	—.0006 (.0008)	—.2159 (.2230)	.0104 (.1548)	5.9589 (4.3074)	3.10
9.4	Cattle hides ..	.8590	1.8161	.0058 (.0011)	—.0389 (.0209)	.0013 (.0005)	—.0239 (.0141)	—.0188 (.0131)	.1650 (.3100)	3.10
9.5	Animal skins ..	.8147	10.1874	.0016 (.0006)	—.0440 (.0199)	—.0030 (.0026)	—.0034 (.0121)	.0029 (.0110)	.1979 (.3465)	2.00
9.6	Tin ore	.7817	39.3340	.0008 (.0017)	—.1066 (.0682)	.0052 (.0032)	—.0898 (.0380)	—.0453 (.0364)	1.3729 (.6975)	1.93
9.7	Groundnuts ..	.7198	207.9417	—1.5611 (1.1165)	3.3751 (3.1966)	.0071 (.0438)	.7785 (1.6725)	.0378 (1.7092)	.3683 (29.1927)	2.32
9.8	Palm kernels ..	.7823	454.5665	—.8107 (.3306)	3.4011 (.1599)	.2425 (1.1956)	—.7010 (.4693)	.4619 (.5090)	7.3696 (11.6248)	2.14
9.9	Groundnut oil ..	.9783	—65.3947	.0013 (.0268)	.3571 (.1693)	.0582 (.0326)	.2513 (.0826)	—.1026 (.0819)	—.4584 (1.5874)	1.32r
9.10	Palm oil	.8026	277.4200	—.2830 (.1355)	1.5582 (.6031)	.0567 (.0568)	—.5169 (.3613)	.2959 (.2804)	3.7793 (8.5280)	2.14
9.11	Rubber	.7984	39.6097	—.0138 (.0275)	.0042 (.5088)	.0538 (.0653)	—.1763 (.2428)	—.3309 (.2521)	5.3823 (4.7535)	1.53r
9.12	Wood and timber	.8274	—407.2337	—8.2225 (8.5738)	1.1248 (3.5130)	.6578 (.7791)	—.7300 (1.7906)	1.9990 (2.0275)	15.7671 (40.3237)	2.41
9.13	Beniseed	.7085	—426.2217	.1915 (.5665)	2.1315 (1.6807)	—.0122 (.1107)	.9520 (.9243)	.6537 (.8104)	—28.9893 (18.6699)	1.86r

Note : Figures in parentheses are the standard errors of regression co-efficients.

co-efficients is that these co-efficients must be greater than or equal to twice the value of their respective standard errors of estimate. On this basis, many of the parameters are not significant.[15]

Similarly, our test for serial correlation is that the calculated d^+ statistic should be greater than the tabulated upper range of the Durbin-Watson statistic for the case of five regressors by at least 0.05. This tabulated value for 17 observations at the 1 per cent level of significant is 1.85. In other words, our blanket test statistic for the case of 6 regressors is 1.90. It should be stressed that this rather arbitrary test statistic would suffice to enable us to make valid judgments as to the predictive value of the regression co-efficients. On this basis, those equations in which the null-hypothesis is rejected by the calculated d^+ statistic are marked with letter "r". In this connection equations 9.1 to 9.11 and equation 9.13 show evidence of serial correlation.

Furthermore, in these linear estimating equations, the six regressors account for between 70.85 and 97.83 per cent of the variability in the quantity of the commodities exported. This is a considerable improvement over the results of an exploratory analysis where only between 20.62 per cent and 69.15 per cent was explained by two variables with the only exception of banana where it was 89.51 per cent.[16] This considerable improvement justifies our contention in that exploratory analysis that the degree of fit could be improved by making use of the variables which we have employed in the present study.

The linear function may be regarded as a useful predicting function for cotton, groundnuts, palm kernels, palm oil, and wood and timber. These are the commodities for which the estimating demand equations have proper signs, have high R^2, and also show no evidence of serial correlation. For cocoa and rubber the estimating equations have proper signs, with high R^2, but show evidence of serial correlation. The predictive value under such a condition will be subject to large sampling variances. This limits the usefulness of the equations for predicting demand for cocoa and rubber.

(*b*) *Power Function*

Equation 10 (*i.e.*, equations 10.1 to 10.13) in Table II is a presentation of the results in which the power function was used. The variables are as previously defined under the linear function, except that the asterisks (*e.g.*, Y_t^*) on the explanatory and dependent variables imply the natural logarithms of those variables.

The results show that the six regressors explain between 64.51 per cent and 97.88 per cent of the variability in the regressand. The regression co-efficients were mostly not significant, judged by the rule established earlier. Four of the

15. N. Draper, and H. Smith : Applied Regression Analysis, John Wiley & Sons, Inc., New York, 1966, p. 407; and E. J. Working, "What do Statistical Demand Curves Show," *Quarterly Journal of Economics*, Vol. 41, 1927, pp. 215-235.

16. S. O. Olayide, "Some Estimates of Supply and Demand Elasticity in Nigeria's Foreign Trade," *Journal of Business and Social Studies*, Vol. 1, No. 1, September, 1968, pp. 1-9.

TABLE II—EXPORT DEMAND EQUATIONS : REGRESSION RESULTS USING POWER FUNCTION (LINEAR IN LOG) WITH QUANTITY OF EXPORTS (Q*) AS DEPENDENT VARIABLE

Equation 10		R^2	Constant term	P_t^*	K_t^*	X_t^*	Y_t^*	I_t^*	T^*	d+
10.1	Cocoa	.8777	4.4198	—.5073 (.2143)	.1089 (.2465)	—.4639 (.3759)	1.0040 (.3573)	.0967 (.2245)	.1232 (.0463)	2.46
10.2	Banana	.8047	—.1603	.4779 (.7094)	.3892 (.2549)	.5856 (.7875)	—1.3119 (.6255)	.8273 (.3777)	—.2036 (.0713)	2.77
10.3	Cotton	.8860	—6.0165	.0334 (.2937)	.5662 (.3063)	—.1035 (.2770)	1.3753 (.2920)	.0488 (.4520)	—.1652 (.0934)	3.26
10.4	Cattle hides ..	.8168	—10.9274	.7437 (.2027)	—.2458 (.1533)	1.6251 (.6762)	—.7206 (.2327)	—.3629 (.2270)	—.0954 (.0716)	2.65
10.5	Animal skins ..	.8889	5.7271	.4903 (.2731)	—.3684 (.1824)	—.9431 (1.1361)	—.0507 (.6314)	.1252 (.2482)	.0783 (.0509)	1.75r
10.6	Tin ore	.7983	5.6116	.4111 (.2748)	—.2689 (.3381)	.2093 (.3381)	—.7870 (.5470)	—4601 (.4287)	—.2095 (.0860)	1.95
10.7	Groundnuts ..	.6451	—1.2732	—.6629 (.6414)	.4602 (.4496)	.8128 (1.8054)	.3873 (.9885)	—.1932 (.5458)	.0224 (.1057)	2.23
10.8	Palm kernels ..	.7518	5.1067	—.3119 (.1522)	.4060 (.1499)	.3317 (.2798)	—.2948 (.2659)	.1358 (.1459)	—.0096 (.0371)	2.15
10.9	Groundnut oil ..	.9788	—19.1838	.0471 (.3915)	.8450 (.3294)	—.3774 (.4541)	3.8407 (.3783)	—.1102 (.3900)	—.4772 (.0938)	1.49r
10.10	Palm oil	.7885	7.6504	—.3882 (.1844)	.4710 (.1612)	.3339 (.2377)	—.8882 (.3773)	.1871 (.1753)	—.0015 (.0663)	2.09
10.11	Rubber	.9521	—11.1021	.3278 (.2651)	.3570 (.3216)	.2351 (1.8111)	2.1270 (.6088)	—.4852 (.4005)	—.3766 (.0756)	1.64r
10.12	Wood and timber	.8290	—19.7625	—1.0216 (.8038)	.2374 (.4115)	3.3399 (4.1763)	—.0886 (1.8615)	.9257 (.6513)	—.0995 (.1039)	2.29
10.13	Beniseed	.8271	10.1173	.4372 (1.5504)	1.6989 (.9217)	.1957 (.7913)	—4.1297 (1.0281)	1.4596 (1.1255)	.6789 (.2493)	1.87r

Note : The figures in parentheses are the standard errors of regression coefficients.

estimating equations (equations 10.5, 10.9, 10.11 and 10.13) show the presence of serial correlation in the residuals. The results appear more dependable than those of the linear function. The function will be most ideal for predicting demand situations for cocoa, groundnuts, palm kernels, wood and timber, and palm oil. For the other commodities, the equations are either wrongly signed or they show evidence of serial correlation or both. In such cases, the equations could still be used for predictive purposes, but their limitations should be clearly understood.

(*c*) *Exponential Function*

The results of the estimating equations for the thirteen commodity exports are presented as equation 11 (*i.e.*, equations 11.1 to 11.13) in Table III. Most of the regression coefficients are not statistically significant, while five of the estimating equations show evidence of serial correlation (*i.e.*, those in which the d^+ statistic is marked with "r"). The function has, however, provided a good fit to data. This is illustrated by the fact that the six main explanatory variables account for between 64.69 per cent and 95.50 per cent of the variability in the quantity of commodity exports.

This function is of the inverse semi-log type. Thus, for cases in which b_{pt} (that is, the regression coefficient of the price variable) is less than zero, the demand curve is well-behaved. This function thus provides a good estimate of the export demand equation for cocoa, cotton, groundnuts, palm kernels, palm oil, wood and timber, and rubber. Of these seven commodity estimating equations having proper signs, two (rubber and cocoa) show evidence of serial correlation, thus limiting predictive value of the function to them. For the remaining five commodities, the exponential function could provide useful predictions of price-quantity relationships.

In interpreting the statistical results presented in Tables I, II and III, there is a need to be aware of the limitations inherent in the level of aggregation and the inability to specify, in a more detailed fashion, the structural components of the export demand.

Furthermore, there is the problem of the proper signs of the variables. Our expectations as to "signs" taken by the regression coefficients are negative for P_t, negative or positive for K_t (which implies that restriction hurts or it does not hurt), positive or negative for X_t (implying competing or moving together), strictly positive for Y_t (but negative sign could permissibly imply that less of the product is purchased with a rise in income), positive or negative for I_t (implying a quickening or a slackening in demand with rise in industrial activity) and positive or negative for T (implying increasing or decreasing "taste" for the commodity over time). Outside of these rather special explanations, wrong signs are largely due to random factors in the variables, or to wrong estimating equations or to both.[17]

The most serious "signing" error is that of P_t. The results show that the three functions gave wrong signs for regression coefficient of this variable for banana,

17. H. Wold and L. Jureen : Demand Analysis : A Study in Econometrica, John Wiley & Sons, Inc., New York, 1953, p. 358; and Carl F. Christ: Econometric Models and Methods, John Wiley & Sons, Inc., New York, 1966, p. 705 (specifically Chapter 10, pp. 495-578).

TABLE III—EXPORT DEMAND EQUATIONS : REGRESSION RESULTS USING EXPONENTIAL FUNCTION (INVERSE SEMI-LOG) WITH QUANTITY OF EXPORTS (Q*) AS DEPENDENT VARIABLE

Equation 11		R^2	Constant term	P_t	K_t	X_t	Y_t	I_t	T	d+
11.1	Cocoa	.8777	3.4342	.0008 (.0004)	.0046 (.0067)	—.0005 (.0006)	.0062 (.0034)	.0014 (.0025)	—.0606 (.0516)	1.79r
11.2	Banana	.7875	7.0961	.0062 (.0080)	.0082 (.0058)	—.0001 (.0003)	—.0132 (.0040)	.0070 (.0037)	.2052 (.0922)	2.46
11.3	Cotton	.8708	6.4258	—.0001 (.0005)	.0094 (.0084)	—.0001 (.0002)	—.0100 (.0071)	.0004 (.0049)	.2680 (.1370)	2.76
11.4	Cattle hides ..	.8350	1.9556	.0008 (.0002)	—.0057 (.0034)	.0002 (.0001)	—.0050 (.0023)	—.0025 (.0022)	.0550 (.0511)	2.96
11.5	Animal skins ..	.8407	2.1446	.0004 (.0002)	—.0110 (.0051)	—.0006 (.0007)	—.0001 (.0031)	.0013 (.0028)	.0194 (.0885)	1.81r
11.6	Tin ore	.7895	6.0738	.0001 (.0002)	—.0088 (.0084)	.0004 (.0004)	—.0116 (.0047)	—.0052 (.0055)	.1711 (.0863)	1.92
11.7	Groundnuts ..	.6469	5.8197	—.0041 (.0036)	.0102 (.0103)	.0001 (.0001)	.0005 (.0054)	—.0016 (.0055)	.0234 (.0943)	2.24
11.8	Palm kernels ..	.7653	6.1437	—.0020 (.0009)	.0082 (.0030)	.0006 (.0005)	—.0018 (.0012)	.0013 (.0013)	.0203 (.0302)	2.09
11.9	Groundnut oil ..	.9550	5.4937	.0026 (.0018)	.0217 (.0114)	.0040 (.0022)	—.0144 (.0056)	—.0025 (.0055)	.4362 (.1072)	1.46r
11.10	Palm oil	.7826	5.7175	—.0016 (.0009)	.0094 (.0039)	.0004 (.0004)	—.0032 (.0024)	.0019 (.0018)	.0211 (.0556)	2.11
11.11	Rubber	.8840	5.0387	—.0001 (.0007)	.0056 (.0124)	.0016 (.0015)	—.0128 (.0059)	—.0051 (.0061)	.2997 (.1157)	1.57r
11.12	Wood and timber	.8468	6.6791	—.0330 (.0239)	.0012 (.0098)	.0012 (.0022)	—.0079 (.0050)	.0081 (.0057)	.1727 (.1125)	2.47
11.13	Beniseed	.7490	—4.7639	.0001 (.0093)	.0354 (.0276)	—.0005 (.0018)	.0178 (.0152)	.0139 (.0133)	—.5208 (.3062)	1.73r

Note : The figures in parentheses are the standard errors of regression co-efficients.

cattle hides, animal skins, tin ore, groundnut oil, and beniseed. Only power function gave wrong signs for cotton and rubber. The limitations in this connection arises in the calculation of price elasticity of demand for export. In the cases where positive sign appears for P_t, X_t always possesses a negative sign or, in default, the proportion of Nigeria's contribution to world demand is very small. Consequently, wrong sign for P_t does not constitute any serious limitations on the usefulness of the results for forecasting and/or predictive purposes.

The elasticities which might be considered useful in planning export promotion and diversification policies are partial price elasticity of export demand (E_P), partial income elasticity of export demand (E_Y), and partial elasticity of export supply by competing producers (E_X). These elasticities are calculated for the mean values of the variables in equations 9 and 11 while the regression co-efficients in equation 10 are direct elasticities. These are shown in Table IV.

In general, the results of the regression analyses and the calculated elasticities in Table IV show that exports were not too sensitive to prices, competitors' supply, export taxes and fluctuations in industrial activity during the period under study. On the other hand, the results in Table IV show that export demand was generally income elastic for cocoa, banana, cotton, groundnut oil, rubber and beniseed. The linear and exponential functions also indicate income elastic demand for cattle hides, tin ore, and palm oil, while only the exponential function gives an indication of income elastic demand for wood and timber. The other commodities (animal skins, groundnuts, and palm kernels) are income inelastic.

IV. SUMMARY

An attempt has been made in this paper on Nigeria's foreign trade to estimate the export demand equations for thirteen commodities. Tin ore is the only mineral included in the analysis, while petroleum was excluded because as a young industry and a late-comer, any regression analysis will be faced with the problem of small degrees of freedom. On the other hand, our justification for excluding coal is that it is a declining industry which no longer serves any external market. The other twelve commodities are agricultural products in processed or semi-processed forms. Since the full list of exports is not covered by the analysis, it is not realistic to obtain aggregate export demand elasticities by assigning weights to the individual commodity estimates, even though 13 commodities accounted for over 70 per cent of the exports during the period under study.

The results of the estimating equations show that the three functions—linear, power and exponential—provide good fit to data and could be very useful for estimating price-quantity relationships in export trade. The six explanatory variables account for 65 to 98 per cent of the variability in commodity trade and hence are useful variables in forecasting future demand for export.

Several reasons may be adduced for the low industrial activity elasticity of demand for exports and for the negative income elasticity. Firstly, this usually is the case with food items. Secondly, it is very true for raw materials due to increasing substitution of synthetics and to the fact that technological progress has made possible economies on use of raw materials in making a product. Lastly,

TABLE IV—ELASTICITIES FROM EXPORT DEMAND EQUATIONS

	E_P			E_X			E_Y		
	Equation 9	Equation 10	Equation 11	Equation 9	Equation 10	Equation 11	Equation 9	Equation 10	Equation 11
1. Cocoa	—.476	—.507	—.520	—.369	—.464	—.385	+2.318	+1.004	+2.027
2. Banana	+.733	+.478	+.622	—.349	+.586	—.307	—4.209	—1.312	—4.316
3. Cotton	—.248	+.033	—.068	—.344	—.104	—1.540	—2.624	+1.375	—3.270
4. Cattle hides ..	+.651	+.744	+.548	+1.818	+1.625	+1.706	—1.281	—.721	—1.635
5. Animal skins ..	+1.004	+.490	+.753	—2.400	—.943	—1.498	—.356	—.051	—.033
6. Tin ore	+.118	+.411	+.147	+.766	+.209	+.590	—2.936	—.787	—3.793
7. Groundnuts ..	—.679	—.663	—.720	+.204	+.813	+1.160	+.630	+.388	+.163
8. Palm kernels ..	—.281	—.312	—.285	+.301	+.332	+.305	—.559	—.295	—.582
9. Groundnut oil ..	+.012	+.047	+.799	+.398	—.377	+.936	+2.403	+3.841	—4.709
10. Palm oil	—.365	—.388	—.348	+.192	+.334	+.229	—1.001	—.888	+1.046
11. Rubber	—.172	+.328	—.053	+2.377	+.235	+2.997	—1.360	+2.127	—4.185
12. Wood and timber	—.460	—1.022	—.992	+2.021	+3.340	+1.983	—.444	—.889	—2.583
13. Beniseed	+2.778	+.437	+.019	—.463	+.196	—.252	+6.997	—4.130	+5.820

in developed countries rising incomes means expansion of the tertiary[18] sector which absorbs less raw materials. No attempt has been made to estimate the elasticity of substitution between Nigeria's exports and those of our competitors since we have not used producer prices in our analysis. But we have tried to measure instead elasticity of export supply by competitors and this leads to some multicollinearity in our results.

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18. G. C. Da Costa, "Elasticities of Demand for Indian Exports—An Empirical Investigation," *The Indian Economic Journal*, Vol. 13, No. 1, July-September, 1965, pp. 41-54.