DOES INCREASING AGRICULTURAL EXPORTS RAISE INCOME INSTABILITY? 
AN EMPIRICAL NOTE

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Recent discussions of food security issues for developing countries have drawn attention to short-term fluctuations in effective demand, especially of the low-income households, as a critical area for policy analysis. Real income instability is presumed to be particularly acute in the rural areas, given fluctuating agricultural production and volatile international markets for primary commodities. This paper provides a systematic examination of income variability in food and export crop production, developing a suitable framework of analysis and using it to investigate the instability of total agricultural crop income in the Philippines and how it has been affected by the marked increase in the share of export crops over the postwar period. Some policy implications of the empirical results are briefly considered.

It is a common perception in developing countries (LDCs) that agricultural exports are vulnerable to the inherent volatility of world commodity markets. Indeed this represents one facet of so-called food-export crop tradeoffs indicating a conflict between the likely gains in efficiency and income from exploiting comparative advantage in export crop production and the greater instability in agricultural income that may result from an increasing share of export crops. The analytical distinction between food and export crops is appropriate for many developing countries that effectively insulate the agricultural food sector from the world market but are significant exporters of some other agricultural products. Direct government intervention in food trade is widely observed among food-deficit LDCs, the chief reason being that the domestic price of food, in terms of both its level and variability, is regarded as an all-important economic-political variable which needs to be tightly controlled.

While there have been numerous empirical studies of export earnings instability in primary-producing LDCs, the linkage to

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1 Thus, "during the 1970s, government policies generally reduced domestic prices of export crops below those which would have prevailed under the previous regime" (David, 1982, p. 5) of insignificant government intervention in the production and trade of export crops.
agricultural income variability, and hence to rural food insecurity (Valdés, 1983), has not been given explicit attention. On the other hand, instability in LDC crop production has also been widely investigated, but which generally abstract from considerations of farm price variability and the contribution of export crops to the instability of agricultural income.

The purpose of this paper is to provide a systematic examination of relative income instability in food and export crop production, developing a suitable framework of analysis and using it to investigate the variability of total agricultural crop income in the Philippines and how it has been affected by the marked increase in the share of export crops over the postwar period. The analytical discussion in the following section describes the conditions under which a rise in export share will increase total income instability. In application to Philippine agriculture, the export value share associated with minimum income instability is calculated and the induced change in total income instability estimated for each of the different cases considered. Some policy implications of the empirical results are briefly considered and other concluding remarks are given in the final section.

**Analytical Framework**

In the representation of the instability in total crop income arising from the variability of food and export crop incomes, we focus on the gross value of crop production, abstracting from fluctuations in the costs of intermediate and other inputs (which, following Newbery and Stiglitz (1981), may be considered to be of second-order importance). Total crop income in real terms ($Y$), may then be expressed as the sum of the nominal production values of food and export crops ($Y_{nf}$ and $Y_{nx}$, respectively) divided by the general price index ($P$):

$$Y = \frac{Y_{nf} + Y_{nx}}{P} = \frac{Y_{nx}}{P} + \frac{Y_{nf}}{P} = Y_f + Y_x$$

(1)

where $Y_f$ and $Y_x$ are the real incomes from food and export crops, respectively. The variance of $Y$ is given by:
(2) \( \text{Var}(Y) = \text{Var}(Y_f) + \text{Var}(Y_x) + 2 \text{Cov}(Y_f, Y_x) \)

For present purposes the coefficient of variation (CV) is preferable to use since, unlike the variance, it is dimensionless and does not require adjustment for scale differences. Equation (2) can be written as follows (cf. Koester, 1982):

(3) \( CV_y^2 = S_f^2 CV_f^2 + S_x^2 CV_x^2 + 2S_fS_x rCV_fCV_x \)

where \( S_f \) and \( S_x \) are the shares of food and export crops, respectively, in total value of production; \( CV_y, CV_f \) and \( CV_x \) are the coefficients of variation of total crop income, food crop income, and export crop income, respectively; and \( r \) is the correlation coefficient between \( Y_f \) and \( Y_x \).

Thus, given the coefficients of variation of \( Y_f \) and \( Y_x \) and their correlation coefficient, the food-export shares in production value determine total crop income instability. To see how the latter would be affected by a change in production-mix, assuming that the \( CV \)'s and \( r \) remain unchanged, equation (3) can be totally differentiated to give:

(4) \( CV_y \frac{dCV_y}{dS_f} = CV_y^2 S_f \frac{dS_f}{S_f} + CV_x^2 S_x \frac{dS_x}{S_x} + rCV_fCV_x \left( \frac{dS_f}{S_f} + \frac{dS_x}{S_x} \right) \)

Setting \( S_f = 1 - S_x \) and \( dS_f = -dS_x \) yields

(5) \( CV_y \frac{dCV_y}{dS_x} = -(CV_f^2 - rCV_fCV_x) + (CV_f^2 + CV_x^2 - 2rCV_fCV_x) S_x \)

Therefore, a rise in the income share of export crops will result in greater instability in total crop income if:

(6) \( S_x > \frac{CV_f^2 - rCV_fCV_x}{CV_f^2 + CV_x^2 - 2rCV_fCV_x} = S^*_x \)
Provided that the second order condition is met, i.e., $d^2 CV_x / dS_x^2 > 0$, the right-hand side in inequality (6) also represents the export crop share ($S_x^*$) at which total crop income instability is lowest.

For simplicity of exposition, we proceed to consider the determination of the shares of food and export crops associated with minimum instability in total crop income under the special case of zero correlation coefficient between $Y_f$ and $Y_x^2$. Equation (6) may then be written:

$$S_x > \frac{1}{1 + CV_x^2 / CV_f^2} = S_x^*$$

Thus, the larger is the ratio of the income variability of export crops to that of food crops, the smaller is the "optimum" (i.e., income instability-minimizing) export crop share. It is also evident that $S_x^*$ will be zero, meaning complete specialization in food crops, only if: (1) there is no instability in $Y_f$; and (2) $CV_x$ is nonzero. If $CV_f = CV_x$, then $S_x^* = .5$, which means that equal income shares of food and export crops will lead to minimum instability in total crop income. Finally, even if instability is greater in $Y_x$ relative to $Y_f$, a change in production-mix favoring export crops will increase total crop income instability only if the initial export share is greater than $S_x^*$; otherwise, further diversification of production into export crops can reduce instability of total crop income.

Figure 1 gives a graphical representation of the foregoing analysis, patterned after Markowitz' (1959) classic analysis of invest-

![Figure 1 -- Determination of $S_x^*$](image-url)
ment portfolio choice. The ellipses, centered at the origin, reflect the above assumptions that the correlation coefficient between $Y_f$ and $Y_x$ is zero and that $CV_x > CV_f$ (i.e., greater instability in export crop income). Each ellipse represents the combinations of $S_f$ and $S_x$ values corresponding to a given level of instability in total crop income; the smaller the ellipse the lower is the income instability. The feasible values of $S_f$ and $S_x$ are represented by the straight line with intercepts at $S_f = 1$ and $S_x = 1$. This line is tangent to the smallest ellipse shown at the point $(S_x^*, S_f^*)$ where the slope is

$$\frac{dS_f}{dS_x} = \frac{-S_x^* CV^2_x}{S_f^* CV^2_f} = -1$$

using equation (4) and setting $dCV_r = 0$. $S_x^*$ and $S_f^*$ are the shares yielding the lowest level of total crop income instability. Note that, if the initial export crop share is $S_x^0$, shifts in production away from food into exports crops will reduce instability as long as the export crop share is less than $S_x^*$. Therefore, the common sense proposition that an increasing share of export crops will give rise to greater variability of total crop income, does not necessarily hold.

The Philippine Case

Over the two postwar decades of the 1950s and 1960s, the export orientation of Philippine crop production increased significantly — in value terms, from 36.8% in 1950 to 48.6% in 1960 and 56.1% in 1970. This was accompanied by a rapid growth of agricultural exports — by 64% in (U.S. dollar) value terms from 1949/51 to 1969/71 — and an increasing dependence on imports of cereal products (which grew by 46% in per capita quantity terms from 1953/56 to 1967/70). After the food supply crisis of 1972-73, policy efforts to promote domestic food (especially rice) production were greatly intensified, the national government implementing a massive fertilizer and credit subsidy program (and continuing to promote the adoption of high yielding rice varieties started in the late sixties).

The early 1970s also witnessed a major policy shift toward the promotion of nontraditional exports, mainly labor-intensive manufactures, and greater domestic processing of primary products for export (cf. Bautista, Power, and Associates, 1979). Export taxes were levied on primary products beginning 1970 as a stabilization measure in support of the February devaluation of the Philippine peso (from 3.9 pesos per U.S. dollar to 6.4 by the end of the year),
out which later on became a permanent part of the country’s tax system. Additionally, export premium duties were imposed in 1973, which served to partly siphon off the windfall gains from the world commodity boom at the time. These policy developments help explain the observed leveling of the value share of export crops during the 1970s to 56.8% in 1979-80.

The primary concern here is, of course, not the explanation of food export share changes, but in the evaluation of their effect on instability in total crop income. In particular, to what extent had the marked increase in the share of export crops in the 1950s and 1960s led to greater (or lower) real agricultural crop income instability (and hence, rural food insecurity)? As the discussion in the preceding section has shown, the answer would depend on the relative variability of food and export crop incomes, their correlation and the initial crop value shares.

In view of the significant policy shifts in the early 1970s as noted above, it is useful to distinguish between the two postwar subperiods 1949-69 and 1970-80 in our preliminary analysis of instability in nominal incomes. Table 1 gives a comparison of instability indices for export earnings on agricultural crops, export crop income and food crop income based on annual data for the two subperiods and the entire period 1949-80. Following Cuddy and Della Valle (1978), the instability measure used here is the “corrected”

Table 1 — Calculated Values of Detrended Coefficient of Variation (based on deviations from linear trend)

<table>
<thead>
<tr>
<th></th>
<th>1949-80</th>
<th>1949-69</th>
<th>1970-80</th>
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<tbody>
<tr>
<td>Crop Export Earnings* (U.S. dollars, f.o.b.)</td>
<td>44.0</td>
<td>11.0</td>
<td>20.7</td>
</tr>
<tr>
<td>Nominal Income from Export Crops, (Y_{nx}) (pesos; farmgate)</td>
<td>75.4</td>
<td>28.5</td>
<td>18.6</td>
</tr>
<tr>
<td>Nominal Income from Food Crops, (Y_{nf}) (pesos, farmgate)</td>
<td>62.9</td>
<td>23.3</td>
<td>11.9</td>
</tr>
<tr>
<td>Real Income from Export Crops, (Y_x)</td>
<td>21.9</td>
<td>15.8</td>
<td>12.4</td>
</tr>
<tr>
<td>Real Income from Food Crops, (Y_f)</td>
<td>17.7</td>
<td>12.6</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Note: *Includes processed products.
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(or detrended) coefficient of variation $CV \sqrt{1-R^2}$, where $R^2$ is the coefficient of determination adjusted for degrees of freedom in a trend regression, which has been shown to be equal to the ratio of the standard error of the estimate and the mean of the variable. This index is bounded, with a lower limit at zero (when $R^2 = 1$) and an upper limit at the (uncorrected) $CV$, which is intuitively reasonable.

From Table 1, it can be observed, first of all, that each of the five income variables has markedly lower instability values for the two subperiods compared to those for the entire period 1949-80. This reflects the much greater deviations from the estimated 32-year trend lines and indicates the need to incorporate, in the income instability measure based on the entire period, the significant difference in the observed trends for the two subperiods.

Secondly, it is worth noting that the instability of foreign exchange earnings from export crops during 1949-69 is lower than that of producers’ export crop income, but that the opposite case holds during 1970-80. This would seem in part attributable to the more active government intervention policy in the latter period in response to the increased instability in the foreign trade sector as described above, and the adoption of a flexible exchange rate inaugurated by the February 1970 floating of the Philippine peso.

Comparing the variabilities of farm incomes from food and export crops in nominal terms, we find consistently lower values for food crop income, which finding is perhaps to be expected from the traditionally tighter government control of the food sector in the Philippines (Bautista, 1978) and the additional instability due to external disturbances to which export crop income is exposed. Finally, it may be noted that, despite the greater instability in Philippine foreign trade in the 1970s (Bautista, 1980), both food and export crop incomes appear from Table 1 to have become less unstable relative to the earlier two decades. Again, this would seem due to the policy developments in the seventies, which apparently provided an effective offset to the exogenous shocks emanating from the external sector.

We now turn to an examination of the relative instability of food and export crop incomes in real terms, which is certainly the more relevant consideration in discussions of rural food security, and therefore is the primary interest in the present study. The last two rows of Table 1 report the calculated values of real income instability pertaining to the deviations from trend of nominal food and
export crop incomes deflated by the consumer price index for the two subperiods 1949-69 and 1970-80 as well as for the entire period 1949-80. That they are consistently lower than the instability values for nominal incomes reflects the positive correlation between the general price level and nominal incomes (in terms of deviations from trend) from both food and export crops. Another striking observation is the greater variability of export crop income (in real terms) relative to food crop income; however, the disparity in instability values is surprisingly rather small — 4.2 percentage points for 1949-69, 3.2 for 1949-69, and 1.2 for 1970-80.

Although the respective $Y_{f}$ and $Y_{x}$ instability values are closer for the two subperiods compared to those based on nominal incomes ($Y_{nf}$ and $Y_{nx}$), it is seen that the variability around the 1949-80 trend line is much higher for both $Y_{x}$ and $Y_{f}$. One way of measuring stability for the entire period that would allow for a shifting trend between the two subperiods is to introduce intercept and slope dummies in the trend equation as follows:

$$3) \quad Y = a + bT + cD + dDT + e$$

where $Y$ and $T$ are the income and trend variables, respectively, $e$ the error term, and $D$ is a dummy variable equal to zero for the years from 1949 to 1969 ($T = 1, \ldots, 21$) and unity for the years 1970 to 1980 ($T = 22, \ldots, 32$). On this basis the calculated instability values are 12.4 for $Y_{f}$ and 14.7 for $Y_{x}$, while the correlation coefficient (of their residuals) is computed to be .167. Real income from export crops is still seen to be more unstable (but not markedly so) relative to food crops, the difference in their instability values being 2.3 percentage points.

We may now use equation (6) above to calculate the export share associated with minimum instability in total crop income, based on the foregoing values of $CV_{f} = 12.4, CV_{x} = 14.7$ and $r = .167$,

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3 Calculated values of the correlation coefficients are as follows:

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>$Y_{nf}$ and $P$</td>
<td>.975</td>
<td>.914</td>
<td>.338</td>
</tr>
<tr>
<td>$Y_{nx}$ and $P$</td>
<td>.970</td>
<td>.845</td>
<td>.695</td>
</tr>
</tbody>
</table>

4 In the context of food security, defined as the ability to meet target consumption levels (Valdes and Siamwalla, 1981), the implication of a shifting trend line is that target consumption levels over time are not being set along a strictly linear trend owing to changes in the economic environment.
the calculated \( S^* \) is 39.9%. This is higher than the initial export share in total crop income (36.9% for 1949 and 1950) but much lower than the export share prevailing in 1979 and 1980 (56.8%).

The change in total crop income instability induced by the observed increase in export share from 1949-50 to 1979-80 may be estimated from equation (3) above, which gives \( \Delta CV_y = 10.65 - 10.24 = .41 \) percentage points, or only 4.0% of the initial value. Using the CV’s and r’s for the separate subperiods 1949-69 and 1970-80 yields even smaller increases in the variability of total crop income (in real terms) — by only 3.5% and .12% of the (initial) CV values in 1949 and 1970, respectively. The very small increase in income instability from 1970 to 1980 is attributable to: (1) the insubstantial rise in the export share (from .561 to .568); (2) the small difference in \( CV_y \) and \( CV_x \) values (11.3 vs. 12.4, from Table 1); and (3) the insignificant correlation between \( y \) and \( x \) during the period (\( r = -.078 \)).

The above estimates represent relatively modest increases in real income instability arising from the observed rise in export crop share over the postwar period. What may be called the ex post elasticity of real crop income instability with respect to export crop share for the entire period 1949-80 is calculated to be only \( .074 \) (\( = 4.0 \div 53.9 \)).

Conclusion

The results of the above empirical analysis confirm, for Philippine agriculture in the postwar period, the greater income instability for export crops relative to food crops. What is surprising, however, is the comparatively small difference in the instability values, especially for the 1950s and 1960s (during which period the export orientation of crop production in the Philippines increased markedly), considering that the food sector had been effectively shielded by government policy from international price fluctuations. In the 1970s the variability of both food and export crop incomes decreased significantly, which contrasted with the increased instability in the country’s foreign sector, particularly export earnings from agricultural crops. This is related to the greater degree of government intervention in the 1970s, especially in the agricultural export sector,

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5This is well documented in the case of rice, the dominant food crop in the Philippines, see for example, Bouis (1982).
h apparently provided a partial offset to the foreign price 
valuations of primary product exports during the decade.

It is interesting to note that this decline in export crop income 
ability was not accompanied by a continuation of the increasing 
port share in total crop income, which actually levelled off in the 
0s. Export crop production presumably became less attractive 
to food crop production as a result of the changed policy 
environment which actively promoted food crop production at the 
time that the gains to agricultural export producers from ex- 
change rate liberalization and favorable world commodity prices 
being siphoned off through various “stabilization” tax means. Thus, 
it would seem that the reduction in export crop income 
ability in the 1970s was achieved due to the heavier export 
tion in times of improved earnings, effectively reducing the 
age profitability of export crop production. Whether this is a 
cable policy to maintain if the world economy continues to be 
able is a question that deserves serious study.

The empirical estimate of only a moderate effect on income 
ability due to the large increase in export crop share in the 1950s 
1960s does not validate the prevalent apprehension among LDC 
cy-makers about the increased instability in agricultural income 
ing from greater export orientation of agricultural production 
ch, it should be emphasized, took place before the policy inter-
ions of the 1970s. It illustrates the possibility of a relatively 
ll cost, in terms of rural income instability, of agricultural export 
asion in developing countries. This has clear implications for 
cultural development strategy that should not be lost to LDC 
cy-makers.

The important point is that the nature of food-export crop 
eoffs in developing countries needs to be carefully examined, 
er than presumed. Empirical knowledge of the tradeoffs can 
ide guidance to LDC governments in selecting policy instruments 
development strategies that are consistent with their own overall 
pects. While this paper has focussed, rather narrowly, on 
come instability, considerations affecting the choice of food-
ort crop output-mix related to some of the other major concerns 
development policy (such as employment and income distri-
on) also warrant systematic analysis.
REFERENCES


Bouis, H. E. (1982), Rice Policy in the Philippines, Ph. D. dissertation submitted to the Food Research Institute, Stanford University (February).


Congress of the International Economic Association, Madrid (September 5-9).


DATA APPENDIX

The Crop, Livestock and Natural Resources Statistics, published by the Bureau of Agricultural Economics (BAE) is the source of annual data on value of crop production at farmgate prices, including home-consumed and marketed output. It distinguishes between food and commercial crops. The latter category includes all unfood crops (e.g., tobacco, rubber, abaca and other plant fibers, etc.) as well as some food crops which are largely processed before final consumption (e.g., coconut, sugarcane, etc.); the common characteristic among these crops is that they are produced by market-oriented producers for both domestic and export markets. Under the "food" category are all crops intended for food that do not undergo significant processing before final consumption, and they consist mainly of so-called "subsistence" crops (rice, corn, etc.) effectively isolated from world market developments by domestic ice and trade controls; however, some food items under this BAE category are being exported in significant amounts (principally, nana and mango) which, for the analytical purposes of the present study, are more appropriately treated as export rather than food crops.

The composition of the two crop categories adopted here is, therefore, as follows: food crops - rice, corn, root crops, vegetables, nuts, other fruits and nuts, beans and peas, other food crops; export crops - coconut, sugarcane, banana, coffee, cocoa, mango, pineapple, citrus, abaca, native tobacco, Virginia tobacco, rubber, pine, maguey, other commercial crops. (This list exhausts all crops included in the above-mentioned data source.) Rice, corn and root crops are the major food crops, accounting for 22.1%, 8.2% and 9%, respectively, of the total value of Philippine crop production 1980; coconut and sugarcane dominate the export crop category, contributing 24.4% and 11.1%, respectively.

Annual data on f.o.b. value (in U.S. dollars) of agricultural crop exports and on the consumer price index have been obtained from various issues of the Statistical Bulletin, a publication of the Central Bank of the Philippines.