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An analysis of short-run response of export and domestic agriculture in sub-Saharan Africa☆

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Abstract

Short-run responses of export and domestic shares of total agricultural output to changes in stocks of domestic savings (SAV), development assistance (ODA), private foreign commercial capital (PFX) and other variables is investigated. A profit function approach is used. Time series data for 19 sub-Saharan African countries are pooled into three panels using similarities in changes in economic policy regime.

Statistical evidence suggests that for the panel of countries that were undertaking liberalized economic reforms, the slope coefficients of some of the variables in the models have changed significantly between 1970–1980 and 1981–1993. For the 1981–1993 period, the impacts of ODA, PFX and SAV on export and domestic shares were different for this panel. The effect of increases in agricultural labor was different across the three panels. There is also evidence that productivity growth in the export agriculture sub-sector is negative in all the groups.

It is recommended that to halt the decline in export share of agricultural output in the group of countries that have undertaken substantial improvements in economic policy environment, efforts must be made to reduce the negative impact of domestic savings and agricultural labor, while at the same time working to reduce the bias of development assistance against food security.

Keywords: Official development assistance; Private foreign commercial capital; Domestic savings; Export and domestic shares of agricultural output; Profit function; Panel data

1. Introduction

This paper investigates the short-run response of the shares of agricultural exports and agriculture for domestic consumption in sub-Saharan Africa (SSA) to producer prices, factor inputs, macroeconomic policy, and exogenous shocks. Panel data for 19 SSA countries are used. Particular attention is paid to foreign and domestic components of investment capital as well as on-going economic structural adjustment programs.

SSA countries export primary agricultural products in order to earn foreign exchange to pay for their imports. There is some indication that in many instances, export agriculture is undertaken at the expense of agriculture for domestic consumption, which is mostly food. For, government pricing policies and the roles of marketing boards (marketing of produce, provision of infrastructure, etc.) have tended to favor agricultural exports. In fact, crops grown for export are commonly referred to as 'cash crops'. That is, these are the crops

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that have traditionally brought income to the farmer. In addition, there is anecdotal evidence that foreign investment capital benefits the export sub-sector at the expense of the domestic sub-sector by either being invested in this sub-sector directly (for example, by influencing the availability and distribution of inputs and infrastructure), or by encouraging research and development that mostly benefits the agricultural export sub-sector. [1]

In spite of this attention, Africa has been losing her share of world trade with respect to many of her products, especially agriculture. Available data indicates that, currently, agricultural exports make up just about a quarter of total agricultural output in SSA, whereas around the middle to the late 1970s, the proportion was about half. In addition, Ng and Yeats (1997) recently documented ample evidence of this loss and suggested that this has been due to economic policies pursued in these countries. Unfortunately, in the face of this loss of her share of agricultural export market, food security is becoming a problem in some parts of SSA, leaving researchers wondering how resources are being allocated between export and domestic agriculture.

Also of concern is the fact that since the early 1980s, many SSA countries have embarked upon economic policy reforms to try to address deteriorating economic conditions in their countries. Often, the extent of reforms are a major determinant of the amount of flow of financial resources from the World Bank, the International Monetary fund and international capital markets to these countries. External financial resources that are investigated here are the stocks of the net balances in the capital account components (of balance of balance of payments) referred to as foreign private commercial capital (PFX) and overseas development assistance (ODA). Also investigated is the stock of the gross domestic saving (SAV). All three are considered as important forms of investment in agriculture (Papanek, 1973; Kherallah et al., 1994).

PFX include foreign direct investments, commercial loans from foreign banks and other sources, as well as portfolio equity investments in financial and equity markets. ODA refers to resources that are provided on concessional terms. The criteria for a flow of resources to qualify as ODA are: (i) the resources are provided by official agencies, including state and local governments or their executive agencies, (ii) the resources are provided with the promotion of economic development and welfare as the main objective, and, (iii) the resources are provided on concessional terms and as well convey a grant element of at least 25%. Gross domestic saving equals gross domestic product minus total consumption.

The investigation of the impact of these factors on export and domestic agriculture is conducted by examining how these factors explain the proportion of agricultural output that is exported and that which is consumed domestically. Country data are pooled into three groups: those countries that are considered to have shown large improvement in economic policies in the 1980s and early 1990s, those that are considered to have shown only small improvement and those whose economic policy environment is considered to have deteriorated over the period. A profit function approach is used to obtain the export share of agricultural output in terms of explanatory variables. Export share is defined as the of total agricultural exports divided by total agricultural output. Corresponding domestic share coefficients are easily obtained from export share coefficients. Use of the profit function approach enables one to analyze the domestic sub-sector just as well as the export sub-sector. Thus, one is able to circumvent some methodological and data problems that have plagued researchers in efforts to investigate the domestic sub-sector of agriculture in SSA (e.g., Jaeger, 1992).

The structure of the paper is the following. The next section reviews the conceptual framework and pertinent empirical studies. The econometric approach is then discussed, followed by a description of data sources. Following this, estimation results are presented and discussed. Conclusions and policy implications are then presented.

2. Conceptual framework and review of empirical evidence

2.1. Growth theory

The investigation of export and domestic share response conducted here is cast in the framework of

[1] This paper shall often refer to agriculture for exports and agriculture for the domestic consumption as the export and domestic sub-sectors of agriculture.

economic growth theory. While neo-classical growth theory emphasizes the role of factor accumulation in the production process, endogenous growth theory allows intangible inputs such as knowledge acquisition, human capital (e.g., skills acquired by labor), as well as factors that enhance the efficiency of inputs to affect the production process. These models are thus able to explain non-decreasing returns to reproducible factor inputs. In particular, outward oriented trade policies are said to promote competition and result in raising the efficiency with which factor inputs are used. Trade also enhances externalities as it leads to access to improved technologies. Poor economic growth in SSA has been blamed originally on inadequate investment, but more recently on bad macroeconomic policies which are said to have hampered the efficiency with which inputs are used.

Other researchers such as Easterly et al. (1993) have found that shocks, especially terms of trade, are also important in determining long-run growth. For in a typical SSA country, changes in her external terms of trade affect her foreign currency receipts from agricultural exports. This in turn affects the resources that these governments devote to agriculture (e.g., proportion of international prices paid to producers), provision of infrastructure, etc. Indeed, Deaton and Miller (1995) find that African economies grow faster when prices of their exports are increasing.

The weather too no doubt is an important exogenous shock that impacts agricultural output. However, quantifying its effect is dicey. For one thing, daily rainfall, rainfall patterns and evaporation rates affect individual crops differently. Here, a proxy is derived by taking the residuals of a regression trend line for cereal yields to proxy the effect of weather on agriculture in each year. This is done on the grounds that cereal (or animal) output would respond most readily to moisture changes. Even though other factors such as fertilizer use (only minimally in SSA) may affect cereal output, these are not likely to dominate the impact of rainfall. All the preceding factors are considered in specifying the econometric model investigated.

In this paper, it is reasoned that PFX, ODA and SAV will have different impacts on domestic and export agriculture. PFX generally supports international trade (World Bank, 1997). Thus, its impact on agriculture is more likely to be positive for agricultural exports than for domestic agriculture. ODA flows are influenced by political considerations and in recent times by the extent of economic reforms undertaken. Chances are therefore high that ODA too will impact agricultural exports more positively than domestic agriculture. The third component of investment capital investigated are domestic savings (SAV). With SSA governments giving more incentives to agricultural exports, farmers are likely to respond by investing more of their savings in export agriculture. Thus, the impact of invested domestic savings too is likely to benefit export agriculture at the expense of domestic agriculture.

Hence all things being equal, PFX, ODA and SAV are conjectured to impact export share positively.[2] However, with food security becoming a problem in many countries, it may be the case that these resources are being reallocated towards food production. Economic reforms as being currently pursued may also have a bearing on the impact of PFX, ODA and SAV on agriculture. Within the period of study (1981–1993), governments of countries that are considered to have undertaken positive economic policy changes still fix producer prices of agricultural exports while generally allowing market forces to determine the prices of agriculture for domestic consumption. This fact too may affect the manner in which resources are being allocated.

2.2. *Short-run supply response studies*

Available agricultural response studies do not fully address the response to factor inputs alongside producer prices. For example, Binswanger et al. (1987) investigated aggregate short-run supply response of agriculture to price and various public inputs using panel data for 58 countries. Their study covered the period 1969–1978. They found that the main determinants of output are variables representing infrastructure and that the effect of price was relatively weak. In the same spirit, in their survey of supply responses, Schiff and Montenegro (1997) provide some evidence in support of complementarity between producer prices and public goods (infrastructure, supporting services, legal and institutional framework) using data for 18 countries of the world of which three are in SSA. The present

[2] However, it is argued and shown in a related paper, Aboagye (1998), that these three forms of capital have different impacts on the agricultural sector in SSA.

study while investigating producer price treats PFX, ODA, and SAV both as capital for building infrastructure and as factor inputs and investigates the impact of each on the two sub-sectors of agriculture. This is more in the spirit of growth theory.

Jaeger (1992) studied the short-run response of total agricultural exports and individual export crops to real producer prices, real effective exchange rates, weather and disaster variables. He used panel data for 21 countries of SSA covering the period 1970–1987. He also examined the possibility that export agriculture may crowd out food production. He found that in the short-run, elasticities of tree crop exports are only moderately responsive to price incentives, while annual crops exports are more elastic. He commented that lack of price data for food crops prevented him from studying the impact of policy on food production the way he did for agricultural exports. He however, found that 'growth in export agriculture does not appear to come at the expense of food production'. Further, he added that there was evidence to suggest that poor policies have had a major role in the decline of African agriculture. Clearly, Jaeger did not concern himself with the role of factor inputs. This study does, and in addition it investigates domestic and export shares of agriculture equally.

2.3. Other related studies

Krueger et al. (1991) edited a World Bank sponsored comparative study (individual country case studies) that assessed the impact of direct and indirect intervention in agricultural prices in 18 countries. Three of these are SSA countries. They found that agriculture in these countries was more heavily taxed than subsidized. Similarly, Bautista and Valdes (1993) also edited a volume that investigated the effect of trade and macroeconomic policies on agriculture in another sample of 18 countries. Two of these countries are in SSA. They also concluded that restrictions on trade, foreign exchange rates, direct and indirect taxes constitute bias against agriculture. It has been commented above that even countries that are considered to have liberalized many sectors of their economies had not done so with respect to agricultural exports during the period covered by this study. This study would be able to comment on the impact of this intervention in the shares of agricultural exports.

The supply response studies cited above (and others) clearly suggest that agricultural response to producer prices is small and that macroeconomic factors impact overall agricultural and agricultural share. While the Binswanger et al. study suggests that variables representing infrastructure are more important than price, it does not investigate share responses. This paper examines directly the response of export and domestic shares to the factors of production, (in addition to other factors) hypothesizing that investment capital and on going reforms in the macroeconomic environment are likely to impact export agriculture positively at the expense of domestic agriculture.

3. Econometric specification

The profit function or the gross domestic product (GDP) function approach is used to obtain export share. This approach enables one to analyze the response of this sub-sector not only to price, but also to changes in factor inputs, external shocks, and the effect of policy environment. Inference with respect to the domestic sub-sector is easily made from estimation of the export share equation.

3.1. Export share

Consider utility maximizing economic agents making decisions with respect to factor inputs, output prices and other variables that affect their profits. Given perfect competition in input and output markets, the decision they face is that of maximizing the value of output quantity, y, subject to available production technology, T, factor endowment vector, x (say, capital, land, labor and human capital), and a vector of prevailing positive output prices, p. Prices of agricultural exports are exogenously determined by governments or in the world market, while domestic agricultural prices may be determined by the demand and supply situation in the home country or sometimes by governments.

By definition, the profit function, π, in terms of output prices and input vector may be written as the solution to the maximization problem

$$\pi(p, x) = \max_{y}\{p'y : (x, y) \in T, (x, y) \gg 0\}, \qquad (1)$$

Restrictions are then imposed to ensure that the function is well behaved. The restricted profit function is homogenous of degree 1, convex and increasing in output prices.[3] Under the assumption of constant returns to scale, it is also homogenous of degree one, concave and increasing in quantities of given inputs. The assumption of constant returns to scale is used often. In this context, it is justified on the grounds that, agricultural land, the only factor input that is not reproducible is for now, at least, not a constraint in SSA. MacFadden (1973) has shown the existence of a one-to-one correspondence between the set of concave production functions and the set of profit functions. This observation allows one not to worry about the specific form of the production function.

The agricultural profit function is represented here as a transcendental logarithmic function. This specialization of the GDP function enables one to obtain value shares of each sub-sector of agriculture (export and domestic) in terms of factor inputs, producer prices, external prices, a policy variable, and the weather, by differentiating with respect to producer price in each sub-sector. The two sub-sectors span total agricultural production.

The translog function also allows the elasticity of substitution between inputs to be flexible, and does not impose input-output separability. It has been used by Lawrence (1989), for example, to study substitution possibilities between Canadian imports, exports and domestic inputs or outputs. More recently, Martin and Warr (1993, 1994) used it to study the decline of agriculture vis-a-vis manufacturing and service sectors of Indonesia and Thailand.

The GDP function is then written as

$$\ln \mathrm{AGDP} = \theta_0 + \sum_{i=1}^{2}\theta_i \ln p_i + \frac{1}{2}\sum_{i}^{2}\sum_{j}^{2}\gamma_{ij} \ln p_i \ln p_j + \sum_{k=1}^{6}\beta_k \ln F_k + \frac{1}{2}\sum_{k=1}^{6}\sum_{m=1}^{6}\delta_{km} \ln F_k \ln F_m + \sum_{i=1}^{2}\sum_{k=1}^{6}\eta_{ik} \ln p_i \ln F_k, \quad (2)$$

where, AGDP is the agricultural GDP; the p_i are the producer prices prevailing in the domestic (i=1) and export (i=2) sub-sectors; and the F_k are the six factor inputs, namely, the stock of ODA (K_1), the stock of PFX (K_2), the stock of SAV (K_3), agricultural labor force (LABOR), agricultural land (LAND), and the stock of human capital (HCAP). In addition, $\theta_i = \boldsymbol{X}\boldsymbol{\Psi}_i$, where $\boldsymbol{X}$ is a vector (transposed) of policy and exogenous variables and $\boldsymbol{\Psi}_i$ is the corresponding vector of coefficients that relate the producer price in the ith sub-sector to AGDP.

While the intuition for the inclusion of human capital in empirical growth investigations is easy to follow, appropriate measures of human capital are not easy to find. School enrollment rates, literacy rates, years of schooling, even wage rates of the labor force have been used as proxies in many studies. On the whole, empirical coefficient estimates in the presence of these proxies have yielded mixed results. In agricultural production functions, these proxies have sometimes yielded unacceptable results. Kawagoe et al. (1985) and Lau and Yotopoulos (1989) dropped this variable from their models because they found the coefficients of the general education variable to be unreasonably large. Binswanger et al. (1987), also obtained unacceptable coefficients for this variable.

In the related study referred to earlier, Aboagye (1998) attempted to use the average years of schooling of the population aged 15 years and over to proxy the stock of human capital in the population. Coefficient estimates obtained when this variable was included were judged to be unacceptable. This variable was then dropped from further consideration. In the same spirit, this paper also drops the human capital variable from further consideration.

Export and domestic share equations were then derived as follows. By Young's theorem (symmetry of the mixed partial second derivatives), $\gamma_{ij}=\gamma_{ji}$, $\delta_{km}=\delta_{mk}$, in the GDP function equation (2). In addition, homogeneity of degree 1 in prices requires that

$$\sum_{i=1}^{2}\theta_i = 1, \qquad \sum_{i=1}^{2}\gamma_{ij} = 0, \qquad \sum_{j=1}^{2}\gamma_{ij} = 0,$$

$$\sum_{i=1}^{2}\sum_{j=1}^{2}\gamma_{ij} = 0, \qquad \sum_{i}\eta_{ik} = 0.$$

The share of each sub-sector in agricultural output is then obtained by logarithmic differentiation with

[3] See for example, Chambers (1988) and Varian (1992).

respect to the respective prices. For i=1, the share equation is

$$s_1 = \theta_1 + \gamma_{11} \ln p_1 + \gamma_{12} \ln p_2 + \eta_{11} \ln K_1 + \eta_{12} \ln K_2 + \eta_{13} \ln K_3 + \eta_{14} \ln \text{LABOR} + \eta_{15} \ln \text{LAND}, \quad (3)$$

Factors of production are assumed to be mobile between the two sub-sectors with the rental price of each given by its marginal product. Prices are then expressed relative to each other, since the share equations being profit functions must be homogenous of degree 1 in prices. Given the assumption of constant returns to scale in factor inputs, factor inputs are deflated by the LAND variable. This focuses the discussion on yield (per hectare). This normalization also helps in controlling for heteroskedasticity among the countries (of different sizes).

Thus, a representative share equation is now written as

$$s = \alpha_1' + \alpha_2' \ln \frac{p_1}{p_2} + \alpha_3' \ln \text{KODA} + \alpha_4' \ln \text{KPFX} + \alpha_5' \ln \text{KSAV} + \alpha_6' \ln \text{LABR} + \varepsilon, \quad (4)$$

where, KODA, KPFX and KSAV, are economy wide stocks of development assistance, private foreign capital and domestic savings, while LABR is agricultural labor force, all expressed per hectare of land, and α_1' is θ_1 with a modified coefficient vector. The share equation to be estimated is then written as

$$\text{AEXP}_{it} = \alpha_1 \ln(\text{PRICE})_{it} + \alpha_2 \ln(\text{KODA})_{it-1} + \alpha_3 \ln(\text{KPFX})_{it-1} + \alpha_4 \ln(\text{KSAV})_{it-1} + \alpha_5 \ln(\text{LABR})_{it} + \alpha_6 \text{OPEN}_{it-1} + \alpha_7 \text{EXO1}_{it-1} + \alpha_8 \text{EXO2}_{it} + \varepsilon_{it}, \quad (5)$$

for the export share AEXP. PRICE is the ratio of the index of real producer price of agricultural exports to the index of the real producer price of agriculture for domestic consumption. The policy and exogenous components of $\boldsymbol{X}$ are posited to be the openness of the economy, OPEN (measuring the extent to which a country trades with the rest of the world), the external terms of trade, EXO1, and the variability of the weather, EXO2. Also, ε_{it} is an error term discussed below. The profit function for agriculture, Eq. (2), and the derived share equation can be justified on the grounds that all services supplied by agricultural labor are devoted to agriculture, while land used for agriculture cannot be used for other purposes. For KODA, KPFX and KSAV, being total stocks, one implicitly assumes that the components relevant to agriculture are a constant share of each total, or if not, that deviations do not bias results in any significant manner (see for example, Binswanger et al., 1987). Also, in the short-run, land used for agricultural exports is not available for use for domestic agriculture and vice-versa. Further, very little of SSA agricultural exports (mostly cocoa, coffee, tobacco, cotton) are consumed at home. Domestic consumption of these is small enough not to significantly affect estimation results.

The relationship between the dependent and explanatory variables in Eq. (5) is hypothesized to be the following. KODA, KPFX and KSAV which are lagged 1 year to allow time for investments to come into the production process, will be positive. LABR will positively impact export share if agricultural labor responds to incentives in the export sub-sector. On the other hand, if food security and other concerns are causing more people to take to food production, the coefficient of this variable would be negative. OPEN is being used here as a proxy to measure the efficiency with which factor inputs are used. So far as openness enhances more efficiency in export agriculture (than domestic agriculture), its coefficient in the export share equation should be positive. External terms of trade will influence export share as follows. Increased revenues in the previous year resulting from improved terms of trade will enhance governments' ability and willingness to do more to encourage exports. OPEN and EXO1 are lagged 1 year on the grounds that it is last year's openness and external shocks (rather than this year's) that influence this year's export and domestic shares. If the weather affects both sub-sectors of agriculture equally its coefficient should not be significant in the AEXP equation. PRICE should be positively related to AEXP since increasing producer price for exports (than domestic) can be expected to induce farmers to produce more exports (all be it with some lag). In the literature, the impact of producer price increases by themselves in share response in most countries is positive but limited (Chhibber, 1988; Binswanger, 1989).

One recognizes the advantage of dynamic general equilibrium models in allowing for factor movement

between sectors of the economy in response to incentives. However, single equation models are more common in the literature. It is reasoned in this paper that, with large agricultural sectors and little factor movement between sectors of the economy in SSA, a single equation specification is appropriate in helping uncover the short-run impacts of policy regimes. In addition, variables likely to be endogenously determined are lagged.

Since the two shares (export and domestic) must add up to one, the corresponding coefficients of the domestic share equation are easily obtained from those of export share. Slope coefficients of the equation for domestic share will equal the negative of the export share equation slope coefficients, while the constant term of the domestic share equation equals one minus the constant term in the export share equation. Thus, a positive and significant coefficient of a variable in Eq. (5), which implies that increases in this variable significantly increase export share, also implies that increases in this variable significantly decrease domestic share.

3.2. Panel data issues

The advantages of using panel data are many and are discussed in Baltagi (1995) among others. They include increased number of observations, increased ranges of variation of the variables in the model, thereby allowing for more precise estimates and reduced multicollinearity among explanatory variables. In addition, use of panel data makes it possible to differentiate between economies of scale and technical change as well as providing the potential to study dynamic effects. Thus, use of panel data in this paper will enable one to make valid inferences about the state of affairs in the region beyond what can be done using only individual country case study data.

However, when one pools data across many countries, one must recognize the potential of differences in definition, measurements and even qualities of inputs across countries. There is also the question of differences in economic environment across countries. In addition, one should be careful not to carry the assumption of a common production technology too far. The latter issue may be addressed by statistical tests however. This is discussed below.

Pooling data for different countries immediately raises the question of heteroskedasticity of variances of residuals. Use of individual country dummy variables goes some way in addressing this problem. So does standardizing factor inputs by dividing these quantities by the agricultural land area. Also, estimating the variance-covariance matrix by a robust estimator helps. If autocorrelation is also found to exist, then a modification to the robust estimator that addresses autocorrelation would be appropriate.

This paper heeds the advice of Dagenais (1994) and Mankiw (1995) among others and does not mechanically transform the model to remove serial correlation because of concern that such transformation may introduce more bias in coefficient estimates than otherwise. This concern stems from the very real chance that measurement errors are present in the data. Economists who work with SSA data generally believe that the data quality needs to be improved further. For panel data, the error term ε_{it}, for the AEXP equation (5), decomposes to

$$\varepsilon_{it} = \gamma_i + \zeta_t + e_{it},$$

where γ_i is the country-specific effect, and ζ_t is the time-specific effect and e_{it} is a random term. The country and time specific components of the error term may be fixed or random. In this paper, a fixed effects model is posited since the sample of countries is not random. Rather, these are the SSA countries for which complete data for this study are available. Inference made in this study may therefore be considered to apply to this group of countries only. In addition, statistical tests for random effect specification yielded evidence against such specification (Mundlak, 1978).

Having established that the fixed-effect specification is not rejected, the time dummy variables are dropped and a time trend is used to capture autonomous growth in productivity over time (as well as effects of omitted trending variables).

4. Data description and sources

This study pools cross-country and time series data for 19 SSA countries classified into three economic policy groups. The first group is classified as having undergone LARGE positive changes in macroeconomic policy (fiscal, monetary and exchange rate

Table 1
Parameter estimates for export share regression[a] for *Policy groups*, 1981–1993

Variable[b]	LARGE[c]	SMALL[d]	POOR[e]
ln(KODA)	0.180** (4.500)	−0.013 (−0.348)	−0.171 (−1.373)
ln(KPFX)	0.012 (0.354)	−0.077** (−5.649)	0.018 (0.474)
ln(KSAV)	−0.092** (−2.977)	0.043 (1.884)	0.056 (1.298)
ln(LABR)	−0.296** (−3.232)	−0.073 (−1.170)	0.940** (2.653)
OPEN	0.094 (1.460)	0.127** (2.957)	−0.093 (−1.428)
EXO1	−0.005 (−0.094)	0.029 (0.915)	0.088* (2.027)
EXO2	−0.075 (−1.678)	−0.154** (−2.787)	−0.029 (−1.129)
ln(PRICE)	0.038 (1.269)	0.070** (3.277)	−0.010 (−0.366)
TREND	−0.028** (−5.415)	−0.008** (−3.576)	−0.018** (−2.444)
d.f.[f]	53	89	63
R^2	0.971	0.977	0.973

* Indicate statistical significance at 0.05 level.
** Indicate statistical significance at 0.01 level.
[a] The *t*-statistics are in parenthesis next to the coefficient estimates.
[b] Variables are defined in Section 3.
[c] LARGE: Gambia, Ghana, Madagascar, Tanzania and Zimbabwe.
[d] SMALL: Central Africa Republic, Kenya, Malawi, Mali, Niger, Nigeria, Senegal and Togo.
[e] POOR: Benin, Cameroon, Cote d'Ivoire, Rwanda, Sierra Leone and Zambia.
[f] d.f. denotes degrees of freedom.

policies) between 1981–1986 and 1987–1992. The second as having undergone SMALL positive changes in macroeconomic policy over the same period. The third as having undergone POOR (negative) changes in macroeconomic policy also over the same period. This classification was performed by Bouton et al. (1994). Countries belonging to each group are given below Table 1.[4]

4.1. AGDP, agricultural gross domestic product at factor cost

Defined as value added in agriculture, these data were obtained from World Bank (1995) and earlier issues. Agricultural output reported includes agricultural and livestock production, fishery and forestry output. Agricultural gross domestic product in constant 1987 domestic currency values are converted to 1987 United States dollars (US$), using the World Bank's conversion factor for each country.

[4] While SSA may be divided into three or four agricultural or climatic regions, some important domestic and export crops and animals are common to countries in different climatic regions. This study thus focuses on economic policy differences.

4.2. AEXP, share of agricultural exports in total agricultural output

Computed as the ratio of agricultural exports in US$ divided by total agricultural output also in US$. Agricultural exports are obtained from FAO Trade Yearbook (1996) and earlier issues.

4.3. LAND, agricultural land

This is obtained from FAO Production Yearbook (1996) and earlier issues. Agricultural land is computed as the sum of land used for (i) arable and permanent crops, (ii) permanent pasture, (iii) forest and woodland.

4.4. KODA, stock of ODA; KPFX, stock of PFX; KSAV, stock of SAV

For ODA, net annual flows from 1960 to 1995 in current United States dollars were supplied by William Easterly of the World Bank. Annual ODA data were first converted to constant 1987 US$ using US consumer price index. Next, stock data were constructed by the perpetual inventory method assuming that investments take place at the beginning of the

year. The depreciation rate of capital was set to 10%. For PFX, annual flow data were also obtained from William Easterly. These were supplemented by data from World Bank (1996b) and earlier issues. Stocks of PFX were constructed as done for ODA from 1970 to 1993. Annual data on gross domestic savings were obtained from World Bank (1995) and earlier issues. Stocks of gross domestic savings were computed in the same way as KODA.

4.5. OPEN, openness of an economy

Measured as foreign trade share of GDP, i.e., OPEN=(Exports+Imports)/GDP. Exports are exports of goods including agricultural exports and non-factor services (*free on board*). Imports are imports of goods and non-factor services (*cost insurance and freight*). GDP is obtained from World Bank (1995).

4.6. HCAP, the stock of human capital

The stock of human capital is the average number of years of schooling in the total population over 15 years of age. These are obtained directly, interpolated or extrapolated from Nehru et al. (1995) and Barro and Lee (1996).

4.7. LABR, the stock of agricultural labor force in each economy

This was obtained from World Bank (1995) and earlier issues and FAO Production Yearbook (1996) and earlier issues.

4.8. EXO1, terms of trade

This is defined as the index of export prices divided by the index of import prices. Obtained from World Bank (1995) and earlier issues.

4.9. EXO2, measure of weather variability

This was constructed as the deviation of the index of cereal yield from trend. Jaeger (1992) has data from 1970 to 1987. This was extended to 1993. Indices of cereal production per country are given in FAO Yearbook, various issues.

4.10. PRICE, ratio of the index of real producer prices for exports to the index of real producer prices of agriculture for domestic consumption

Jaeger (1992) supplies 'Average Real Producer Price for Major Export Commodities Index (1980=100)', 'Real Producer Price for Major Food Crops Index (1980=100)' both for the period 1970–1987. These are computed as Laspeyres' indices with 1980 as base and extended to 1992 using representative export and food crop producer prices in local currencies. Producer prices were obtained from World Bank (1996a) and earlier issues. 1980 production quantities were obtained from FAO Production Yearbook. Consumer price indices were obtained from World Bank (1995).

5. Empirical results

This section discusses estimation of the static export share equation (5) with the time-specific dummy variables replaced by a time trend.

5.1. Estimation

The model was estimated on a personal computer running *Winrats* — 32 version 4.3. A consistent estimate of the variance–covariance matrix is obtained in the presence of heteroskedasticity and autocorrelation of residuals by specifying the 'ROBUSTERRORS' and 'LAGS' options, respectively, in *Winrats*. The ROBUSTERRORS option is important in situations where some forms of the generalized least squares may be 'inconsistent because the regressors (or instruments) are correlated with past residuals' (Doan, 1992). The LAGS option is used only when residuals are determined to be serially correlated. Country-effects and coefficients of the export share equation (5) reported are estimated in one step.

For each of the LARGE and SMALL groups, estimation with the full complement of country dummy variables yielded country dummies whose coefficients were not significantly different from zero. A test that all coefficients were zero was rejected. Two pairs of countries were assigned a common dummy variable and the equation re-estimated. The impact

of this was to change the coefficients and standard error estimates of some variables somewhat. This is done on the grounds that the variances of the country dummy variables were not efficiently estimated initially, possibly due to collinearity between country dummies and some variables. By combining the dummy variables, one opts for a more efficient variance. The price of this, however, is possible bias in coefficient estimates. For the POOR group, however, most country dummy variables obtained in the first estimation were significantly different from zero, thus no country dummies were combined.

5.1.1. Diagnostic tests of regression adequacy

Standard diagnostic tests were performed to assure validity of estimation results. Autocorrelation function tests suggested that the variables in the model were stationary in levels, while variance inflation factors computed for all explanatory variables were all well below 10, suggesting that multicollinearity is not a problem.

Tests for outlying cases with respect to the regressors (leverage values of observations) and dependent variables (studentized deleted residuals) were performed. No significant leverage values or studentized deleted residuals were determined. Finally, computation of the Cook's distance statistics did not suggest that any observation had significant influence on parameter estimates.

5.1.2. Differences between periods: 1970–1980 and 1981–1993

Tests for stability of slope parameters with respect to the three policy groups, LARGE, SMALL and POOR were performed for stability over time (or otherwise) for each policy group between the periods 1970–1980 and 1981–1993, and then for poolability across groups.[5] From the Wald test statistic that was computed one is unable to accept the null hypothesis of constancy of slope coefficients for the LARGE group between the two periods. At the 1% significance level, the slope coefficients of KPFX, LABR and PRICE were significantly higher during the second period than the first. In addition, at the 5% level EXO1 was significantly higher, while KODA was significantly lower during the second period. Thus, one would infer that changes in KPFX, LABR and PRICE (to a lesser extent EXO1) were in the same direction as changes in export share between the two periods, while changes in KODA were in the opposite direction.

For the SMALL group too the corresponding test gives indication of change in slope coefficients. This time KPFX is identified as the only slope coefficient that is significantly lower during second period at the 1% level. No variable was significant at the 5% level. For the POOR group, on the other hand, one is unable to reject the null hypothesis of no change in slope parameters. Poolability of data across all three groups or for any pair during the period 1981–1993 is strongly rejected.

5.1.3. Parameter estimates

Estimates of parameters for the policy groups are presented in Table 1. Equality of the coefficients of ln(KODA) and ln(KSAV) was rejected for both the LARGE and SMALL groups, providing support for disaggregation.

5.1.3.1. Stocks of capital, KODA, KPFX, KSAV. For the LARGE group, the KODA coefficient is positive, large (compared to most other coefficients) and significant. The corresponding estimate for both the SMALL and POOR groups are not significant. KPFX is significant only in the SMALL group where it is negative. Domestic savings are significant only in the LARGE group. In this group, the coefficient is negative.

Thus, it would appear that the contention that development assistance is more likely to benefit agricultural exports is borne out here. For, the LARGE group is the one that receives most of the development assistance earmarked for countries pursuing economic restructuring programs (an increasing proportion of ODA in recent times compared to ODA flows due to political considerations). The impact of development assistance on the domestic and export agriculture in the SMALL and POOR groups appears to be equal.

On the other hand, private foreign commercial capital appears to promote the export and domestic agriculture equally in the LARGE and POOR groups, while significantly impacting domestic share at the

[5] Data are available for all countries for 1970–1993 period.

expense of export share in the SMALL group. The impact of this variable was identified earlier to be significantly lower during the 1981–1993 period than during the 1970–1980 period. The SMALL countries did suffer more from the incidence of high capital flight recorded in countries of SSA during the 1980s. That is, that sub-sector that was benefiting more from PFX inflows stood to lose more when capital flight occurred.

The reason domestic savings appear to significantly impact export share negatively in the LARGE group may be due to allocation or redeployment of domestic savings to food production activities. The explanation for this may be that in the face of liberalized economic policies (market forces), economic agents naturally allocate resources to sectors in which they can receive the highest return (given the level of risk). Taxation of the export agriculture in the form of government price fixing still persists even under conditions of economic reforms. Under these conditions farmers will allocate their resources to the domestic sub-sector where they were likely to earn higher returns.

5.1.3.2. Labor, LABR. The labor coefficient is significant in both the LARGE and POOR groups. It is large and negative in the LARGE group and larger and positive in the POOR group. It is not significant in the SMALL group. That the impact of agricultural labor is negative in the LARGE group is consistent with the contention that direct taxation of export agriculture as opposed to domestic agriculture, renders domestic agriculture more attractive to farmers. Thus, farmers in these countries appear to be reallocating not only their domestic savings to domestic agriculture, but also increases in their numbers increase domestic share of agriculture.

On the other hand, within the POOR group where the policy regime change was a shift away from a market economy towards more government intervention in the economy, the fact that governments provided more incentives to export agriculture while taxing both export and domestic agriculture must have had the effect of inducing more farmers to pay more attention to export agriculture. The finding that for the SMALL group the impact of labor is not significant in one sub-sector at the expense of the other is consistent with a policy environment that is between the liberalized environment of the LARGE group and the interventionist environment of the POOR group.

5.1.3.3. Openness, OPEN. Openness is not significant in the export share equations of LARGE and POOR countries. Its coefficient is positive and significant in the SMALL group. Thus, for countries in the SMALL group, increasing international trade enhances efficiency in the use of factor inputs in export agriculture. This efficiency is not realized in the POOR and LARGE groups. In the former case it must be because of excessive government intervention, in the later case it must be because of increasing attention to domestic agriculture and other sectors of the economies (such as mining).

5.1.3.4. Terms of trade, EXO1. The external terms of trade coefficients are not significant at the 1% level in any group. In the POOR group the coefficient has a p-value of 0.04. Thus, on the whole the terms of trade do not significantly impact export or domestic share. The explanation is to be found in the fact that in virtually all SSA countries during the period covered by this study (1981–1993), farmers were not impacted directly by changes in the terms of trade since it is governments which fixed producer prices.

5.1.3.5. Weather variability, EXO2. The coefficient of this variable in the export share equation is not significant in the LARGE and POOR groups. This suggests that variability in the weather affects both export and domestic agriculture equally. In the SMALL group, however, the coefficient of this variable is negative and significant, suggesting that variability in the weather is having negative impact on export share. Four out of the eight countries in this group are virtually wholly within the Sahara desert whose deteriorating impact on the environment (climate) is being felt more and more. In such a situation, growth of domestic food crops which are generally seasonal (a few months) is more likely to be timed to coincide with the rainy season than export crops which are annual or perennial, hence the negative impact on export share.

It is also noted that, in addition to capturing the effects of the variability in the weather, this variable

will also capture the impact of disruption in export share due to other exogenous factors such as civil strife. Dropping this variable from the export share equation has no significant impact on the coefficients of the remaining variables in the LARGE and POOR groups.

5.1.3.6. PRICE. The coefficient of this variable is not significant in both the LARGE and POOR groups. It is significant in the SMALL group but with a small magnitude (0.07). This finding is in line with the literature, that increases in producer prices have positive but limited impact on aggregate agricultural output.

5.1.3.7. TREND. The trend coefficient is negative and significant in all cases. However, its magnitude is very small. Interpreting this coefficient as productivity growth, one would conclude that aggregate productivity is falling in the export sub-sector across the groups. The other side of the argument is that productivity appears to be improving more in the domestic sub-sector.

6. Conclusions and policy implications

This paper has modeled the static response of export and domestic shares of agriculture in 19 SSA countries over the period 1981–1993. The countries were pooled into three panels according to progress made in liberalizing their economic policy environment. Three components of investment capital (official development assistance (ODA), private foreign commercial flows (PFX) and domestic savings (SAV)) were emphasized. The analysis also includes the openness of each economy, labor, terms of trade, producer prices and the role of the weather.

Statistical tests suggest that for the countries that were undertaking liberalized economic reforms, the slope coefficients of some of the variables in the models have changed significantly between 1970–1980 and 1981–1993. For these countries too, the impacts of ODA, PFX and SAV on export and domestic shares were different. However, the impacts of these variables in the group that underwent deterioration in economic policy environment were not different. The effect of increases in agricultural labor was also different across the groups. Domestic prices and openness of the economy were found to have significant impact in only one group. Finally, there is ample evidence that changes in productivity are having negative impact on export share in all the groups.

6.1. Implications of empirical findings

The preceding analysis has thrown some light on the response of export and domestic shares to factor inputs and other variables. To halt the decline in export share of agricultural output in the LARGE group, efforts must be made to reduce the negative impacts of domestic savings and agricultural labor. This may take the form of reducing the direct taxes imposed on agricultural exports by increasing the proportion of international prices paid to farmers. It would also appear that in order not to increase the incidence of food insecurity, the impact of development assistance to the LARGE countries should be reviewed in favor of domestic agriculture.

For the SMALL group, it would appear that some effort must be made to increase the positive impact of foreign private capital on agricultural exports. This may be achieved by pursuing economic policies that enhance the inflow of foreign capital. Here it will take the form of going the extra mile in their economic reform efforts. For this group too, it is desirable to try to understand why openness of the economy positively impacts export share at the expense of domestic share. This way, efforts may be made to rectify any negative effects of such impact on domestic share. For the POOR group, policies that will make domestic agriculture more attractive to agricultural labor than is currently the case will help reduce the imbalance in the allocation of this factor between the two sub-sectors and reduce the risk of food insecurity.

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