Policy, Research, and External Affairs

WORKING PAPERS

Welfare and Human Resources

Population and Human Resources
Department
The World Bank
July 1990
WPS 460

Does Food Aid Depress Food Production?

The Disincentive Dilemma in the African Context

Victor Lavy

Food aid has a significant positive effect on food production. Any disincentive induced by the additional supply of food is offset by the positive effects — particularly when the basket of food aid is very different from the locally produced basket, as is often true in Sub-Saharan Africa.

Policy, Research, and External Affairs

WORKING PAPERS

Welfare and Human Resources

WPS 460

This paper — a product of the Welfare and Human Resources Division, Population and Human Resources Department and the African Food Security Unit — was written as a background paper for the *Food Aid in Sub-Saharan Africa* study. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Angela Murphy, room S9-114, extension 33750 (28 pages with tables).

Food aid averages only 10 percent of total financial aid to developing countries, but in certain African countries — Botswana, Cape Verde, Mauritius, and Mauritania — it represents more than half the food available for consumption.

What is the relationship of food aid to food production and to commercial imports? Three main hypotheses have been advanced:

- Food aid is an addition to local food supplies that ultimately lowers prices and acts as a disincentive to local producers. The immediate effects may be small, but a lagged response can be generated.

- Food aid displaces commercial imports and does not add to domestic food supplies. If there is full displacement, prices should not change and there will be no effect on incentives.

- Food aid is determined to some extent by local food production. But in the medium run it can generate a positive supply effect that increases the level of production.

Lavy applied vector auto-regression (VAR) analysis to data for Sub-Saharan Africa to test these hypotheses. The issue is not whether food aid is good or bad but how it can be used to promote economic development and improve the nutrition of the food-insecure.

Lavy found that food aid has a significant positive effect on food production. Any disincentive induced by the additional supply of food is offset by the positive effects.

The total net increase in food supply following an increase in food aid is, however, of lower magnitude than expected — because food aid tends to replace almost an equivalent amount of regular food imports.

The extent to which an increase in food aid will lead to a drop in prices and output depends on whether it leads to a net increase in the food supply. If commercial imports decline as food aid increases, the disincentive effect is mitigated.

Food aid is more likely to have a positive effect in countries that use fertilizer intensively. One possible explanation for this is that countries that enjoy a relative abundance of regular food aid can use the resources made available through reduced food imports to invest more in the agricultural sector — which is more likely when such an investment is a condition imposed by the aid donors.

Does Food Aid Depress Food Production?
The Disincentive Dilemma in the African Context

by
Victor Lavy*

Table of Contents

* This paper was written under the auspices of the African Food Security Unit of the World Bank, as a background paper to the *Food Aid in Sub-Saharan Africa* study. I would like to thank Shlomo Reutlinger for his assistance and useful insight and comments on the paper. I would also like to thank the World Bank Research Committee for financial support.

Victor Lavy, currently at the Department for Population and Human Resources of the World Bank, is on leave from the Department of Economics at the Hebrew University of Jerusalem.

I. INTRODUCTION

The focus on reducing poverty and the food crises in Sub-Saharan Africa have drawn attention to food aid as one way to increase the income of the poor. Food aid averages only 10 percent of total financial aid to the developing countries, but it is much more important for the least developed countries in Africa than the global figure indicates. In such countries as Botswana, Cape Verde, Mauritius, and Mauritania food aid contributes more than half the total food available for consumption. And for some of the poorest countries, food aid also provides resources for investment in the agricultural sector and saves foreign exchange.

Africa's population is growing faster than its growth rate of food production. Since 1961 food production has grown by 1.6 percent (compared to 3.1 percent in all developing countries), while population has climbed by 2.8 percent. During 1980-86 the growth rate of food production declined to 1.2 percent a year. This article concentrates on food aid to Africa for developmental (non-emergency) uses and its relationship to food production and to commercial imports. Three main hypotheses have been advanced (Schultz 1960; Srinivasan 1989; and Singer 1988) to explain these effects:

1. Food aid is an addition to local food supplies that leads to lower prices and acts as a disincentive to local producers. While the immediate effects may be small, a lag response can be generated.

2. Food aid displaces commercial imports and does not add to domestic food supplies. If there is full displacement, prices should not change, and there will be no effect on incentives.

3. Food aid is determined to some extent by local food production. In

the medium run, however, it can generate a positive supply effect that increases the level of production.

Each of t`) hypotheses has a straightforward implication for the time series properties of food aid and production -- or imports -- of food. Under the first hypothesis, the previous level of aid should predict current food production levels. The second hypothesis, on the other hand, implies that there is no causal effect from food aid to food production, and the third argues that the effects go both ways: previous levels of food production also explain current levels of food aid.

In the standard terminology on vector auto-regression (VAR) analysis, the issue is whether food aid causes food output (in the sense of Granger causality), or food production affects food aid. This paper applies VAR techniques to data for Sub-Saharan Africa to study food production and food aid. Rather than analyzing a specific country in a structural model of the agricultural sector (see Mann 1967; Hall 1980; Dudley and Sandilands 1975; and Blandford and Von Ploski 1977), I use a typical relationship based on a large set of countries over a long period of time. The empirical framework is based on reduced form equations. Given that such major variables as consumer and producer food prices are not available for Africa on a systematic time series basis, attempts to estimate a structural model for each country or set of countries will be futile. We present, however, some of the analytics of food aid in a general equilibrium model. The comparative static and dynamic analysis of this model can help interprete the VAR results.

Within this empirical framework, we explicitly test the three hypotheses rgarding the relationship between food aid and domestic food production. The results, contrary to what is presented in the popular literature on the topic, show that food aid is having a significant positive effect on food production. However, the total net increase in food supply following an increase of food aid is of much lower magnitudes than expected, since food aid tends to replace almost an equivalent amount of regular food imports. The results and their interpretation are presented in sections IV and V.

II. FOOD AID AND FOOD PRODUCTION

Following Schultz's (1960) work on the effects of food aid on farm prices, there have been several attempts to develop the analytics of food aid. Fisher (1963) first derived the partial equilibrium relationship between food production and imports of surplus food. And recently Bhagwati (1986) and Srinivasen (1989) presented a general equilibrium analysis that will be followed here.

Starting with the case of no international trade, assume that the country receives food aid in a given amount. What effect will the aid have on domestic food prices and production? The answer depends on how the recipient government responds to the aid, and what conditions, if any, the donor imposes. If the government sells the food aid in the open market and returns the proceeds to consumers as lump-sum income transfers, domestic food supplies will rise, resulting in excess supply. As the relative price of food falls, food output declines (the disincentive effect). But the government can maintain producer incentives by keeping relative prices up through a) a food subsidy for consumers (or an equivalent tax on nonfood); or b) a production subsidy on food relative to the consumer price (or an equivalent production tax on nonfood). As demonstrated in Srinivasen (1989), consumer welfare (assuming an homothetic social preference) will unambiguously rise, although any distorting policy that is implemented to mitigate the price fall will reduce the welfare gain from food aid.

In the case in which the recipient country is open to international trade, assume that the country is a price taker and that it follows a free trade policy. With prices unchanged (because of free trade), the flow of food aid will not alter production, but consumption will rise and imports will fall as part of the food aid replaces commercial imports. If, however, the donor requires the recipient to continue to import at least as much as it did from commercial channels prior to food aid, the domestic price will fall below the world price. This drop will discourage domestic food production and consumption enough to increase imports of food to the required level. The optimum policy to achieve this objective is an import subsidy, as shown by Bhagwati and Srinivasen (1969).

Table 1 shows the effects of food aid under various economic regimes. Food prices and production can either fall or remain unchanged. Are there any circumstances under which food aid can increase domestic production? If the aid commodity is not a perfect substitute for the domestic commodity, or if it is complementary, then the income effect (a shift in the demand for food) may dominate the price effect (a shift in the supply function), increasing domestic production. This would be the case in an international trade regime where the price of the domestically produced food may even rise. For example, when yellow maize is offered to Kenyans who prefer white maize, the supply of the yellow variety will not affect the supply of white maize, but the income effect may lead to higher demand, higher prices, and higher domestic output of white maize. Such a development may be mitigated if the recipient country is permitted to exchange commodities received in aid for those it can supply. Most cereal aid, however, consisted of wheat and rice, which were not as desirable in Africa as domestically produced coarse grains. The extent of substitution among these items can lead to a net increase in domestic production.

So-called program food aid, which provides food for sale in the recipient country for balance-of-payments support, can also have a positive effect on domestic output. If this food just replaces commercial food imports (without net additionality), it should be equivalent to financial aid in the form of a transfer of foreign exchange. The income effect should lead to higher demand and increased production of food. The revenues accruing to the government from the sale of this food are used to cover the costs of agricultural development projects to enhance food production, including rural credit and infrastructure, imports of fertilizer or other agricultural inputs, and nutrition programs for adults and children. The same effect is obtained when food aid is converted to financial aid. This means that food aid is sold near the port of entry, normally in large urban centers. The sale proceeds are then used to finance such rural development projects as labor-intensive public works, which generate additional demand for local food. These "supply" effects of food aid take some time to be realized.

III. THE EMPIRICAL FRAMEWORK

Previous studies have analyzed the relationship between food aid and domestic production by specifying and estimating a model in which domestic food production in a given period depends on food aid in that period. Past levels of aid and production are assumed to have had no impact on current production or on current levels of aid.

TABLE I: THE EFFECT OF FOOD AID ON THE RECIPIENT FOOD MARKET

Market Structure	Domestic price	Imports	Domestic production	Welfare
Closed Economy				
Government sells at free market and returns proceeds as transfer	(-)	0	(-)	(+)
Open Economy				
Recipient is a price taker (free trade policy)	0	(-)	0	(+)
If imports are kept constant	(-)	0	(-)	(+)

Note: The (-) sign denotes a decline, (+) denotes an increase, and 0 denotes no effect.

On theoretical grounds, however, it is plausible to expect intertempor relationships between food aid and food production. The most probable relationship that food production will be affected by aid in previous periods. One might also expe that past levels of production would help predict current food aid. This mutua. dependence of production and aid on the lagged values of own and other variables giv the following vector auto-regression:

$$p_t = \alpha_0 + \sum_{\ell=1}^{m} \alpha A_{t-} + \sum_{\ell=1}^{m} \beta_\ell p_{t-\ell} + u_t$$

(1)

$$A_t = \alpha'_0 + \sum_{\ell=1}^{n} \alpha'_\ell A_{t-\ell} + \sum_{\ell=1}^{n} \beta_\ell p_{t-\ell} + \epsilon_t$$

where p denotes food production and A denotes food aid. The α (α') and the δ (δ') a the coefficients of the linear projections of A_t (p_t) onto a constant and past valu of A_t and p_t, and the lag length m and k are sufficiently large to ensure that u_t and are white noise error terms. While it is not essential that the lag length for A a P be equal, we follow typical practice by assuming that they are identical.

To estimate the dynamic relationship described in equation (1) and obta consistent estimates of the α's and β's, there must be enough observations on p and Each country sample does not have the requisite number of observations. Panel data th combine large numbers of cross sectional units (countries), but only a few years observation in each unit may yield enough observations. To estimate the system equations, we would therefore typically pool data from different countries, at t expense of imposing the constraint that the underlying structure is the same for ea country.

In an attempt to relax somewhat the 'common' structure assumption, it necessary to allow for the possibility that each country has an "individual effect" that translates in practice to its own intercept. The individual effect summarizes the influence of unobserved variables that have a persistent effect on the dependent variable. For example, in each period a country's food aid might be affected by the rainfall level of the previous year, or by political events. To the extent that the other right-hand side variables are correlated with the individual effect, its omission results in inconsistent estimates.

Incorporating individual effects into (1), assume that the panel data consists of cross-sectional countries observed over t time periods. Let i index the countries observations and t the time periods. Denoting the individual effect as v_i, equation (1) can be rewritten as:

$$p_{it} = \alpha_0 + \sum_{\ell=1}^{m} \alpha_\ell A_{it-\ell} + \sum_{\ell=1}^{m} \beta_\ell p_{it-\ell} + v_i^{\ell c} + u_{it} \qquad (2)$$

and a similar respective equation for A_{it}.

A standard method of estimating the individual effect is to first difference the data to eliminate v_i and v_i' and then use ordinary or generalized least squares to estimate the differenced equation.

$$A_{it} - A_{it-1} = a_t + \sum_{k=1}^{n} \alpha'_\ell (A_{it-\ell} - A_{it-\ell-1}) + \sum_{k=1}^{n} \beta'_t (p_{it-\ell} - p_{it-\ell-1}) + \mu_{it}$$

$$p_{it} - p_{it-1} = a_t + \sum_{\ell=1}^{m} \alpha (A_{it-\ell} - A_{it-\ell-1}) + \sum_{\ell=1}^{m} \beta_t (p_{it-\ell} - p_{it-\ell-1}) + \phi_{it} \qquad (3)$$

Equation 3 indicates a simultaneity problem because A_{it-1} (p_{it-1}) depends on u_{it-1} (ϵ_{it-1}), the error term $u_{it} - u_{it-1}$ ($\epsilon_{it} - \epsilon_{it-1}$) is correlated with the regressor $A_{it-1} - A_{it-2}$ ($p_{it-1} - p_{it-2}$). The fact that differencing can induce a simultaneity problem is well known from the conventiona literature on time series and has been explored in a panel data context (see Chamberlai 1983). The usual solution is to employ an instrumental variables estimator. Holtz Eakin and others (1988) have considered this problem in the context of estimating an testing vector auto-regression coefficients using panel data. Thei. results sugges that the instrumental variable approach is the appropriate one, but it should h implemented in a different fashion because the variables that are legitimate candidates for use as instrumental variables change over time. To derive their instrumental variables estimator, which has a generalized least squares (GLS) interpretation, one needs to assume that the error term $u_{it}(\epsilon_{it})$, is uncorrelated with all past values of P and A and the individual effect:

$$E[A_{is}u_{it}] = E[P_{is}u_{it}] = E[v_i u_{it}] = 0 \tag{4}$$

(and a similar condition for ϵ_{it}). The orthogonality conditions (4) are used to identify the parameters of (3), since the disturbance term μ_{it} $(=u_{it} - u_{it-1})$ and ϕ_{it} $(=\epsilon_{it} - \epsilon_{it-1})$ will be uncorrelated with p_{it-s} and A_{it-s} for $s \leq 2$. The equation for each time period t has 2m right-hand side variables. To identify the parameters, there must be at least this many instrumental variables. The 2(t-2) variables $[p_{it-2},\ldots p_{i1},A_{it-2},\ldots,A_{i1}]$ are available as instrumental variables to estimate the equation for the time period t. Thus to have at least as many instrumental variables as right-hand side variables, it must be true that $2(t-2) \leq 2m$ or $t \leq m+2$.

Holtz-Eakin and others (1988) demonstrate that in the absence of cross-section heteroshedasticity in the forecast errors u_{it} and ϵ_{it}, and if stationarity is assumed in the individual effect coefficients and in the lag coefficients as well, than assumed in the individual effect coefficients and in the lag coefficients as well, than the above first differencing (equation 3) transformation can be used to identify the parameters. This transformation has been suggested for estimation of univariate auto-regressive models in panel data by Anderson and Hsiao (1982). More generally, this transformation is a quasi-differencing transformation that has been suggested by Chamberlain (1983). It is well known that in models with lagged dependent variables it is inappropriate to treat individual effects as constants to be estimated. The first difference transformation takes care of this problem since the individual fixed effects are cancelled out.

In the panel VAR case the estimation is done in three steps: (1) first, estimating the equations for each time period using 2SLS. Because the list of variables that are uncorrelated with the errors changes each period, so does the list of instrumental variables; (2) second, using the residuals and the matrix of instruments, the joint covariance of the error terms is estimated; (3) all the parameters are estimated simultaneously using generalized least squares on the stached equations. The explicit formulas are provided in Holtz-Eakin.

IV. ESTIMATION AND HYPOTHESIS TESTING

I estimate equations for food production and food aid for 1970-87 for a sample of 33 countries in Sub-Saharan Africa.[1] The production variable reflects annual domestic cereal production (in grain equivalent). Cereals include wheat, rice, oats,

[1] Those countries that receive food aid are: Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Republic, Chad, Cameroon, Djibouti, Ethiopia, Gambia, Ghana, Kenya, Lesotho, Liberia, Madagascar, Mauritius, Mauritania, Mali, Malawi, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Uganda, Zaire, Zambia, and Zimbabwe.

maize, rye, sorghum, millet, barley, and mixed grains. Food aid data[2] are in the sa units of grain equivalent comparable to the food production variable. The ti dimension of the aid and import variables is different from that of the production dat the last two are calendar year while the first is crop year. It is assumed that t crop year leads the calendar year by two to three months.

The dynamic relationship between food aid and food production is explored investigating the characteristics of the VARs for these variables. First, a model estimated in which food production appears on the left-hand side, and its own lags a lags of food aid appear on the right-hand side. The regression does not include a information on variations in climate, soil quality, production technology, or any other economic characteristics, although all of these may affect food production. To t extent that these variations can be regarded as "country effects," however, the omission should not cause any problem. In essence, the estimation procedure discuss above eliminates these effects via differencing. In addition, the equation contains dummy variable for each year. The system of dummies will capture any underlying tre in the data as well as important influences common to all countries in a given year such as a drought.

Two other estimation problems are important. The first is whether t parameters are stationary over time. The above model (and virtually all work analyzi panel data), assumes that the parameters are constant not only across different uni but also over time. Similarly, each individual effect is time invariant. Holtz-Eakin and others (1988) derive a more general specification that allows all the parameters depend on the time period. Since this amounts to estimating a separate equation f

[2] The FAO and the World Food Program provided the data on food aid and commercial food imports.

each cross-section, it imposes more restrictions on the number of instrumental variables that should be used for each period and makes identification of the parameters more difficult. Given the small number of cross-section observations (33 countries) and the potential pattern of long lagged effects, it may be very difficult to test for stationarity. I thus proceed with the maintained stationarity assumption regarding the fixed effects and all the other parameters and address this point from a different angle. After estimating the model using the whole 1970-87 data, it is reestimated with two subsamples, 1970-78 and 1979-87, which correspond to different trends in food and commodity prices. The sample is disaggregated to two groups of countries and again reestimated and the results compared. Finally, I attempt to allow for a country-specific coefficient representing the effect of food aid on food production.

The correct lag length is determined by initially selecting an arbitrary -- but long enough -- lag length. The system is then reestimated with a shorter lag. The increase in the sum of squared residuals can be used to test which lag length is appropriate. Changing the lag length can be treated as linear constraints that can be tested by noting that the difference in the constrained and unconstrained sum of squared residuals has a χ^2 distribution.

Food Production. An equation is estimated with three lags of each of the right-hand side variables: in terms of the notation, m=3. This lag length is used to estimate the covariance matrix necessary to test for this and other longer or shorter lag lengths. The first differenced version, then, has four lags. Given that in the data T=18, m=3 implies that parameters can be estimated only for the last 13 years in the data set; that is, t=13 1975-87. When equations for these years are estimated jointly using the three-stage procedure described, the minimized value of the χ_2 test statistic, denoted by Q, is equal to 183.35 and has 96 degrees of freedom (see table 2).

To test whether the data will permit shortening the lag length from three to two I impose m=2, and the Q value obtained is 186.50. Comparing this to the value of Q in line 1 of table 2, I find L=3.15, and it has two degrees of freedom. The critical value of x^2 distribution at the 0.10 level is 4.61. I accept the restriction that three lags in each variable characterize the data better than four lags. A more parsimonious specification, m=1, is rejected by the data. When the production equation is estimated with one lag at the level (two lags is the difference equation) the value of Q jumps to 203.27: the associated value of L is 16.77 (203.27 - 186.50). The data reject this hypothesis by a wide margin (line iii, table 2).

Conditional on m=2, I turn to causality issues. In the Granger definition of causality, food aid causes food production if the past value of the food aid can add any statistically significant explanatory power to the variance of the latter that is not already explained by its own past values. In terms of equation (3) this is a test of the joint hypothesis $\alpha_1=\alpha_2=\alpha_3=0$. This hypothesis can be tested by excluding food aid and evaluating the increase in the minimum x^2 test statistics. The value of Q when aid is excluded is 217.83; the value of L is 186.50, therefore 31.33 (217.83-186.5), and it has 3 degrees of freedom. The critical value of x^2_3 distribution at 0.01 significance level is 6.25. Thus the data reject by a wide margin the notion that food aid does not cause food production.

Two other hypotheses are tested and accepted. The first relates to the time-specific effect; the second to country-specific dummy variables. The hypothesis of no time-specific effect is accepted at the 10 percent significance level, its L statistic is equal to 11.2 compared to x^2_{13} of 19.81. For the country fixed effect, the L statistic is 9.42 while the x^2_{36} statistic is 46.20. The only country that stands out

TABLE 2: **FOOD PRODUCTION EQUATION: Hypothesis Testing**

		Q	L	Degrees of freedom	x^2
(i)	m = 3	183.35	-	96	107.57
(ii)	m = 2	186.50	3.15	2	4.61
(iii)	m = 1	203.27	16.77	2	4.61
(iv)	Excluded aid, m = 2	217.83	31.33	3	6.25
(v)	Excluded time effects, m = 2	197.44	11.20	13	19.81
(vi)	Excluded country effects, m = 2	195.92	9.42	36	46.20

Note: x^2 is estimated at the 0.10 significance level.

with a significant different intercept is Tanzania (positive). Thus first differencing completely neutralized the fixed country effects. The implication is that if there are country-specific factors that should explain how much food aid a country receiv: (beyond what is explained by lagged aid and food production), the differencing procedure accounts for it. Thus differencing and instrumenting for the food aid variable account for its endogeneity in the food production equation.

In sum, domestic food production is a dynamic process that has a three-yea lag of production and of food aid. One can reject the hypothesis that food aid does no cause domestic production. Differencing the data makes it possible to get rid of tim effects and country fixed effects.

Food Aid. A symmetric set of tests is performed for the food aid equation (see table 3). A lag length of three fits the data better than any other value of k (see lines ii and iii). The hypothesis that food production does not cause food aid is rejected. The Q value under the exclusion hypothesis is 210.17 compared to Q=195.54 under the alternative hypothesis and k=3. The resulting L statistic is 14.61, higher than $x^2_4 = 8.31$.

This result indicates that past output affects current levels of food aid Other nonobserved country-specific factors also affect the level of food aid, and these are captured by the country dummies. Differencing the equations accounts for these effects and the hypothesis of no remaining country effects is accepted (line vi). The only countries that still stand out with a significant different intercept are Ethiopia and Sudan (both positive). On the other hand, the hypothesis of no time-specific effect is rejected at the same significance level; its L statistic is equal to 22.4 compared

TABLE 3: AID EQUATION: Hypothesis Testing

		Q	L	Degrees of freedom	x^2
(i)	k=3	195.54	-	96	107.57
(ii)	k=2	202.55	7.01	2	4.61
(iii)	k=1	208.12	12.58	2	4.61
(iv)	Excluding food production, k=3	210.17	14.61	4	8.31
(v)	Excluding time effects, k=3	180.13	22.42	13	19.81
(vi)	Excluding country effects, k=3	190.18	12.37	36	46.20

Note: x^2 is estimated at the 0.10 significance level.

to x^2_{13} = 19.8. This result reflects mainly the large flow of emergency aid in 198 85 following the droughts during 1983-87. The coefficient value of the 1984 dummy is 56,000 tons of grain, compared to a zero intercept in the regression and a mean sample of 4,900 tons of grain of food aid in the sample.

Parameter Estimates Table 4 estimates the food production equation assuming parameter stationarity. As table 2 indicated, the lag coefficient of the most parsimonious specification consistent with the data is three lags. The most important implication of the estimates in table 4 is the positive effect of food aid from the first to the third lagged values on domestic production. This result is not sensitive to lag length, the positive and significant effect of A_{t-i} on P_{t-i} are robust. Thus fooc aid does not depress food production; on the contrary it leads to a positive growth in output in one to three years. A more intuitive interpretation should be based on the moving average representation of the VAR. The impulse response pattern suggests the same qualitative results: an increase in food aid leads to a positive increase in fooc production. The moving average relationship is not sensitive to the orthogonalization assumption, namely whether we allow the food aid shock to have a contemporaneous effect on food production, or whether we constrain this effect to commence only from t-1.

A further test of the sensitivity of our results to the VAR estimation approach is presented in Table 5. The reduced form equations in Table 4 excluded the contemporaneous value of food aid (A_t), but the moving average representation could capture the effect of A_t on P_t through the contemporaneous correlation of the innovations in the two equations. In Table 5 we present alternative estimates of the production equation that includes A_t but exclude lagged values of food production as regressors. The equation is estimated in first differences to eliminate the fixed effects and th

TABLE 4: FOOD PRODUCTION EQUATION: PARAMETER ESTIMATES

Dependent variable = P_t				
P_{t-1}	-0.576 (21.2)	-0.587 (21.7)	-0.611 (19.7)	-0.664 (45.3)
P_{t-2}	-0.532 (21.3)	-0.534 (22.5)	-0.336 (18.5)	0.573 (27.6)
P_{t-3}	0.069 (2.4)	0.076 (2.8)	0.062 (2.1)	-
P_{t-4}	-0.008 (0.6)	-	-	-
A_{t-1}	0.164 (1.6)	0.170 (1.7)	0.353 (3.2)	0.190 (2.2)
A_{t-2}	0.597 (5.4)	0.580 (5.4)	0.591 (5.2)	0.573 (5.8)
A_{t-3}	0.122 (0.9)	0.217 (1.9)	0.209 (1.7)	-
A_{t-4}	-0.325 (2.0)	-	-	-

Note: All variables are measured as first differences.

Numbers in parentheses are t values. In the third column, the instrument used is lagged from t-2 to t-4; in the second column the instrument is lagged from t-2 to t-5.

Table 5: Food Production Equation

Dependent variable = P_t				
A_t	0.412 (2.3)	0.577 (3.7)	0.051 (0.3)	-
A_{t-1}	0.513 (3.3)	0.606 (4.3)	0.617 (6.1)	0.423 (4.9)
A_{t-2}	-	0.525 (5.3)	0.565 (9.3)	0.538 (8.7)
A_{t-3}	-	-	-0.09 (1.2)	-0.088 (1.1)

Note: See Table 4

food aid variables are instrumented with their own laggs and lagged values of food production. The parameter estimates yield the same positive effect of food aid on food production and this result is not sensitive to the inclusion or exclusion of the contemporaneous value of food aid.

The constraint that the time series relationship of A and P is the same for each time period or cross-sectional unit (country) is likely to be violated in practice, so it is desirable to relax this restriction. Here it is relaxed by allowing for an "individual" and "time" effect. I also allow for "quasi" stationarity by reestimating the model for two sub-periods, from 1970-78 and from 1979-87. The short length of each sub-period does not allow much experimentation with the lag pattern, but the results are qualitatively similar to those obtained with the whole period, although the estimates are less precise.

I further relax the model by allowing the slope parameter to vary across meaningful groups of countries. Two such groups are derived by classifying countries by their economic regime and level of development. The model is reestimated with two sub-samples -- the socialist and mixed socialist countries,[3] and the rest of the countries. The basic positive effect of A_{t-i} on P_{t-i} is almost identical in absolute terms for the two groups, although it is more precisely estimated for the nonsocialist group (more degrees of freedom).

Grouping by income per capita as a proxy for the level of economic development led to very similar results, probably due to the high correlation between the classification of socialist/nonsocialist and income per capita.

[3]Angola, Benin, Cape Verde, Ethiopia, Guinea, Madagascar, Mali, Mozambique, Rwanda, Somalia, Sudan, Tanzania, Togo, and Zambia.

TABLE 6: AID EQUATION: PARAMETER ESTIMATES

Dependent Variable = A_t			
P_{t-1}	0.000 (0.2)	0.032 (0.3)	-0.001 (0.2)
P_{t-2}	-0.010 (2.1)	-0.013 (2.5)	-0.012 (2.4)
P_{t-3}	0.005 (0.9)	0.008 (1.3)	-
P_{t-4}	0.006 (2.6)	-	-
A_{t-1}	-0.159 (4.8)	-0.160 (4.9)	-0.163 (5.0)
A_{t-2}	-0.068 (2.7)	-0.066 (2.7)	-0.053 (2.3)
A_{t-3}	-0.024	-0.054	-
A_{t-4}	0.047 (0.4)	-	-

Note: All variables are measured as first differences. Numbers in parentheses are t-values.

V. INTERPRETATION AND CONCLUSION

The value of food aid to Africa is about $1 billion a year, almost as much as the IDA support to this region. The key issue that emerges from the above analysis is not whether food aid is good or bad, but how it can be used to promote economic development and improve the nutrition of the food insecure. This section provides some explanations for the positive association between food aid and food production and interprets the implications for the efficient use of food aid. In this analysis the assumption that the model is identical for all countries is relaxed further, allowing the coefficients in the VAR system to vary by interacting food aid with other relevant variables.

The positive net effect of food aid on food production suggests that any disincentive induced by the additional supply of food is offset by the positive effects. The magnitude of the direct effect of food aid on domestic food production in the recipient country is very sensitive, in theory, to the proportion of food aid to domestic production. During the 1960s food aid was a minor share of domestic food production, generally less than 2 percent. But in the 1970s and 1980s, the ratio of cereal food aid grew to more than 100 percent in countries like Botswana, Mauritius, Mauritania, and Cape Verde. In Congo, Gambia, Burundi, Senegal, and Somalia, the ratio is 0.1 to 0.2.

Is the size of the effect of food aid on production negatively correlated with the above proportions? I have reestimated the VAR system to allow for an interaction of the food aid variable with its proportion in food production. The coefficients of equation 3 are therefore allowed to differ for each country, depending on the proportion of food aid. The coefficient on the interaction term is negative but not significant (with a t ratio of 0.5). We therefore do not have any evidence to support the hypothesis that the smaller the amount of food aid as a share of food production, the higher the probability that food aid will have a positive net effect on production.

As noted earlier, the extent to which an increase in food aid will lead to a drop in prices and output depends on whether it leads to a net increase in food supply. If commercial imports decline as food aid increases, the disincentive effect is mitigated. For the sample of countries in this paper, an increase in food aid is contemporaneously negatively correlated with commercial food imports, with a regression coefficient of -0.25 and a standard error of 0.08. Thus food aid replaces food imports to some extent. Surprisingly, however, food aid lagged two and three years has a positive effect on free food imports, though these coefficients do not completely offset the earlier negative effect. The lagged positive effect may reflect the fact that a large component of food aid is given as balance of payments support: it relaxes the foreign exchange liquidity constraint of the receiving country and allows an increase in all imports, including food. It may also reflect the trade expansion generated by the income effect of the transfer of food aid.

Before we resort to these explanations, however, we have to make sure that the above positive correlations are not spurious. One source of such a spurious correlation could be the positive association between emergency food aid and commercial food imports. Lavy's (1990) findings suggest that transitory shortages of food supply lead to immediate increases in both emergency food aid and commercial food imports. Since the measure of food aid used in this paper includes emergency food aid, it explains its positive correlation with food imports.

Time series data on emergency and non-emergency food aid are available only from 1979. Although this short panel does not allow the VAR estimation applied in this paper, it still allows us to examine the relationship between non-emergency food aid and commercial food imports. Indeed, the results are changed dramatically when the emergency components are netted out of total food aid. The contemporaneous coefficient of non-emergency food aid in the food import regression (that includes also lagged values of non-emergency food aid) now increases to -0.816 with a t value of 6.1. The parameter estimates of the aid variable lagged 3 periods are now all <u>negative</u>, but only marginally significantly different from zero. The important implication of these results is that increments to regular non-emergency food aid are replacing on the margin regular food imports almost totally. Thus the main force behind the disincentive hypothesis is eliminated: the net increase in food supply following an increase in regular food aid is relatively very small. We also estimated an equation that included 3 lagged values of the dependent variable, commercial food imports, as well as current and lagged value of regular non-emergency aid. The results did not change very much.

In another scenario the negative effect of food aid is minimized when the basket of food aid products is very different from the locally produced basket. In the short run there are more possibilities for complementarity than substitutability. The demand for domestic products may even increase. This is additional to the income effect generated from the transfer of income in kind (which leads to an increase in demand for domestic output). The available evidence suggests that most of the food items in the aid basket are different from the local produce in Sub-Saharan Africa.

Having eliminated the possibility that food aid has a large negative effect on food production, we next look to explain the positive effect estimated in the previous section. Program food aid in the form of balance of payments support or budget relief is also intended to facilitate imports of agricultural inputs, including fertilizers. To examine whether the positive effect of food aid on food production is related to its effect on fertilizer consumption from 1970-86, I have interacted these variables with food aid in equation 3, just as described in the case of the aid share. The coefficient of the interaction term was positive with a t value of 1.7, which allows for the acceptance of the hypothesis that it is different from zero at a 0.09 significance level. Separate regressions related the level and change in fertilizer consumption to the level (share) of food aid. The correlation between the amount of fertilizer consumed (hundreds of grams of plant nutrient per hectare of arable land) and the share of food aid is negative and highly significant, but the association of the change in fertilizer consumption with the aid share is positive (though with a t value of only 1.4). The first negative association is probably due to the allocation of more food aid to countries with a less developed agricultural sector, a characteristic that is correlated with low intensity of fertilizer consumption in production. Although no causal link between the growth in fertilizer consumption and food aid is established (and the above relationships are not very precise), the results suggest that food aid, which is positively correlated with increased fertilizer use, has a higher probability of having a positive effect in countries that use fertilizer intensively. A related explanation suggests that countries which enjoy relative abundance of regular food aid, use the resources that become available from the reduction of regular food imports to augment their investment in the agricultural sector. This hypothesis is enhanced by the conditionality that is often imposed by donors that the food aid proceeds, both in local and foreign currency, be invested in the agricultural sector. We do find some support to this hypothesis as evidenced by a positive correlation between food aid and the share of investment in agriculture, though no casual relationship can be inferred.

REFERENCES

Anderson, T.W. and C. Hsiao. 1982. "Formulation and Estimation of Dynamic Models Using Panel Data." Journal of Econometrics. 18: 47-82.

Bhagwati, Jagdish. 1986. "Food Aid, Agricultural Production and Welfare." In S. Guhan and M.R. Shroff, eds. Essays on Economic Progress and Welfare in Honor of I.G. Patel. New Delhi, Oxford University.

Bhagwati, Jagdish, and T.N. Srinivasen. 1969. "Optimum Policy Intervention to Achieve Non-Economic Objectives." Review of Economic Studies: 27-38.

Blandford D. and Von Ploski J. 1977. "Evaluating The Disincentive Effect of PL480 Food Aid: The Indian Case Reconsidered." Ithaca: Cornell University.

Chamberlain, Gary. 1983. "Panel Data." In The Handbook of Econmetrics. Vol. 2, Z. Griliches and M. Intriligator, eds. Amsterdam: North Holland Publishing Company.

Dudley, L. and R.J. Sandilands. 1975. "The Side-effects of Foreign Aid: The Case of PL480 Wheat in Colombia." Economic Development and Cultural Change. 23 (2).

Fisher, F.M. 1963. "A Theoretical Analysis of the Impact of Food Surplus Disposal on Agricultural Production in Recipient Countries." J. Farm Econ. 45: 863-75.

Hall, L. 1980. "Evaluating the Effects of PL480 Wheat Imports on Brazil's Grain Sector." American Journal of Agricultural Economics. 62: 19-28.

Holtz-Eakin, Douglas, Whitney Newey, and Harvey S. Rosen. 1988. "Estimating Vector Autoregression with Panel Data." Econometrica 56: 1371-95.

Isenman, Paul J. and Hans Singer. 1977. "Food Aid: Disincentive Effects and Their Policy Implications." Economic Development and Cultural Change. 25 (2).

Lavy, V. 1990. "Alleviating Transitory Food Crisis in Africa: International Altruism and Trade." The World Bank, Washington, D.C.

Mann, J.S. 1967. "The Impact of PL480 Imports on Prices and Domestic Supply of Cereals in India." Journal of Farm Economics. 49 (1).

Shultz, T.W. 1960. "Value of U.S. Farm Surpluses to Underdeveloped Countries" Journal of Farm Economics. 42 (5).

Singer. 1988. "Food Aid," discussion on paper, The World Bank, Washington, D.C.

Srinivasen, T.R. 1989. "Food Aid: A Cause of Development Failure or an Instrument for Success?" The World Bank Economic Review, 3 (1): 39-66.

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS443	The Inflation-Stabilization Cycles in Argentina and Brazil	Miguel A. Kiguel Nissan Liviatan		
WPS444	The Political Economy of Inflation and Stabilization in Middle-Income Countries	Stephan Haggard Robert Kaufman	June 1990	A. Oropesa 39176
WPS445	Pricing, Cost Recovery, and Production Efficiency in Transport: A Critique	Rachel E. Kranton	June 1990	W. Wright 33744
WPS446	MEXAGMKTS: A Model of Crop and Livestock Markets in Mexico	Gerald T. O'Mara Merlinda Ingco	July 1990	C. Spooner 30464
WPS447	Analyzing the Effects of U.S. Agricultural Policy on Mexican Agricultural Markets Using the MEXAGMKTS Model	Gerald T. O'Mara	July 1990	C. Spooner 30464
WPS448	A Model of U.S. Corn, Sorghum, and Soybean Markets and the Role of Government Programs (USAGMKTS)	Richard E. Just	July 1990	C. Spooner 30464
WPS449	Analysis of the Effects of U.S. Macroeconomic Policy on U.S. Agriculture Using the USAGMKTS Model	Richard E. Just	July 1990	C. Spooner 30464
WPS450	Portfolio Effects of Debt-Equity Swaps and Debt Exchanges with Some Applications to Latin America	Daniel Oks	June 1990	S. King-Watson 31047
WPS451	Productivity, Imperfect Competition and Trade Liberalization in the Côte d'Ivoire	Ann E. Harrison		
WPS452	Modeling Investment Behavior in Developing Countries: An Application to Egypt	Nemat Shafik	June 1990	J. Israel 31285
WPS453	Do Steel Prices Move Together? A Cointegration Test	Ying Qian	June 1990	S. Lipscomb 33718
WPS454	Asset and Liability Management in the Developing Countries: Modern Financial Techniques -- A Primer	Toshiya Masuoka	June 1990	S. Bertelsmeier 33767

PRE Working Paper Series

	Title	Author	Date	Contact for paper
WPS455	A Formal Estimation of the Effect of the MFA on Clothing Exports from LDCs	Junichi Goto	June 1990	M. T. Sanchez 33731
WPS456	Improving the Supply and Use of Essential Drugs in Sub-Saharan Africa	S. D. Foster	June 1990	Z. Vania 33664
WPS457	Financing Health Services in Africa: An Assessment of Alternative Approaches	Germano Mwabu	June 1990	Z. Vania 33664
WPS458	Does Japanese Direct Foreign Investment Promote Japanese Imports from Developing Countries?	Kenji Takeuchi	June 1990	J. Epps 33710
WPS459	Policies for Economic Development	Stanley Fischer Vinod Thomas	June 1990	WDR Office 31393
WPS460	Does Food Aid Depress Food Production? The Disincentive Dilemma in the African Context	Victor Lavy	July 1990	A. Murphy 33750