IMPORT ELASTICITIES OF AFRICAN COUNTRIES: SOME EMPIRICAL EVIDENCE

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ABSTRACT

This paper uses time series data to estimate disaggregated import elasticities for a sample of Sub-Saharan African countries. The results suggest systematic patterns of import behaviour even with reservations about the quality of the data. Oil imports appear income (GDP) elastic. The relative prices for oil and food imports have mostly inelastic and negative coefficients. There is indication of a structural shift particularly in food imports and intermediate goods imports in a few countries following the oil crises (post 1973). The overall results confirm a scope for import substitution production of food and energy, and price rationing of imported goods.

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Imported goods have been crucial for economic activity in Sub-Saharan African countries particularly where imported investment goods are a source of capital formation, agriculture and import-substitution manufacturing industries depend on imported intermediate goods, and food imports constitute a significant component of consumption. These roles of imports in economic growth and development underlie interest in import elasticity estimates, since they are relevant for indicating the extent of import compression consistent with growth targets, and the efficacy of pricing policies for correcting persistent balance of payments deficits.

Though import studies depending mainly on cross-section and aggregate data for low income African countries and other developing regions exist (e.g. Winters, 1984, 1985; Taylor et al, 1984; Chow et al, 1981), there is a dearth of evidence on disaggregated import elasticities for individual Sub-Saharan African countries. This study uses time series data to estimate import elasticities of major commodity groups for a sample of Sub-Saharan African countries. The commodity groups are (a) food imports, (b) investment goods imports, (c) petroleum imports and (d) intermediate goods imports.

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The estimated results suggest that oil imports are income elastic which is consistent with studies using cross-section data (e.g. Manne, 1981; Chow et al, 1981). For food imports the per capita agricultural output elasticity is ambiguous, being positive for some countries (e.g. Nigeria, Ghana, Liberia, Senegal) and negative for others (e.g. Malawi, Ivory Coast, Togo, Niger), and therefore only partially consistent with Winters (1984) who found a positive coefficient using cross-section data for low income African countries. This would suggest the need for caution in applying results of cross-section studies of food imports to individual countries.

For the intermediate and investment goods imports, the estimated coefficients have the expected signs and most are statistically significant. The lagged dependent variables appear unimportant in most equations. The intercept dummy variables indicate structural shifts in the import patterns of some commodities in the post-oil-crises (after 1973) period, resulting in increased food imports in some cases (e.g. Niger, Nigeria, Liberia, Togo), and reduced intermediate goods imports in other cases (e.g. Tanzania, Niger). The jump in food imports (DUM in Table 2) coincided with increases in the prices of petroleum and petroleum based agricultural inputs (FAO, 1983). The behaviour of investment goods imports appear to be the least affected by the oil crisis.

The quality of data problems and dependence on a sample of 14 out of 39 countries in the region would warrant some modesty in making inferences from the estimation. Still systematic patterns in the results cannot be ignored. The confirmation of an elastic GDP elasticity for oil imports, for example, suggests a limited scope for

compressing oil imports to a growth rate below expected GDP growth. Similarly the coefficients of the relative prices for oil and food imports appear mostly negative and inelastic. Increases in world prices would lead to more foreign exchange expenditures on these goods. However, given world prices, increases in domestic prices (through tariff or exchange rate adjustment) would raise the domestic currency expenditures while reducing import demand, and foreign exchange expenditures on these goods. Thus pricing policies remain relevant for rationing these imported goods and seeking improvements in external imbalances.

Analytical Framework

The major models of import behaviour in the developing countries include (a) the standard trade model based on imperfect substitution between imports and domestically produced goods (Khan, 1974; Houthaker and Magee, 1969), (b) models concerned with long-run external equilibrium with imports depending on external earnings and reserves (Hemphill, 1974), (c) models of inter-temporal utility maximization which use external borrowing to achieve orderly external financing flows despite fluctuations in export receipts (Sachs, 1981, Dornbusch, 1983), and (d) eclectic models embracing aspects of the other models (Winters, 1985).

These models presume cost minimization (utility maximization) among producers (consumers). The relevant costs include import prices, costs of reserve fluctuations, and output costs due to import compression. Each model, thus gives guidance on the factors that theoretically should explain import behaviour. Empirically, however,

the selection of variables that enter the import demand function tends to depend on the commodity grouping, data considerations, and the structural characteristics of the economy.

For the four commodity groupings mentioned above, the import equations are stated as:

$$FM_t^d = G(AGY_t, PF_t) \qquad G_1 \gtrless, G_2<0 \qquad (1)$$

$$OM_t^d = H(GDP_t, PO_t) \qquad H_1>0, H_2<0 \qquad (2)$$

$$KM_t = R(INV_t, XE_t) \qquad R_1>0, R_2>0 \qquad (3)$$

$$INM_t = S(IDY_t, XE_t) \qquad S_1>0, S_2>0 \qquad (4)$$

$$PF = (1 + TRF)\ E/PFh \qquad (5)$$

$$PO = POw\ (1 + TRO)\ E/POh \qquad (6)$$

Variables

AGY = Per capita agricultural output

DUM = Dummy variable

E = Exchange rate

FM = Per capita food import

IDY = Industrial output

INM = Import of intermediate goods

INV = Gross domestic investment

KM = Import of machinery and transportation equipment

OM = Petroleum imports

PF = Relative price of imported food

PFh = Domestic food price index

PFw = World price index of imported food

PO = Relative price of oil

POh = Domestic food price index

POw = World price of oil

TRF = Tariff on food import

TRO = Tariff on oil import

XE = External earnings

Equations (1) and (2) follow the standard trade model with relative prices PF and PO capturing substitution between imported food and locally produced food, and between imported oil and domestic energy sources such as fuelwood, agricultural waste, and hydro-power (Parikh, 1978; Anderson and Fishwick, 1984). Equations (3) and (4) on the other hand, belong to the Hemphill type of models with imports dependent on activity levels and foreign exchange constraints. The equations (3 and 4) also reflect economies with no adequate domestic substitution production of capital and intermediate goods.

The specification is completed by imposing a simple partial adjustment representing lag response and some quantity rationing in the light of persistent external imbalances and foreign exchange bottlenecks. Assuming a Cobb-Douglas form for the import function and for a simple one period lag structure lead, in the case of equation 1 for example, to the log-linear relation:

$$\text{In}FM_t = \beta_0 + \beta_1 \ln AGY_t + \beta_2 \ln PF_t + \beta_3 \ln FM_{t-1} + e_t$$

where β_3 is the partial adjustment coefficient, and the coefficients for AGY and PF are respectively: $\gamma_1 = \beta_1/(1-\beta_3)$, and $\gamma_2 = \beta_2/(1-\beta_3)$.

Data

One difficulty with the empirical investigation is the quality of the import data. To minimize inconsistencies due to mixing data from various sources, the estimation is based on data from the International Monetary Fund and World Bank Trade System. Fourteen countries out of a total of 39 in the region are included in the sample on the basis of availability of data.

The classification of imports follow the international (SITC) convention.

SITC 0 = Import of food and live animals

SITC 33 = Petroleum imports

SITC 7 = Imports of machinery and transportation equipment.

SITC 2 + 6 + 51 + 52 + 53 = intermediate goods imports.

These together constitute between 75 and 90 percent of the value of merchandise imports during 1980-84. Figures are in constant 1980 US dollars.

Foreign exchange earnings are represented by the purchasing power of exports (value of exports deflated by the unit value of imports). World prices are represented by the unit value indices of the relevant imports, and the consumer price index is a proxy for domestic prices. Tariffs are excluded from the price variables because of inadequate data.

The sample size (N) and period of data are Ethiopia (21), 1962-82; Ghana (19), 1962-80; Ivory Coast (22), 1962-83; Liberia (20), 1962-82; Malawi (18), 1964-81; Niger (20), 1962-81; Nigeria (20), 1962-81; Senegal (20), 1962-81; Somalia (20), 1962-81; Tanzania (15), 1967-81; Togo (20), 1962-81; Zaire (17), 1962-78; Zambia (16), 1964-79.

Estimation Technique and Results

Since imports are disaggregated, there is no a priori reason to suppose simultaneity with export receipts. Also tests of serial correlation did not show significant results. Therefore, the ordinary least squares technique was applied. The impact of the oil crises was captured with a dummy variable (DUM) specified as zero up to 1973, and unity afterwards. Of the 14 countries included in the sample, only the results of 10 are reported for each equation (Table 1-4). The other results show implausible coefficients with the independent variables having very little explanatory power.

As the results show, oil import demand is income elastic. Countries with important mining sectors (Zaire and Zambia) have relatively higher elasticities (Hoffman and Mors, 1979) of 2.9 and 2.7 respectively. Most of the other GDP elasticities are within the range of 1.2 and 1.9 obtained from cross-section estimates for developing countries (Choe et al, 1981; Manne, 1981) except Malawi which has an extreme value of 3.6. Liberia's rather low estimate (0.47) is not statistically significant.

For oil and food imports the relative prices are statistically significant for the most part with negative and inelastic coefficients. The output elasticity for food imports is however, ambiguous, being positive for countries in the sample (Nigeria, Ghana, Liberia, Senegal) which have "poor" growth in agriculture, and negative for other countries (Ivory Coast, Malawi, Togo, Niger) which broadly have achieved relatively higher agricultural growth[1/]. These results are not entirely consistent with Winters (1984) who found a positive output elasticity for food imports from a cross-section data for low income African countries[2/]

Table 1: PETROLEUM IMPORT ELASTICITIES

	GDP	PO	LAG	DUM	R^2	DW
Ethiopia	1.2 (0.47)*	-0.35 (0.70)	-	-	0.68	0.7
Ghana	1.08 (0.39)*	-0.14 (0.03)*	-	-	0.45	1.8
Ivory Coast	1.35 (0.15)*	-0.49 (0.10)*	-	0.62 (0.19)*	0.89	1.5
Liberia	0.47 (2.4)	-0.10 (0.06)**	-	-	0.67	2.0
Malawi	3.6 (0.22)*	-0.10 (0.03)*	-	0.16 (0.13)	0.98	1.5
Niger	1.8 (0.51)*	0.06 (0.05)	-	-	0.52	1.5
Somalia	1.41 (0.89)**	-1.04 (0.09)*	- -	1.06 (0.34)*	0.90	2.2
Tanzania	1.90 (0.74)*	-1.10 (0.10)*	-	-	0.70	1.9
Zaire	2.92 (0.74)*	-0.67 (0.10)*	-	-	0.73	1.9
Zambia	2.7 (1.5)**	-0.39 (0.14)*	0.16 (0.23)	-	0.65	2.3

Standard errors are in parentheses.

DW = Durbin Watson Statistic.

R^2 is adjusted for degrees of freedom.

* = Statistically significant with 5 percent error for one sided t test.

** = Statistically significant with 10 percent error for one sided t test.

Constant terms are not reported.

Table 2: ELASTICITY OF FOOD IMPORTS

	AGY	PF	LAG	DUM	R^2	DW
Ethiopia	-0.72 (0.85)	-0.75 (0.20)*	0.51 (0.15)*	-	0.74	2.1
Ghana	0.83 (0.62)*	-	-	-	0.66	1.5
Ivory Coast	-0.61 (0.41)**	-0.73 (0.21)*	-	0.39 (0.18)*	0.66	2.3
Liberia	0.38 (2.0)	-0.88 (0.25)*	-	0.35 (0.17)*	0.60	2.1
Malawi	-0.33 (0.38)	-0.077 (0.34)	-	-	0.2	1.5
Niger	-0.43 (0.24)*	-1.43 (0.37)*	-	0.55 (0.18)*	0.60	2.1
Nigeria	1.06 (0.54)*	-1.93 (0.25)*	-	0.98 (0.12)	0.92	1.8
Senegal	0.28 (0.19)**	-0.46 (0.28)*	-	-	0.2	1.5
Somalia	0.3 (0.32)	-0.43 (0.20)*	-	-	0.2	2.3
Togo	-1.6 (1.3)	-1.5 (0.39)*	-	0.27 (0.19)**	0.68	1.6

Table 3: INVESTMENT GOODS IMPORTS ELASTICITIES

	INV	XE	LAG	DUM	R^2	DW
Ivory Coast	0.34 (0.11)*	0.84 (0.19)*	-	-	0.98	2.0
Liberia	0.39 (0.10)*	0.39 (0.11)*	-	0.11 (0.07)**	0.75	1.3
Malawi	0.57 (0.12)*	0.24 (0.26)	-	-	0.83	2.0
Senegal	0.51 (0.25)*	0.29 (0.12)*	0.64 (0.12)*	-	0.94	1.9
Somalia	0.07 (0.27)	2.5 (0.69)*	-	-	0.4	1.6
Sudan	1.04 (0.14)*	0.41 (0.28)*	-	-	0.78	1.3
Tanzania	0.91 (0.23)*	0.05 (0.09)	-	-	0.5	1.3
Togo	1.12 (0.13)*	0.05 (0.15)	-	-	0.9	2.1
Zaire	0.46 (0.14)*	0.84 (0.17)*	-	-	0.75	1.9
Zambia	0.34 (0.12)*	0.44 (0.16)*	-	-	0.62	1.8

Table 4: INTERMEDIATE GOODS IMPORT ELASTICITIES

	IDY	XE	LAG	DUM	R^2	DW
Ivory Coast	0.8 (0.07)*	-	-	-	0.9	1.02
Liberia	0.09 (0.07)	0.67 (0.17)*	-	-	0.52	1.2
Malawi	(0.64) (0.25)*	-	-	-	0.63	1.4
Niger	0.26 (0.24)	0.33 (0.25)**	-	-0.26 (0.20)	0.4	1.4
Nigeria	0.37 (0.24)**	0.19 (0.20)	-	0.48 (0.22)*	0.9	1.6
Senegal	0.10 (0.09)	0.38 (0.08)*	-	-	0.67	1.9
Somalia	0.40 (0.10)*	0.50 (0.06)*	-	0.8 (0.07)*	0.9	1.5
Sudan	0.17 (0.03)*	0.15 (0.10)**	0.85 (0.07)*		0.92	1.9
Tanzania	0.88 (0.37)*	0.10 (0.09)	-	-0.3 (0.15)*	0.2	2.1
Zaire	0.45 (0.51)	0.51 (0.18)*	-	-	0.49	1.6

The positive agricultural output elasticity for food imports may mean that (i) agricultural export crop expansion occurs at the expense of domestic food production thereby widening the gap between domestic food supply and demand, or (ii) that the growth of agricultural incomes generates spill-over effects causing increased demand for imported food to supplement local staples. The first explanation does not appear consistent with the preliminary evidence[3/]. A more thorough analysis, however would require the use of more disaggregated data separating staple food from non-staple food imports, and detailed data on agricultural output and cropping patterns.

The coefficients in the capital and intermediate goods equations are mostly inelastic with the correct signs. The constraint (export) variable is statistically significant in most of the equations. The sum of the export elasticities for investment and intermediate goods imports (Tables 3 and 4) is more than unity for countries with severe external debt difficulties (e.g. Zaire, Somalia, Liberia)[4/]. These same countries also have investment elasticity of capital goods imports significantly different from (less than) unity. Apart from the quality of the data, it would seem that for these countries, domestic investment plan considerations have less influence on imports than external factors.

The lagged values appear unimportant suggesting that disequilibrium effects are adequately captured by the foreign exchange and activity variables. The dummy variable for structural change is statistically significant only in a few equations, and indicates differences in the response pattern of different commodities to changes in the international economic environment. The increase in oil imports

after 1973 as shown by the dummy (Table 1) is, for example, consistent with increases in oil refining activities in the countries concerned.

Conclusion

This paper attempts to investigate import behaviour in selected Sub-Saharan African countries. Because of the quality of the data we abstract from country specific institutional structures, as these are subsumed under foreign exchange constraint and activity variables. Despite this caveat, some of the evidence appear systematic. The confirmation of elastic income elasticity for oil imports is useful for evaluating oil imports requirements consistent with expected GDP growth rates. The coefficients of the price variables do not negate the efficacy of pricing policies. The results also indicate the need for caution in applying the estimates from cross-section data to individual countries. The effects of structural shift on the slope coefficients and the causes of differences in the food import response to agricultural output remain subjects for further investigation.

FOOTNOTES

1/ See Acharya (1981) and Hinderink and Starkenburg (1983) for a discussion of agricultural performance in Africa.

2/ Winters used GDP measure for output, while this paper used agricultural output only. But this difference is unimportant given these are basically agricultural economies with direct correlation between GDP growth and agricultural growth. Taylor et al (1984) found a negative GDP elasticity for a sample of low growth LDCs.

3/ A simple preliminary test for the correlation between food output growth and nonfood export crop output growth is shown by the cross-section generalized least squares estimate:

$$FQ_t = 1.56 - 0.016NQ1 + 0.049NQ2 + 0.147NQ3 + 0.106NQ4$$
$$(0.18) \quad (0.04) \quad (0.02) \quad (0.03) \quad (0.03)$$
$$\bar{R}^2 = 0.63, \quad N = 36, \quad DW = 1.5$$

FQ = food production growth

NQ = nonfood export crop production growth

1 = semi arid low income countries

2 = other low income countries

3 = middle income oil importing countries

4 = middle income oil exporters

Data obtained from World Bank (1982): Accelerated Development in Sub-Saharan Africa (p. 167). The estimates do not show a negative correlation between food output growth and non food output growth except for the semi-arid low income countries. Even in this case, the coefficient is not statistically significant. It must be noted that this estimate is not a supply function.

4/ In Somalia with export elasticity of 2.5 (Table 3), for example, the entire investment program has been dependent on external loans and grants. Debt service ratio (to exports) is more than 100 percent.

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