DETERMINANTS OF AGGREGATE PRIMARY COMMODITY EXPORT SUPPLY FROM AFRICA: AN ECONOMETRIC STUDY[+]

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Abstract

The literature of commodity supply functions is characterized by explanatory variables which are either current or lagged (relative) prices. This study not only underlines the existence of other factors but also emphasizes their explicit incorporation in estimation. By using pooled data of African countries, first, price focused estimations are explored. Subsequently estimation using other relevant regressors, which are rare in the literature, is carried. The result shows that (a) there is a clear difference between UNCTAD's world prices and the regional price constructed for Africa, hence previous studies using the former could have biased elasticities (b) real exchange rate has statistically significant elasticity with clear long and short run distinction, this underscores the relevance of the Error Correction Model (ECM) (c) capital formation indicators are also found to have positive elasticities, (d) there is a variation across regions and (e) estimation with foreign inflow included gives a mixed result.

Key words: Primary commodity export, supply functions, Dutch disease, Africa, co-integration, error-correction.

1. INTRODUCTION

Most of the analysis about the export problems of primary commodities of under developed countries in general and African countries in particular concludes that it suffers from price problems (especially of overvaluation, marketing board intervention etc.). Not surprisingly, the literature of the commodity (export) supply functions, although starts from structural equations which accommodates other factors, its reduced form, which is used for estimation, is characterized by explanatory variables which are either current or lagged (relative) prices. The attempt in this study is to underline the existence of other equally or more important factors which affect export of primary commodities and explicitly consider them in estimation. Two fundamental points

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are the reason for doing so. First, exclusion of such variable is simply omitting variables and obviously bad econometrics. Second, such omission deprives countries of policy handles other than price. I have dealt with this issue first by exploring price-focused estimations. Subsequent estimations are carried by adding other relevant explanatory variables which are rare in the literature.

The rest of the paper is organized as follows. Section 2 briefly discusses the literature by focusing on supply of commodities. This will be useful in coming up with the approach followed in this study. Section 3 highlights the nature of the data used. Section 4 deals with estimation of aggregate export supply functions. Section 5 presents the conclusions.

2. THE LITERATURE

The literature on supply of primary commodities attempts to answer the question, 'what determine the supply of primary commodity exports?' Broadly, these supply determining factors include: cost and accessibility of consumer goods, farm subsidies and taxes, research and extension, road infrastructure (including its quality) and services such as marketing or credit (Binswanger, 1992). Infrastructure might include the indirect impact of services, too. Services like credit (number of commercial banks or total credit) might affect the accessibility to fertilizer. Agro-climatic condition and human capital (e.g. rural population density and literacy) are also important factors. Further, these studies show that the short run elasticities are generally low simply because the factors of production (i.e. land, labour and capital) are fixed in the short run and these constitute 70-85% of cost of agricultural production (Binswanger, 1992:151).

Attempt to specify supply functions is carried with this broad idea of supply determining factors although most writers ended up specifying their supply equations in terms of (relative) prices. In general, these studies can be categorized under two themes (a) *price focused Models* which use prices of different complexities as explanatory factors and (b) *Mixed (heterodox) factors based Models.*

2.1. Price Focused Models

Price focused supply models began from the simple 'cobweb theorem' of Ezekiel (1938) which states that output is determined by the level of price in the previous period. This has developed, through time, in to Nerlove (1958) who modified the 'cobweb theorem' assumption about previous period prices. Nerlove (1958) maintained that producers are influenced by their perception of 'normal' price which could be captured by the adoptive expectation scheme developed by Cagan (1956) for another work. In terms of commodity model classifications (See Alemayehu, 1998), these models fall under the category of *econometric market models*. This original formulation of supply and price relation went through numerous changes. Some studies emphasized the distinction between the long run (potential supply) and the short run (a proportion of potential supply) responses (Wickens and Greenfield 1973; Chu and Morrison 1986). For instance, Chu and Morrison (1986) defined the structural equations of supply as the sum of utilization of potential output–*the utilization rate approach* and potential output–*potential supply approach*. In the end, however, supply (in reduced form) in this model is specified as the function of current and lagged prices, exchange rate and a supply shock indicator. Similar approach is used in an earlier work by Wickens and Greenfield (1973). Such classification is typically used for perennial crops and minerals.

Other studies used optimization strategy of agents, under different assumptions. This is widely used in explaining mineral extraction. It comprises: maximization of average return per unit of cost (Gray (1914) cited in Chu and Morrison 1986), optimizing the amount of total deposit to be exploited given first decreasing and then increasing cost structure over the expected life of the mine (Carlisle, 1954), maximizing the present value of discounted future net profit (Hotelling (1931) cited in Chu and Morrison 1986), optimizing expected profit under free competition both at firm and industry level (Herfindahl 1955) and finally a model which relates higher rate of short-term rate of extraction under uncertainty and high rate of interest (Parish (1938) cited in Chu and Morrison, 1986). In terms of the theoretical classification of commodity models these models broadly fall in the category of *econometric optimization models* (Alemayehu, 1998).

Following Shu (1975) and Askari and Cummings (1976), supply response functions can be categorized under three groups: those for annual crops, marketed surplus and perennial crops. For annual crops, six different models can be fitted: (i) the simple Koyck distribution lag model or the simple Nerlovian expectation model (ii) the complex Nerlovian expectation model, (iii) the Koyck second-order lag model, (iv) the Nerlovian adjustment model, (v) the expectations-adjustment model and (vi) the simple model (Shu, 1975:27). The Koyck model uses lagged prices (with a geometric lag assumption among the lagged prices) as the only explanatory variable. In Nerlove this is replaced by expected prices. The complex Nerlove adds to this other expected values (like expected yield). Koyck's second-order lag function uses lagged dependent as a regressor under the assumption of slow response due to institutional factors. Similarly, the Nerlovian adjustment model employs lagged dependent variable by assuming that farmers' adjustment by learning from their past expectation mistakes. The simple model (which has neither adjustment nor expectation variables), on the other hand, usually contains lagged price, lagged yield and trend variable to capture 'other' factors. Estimation invariably is carried by simple OLS. In fact, the theoretical models were ahead of the development of relevant estimation techniques which accommodate their basic idea of adjustment to past disequilibrum (The relevance of Error Correction Model in this context is discussed below).

As to perennial crops, the first of such models is that of Bateman (1965) which is specified to explain the supply of cocoa in Ghana. This model uses both expected (own) producer and competing crop (i.e. coffee) prices, which are believed to show expected profit, as regressors. Other non-price factors are completely ignored. The dependent variable is the additional acreage under crop (the planted crop) in the year in question (Shu, 1975:55-69; Askari and Cummings, 1976: Ch. 7). Other models shown in Shu (1975), and Askari and Cummings (1976) (e.g. the Beherman model, The French[1] and the Matthew models) are not different in terms of explanatory variables used. Similar but alternative approach to Bateman is to use the stock of trees in stead of planted crops as dependent variable. However, differentiating such specification yields equations similar to that of Bateman except the replacement of the explanatory variable, lagged planted trees, by lagged stock of trees.[2] The latter models, although are fundamentally price based, show a trend towards including other factors in specifying supply function. However, in general, price focused models use functional forms which either explicitly exclude non-price factors or structural equations which include other non-price factors but ultimately could be explained by price. The end result in both cases is price-based estimation.

2.2. Mixed (Heterodox) Factors Based Models

The Ady (1968) model, which is used for perennial crops in Ghana, Nigeria and Uganda, is an improvement to that of Bateman in that it includes, on top of price, the existing acreage (i.e. the stock of the crop) in the pervious period. Another strand of supply function which focuses on heterodox factors is what is called the 'liquidity model.' This model takes farmer's income as additional explanatory variable to indicate his/her capacity to invest. This model is otherwise similar to Bateman's model. Its basic feature is to relate investment to the difference between desired and actual level of capital. Wickens and Greenfield (1973), Palaskas (1986), Chu and Morrison (1986) summarized such models by characterizing them as models essentially based on capital and investment behavior theory presented in Nerlovian adjustment model[3]. Alternative forms of this theory arise in specifying the factors that determine the desired level of capital stock. These different factors are: capacity utilization (capacity utilization theory); net output or return to capital (neo-classical); internal cash flow (liquidity theory) and expected profit based approach which earned different degree of emphasis by different authors (Palskas, 1986:16-18, Chu and Morrison, 1986:142-143, Wickens and Greenfield 1973). In some studies supply is also considered as a function of expected price, expected opportunity cost, production costs, stock of output (trees specifically in perennial crops), potential output of the industry and tax considerations (Kalaitzandonakes *et al*, 1992). In terms of theoretical commodity model classification such models are a hybrid of process and market models (See Alemayehu, 1998). Another important explanatory variable reported in the literature is domestic demand (Pal, 1992).

Bond (1987), based on the original works of Goldstein and Khan (1978), used exchange rate, current and lagged price, an index of productivity and a vaguely defined supply shock factor and a time trend to estimate her model. These factors are far less than the supply factors mentioned in the text of her discussion– indicating the difficulty of either quantifying or/and data. In Ramanujam and Vines (1989) supply is specified as a function of current price, lagged series of past price (due to cost of adjusting output) and exogenous factors to capture 'others'[4]. This general form is estimated for different commodity groups. Hwa (1985) emphasized the effect of supply and demand through stock demand and supply conditions. Palaskas and Gilbert (1990) have reviewed Haw's model and argued that storage disequilibrium is an implausible basis for a price adjustment theory. They noted, first, correct specification/estimation of Haw's model shows poor performance and, second, the model essentially relates price changes to the disturbance term on stock demand equation. For them this is the least important source of price variation (Palaskas and Gilbert, 1990:1424). However, it seems they have downplayed his main/structural equations (where supply and demand are allowed to vary) simply because they focused on the reduced form equation.

Late development in commodity supply modeling hardly differs from much of the discussion above. Still, the emphasis is on relative prices, expectation and type of equilibrium across different commodity groups.[5] In other words, it is hard to find well-elaborated supply functions. A recent supply management study for tropical beverages essentially shares the tradition of using lagged prices (and sometimes output). In their recent work on coffee, tea and cocoa supply management, Maizels *et al* (1992, 1993a, 1993b) specified a commodity model which has both supply and demand sides. They specified their supply function, after a modest review of supply functions. The essential argument used in their beverage supply models is that output is explained by: area harvested (believed to reflect maximum potential output), real producer's price, a lagged output (to reflect relations between successive years) and a time trend to allow for trends in productivity. An important result in their study is that in every case area is correlated with output[6]. They also used acreage equations which relate the area harvested to lagged prices to show long run investment equation.

Finally, most studies carried about the export of African countries have also followed a similar approach. That is, the supply response is studied in terms of current and lagged prices. The finding (for small African countries and in the period of 1960s and 1970s) was that short run elasticities are high for annual crops while long-term elasticities are high for tree crops and minerals (Rwegasira, 1984:7-9). On the other hand, recent work on aggregate commodity export functions is not generally there. A recent paper which assessed the export performance of Sub-Saharan African countries called for a disaggregate estimation of export supply functions to shed light on factors which influence export volume (Svedberg, 1990:32). However, individual commodity supply function estimations are in progress (Gwyer 1971, Alibaruhu 1974, Ghashal 1975, Lupumba and Ndulu 1987, Jones and Mutuura 1989, Eriksson 1993 and Dercon 1993 are good examples).

The emphasis on supply in the above discussion need not imply that commodity models which explore the demand side and hence its simultaneous determination are not there. Such models not only avoid the simultaneous equation bias that could arise from neglecting demand, but also challenge the small country assumption when they are constructed at global level (See Alemayehu, 1998).

3. THE LINK BETWEEN SUPPLY THEORIES AND THE ESTIMATION TECHNIQUE: THE RELEVANCE OF ECM

There are three features of the commodity supply theories discussed above which allow us to link it with the ECM approach: (i) the assumption that there is a long run relationship between the variables under study, (ii) the hypothesis that it could have fairly distinct short and long run features (iii) and finally the assumed existence of some sort of adjustment mechanism in-built in the relationship. The first feature lends itself to the need for running co-integration test (as most series are I(1)). The second feature of the theories is not clear in the literature. Some writers take short/long run to be synonymous with short/long lags. Such approach dismally fails in the face of, especially, short gestation commodities (like food and agricultural raw materials). Other studies, rightly, emphasized short-term to mean utilization of potential capacity while long run is an increase in potential output. But, as most of the latter studies do not use a relevant estimation technique (a simple OLS being the most common one); they are not without problem either. Error Correction Model is a formal representation of dependent and independent variables with explicit distinction between short run variations (the immediate impact effect) and long run aspects (long run level or steady state relationship). Thus, it is an appropriate technique for estimating supply functions which are based on the theory of potential and utilization of potential output distinction. Moreover, since it explicitly includes an adjustment mechanism, it incorporates the third feature of the theories reviewed above.

4. THE THEORETICAL MODEL OF THIS STUDY

The above review gives insight into some important points in specifying export functions of primary commodities. First, factors other than price are important determinants of commodity supply. However, either lack of data and/or difficulty of quantifying them or focusing on reduced forms forced many researchers to use prices as the only explanatory variables. Second, a distinction across commodities (especially between annual and perennial crops) is essential in specifying supply functions. A third and relatively neglected factor is to place the commodity market within a macro framework where the role of stock holding and macroeconomic variables' impact is important[7].

In this study the export supply equation of a typical African economy is specified to depict the behavior of commodity producers mediated through the government. I have further assumed that output of export commodities respond to world price in broadly identical manner[8]. Although government intervention in the export sectors of most African countries is obvious, it is assumed that the impact of world price, especially the *change* in world price, will have similar signals both for the public sector as producer and the individual producers (although the latter surrenders a proportion of its income to the government). The response to price and other supply factors will take two forms. In the short run increased capacity utilization is important. Thus, *short run* parts of the argument would be based on the commodity model of Goldestein and Khan (1976), Chu and Morrison (1986) and Hwa (1985)–where *(latent) capacity utilization theory* is the underlying hypothesis.

In the long run, producers are assumed to respond through change in potential output (capacity creation). *Expected profitability theory*, following Chu and Morrison (1986)[9], and other supply inducing factors (such as capital formation, foreign inflow) are believed to explain it. Foreign inflow, however, can have 'Dutch Disease' effects too (see Alemayehu 1997). This is largely an empirical question, however. Thus, I am essentially arguing that the different factors emphasized by different authors are basically complementary and should be explicitly consider in estimation. The lag structure would vary depending on the nature of the commodity under consideration. That is, longer lag structures should be used for beverages and minerals (which are assumed to be five years in this study), for example, than for annual crops[10]. This gives the following general theoretical model.

$$X_{it}^{ss} = a_0 + a_1\left[\frac{eP_s}{Pd}\right] + a_2\left[\frac{eP_s}{Pd}\right]_{t-1} + \left[a_3\left[\frac{eP_s}{Pd}\right]_{t-i} - k^{-1}\sum_{i=1}^{k}\left[\frac{eP_s}{P_d}\right]_{t-i}\right] + a_4(\Delta k)_{t-i} + a_5 FF_{t-i} \qquad [1]$$

Capacity Utilization Expected Profit Capital Formation

Where:

X - Export supply; e - Exchange rate, Ps - Export price of South; Pd - domestic price; FF - Foreign Inflow; ΔK - Capital formation indicator; the term in bracket, [..], is the expected profit indicator - the deviation of current price from k years moving average.

4.1. The Theoretical Export Supply Function and the Data

In this section the theoretical commodity export function (equation number 1), is adjusted to fit the available data. In our database, investment by commodity sector is not available. This requires the use of instrumental variables. The reparametrization of this theoretical formulation renders this possibility. The following sets of equations are used for that purpose. The distinction between the short run *capacity utilization* theory, and the long run *capital formation* argument will be maintained. To avoid the complex variables in equation number (1) I will designate the eP_s/P_d by P and the expected profit indicator by Π^{σ}. Maintaining ΔK and FF as they are, a shorter version of equation number one can be written as,

$$X_{At}^{ss} = \alpha_0 + \alpha_1 P_t + \alpha_2 P_{t-i} + \alpha_3 \Pi^{\sigma} + \alpha_4 \Delta K + \alpha_5 FF \qquad [2]$$

Our capital formation data is gross fixed capital formation (both public and private at national level). To overcome the lack of sectoral disaggregation of this data, the capital stock is specified in terms of factors that affect its formation. The possible factors and the one that I have access to are: prices, an indicator of expected profit & instability of prices (Π^{σ}), supply of domestic credit (DCR), supply of fertilizer, government investment (I_g) (indicator of infrastructure) and capital inflow (FF) (Like FDI that is important in the mining sector, and other official flows). Of these factors I will omit prices as they are specified in the equation above. This omission might imply that current (and a few periods lagged) price effect is direct (i.e. not through capital formation). However, since the indicator of expected profit & instability is computed from lagged prices the effect could be captured to a degree that is reasonably relevant. Concerning the expected profit indicator, the ideal approach is to use direct profit measures. Nevertheless, the profit data is hard to come by. Its approximation as a deviation from three years moving-average prices makes it similar to the price instability indicator. Hence, in specifying the capital formation it is included as one of the factors. Its coefficient can be interpreted both as profit and price instability index. Thus, the capital stock can formally be given as,

$$\Delta K = \beta_0 + \beta_1 \Pi^{\sigma} + \beta_2 DCR + \beta_3 I_g + \beta_4 FF \qquad [3]$$

Where: DCR is Domestic credit; FF is Capital inflow; I_g is Government investment.

Equation 3 states that capital formation in the commodity sector is determined by prices, availability of domestic credit, public infrastructure provision and foreign inflow. Substitution of this capital formation equation in equation [2] yields the final adjusted equation for estimation.

$$X_{Ai}^{ss} = \phi_0 + \alpha_1 P_t + \alpha_2 P_{t-i} + \phi_1{}' \Pi^{\sigma} + \phi_2 DCR + \phi_3 I_g + \phi_4{}' FF \qquad [4]$$

Where:

$$\phi_0 = \alpha_0 + \alpha_4 \beta_0 ; \quad \phi_1{}' = \alpha_3 + \alpha_4 \beta_1 ; \quad \phi_i = \alpha_4 \beta_i ; \; \phi_4{}' = \alpha_4 \beta_4 + \alpha_5 .$$

At estimation stage the linear formulation is transformed in to log-log form, hence the coefficients to be estimated are elasticities. In the specific case of our data the expected profit indicator is found to be empirically problematic. In all cases it is a stationary series and exhibited a very high correlation (usually greater than 0.80) with the price variables. Given the latter result, the former is logical as the moving average acts as lagged price of prices and hence the series generated is nearly identical to the first difference of prices, which is stationary. This has a series multicloinearity problem and thus a shortcoming of previous studies. Thus, in the estimation below it is omitted from the functional form. The foreign inflow variable (FF) might also create simultaneous equation bias[11] (in one of the estimations) as it affects the other capital formation indicators in the regression. This might not be a serious problem as a very tiny portion of foreign inflow is usually allocated to the primary sectors.

4.2. The Data

The relevant macro data used in this study is derived from a consistent macroeconomic database (Alemayehu *et al*, 1992). However, the most important data, export of commodities and price, are compiled from UNCTAD database (Annual Commodity yearbook). Certain changes are introduced to allow its adoption to the specificity of Africa.

1. Similar commodity categories are used for four commodity groups, these are:

a) Agric. raw materials (excluding Synthetic)	SITIC2-22-27-28-233-244-266-277
b) Tropical Beverages	SITIC 071.1+072+074.1
c) Minerals, Ores and Metals	SITIC 27+28+68+522.56
d) Fuels	SITIC 3

2. The category *food* in this study is slightly different from that of UNCTAD. In the UNCTAD methodology *All food* includes *food* (wheat, Maize, rice, sugar, beef and veal bananas, pepper, soybean meal and fish meal), *tropical beverage* (coffee, cocoa and tea) and *vegetable oil seeds and oils* (soybeans, soybean oil, sunflower oil, groundnut, groundnut oil, copra, coconut oil, palm kernels, palm kernel oil and palm oil). In this study *food* is defined to be all food except tropical beverage (i.e., food + vegetable oilseed and oils, according to UNCTAD definition).

Prices (Export prices)

For each of the commodities above UNCTAD provides a series of prices running since 1970. These price indices are computed by using the total developing countries export of these commodities in the years 1984-1986 as weights. Such index is missing for *food* as defined in our study. I have generated that index by adding price of *vegetable oilseeds and oils* and *food*, weighed by their respective group weight as computed from their share of developing countries export of commodities.

Another major change to UNCTAD's price series is to question whether the weight used in its construction is relevant to our study (i.e. in the context of Africa). In other words, does the averaging method allow to show the world price that the African economies face? To answer this question, the UNCTAD price is re-calculated by weighing it by each region's export. The comparative analysis offers the following conclusions. First, for all Africa, the *food* price index is similar in both (UNCTAD and mine) cases. For North Africa (NA) there was a gap in the 70s and late 80s. For West and Central Africa (WCA) the UNCTAD series show higher price until early 80s and then they are similar for the rest of the decade. For East and Southern Africa (ESA), the UNCTAD series understate the regional indices. Second, for *tropical beverages,* the UNCTAD price series is nearly identical with the regional price series computed in this study. Third, for *agricultural raw materials* for all Africa the UNCTAD series overstates the actual price African economies face. This conclusion is valid to regional prices too. Such over estimation is very large for ESA countries. Fourth, for *mineral, ores and metals* for all Africa the UNCTAD series overstate the actual price African economies face. Such over-statement is severe throughout the period except in early 80s. However, for ESA, it understates the price they faced in early 70s and late 80s. Finally, a comparison of the African regional price series with the one generated by using the sample countries of this study reveals that the sample is nearly identical for all commodities and for all regions except for minerals. Diagrams 1, 2 and 3 show the above conclusion for the three regions (see Annex 1).

This result has profound implication not only to previous studies in Africa but also other studies that used world prices to analyze its regional and country impact. Obviously elasticities computed from such studies will be biased if there is a variation between the regional and that of the world (as given in UNCTAD or IFS) prices even if they have identical trends.

4.3. Estimation

4.3.1. Estimation Approach

Obviously the econometric specification could differ from this general theoretical specification. Based on the recent innovation in time series econometrics, the estimation is carried by formulating an Error-Correction Model (ECM). The estimation is done by pooling the data of the sample countries in each region (1970-90). To ensure that series are not unduly mixed when lag structure is used, careful treatment of end points is made. A constant country dummy is always used if it is found to be statistically significant. Moreover, sample sizes are adjusted (by excluding a country or countries) when such data violates almost all the diagnostic tests. The choice of the variables is made after a search process which includes both diagnostic test and co-integration test. In all cases, the estimation is fully supported by diagnostic tests (Chow, Jarque-Bera and Reset along visual inspection in data exploration process).

Preliminary estimations with current prices and capital formation indicators have shaped the approach followed in this section. That is, data is allowed to inform theory Wuyts (1992). Such preliminary estimates revealed some interesting results. First, short run current price elasticiteis are in general positive but not always statistically significant. For long gestation commodities, price affects mainly capacity utilization. Second, long run current price elasticities are both positive and negative (significantly negative for agricultural raw materials in ESA). In some cases they are not significantly different from zero. Third, capital formation variables are in general positive and significant. Finally, in three of the commodity categories (except minerals) 10-25% of any disequilibrum in the previous period is made up in the current period for countries in WCA. Indicating a general low level of adjustment to disequilibrum (or shocks), this figure (which is 62%) is very high for minerals, however. Similar adjustment coefficients, save for minerals, are obtained for ESA. For NA the adjustment coefficients are quite high, indicating theses economies' capacity to cope with shocks.

The inverse relationship between export and long run current prices observed for agricultural raw materials in all regions and for minerals in North Africa is worth further examining. It provokes at least two propositions about export supply and price dynamics. The first proposition is that domestic prices might not be important and hence relative price (as opposed to nominal) is crucial. In macro context this in turn implies, domestic prices could be affected by capital inflow. This in turn opens the importance of macro variables in the determination of the supply of commodities as long as they affect the level of domestic price. This in turn implies a sort of 'Dutch disease' possibilities. In the 'Dutch disease' context, a real appreciation is possible. Thus, in Tables 5, 10 and 15, I am focusing specifically on this inflationary pressure (which could arise from the spending effect). A one period lag is assumed for the formation of such inflationary pressure. The nominal export price (instead of the real exchange rate) is used for the domestic price is presumed to be affected by the foreign inflow.[12] The use of debt stock data in ECM formulation allows us to see the 'Dutch disease' impact in the short run (for the change could be taken as a flow) and debt overhang problem in the long run. Besides, this specification further allows to see the impact of foreign inflows explicitly.

The second proposition is that the structure of foreign exchange demand (import content of industries, pattern of consumption of a section of the urban population, debt servicing, capital flight etc.) of a typical African economy is that foreign exchange is so desperately needed and hence countries are maximizing total export revenue. This logically entails lower prices trigger more exports[13]. Given these working propositions retrieved from exploratory estimation, each of the aggregate commodities of each region is estimated at three stages. *First*, current price and capital formation indicators are taken as regressors - I will call this Model I. *Second*, the current price is replaced by commodity specific real exchange rate, i.e., the ratio of regional commodity price in domestic currency to domestic price -this is Model II. *Finally*, current prices, a capital formation indicator and foreign capital inflow are used as regressors–this is Model III. Current price is chosen in Model III cognizant of the assumed correlation between foreign inflow and domestic price (which is the denominator in the relative price computation).

In all models, the current price data used is the current commodity price computed for each region. For perennial crops and minerals two sets of lagged prices are used. The one period lag is assumed to affect capacity utilization while the five-year lag is assumed to affect capacity creation. Owing to the ECM approach both period lags have short and long run effects. The variables: consumption of fertilizer, investment and capital stock are interchangeably used (depending on co-integration test, multicoliniarity problem etc.) as indicators (instruments) of capital formation. Thus, the final estimations are the result of an exhaustive search process both using Hendery's general to specific

(GS) approach and the diagnostic tests. The estimation is done using E-views and TSP. The results of this econometric exercise are discussed in the next section.

4.3.2. Results

1. East and Southern Africa (ESA)

A sample that contains eight countries in this region (Botswana, Ethiopia, Kenya, Madagascar, Malawi, Tanzania, Uganda and Zambia) is used. Before the estimation, a test for unit root of the variables of the three Models (I, II, III) is done. The result shows that the series are non-stationary (Table 1) and each model's variables are co-integrated (Table 2) (see Annex 2). The results of this estimation, obtained after an exhaustive search, are reported in Tables 3-5 in Annex 2. The following are the major findings (See Alemayehu (1996) for more details).

1(a). Food: In this region current price of food has strong and positive effect both in the short and long run in Model I and in the long run in Model III. The long run effect being stronger. When Model II is used, only the long run relative price elasticity is found to be positive and significant although significantly lower in magnitude to the elasticity of current prices. All diagnostic tests are quite acceptable. A one period lag is assumed for the impact of foreign inflows (different foreign inflow indicators: bilateral, multilateral, grants and private flows are tried) to have effect while 3 years are allowed for the impact of capital formation indicators to be felt. The result shows that all the variables are not statistically significant. The result also suggests that 'Dutch diseases' possibilities can not be sustained. It suggests the existence of a positive impact of capital formation and generally confirms the positive impact of prices in the long run.

1(b). Agricultural Raw Materials: The estimation for this commodity confirms that capital formation indicators have strong and statistically significant positive impact both in short and long run. Current prices in the long run are found to be either statistically significant and negative (Model I) or statistically not different from zero. This might suggest the confirmation of the second proposition about supply price relationship discussed above. Short run relative price is positive and statistically significant, however. Again, 'Dutch disease' problem cannot be suggested by the data.

1(c). Tropical Beverages: Current prices (with the two types of lags) are found to be positive and statistically significant only in Model I. Relative price which indicates capacity creation (in Model II) is also statistically significant in the long run. The capital formation indicator has ambiguous result (having negative value in Model II and positive in model III). In using Model III, of all capital inflow categories, only multilateral flows are found to be co-integrated with the other regressors. The lag for capital inflow is one period behind that of price and capital formation indicators to allow an inflationary pressure formation. Botswana and Zambia are excluded for they do not have beverage export data. With quite good diagnostic test, the result shows that in the short run none of the variables, except the negative value of the long lag capital inflow–indicating 'Dutch disease' problem, are statistically significant. The foreign inflow shows a statistically significant long run negative (indicating debt overhand) and positive sings for the long and short lag aspects, respectively.

1(d). Minerals, Ores and Metals: The mineral equation is found to be the most difficult to estimate. The real level of mineral exports and its relative price are not co-integrated with 10 types of capital formation indicators. Finally, the co-integration Dickey-Fuller t-statistics for the two variables above with that of investment in the private sector is found to be -3.3 (compared to Mackinnon critical value -3.5 at 10% significance). Given the well-documented uncertainty of this test at border cases, the estimation is carried out with this reservation. The result shows statistically significant negative impact of the short run relative price relevant for capacity creation. In the long run the impact of price which affect capacity utilization is found to be statistically significant and positive. Besides, the capital formation indicator has also statistically significant positive impact. Long run prices show a negative coefficient though not statistically significant. Adjustment to disequilibrium is also found to be very low, only 18% of the past error being made up for in the current period.

In general in this region, the adjustment coefficient varies from model to model. It ranges from 10-50%. This figure is the highest for beverage around 50%. This indicates a general low level of adjustment to disequilibrum (or shocks) for all except that of beverage. It is noted that this is contrary to expectation that short gestation items might adjust fast (see Annex 2).

2. North Africa (NA)

Due to lack of data, three countries are chosen as a sample for North Africa: Algeria, Egypt, and Tunisia (leaving Libya and Morocco). Similar procedure is followed in the estimation. Since these countries have no beverage exports, I used only three sets of estimations under the three Models. A unit root test carried out shows that the series are non-stationary but co-integrated in each model (Tables 6 and 7 in Annex 3). The following observations are made for each of the commodity categories.

2(a). Food: In general, the food function for NA suggests that current prices are not statistically significant, the only exception being the long run value of Model III. The relative price effect is not satisfactory either. However, the result suggests positive elasticity for short run capital formation indicators in Model III. The food equation in Model III further shows that capital inflow had, contrary to 'Dutch disease'/debt overhang hypothesis, positive and statistical significant impact in the long run (positive but statistically insignificant in the short run).

2(b). Agricultural Raw Materials: The export of agricultural raw materials is not co-integrated with current prices and various capital formation indicators. Thus, the estimation is carried using Model II. Model II shows that real exchange rate has a positive elasticity both in the short and long run. However, it is only the long run elasticity which is statistically significant. The capital formation indicator has also positive elasticity in both the short and long run. Only the short run elasticity is statistically significant, however. The use of Model III shows a positive and statistically significant coefficient for the short and long run capital formation indicator. Capital inflow is found to have statistically significant positive impact in the short run and negative impact in the long run. However, caution should be exercised in using Model III as the Chow value is a bit large.

2(c). Minerals, Ores and Metals: Long run current prices (except the capacity utilization indicator in Model I) are found to have a negative and statistically significant value. Supporting the hypothesis that lower price trigger exports (under revenue maximizing regime). The long run capital formation indicator does also show positive and statistically significant value in Model I (having statistically significant negative value in the short run), corroborating the argument of revenue maximization. When the above estimation is done with the real exchange rate instead (Model II), all coefficients in the short run, except the constant, are found to be statistically insignificant. In the long run, however, the price which is assumed to show capacity creation has positive and statistically significant value (capacity utilization indicator price is positive but not statistically significant). The capital formation indicator is not statistically significant in this model. When Model III is used, both types of prices in the long run exhibit negative and statistically significant result. Long run short lag effect of capital inflow is also, contrary to 'Dutch disease' theory, positive and statistically significant, while its long run long lag coefficient suggests negative values. This result may show that capital inflow can ensure capacity utilization but not capacity creation (in fact in the long run, capacity creation aspect; 'Dutch disease' and or debt overhang problems could be expected).

Contrary to the two other regions, in NA the adjustment coefficient is in general high. This shows a good part of errors from previous period are made up in the current period. This indicates a relatively higher capacity of the region to adjust to external shocks (or a deviation from the long run equilibrium) (See Annex 3).

3. West and Central Africa (WCA) Region

Ten countries are selected from WCA region as defined in UN-ECA (Economic Commission for Africa) data reporting system. The sample includes: Benin (Ben), Burkina-Faso (Bf.), Cameroon (Cam), Central African Rep (Car), Gabon (Gab), Ghana (Gha), Nigeria (Nig), Senegal (Sen), Sierra Leon (Ser), and Zaire (Zi). Four commodity export functions are estimated below. All variables used in the estimation are found to be non-stationary series. At the same time they are integrated of order one (Table 11). Thus, the estimation is carried after co-integration test is carried for each Model (I, II and III). The result shows that the variables in each equation are co-integrated, indicating the existence of long run relationships (Table 12). Tables 13-15 show the estimated result of the three Models for the four commodity categories in the WCA region (See Annex 4). The following are the major observations made.

3(a). Food: It can be concluded that the aggregate food function exhibits a statistically significant positive coefficient (except for the long run capital formation in Model I, and the short run capital inflow in Model III) for all variables and in all models both in the short and long run. The possibility of a 'Dutch disease' phenomenon can not be inferred from the coefficient of the short-term inflow. However, long run debt overhang problem can be inferred from the statistically significant negative coefficient of Model III.

3(b). Agricultural raw materials: Regarding current prices The results suggest a positive short run elasticity in Model I and statistically insignificant values in the rest of the cases. However, relative prices are positive and statistically significant. Model I, also shows that capital formation has positive and statistically significant value in the long run Contrary to our hypothesis, capital inflows shows positive and statistically significant values both in the short and long runs.

3(c). Tropical beverages: In sum, when it comes to beverage, the result confirms that price whether current or real determines capacity utilization both in the short and long run. On the other hand prices are found to be unimportant as a factor determining capacity creation. The result also show that capital formation indicators have positive and statistically significant impact in Model II in the long run while exhibiting negative impact in Model III. Capital inflow has also statistically significant positive impact both in the short and long run.

3(d). Minerals, Ores and Metals: This estimation confirms the importance of capital formation indicators in the long run in Model I. It also confirms, both in Model I and III, the positive impact of current prices on capacity utilization in the long run. Real exchange rate (Model II) has statistically significant positive and negative impact on capacity creation and utilization, respectively, in the long run. Model III suggests the possibility of 'Dutch disease' and debt overhang problem in the sector.

In general in this region, for food and agricultural raw materials (non-perennial and short gestation) 10-25% of any disequilibrum in the previous period is made up in the current period. This figure is very high for beverage 25% and minerals 50-60%. This indicates a general low level of adjustment to disequilibrum (or shocks) for the former and a clear distinction between commodities that require long and short gestation period. This is contrary to the intuitive expectation that short gestation items might adjust fast. This might be attributed to the importance of capacity utilization (e.g. recovery rate) in minerals/tree crops.

Table 1 gives the summary result of all the estimation carried out in this study. I have reported only those values which are statistically significant (at around 10% and better). In the summary table [1] indicates Model I where current price and capital formation indicators are the regressors, [2] Model II where the price in [1] is replaced by commodity specific regional real exchange rate. Finally [3] indicates Model III where the first, [1], estimation is augmented by capital inflow indicators.

Table 1. Summary Table of Elasticities: All Africa

	Current Price		*Relative prices*		*Capital formation*		*Foreign inflow*	
	Short -run	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*	*Short run*	*Long run*
West and Central Africa (WCA)								
Food	0.46[1] 0.57[3]	2.4[1] 3.50[3]	0.27		0.11[1] 0.18[2] 0.15[3]	0.42[2] 0.50[3]		-0.39
Agr.Raw materials	0.36[1]		0.48	0.62		1.02[1]	0.21	0.79
Beverage	0.37[1]* 0.37[3]*	0.84[1]*	0.18*	0.50*	-0.25[3]	0.26[2] -0.86[3]	0.19#	0.62* 0.67#
Minerals		2.45[3]*		-2.52* 2.73#		1.03[1]	-0.88*	
East and Southern Africa (ESA)*								
Food	0.29[1]	5.02[1] 1.01 [3]		0.13				0.22
Agr.Raw materials		-1.38[1]	0.33		0.18[1] 0.18[2] 0.22[3]	0.44[1] 1.19[2] 1.16[3]		
Beverage	0.14[1]*	0.54[1]* 0.30[1]# 0.77[3]#		0.12#		0.13[2] 0.58[3]	-0.24#	0.58* -0.66#
Minerals			-0.42#	1.27*		2.36[2]		
North Africa (NA)								
Food		0.90[3]			1.14[3]			0.15
Agr.Raw materials				2.40	0.62[2] 1.21[3]	1.53[3]	0.68	-0.43
Minerals		-0.91[1] -1.02[3]* -1.28[3]#		0.95#	-0.56[1]	1.14[1]		0.58*

* = short lags (indicating capacity utilization)   # = long lags (indicating capacity creation)

In this study an attempt to identify determinants of commodity export supply is made. The approach differs from previous studies because (a) it emphasizes the role of other factors, besides price, in the determination of export supplies, (b) its use of error-correction model and (c) its focus on African countries. The following conclusions emerge from the above analysis. *First*, there comes out a clear distinction between short run and long run elasticities. Hence, ECMs are relevant econometric techniques in estimating commodity models, yet work in this area is in its infancy. *Second*, estimation using relative prices (real exchange rate) gave largely satisfactory results. However, it is noted that the impact of relative prices is largely confined to capacity utilization and not capacity creation. *Third*, although capital formation indicators are neglected in the literature, they are also found to have positive and statistically significant impact especially in the long run. As a result, specific parameters are obtained for each region and for different commodity categories. This has an important implication. On top of giving us one more policy handle than price, it implies boosting capital formation (internal or with aid), instead of welfare aid, can not only raise the level of exports but also has a multiplier effect on output working its way through imports.

An important variation across regions is also observed. The regional variation across commodity categories provides the following picture. For *food* the short run current price elasticity is found to be the highest for WCA. In the long run both WCA and ESA showed higher price elasticity than NA. The short run impact of capital formation indicators on food is found to be strong for NA. A negative Debt overhang effect is observed for WCA but not for the others. *For agricultural raw materials* short run price effect is stronger in WCA, while long run price effect is negative for ESA. Similar short run phenomena is observed for relative prices. Long run relative price effect is found to be strong in NA followed by WCA. Capital formation indicators are found to be strong in NA followed by ESA. Debt overhang problem is found in NA but not for WCA. *For beverage*, current and relative price and capital formation effect is found to be strong in WCA followed by ESA. 'Dutch disease' and debt stress effect is observed for ESA but not for WCA. Finally *for minerals*, long run current price effect is found to be strong for WCA and negative for NA.

The impact of the arguments used in the regression does also vary across regions. Relative price effect is negative for short lag of WCA and short run, long lag, of ESA. Longer lag (capacity creation) long run effects are found to be strong for WCA followed by ESA and NA. The impact of capital formation indicators is strong for ESA and nearly equal for the other regions. 'Dutch disease' possibilities are apparent in WCA only. The above observations leads to the conclusion that there is a variation across the different regions for the different commodities and giving due attention to such differences is very important in analyzing the pattern of trade and finance of Africa. The impact of foreign inflow on exports is not conclusive. I have obtained mixed results. So is the relationship between long run current export price and supply of export when the impact of foreign inflow is explicitly considered in the specification of the model (i.e. The result is mixed). This requires further research both for other regions and at country level.
Although most studies are based on output, and not export supply, I have contrasted them with our finding. Bond (1987) reported aggregate supply price elasticity (using relative price) for Africa of -1.28 for food, 0.70 for agricultural raw material, and -1.89 for minerals. For other regions she found lower elasticities. She attributed the perverse relation in food for population growth and huge gap between world price and producer's price. In an earlier study (Bond, 1983) she found an average aggregate price elasticity of 0.12 (coefficient of logarithm of real price) which for individual countries ranges from 0.03 to 0.22. Binswanger (1992) maintained that price elasticities of sub-Saharan Africa are not lower than other areas and in general long run elasticities are higher than short run. His result shows elasticity values ranging from 0.05 to 0.15 with the exception of Senegal (0.54) and Burkina Faso (0.22); the cross-country result being 0.06. Long run values are in the range of 0.15 to 0.24. He didn't have long run elasticities from cross country regression. Gwyer (1971) found a short run price elasticity ranging from 0.24 to 0.29 and a long run value of 0.48 for sisal in Tanzania. Alibaruhu (1974) found a short run price elasticity ranging from 0.22 to 0.26 and a long run value ranging from 0.44 to 0.66 for cotton in Uganda. Ghashal (1975) found a one period lag price elasticity of 1.16 to 1.71 for rubber in Liberia. Jones and Mutuura (1989) found an elasticity of 1.33 and 1.71 for short and long run, respectively, of cotton in Kenya. Eriksson (1993) reported

supply price elasticity estimates of Tanzania carried by different authors. He reported elasticity ranging from 0.25 to 0.43 for perennials, 0.73 (short run?) to 2.4 in the long run for cotton and a short run value ranging from 1.5 to 2.3 for food crops. Dercon (1993) has also found a short run elasticity of cotton in Tanzania ranging from 0.63 to 0.67. Ramanujam and Vines (1989) reported price (real- it seems they used real price although their glossary is not correct in defining real and current prices) elasticities of 0.10 for food 0.51 for beverages, 0.06 for agricultural raw materials and 0.33 for metals and minerals in the 'long run' (long run being long lags of 5 years). The short run (price with no lag) values are respectively 0, 0.13, 0.08 and 0.31. Abebayehu (1990) estimated an export supply function for Six African countries. His export (price) supply elasticity ranges from 0.50 to 1, if the Kenya's exceptional high value of 2.3 is excluded.

5. CONCLUSION

This study is in agreement with the previous studies in that, in general, long run price elasticities are larger than the short run one. But ours has an advantage in clarifying what long run and short run means using relevant estimation technique. Moreover, it provided stronger and positive elasticity values. The difference in our result could be attributed to the use of error correction model and well-structured database with large degrees of freedom. Since previous studies hardly touched upon other supply factors, a comparison with this study is not done.

The literature of commodity (export) supply functions is characterized by explanatory variables that are either current or lagged (relative) prices. This study not only underlines the existence of other equally or more important factors but also emphasizes their explicit incorporation in estimation. Cross-section data of African countries is used for estimation. First, price focused estimations are explored. Subsequent estimations are carried by adding other relevant explanatory variables that are rare in the literature. This section shows that (a) there is a clear difference between UNCTAD world prices and the regional price constructed for Africa, hence previous works using the former could have biased elasticities, (b) estimation using real exchange rate resulted in statistically significant elasticity coefficients with clear long and short run distinction. This underscores the importance of this particular specification and the Error Correction Model (ECM) in estimation, (c) capital formation indicators are also found to be positive and statistically significant, (d) there is a variation across the three regions of Africa and finally, (e) using the models in this section, estimation with foreign inflow included gives mixed results both as to the relation between export prices and supply of export and the impact of aggregate foreign inflows.

Notes

[1] The Ady model for cocoa and the French model for apples are the only two models prior to the 1960. During this period although the supply response literature was extensive, supply functions were rare (Palaskas, 1986:12).

[2] See Lim Lin Shu (1975), pp. 67-69 for comparison and algebra.

[3] Typical formulation of such investment function is the one which relates current investment I_t (which is the difference between current and lagged level of capital stock, K_t-K_{t-1}) with that of the desired (K*) and actual (K) level of capital stock with adjustment variable α, included. Formally this is given as,

$I_t = K_t - K_{t-1} = \alpha\,(K^*_t - K_{t-1})$ (See Palaskas (1986) for analysis of alternative specification of K*).

[4] At estimation stage these 'other' factors took different forms. For food and beverage price of fertilizer and lagged stock level are used. For agricultural raw materials a time trend and price of oil (as input price) is used. For metals lagged stock level and inters rate (to show cost of capital) are used.

[5] See Alemayehu (1998) Chapter 3 and the excellent survey by Labys *et al* (1991).

[6] This is an important result because one can use output figures as a proxy to area, for the latter data is hard to come by.

[7] See Alemayehu (1998) Chapters 6 and 8. Hwa (1985) is a good example of including stock holding variables in commodity models; Alogoskoufis and Varangis (1992) is an example of using macro variables in commodity modeling.

[8] Most studies use output of a commodity instead of exports, the assumption being change in output is easily convertible to change in exports. Export supply models, on the other hand, employ exports - assuming that change in exports are the results of change in output.

[9] The expected profit indicator used in Chu and Morrison (1986), with minor changes, is used. It can also be interpreted as price instability index. This is so for it is computed as the deviation of current price from a moving average price (at specified lag), which is assumed to show the long run average price.

[10] See Bond (1987) for empirical validity of this argument.

[11] Although in a simple level-based OLS estimation simultaneous equation bias can also arise from lack of a complete demand and supply model estimated simultaneously (like that of Goldestin and Khan (1978)), this limitation will not arise due to the use of the ECM approach (see Kennedy, 1994: 251 for instance. See also Hamiltion (1994) and Rao (1994) for formal treatment of this issue).

[12] In fact, an ECM regression of domestic price (GDP deflator) on foreign inflow is separately run to justify such proposition. The result indicates a strong positive relationship. Such possibility of 'Dutch disease' effect is strong for multilateral debt (which is one of the important flows to Africa).

[13] The problem with this hypothesis is to explain why a rise in price, is then, associated with lower exports if the demand for foreign exchange is so elastic. See also Bevan et al (1987) for an alternative explanation based on the concept of rationing about the so-called perverse relation.

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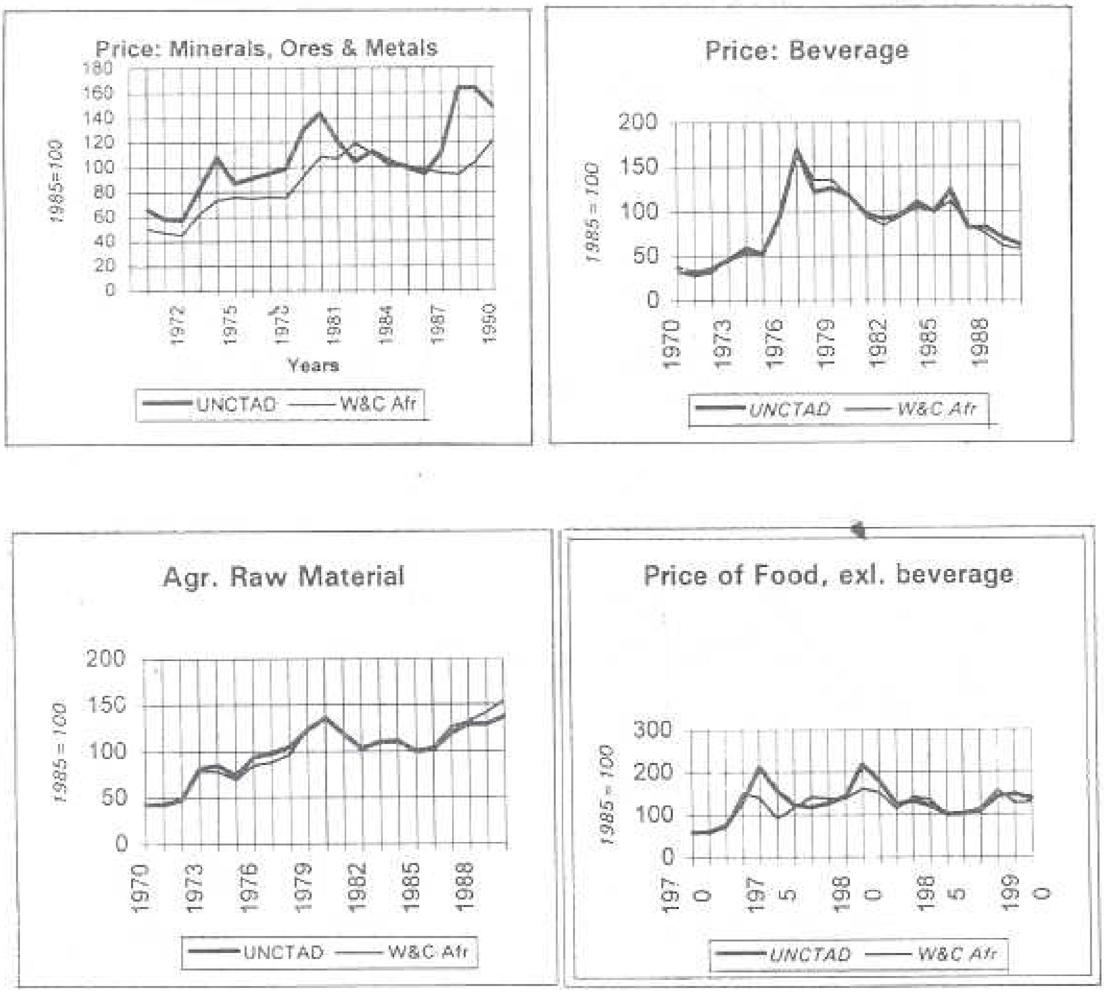
ANNEX 1

Diagram 1. The Modified and Actual UNCTAD Price Series (WCA)

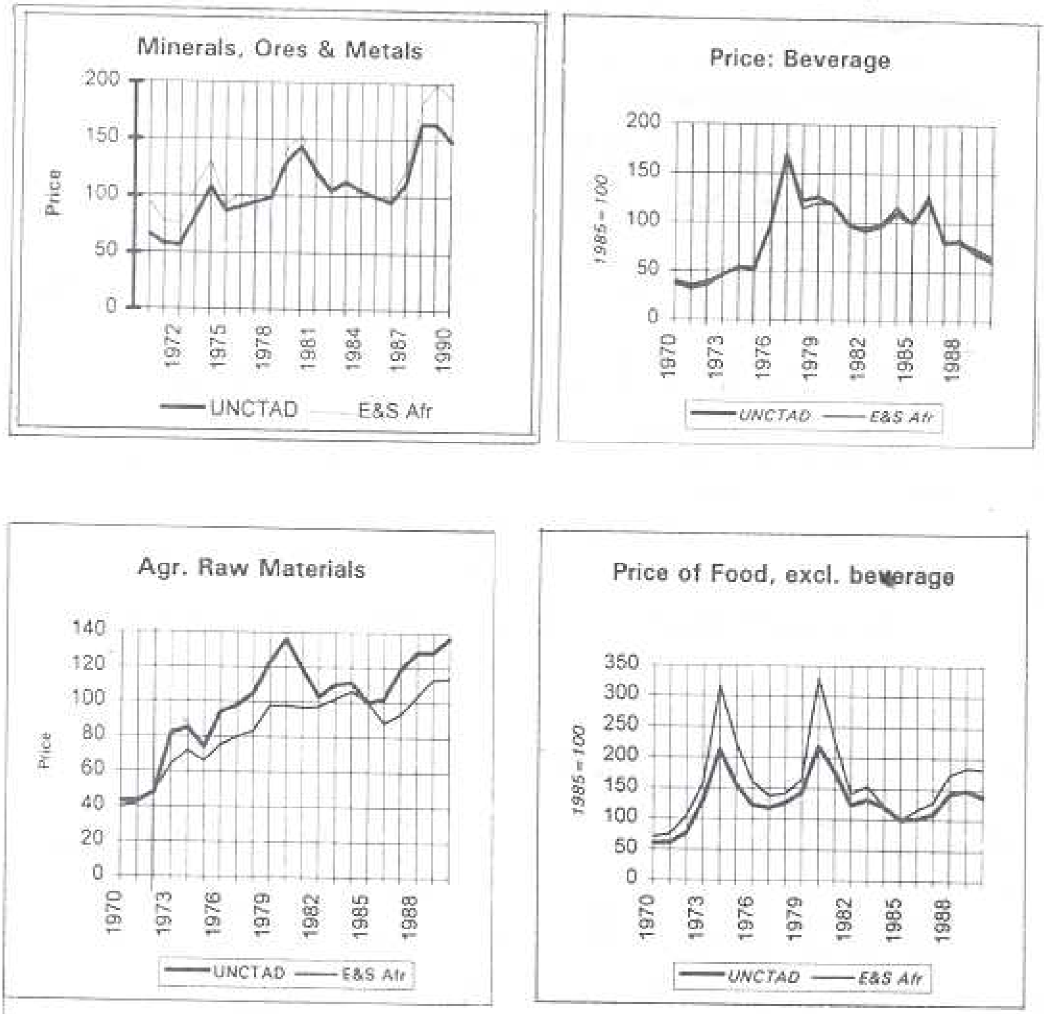


UNCTAD UNCTAD commodity price series

W&CAfr UNCTAD price wieghted by export of West and Central Africa region

(Regions according to UN-ECA classification)

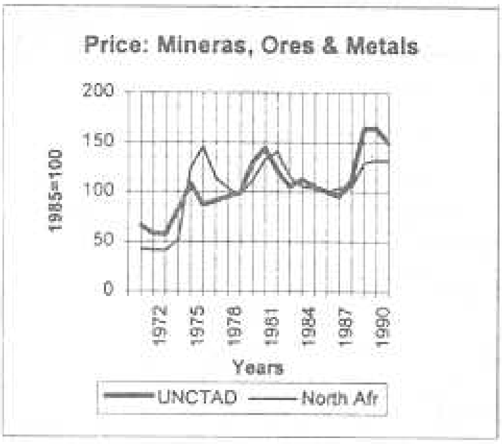
Diagram 2. The Modified and Actual UNCTAD Price Series (ECA)

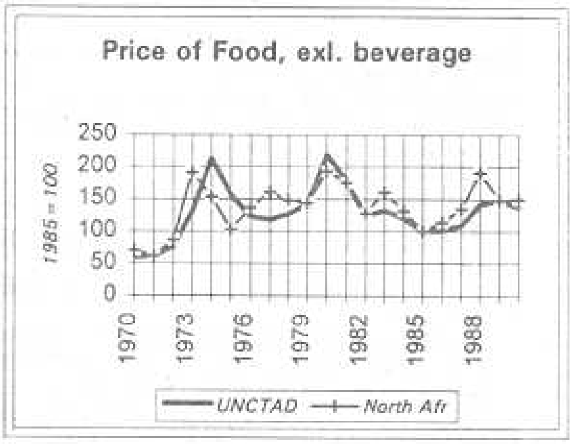


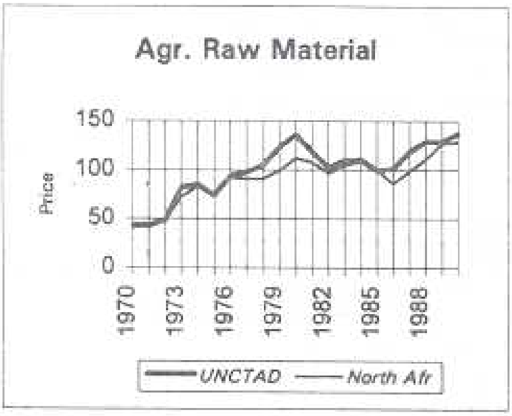
UNCTAD: UNCTAD commodity price series

E&S Afr: UNCTAD price wighed by export of East and Southern African countries (ESA). Regions using UN-ECA classification

Diagram 3. The Modified and Actual UNCTAD Price Series (NA)







UNCTAD UNCTAD commodity price series

North Afr UNCTAD price wighed by export of North Africa coutiries.

ANNEX 2

Table 1. Unit Root Analysis: An ADF Test at 1% Mackinnon Critical Value East and Southern Africa

Name of Variable	Symbol used	Level of Integration
Log of food real (At 1985 price)	LFOODR	I(1)
Log of Agricultural Raw Materials real (at 1985 price)	LAGRMR	I(1)
Log of Agricultural Raw Materials as proportion of GDP	LAGRMG	I(1)
Log of Beverage real (at 1985 price)	LBEVR	I(1)
Log of Beverage as proportion of GDP	LBEVG	I(1)
Log of Minerals real (at 1985 price)	LMMR	I(1)
Log of Minerals as proportion of GDP	LMMG	I(1)
Log of Price of Food, Agricultural Raw material, Minerals, beverag of West and Central Africa sample	LPFESAs, LPAESAs, LPBESAs and LPMESAs	I(1)
Log of Aggregate bilateral, multilateral, private inflows and grants respectively; Log of aggregate inflows, aggregate excluding private flows, Log of Foreign direct investment, log of fertilize consumption	LBILAD, LMULTD, LPRIVD, LGRANT, LBMPGFF, LBMGFF, LFDI, LFERTZ	I(1)
Log of capital stock as ratio of GDP, total, public, private	LKGDP, LKGVGDP, LKPGD	I(1)
Log of domestic credit as ratio of GDP: total, private, respectively	LDCRTG, LDCRPG	I(1)
Log of government investment as proportion of GDP	LIGVGDP (at 10%)	I(0) Border
Log of total, government and private investment as proportion of GDP	LIGDP, LIPGDP	I(1)
Log of (regional) Real exchange rate for food, Agr. raw materials, minerals and beverage (Regional commodity price X nominal exchange rate)/GDP deflator)	LRERF, LRERA,LRERM an LRERB	I(1)

Table 2. Co-Integration Test for East and Southern Africa

Equation	Engel-Granger ADF statistics	Mackinnon critical Value at 5%	Johansen likelihood ratio	Mackinnon critical Value	
				5%	1%
Food					
Model I	-3.929	-3.795	87.21	29.68	35.65
Model II	-3.570	-3.489**	38.20	29.68	35.65
Model III	-3.971	-3.862**	121.68	47.21	54.46
Agr. Raw materials					
Model I	-4.147	-3.794	64.79	29.68	35.65
Model II	-4.176	-4.166	41.58	29.68	35.65
Model III	-3.769	-3.870**	115.92	47.21	54.46
Beverage					
Model I	-3.879	-3.808	31.58	29.68	35.65
Model II	-3.769	-3.500**	21.71	29.68	35.65
Model III	-3.903	-3.876**	73.72	47.21	54.46
Minerals					
Model II	-3.274	-3.511**	31.92	29.68	35.65

** [*] Mackinnon critical value at 10% [1%] level of significance.
The Johansen test used assumes linear deterministic trend in the data with intercept, no trend, in the test VAR (i.e., the Co-integration equation, as an indicator of long run equilibrium relation, has no trend).

Table 3: Estimation with Current prices - East and Southern Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	(t-values)	LAGRMR	(t-values)	LBEVR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Regressors↓								
Constant	-2.40	-3.30***	4.16	3.00***				
ΔLP_1	0.29	2.06**	0.02	0.05	0.14	1.77*		
ΔLP_5					0.05	0.50		
ΔLIPGDP_1			0.16	1.77*				
ΔLIGVGDP_1	-0.21	-1.38						
ΔLKPGDP_5					0.03	0.25		
Long run coefficients (elasticities)								
LP_2	5.03	4.45***	-1.38	-2.21**	0.54	3.26***		
LP_6					0.30	1.63*		
LIPGDP_2			0.44	1.91**				
LIGVGDP_2	-0.45	-0.69						
LKPGDP_6					0.14	0.74		
Dependent_1	-0.11	-1.87**	-0.43	-6.17***	-0.34	-3.79***		
Diagnostic test								
ECM Adjusted R^2	0.18	n=108	0.34	n=85	0.09	n=90		
Level Adjusted R^2	0.14		0.57		0.64			
Jarque-Bera	4.23**		0.40**		0.14**			
RESET(1)	5.60	Pr(0.02)	1.40	Pr(0.24)	0.01	Pr(0.91)		
Chow	1.40**		2.83***		2.77***			
Degree of Multicollin.+	Low		Very Low		Very Low			
Constant (country) dummy used			Botswan Tanzania	-0.95 1.88	Ethiopia Kenya Madagascar Tanzania Uganda	0.59 0.80 0.30 0.46 0.64		

Notes

1. The long run coefficients and their t-values are using the Wickens and Breusch (1988) and Gurney (1989) approach. The Long run R^2 is also taken from the same regression. _1, _2 ...etc. show one , two ...etc. periods lag; ~ weakly significant (closer to 10%)
2. * significant at 10% ; ** at 5% and *** at 1% and less. For all of the equations the F value (over all fit) is significantly different from zero.
3. The Jarque-Bera $\_^2$ statistics at 5% level of significance for 2 degrees of freedom is 5.99. ** indicates significance at this level or better. Note, however, that it is relevant for large sample and visual inspection is important (See Mukherjee *et al* 1997).
4. # Chow break test is carried by using two country data as one series (when there is insufficient data by each country)

\+ For Multicollinearity simple correlation between regressors around <35 is assumed VERY LOW , 35-55 LOW & 55-65 ACCEPTABLE

The error correction form, for instance, for the food equation above can be given by the following (See Appendix 6.1)
ΔLFOODR=0.29ΔLP_1-0.21ΔLIGVGDP_1-0.11(LFOODR-5.03LP_2+0.45LIGVGDP_2+21.82). The long run relationship being,
LFOODR=5.03LP_2-0.45LIGVGDP_2-21.82

Table 4: Estimation with Real Exchange Rate - East and Southern Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	(t-values)	LAGRM	(t-values)	LBEVR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Regressors↓								
Constant	0.84	2.85***	1.02	3.05***	1.84	3.47***	0.54	1.45
ΔLP_1	-0.02	-0.15	0.33	2.25***			0.10	0.48
ΔLP_5					0.08	1.18	-0.42	-1.7*
ΔLIPGDP_2			0.18	2.15**				
ΔLIGVGDP_2	-0.19	-1.08						
ΔLIGVGDP_5							0.18	0.68
Long run coefficients (elasticities)								
LP_2	0.13	1.6*	-0.18	-1.24	0.10	1.19	1.26	1.97**
LP_6					0.23	3.16***	-0.4	-0.64
LIPGDP_3			1.19	2.77***				
LIGVGDP_3	-0.42	-1.4						
LKPGDP_6					-0.27	-2.9***		
LIGVGDP_6							2.36	3.32***
Dependent_1	-0.34	-4.5***	-0.14	-3.43***	-0.50	-4.42***	-0.18	-3.03***
Diagnostic test								
ECM Adjusted R^2	0.12	n=108	0.18	n=108	0.15	n=90	0.07	n=95
Level Adjusted R^2	0.34		0.12		0.81		0.37	
Jarque-Bera	1.53**		2.85**		2.17		74	
RESET(1)	0.17	Pr(0.68)	0.46	Pr(0.50)	1.4	Pr(0.24)	0.07	pr(0.80
Chow	1.8**		2.98***		2.3***		1.55**	
Degree of Multicollin.+	Low		Very Low		Very Low		Low	
Constant (country) dummy used	Zambia	-0.84	Botswan	-0.36	Ethiopia Kenya Madagasca Uganda	0.77 0.95 -0.64 0.29	Botswana Kenya	0.94 0.52

Notes: All Notes are as given inTable 6.3

Table 3: Estimation with Current prices - East and Southern Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	(t-values)	LAGRMR	(t-values)	LBEVR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Regressors↓								
Constant	-2.40	-3.30***	4.16	3.00***				
ΔLP_1	0.29	2.06**	0.02	0.05	0.14	1.77*		
ΔLP_5					0.05	0.50		
ΔLIPGDP_1			0.16	1.77*				
ΔLIGVGDP_1	-0.21	-1.38						
ΔLKPGDP_5					0.03	0.25		
Long run coefficients (elasticities)								
LP_2	5.03	4.45***	-1.38	-2.21**	0.54	3.26***		
LP_6					0.30	1.83*		
LIPGDP_2			0.44	1.91**				
LIGVGDP_2	-0.45	-0.69						
LKPGDP_6					0.14	0.74		
Dependent_1	-0.11	-1.87**	-0.43	-6.17***	-0.34	-3.79***		
Diagnostic test								
ECM Adjusted R^2	0.18	n=108	0.34	n=85	0.09	n=90		
Level Adjusted R^2	0.14		0.57		0.64			
Jarque-Bera	4.23**		0.40**		0.14**			
RESET(1)	5.60	Pr(0.02)	1.40	Pr(0.24)	0.01	Pr(0.91)		
Chow	1.40**		2.83***		2.77***			
Degree of Multicollin.+	Low		Very Low		Very Low			
Constant (country) dummy used			Botswan Tanzania	-0.95 1.88	Ethiopia Kenya Madagasc r Tanzania Uganda	0.59 0.80 0.30 0.46 0.64		

Notes

1. The long run coefficients and their t-values are using the Wickens and Breusch (1988) and Gurney (1989) approach. The Long run R^2 is also taken from the same regression. _1, _2 ...etc. show one, two ...etc. periods lag. ~ weakly significant (closer to 10%)
2. * significant at 10% ; ** at 5% and *** at 1% and less. For all of the equations the F value (over all fit) is significantly different from zero
3. The Jarque-Bera $\_^2$ statistics at 5% level of significance for 2 degrees of freedom is 5.99. ** indicates significance at this level or better. Note, however, that it is relevant for large sample and visual inspection is important (See Mukherjee *et al* 1997).
4. # Chow break test is carried by using two country data as one series (when there is insufficient data by each country)

\+ For Multicollinearity simple correlation between regressors around <35 is assumed VERY LOW , 35-55 LOW & 55-65 ACCEPTABLE

The error correction form, for instance, for the food equation above can be given by the following (See Appendix 6.1)
ΔLFOODR=0.29ΔLP_1-0.21ΔLIGVGDP_1-0.11(LFOODR-5.03LP_2+0.45LIGVGDP_2+21.82). The long run relationship being,
LFOODR=5.03LP_2-0.45LIGVGDP_2-21.82

Table 4: Estimation with Real Exchange Rate - East and Southern Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	(t-values)	LAGRM	(t-values)	LBEVR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Regressors↓								
Constant	0.84	2.85***	1.02	3.05***	1.84	3.47***	0.54	1.45
ΔLP_1	-0.02	-0.15	0.33	2.25***			0.10	0.48
ΔLP_5					0.08	1.18	-0.42	-1.7*
ΔLIPGDP_2			0.18	2.15**				
ΔLIGVGDP_2	-0.19	-1.08						
ΔLIGVGDP_5							0.18	0.68
Long run coefficients (elasticities)								
LP_2	0.13	1.6*	-0.18	-1.24	0.10	1.19	1.26	1.97**
LP_6					0.23	3.16***	-0.4	-0.64
LIPGDP_3			1.19	2.77***				
LIGVGDP_3	-0.42	-1.4						
LKPGDP_6					-0.27	-2.9***		
LIGVGDP_6							2.36	3.32***
Dependent_1	-0.34	-4.5***	-0.14	-3.43***	-0.50	-4.42***	-0.18	-3.03***
Diagnostic test								
ECM Adjusted R^2	0.12	n=108	0.18	n=108	0.15	n=90	0.07	n=95
Level Adjusted R^2	0.34		0.12		0.81		0.37	
Jarque-Bera	1.53**		2.85**		2.17		74	
RESET(1)	0.17	Pr(0.68)	0.46	Pr(0.50)	1.4	Pr(0.24)	0.07	pr(0.80
Chow	1.8**		2.98***		2.3***		1.55**	
Degree of Multicollin +	Low		Very Low		Very Low		Low	
Constant (country) dummy used	Zambia	-0.84	Botswan	-0.36	Ethiopia Kenya Madagasca Uganda	0.77 0.95 -0.64 0.29	Botswana Kenya	0.94 0.52

Notes: All Notes are as given inTable 6.3

Table 8. Estimation with Current Prices - North Africa

Dependent→	Food		Agr. Raw Materials		Minerals	
	LFOODR	(t-values)	LAGRMR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)						
Regressors↓			No Co-integration			
Constant	2.10	0.84			8.52	3.95***
ΔLP_1	-0.26	-0.59			0.21	0.59
ΔLP_5					-0.25	-0.93
ΔLIPGDP_1	0.54	0.86				
ΔLIGVGDP_5					-0.56	-2.24***
Long run Coefficients (elasticities)						
LP_2	0.35	0.96			-0.35	-0.70
LP_6					-0.91	-3.54***
LIPGDP_2	0.08	0.18				
LIGVGDP_6					1.14	5.05***
Dependent_1	-0.96	-6.23***			-0.71	-6.90***
Diagnostic Test						
ECM Adjusted R^2	0.47	n=57			0.60	n=45
Level Adjusted R^2	0.41				0.60	
Jarque-Bera	2.73				1.5**	
RESET(1)	1.78	Pr(0.19)			1.1	Pr(0.30)
Chow	2.7***				2.03**	
Degree of Multicollin.+	Low				Low	
Constant (country) dummy used	Tunisia Egypt	1.11 1.32			Egypt Tunisia	0.48 -0.16

Notes: All Notes are as given inTable 1.3.

Table 9: Estimation with Real prices - North Africa

Dependent→	Food		Agr. Raw Materials		Minerals	
	LFOODR	(t-values)	LAGRMR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)						
Regressors↓						
Constant	4.88	4.4***	1.09	2.13**	2.55	4***
ΔLP_1	-0.52	-1.37	0.63	1.15	0.48	1.42
ΔLP_5					0.32	0.88
ΔLIPGDP_1	0.4	0.64				
ΔLDCRGVG_1			0.62	2.08**		
ΔLIGVGDP_5					-0.19	-0.61
Long run Coefficients (elasticities)						
LP_2	0.3	1.32	2.4	1.7*	0.64	1.38
LP_6					0.95	1.94**
LIPGDP_2	0.00	0.00				
LDCRGVG_2			0.56	1.44		
LIGVGDP_6					0.02	0.07
Dependent_1	-1.02	-7.1***	-0.22	-2.6***	-0.62	-5.9***
Diagnostic Test						
ECM Adjusted R^2	0.48	n=57	0.13	n=56	0.49	n=45
Level Adjusted R^2	0.46		0.56		0.40	
Jarque-Bera	541		343		0.06**	
RESET(1)	0.34	Pr(56)	0.09	Pr(0.77)	0.28	pr(0.60)
Chow	3.5***		3.6-***		4.5	
Degree of Multicollin.+	High++		Low		Low	
Constant (country) dummy used	Algeria	-1.86	Algeria	-2.2	Algeria	-2.13

Notes: All Notes are as given inTable 1.3.

++ The correlation coefficient between LIPG and LRERF = 0.82 (others are LOW)

Table 10. Estimation with Capital Inflow - North Africa

	Food		Agr. Raw Materials		Minerals	
Dependent→	LFOODR	(t-values)	LAGRMR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)						
Regressors↓						
Constant	-0.68	-0.23	-6.0	-3.1***	7.8	3.6***
ΔLP_1	0.05	0.09	0.61	1.12	0.40	1.24
ΔLP_5					-0.43	-1.36
ΔLIPGDP_1	1.14	1.56~				
ΔLIGDP_5					0.31	0.82
ΔLFERTZ_1			1.21	3.2***		
ΔFF_2@	0.98	1.35	0.68	2.19**	-0.39	-0.97
ΔFF_6					-0.05	-0.26
Long run Coefficients (elasticities)						
LP_2	0.90	2.21**	-0.4	-0.6	-1.02	-2.2**
LP_6					-1.28	-3.69***
LIPGDP_2	0.17	0.39				
LIGDP_6					0.25	0.66
LFERTZ_2			1.53	12***		
FF_3@	0.15	1.8*	-0.43	-2.4***	0.58	2.54***
FF_7					-0.02	-0.09
Dependent_1	-1.06	-6.6***	-0.60	-5.5***	-0.75	-4.92***
Diagnostic Test						
ECM Adjusted R^2	0.58	n=50	0.40	n=56	0.54	n=39
Level Adjusted R^2			0.93		0.75	
Jarque-Bera	34		67		0.60**	
RESET(1)	0.49	Pr(0.48)	10.6	Pr(0)	0.06	Pr(0.88)
Chow	3.9~***		6.5		3.22**	
Degree of Multicollin.+	Low		Low		High++	
Constant (country) dummy used	Algeria	-1.53	Algeria	-2.24	Algeria	-0.68

Notes: All Notes are as given inTable 3

@ For agricultural raw material private debt with 1 period lag is used (since others flows are not co-integrated).

++ The correlation coefficient between LBMPGFF and LPMNASs =0.70 so is their difference; others are Very Low

ANNEX 4

Table 11. Unit Root Analysis: an ADF test at 1% Mackinnon critical value West and Central Africa

Name of Variable	Symbol used	Level of Integration
Log of food as proportion of GDP	LFOODG	I(1)
Log of food real (at 1985 price)	LFOODR	I(0)
Log of Agricultural Raw Materials real (at 1985 price)	LAGRMR	I(1)
Log of Agricultural Raw Materials as proportion of GDP	LAGRMG	I(1)
Log of Beverage real (at 1985 price)	LBEVR	I(1)
Log of Beverage as proportion of GDP	LBEVG	I(1)
Log of Minerals real (at 1985 price)	LMMR	I(1)
Log of Minerals as proportion of GDP	LMMG	I(1)
Log of Price of Food, Agricultural Raw material, Minerals, beverage of West and Central Africa sample	LPFWCAs, LPAWCAs, LPBWCAs and LPMWCAs	I(1)
Log of Aggregate bilateral, multilateral, private inflows and grants; same excluding private flows. Log of Foreign direct investment	LBMPGFF, LBMGFF, LFDI	I(1)
Log of total, government and private Investment as proportion of GDP	LIGNP, LIGGNP, LIPGNP	I(1)
Log of (regional) Real exchange rate for food, Agr. raw materials, minerals and beverage (regional commodity price X nominal exchange rate)/GDP deflator)	LRERF, LRERA,LRERM and LRER	I(1)

Table 12. Co-Integration Test for West and Central Africa

Equation	Engel-Granger ADF Statistics	Mackinnon Critical Value at 5%	Johansen likelihood Ratio	Mackinnon Critical Value	
Food				5%	1%
Model I	-6.534	-4.362*	160.05	29.68	35.65
Model II	-6.810	-4.362*	66.53	29.68	35.65
Model III	-6.612	-4.734*	227.00	47.21	54.46
Agr. Raw materials					
Model I	-4.551	-4.362*	71.35	29.68	35.65
Model II	-4.076	-3.783	27.14	29.68	35.65
Model III	-4.860	-4.502@	94.4	47.21	54.46
Beverage					
Model I	-4.142	-3.795	58.41	29.68	35.65
Model II	-3.485	-3.491**	29.58	29.68	35.65
Model III	-4.074	-3.867**	83.25	47.21	54.46
Minerals					
Model I	-3.637	-3.485**	69.32	29.68	35.65
Model II	-4.089	-3.790	109.34	47.21	54.46
Model III	-4.610	-4.163	60.31	47.21	54.46

@ is trend stationary, otherwise are not co-integrated. ** [*] Mackinnon critical value at 10% [1%] level of significance. The Johansen test used assumes linear deterministic trend in the data with intercept, no trend, in the test VAR (i.e., the Co-integration equation, as an indicator of a long run equilibrium relation, has no trend).

Table 13. Estimation with Current prices - West and Central Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	t-values)	LAGRMR	(t-values)	LBEVR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Regressors↓								
Constant	-0.68	-0.74	-0.85	-1.6*			-1	-0.32
ΔLP_1	0.46	3.0***	0.36	1.5~	0.37	2.44***	-0.60	-0.66
ΔLP_5					0.06	0.37	-0.38	-0.40
ΔLFRTZ_1	0.11	1.63*						
ΔLIPGNP_5@					-0.07	-0.60	0.49	1.18
ΔLKG_2			0.12	0.24				
Long run Coefficients (elasticities)								
LP_2	2.4	3.5***	-0.16	-0.35	0.84	2.5***	2.45	1.96**
LP_6					0.46	1.08	-0.73	-1.00
LFRTZ_2	-0.24	-1.06						
LIPGNP_6@					-0.01	-0.04	1.03	3.15***
LKG_3			1.02	5.6***				
Dependent_1	-0.20	-3.01***	-0.25	-4.27***	-0.25	-3.94***	-0.81	-4.9***
Diagnostic Test								
ECM Adjusted R^2	0.24	n=114	0.11	n=126	0.10	n=108	0.27	n=58
Level Adjusted R^2	0.40		0.25		0.54		0.83	
Jarque-Bera	1.19**		0.06**		4.5**		5.3**	
RESET(1)	1.04	pr.(0.31)	0.07	pr.(0.79)	0.13	pr.(0.71)	0.04	pr.(0.83)
Chow	0.94**		1.93**		1.11**#		1.3**	
Degree of Multicollin.+	Acceptable		Acceptable		Low		Low	
Constant (country) dummy used	Bf, Cam, Car, Nig, Zi	-0.65, -0.37, -0.88 -0.35 -0.81	Gha, Sen	-0.30 -0.32	Ben, Car, Gab Sen, Ser	-0.89 -0.62 -0.97 -1.32 -0.57	Ben, Car	-2.75 -1.93

Notes: All Notes are as given inTable 3.
@ For Beverages we used LDCRT (i.e. Total Domestic Credit).

Table 14. Estimation with Real Exchange rate - West and Central Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	-values)	LAGRMR	-values)	LBEVR	t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Repressors↓								
Constant	-0.28	-0.72	0.04	0.10			0.13	0.14
ΔLP_1	0.27	2.19**	0.48	3.3***	0.18	1.96**	-0.12	-0.19
ΔLP_5					0.12	1.1	1.14	1.12
ΔLFRTZ_1	0.18	2.7***	0.01	0.26				
ΔLIPGNP_5@					-0.04	-0.31	0.28	0.50
Long run Coefficients (elasticities)								
LP_2	0.17	1.03	0.62	1.48~	0.50	2.32***	-2.52	-3.02***
LP_6					0.25	1.14	2.73	3.29***
LFRTZ_2	0.42	2.06**	0.03	0.21				
LIPGNP_6@					0.26	2.82***	-1.44	-1.39
Dependent_1	-0.15	-2.88***	-0.12	-2.85***	-0.26	-3.64***	-0.51	-4.28***
Diagnostic Test								
ECM Adjusted R^2	0.16	n=111	0.09	n=133	0.09	n=106	0.24	n=58
Level Adj R^2	0.26		0.09		0.65		0.64	
Jarque-Bera	2.06**		0.05**		2.0**		3.29**	
RESET(1)	0.45	r.(0.50)	0.48	r.(0.50)	0.95	pr.(0.33)	0.01	pr.(0.91)
Chow	0.58**		1.3**		0.85**		0.87**	
Degree of Multicollin.+	Acceptable		Very Low		Low		ery Low	
Constant (country) dummy used	Sen Zi	0.33 -0.18	Ben Sen	-0.15 -0.23	Car Gab Gha Nig Sen	-0.64 -1.06 0.25 0.76 -1.47	Ben Car	-2.55 -2.65

Notes: All Notes are as given inTable 3.

@ For Beverages we used LDCRT (i.e. total domestic credit).

Table 15. Estimation with Capital Inflow - West and Central Africa

	Food		Agr. Raw Materials		Beverage		Minerals	
Dependent→	LFOODR	(t-values)	LAGRMR	(t-values)	LBEVR	(t-values)	LMMR	(t-values)
Short run Coefficients (elasticities)								
Regressors↓								
Constant	-2.28	-2.07**	1.08	1.28	-1.29	-0.84	-3.84	-0.87
ΔLP_1	0.57	2.96***	0.35	1.26	0.37	1.55~	0.51	0.48
ΔLP_5					-0.03	-0.17	0.05	0.05
ΔLFRTZ_1	0.16	2.54***	0.03	0.58				
ΔLIPGNP_5@					-0.25	-1.96**	0.47	1.16
ΔFF_2^	0.04	0.65	0.21	2.55***	0.28	1.23	-0.88	-1.54~
ΔFF_6^					0.19	1.7*	-0.37	-0.75
Long run Coefficients (elasticities)								
LP_2	3.5	2.2***	-1.14	-1.45	1.35	1.42	4.0	1.96**
LP_6					0.05	0.09	0.23	0.18
LFRTZ_2	0.50	2.39***	0.00	0.02				
LIPGNP_6*					-0.86	-2.16**	0.58	0.82
FF_3^	-0.39	-1.63*	0.79	4.0***	0.62	1.57~	-0.55	-0.55
FF_7^					0.67	1.7*	-0.54	-0.67
Dependent_1	-0.14	-3.72***	-0.25	-3.93***	-0.24	-2.9***	-0.49	-4.16***
Diagnostic Test								
ECM Adjusted R^2	0.20	n=106	0.11	n=107	0.03	n=97	0.18	n=68
Level Adjusted R^2	0.29		0.28		0.64		0.70	
Jarque-Bera	0.13**		0.04**		1.47**		3.5**	
RESET(1)	0.02	pr.(0.88)	0.38	pr.(0.54)	0.73	pr.(0.39)	1.06	pr.(0.31)
Chow	0.72**		1.3**		0.99**		1.25**	
Degree of Multicollin.+	Low		Low		High (0.79)++		Low	
Constant (country) dummy used	Sen	0.35	Ben Sen	-0.25 -0.47	Cam Gab Gha Nig Sen	0.5, -0.6 0.7, 0.5 0.84	Ben Car	-2.6 -2.4

Notes: All Notes are as given inTable 3.

@ For Beverage we used LDCRT(total domestic credit).

^ For minerals the foreign inflow used excludes private inflow since private investment is used as one of the repressors.

++ All other correlations are very low except that between LDCRT and LBMPGFF which is 0.79.