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,[1] 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

[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.

gricultural income variablity, and hence to rural food insecurity
Valdés, 1983), has not been given explicit attention. On the other
and, instability in LDC crop production has also been widely in-
estigated, but which generally abstract from considerations of
arm price variability and the contribution of export crops to the
nstability of agricultural income.

The purpose of this paper is to provide a systematic examination
f relative income instability in food and export crop production,
eveloping a suitable framework of analysis and using it to investi-
ate the variability of total agricultural crop income in the Philip-
ines and how it has been affected by the marked increase in the
hare of export crops over the postwar period. The analytical dis-
ussion in the following section describes the conditions under which
rise in export share will increase total income instability. In ap-
lication to Philippine agriculture, the export value share associated
vith minimum income instability is calculated and the induced
hange in total income instability estimated for each of the different
ases considered. Some policy implications of the empirical results
re briefly considered and other concluding remarks are given in the
inal 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 fluct-
uations in the costs of intermediate and other inputs (which, fol-
lowing 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):

$$(1) \quad Y = \frac{Y_{nf} + Y_{nx}}{P} = \frac{Y_{nx}}{P} + \frac{Y_{nx}}{P} = Y_f + Y_x$$

where Y_f and Y_x are the real incomes from food and export crops,
respectively. The variance of Y is given by:

$$(2) \quad Var(Y) = Var(Y_f) + Var\ (Y_x) + 2\ Cov(Y_f, Y_x)$$

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):

$$(3) \quad CV_Y^2 = S_f^2 CV_f^2 + S_x^2 CV_x^2 + 2S_f S_x r CV_f CV_x$$

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:

$$(4) \quad CV_y dCVy = CV_f^2 S_f dS_f + C\,V_x^2 S_x dS_x + r CV_f CV_x$$
$$(S_f dS_x + S_x\,dS_f)$$

Setting $S_f = 1 - S_x$ and $dS_f = -dS_x$ yields

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

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

$$(6) \quad S_x > \frac{CV_f^2 - rCV_f\,CV_x}{CV_f^2 + CV_x^2 - 2rCV_f CV_x} = S_x^*$$

Provided that the second order condition is met, i.e., $d^2CV_y/dS_x^2 > 0$, 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:

$$(7) \qquad S_x > \frac{1}{1 + CV_x^2/CV_f^2} = S_x^*$$

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-
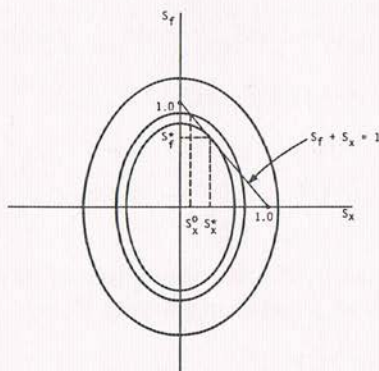

Figure 1 -- Determination of S_x^*

[2] The application to the Philippine case in the next section does not entail this extreme assumption.

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

(8)
$$\frac{dS_f}{dS_x} = \frac{-S_x^* \, CV_x^2}{S_f^* \, CV_f^2} = -1$$

using equation (4) and setting dCV_y, $r = 0$. 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),

ut which later on became a permanent part of the country's tax ystem. Additionally, export premium duties were imposed in 1973, vhich served to partly siphon off the windfall gains from the world ommodity boom at the time. These policy developments help xplain the observed leveling of the value share of export crops during he 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 he preceding section has shown, the answer would depend on the elative 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 ubperiods 1949-69 and 1970-80 in our preliminary analysis of nstability in nominal incomes. Table 1 gives a comparison of ins-ability indices for export earnings on agricultural crops, export crop ncome and food crop income based on annual data for the two sub-periods 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)

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

Note: *Includes processed products.

(or detrended) coefficient of variation $CV \sqrt{1-\overline{R}^2}$, where $\overline{R}^2$ 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 $\overline{R}^2 = 1$) 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

port crop incomes deflated by the consumer price index for the
o subperiods 1949-69 and 1970-80 as well as for the entire period
)49-80. That they are consistently lower than the instability values
r nominal incomes reflects the positive correlation between the
neral price level and nominal incomes (in terms of deviations from
end) from both food and export crops.[3] Another striking observ-
ion is the greater variability of export crop income (in real terms)
lative to food crop income; however, the disparity in instability
lues is surprisingly rather small — 4.2 percentage points for 1949-
), 3.2 for 1949-69, and 1.2 for 1970-80.

Although the respective Y_f and Y_x instability values are closer
r 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
end 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
end[4] between the two subperiods is to introduce intercept and
ope dummies in the trend equation as follows:

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

here 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
ears from 1949 to 1969 $(T = 1, \ldots, 21)$ and unity for the years
970 to 1980 $(T = 22, \ldots, 32)$. On this basis the calculated instabi-
ty values are 12.4 for Y_f and 14.7 for Y_x, while the correlation
oefficient (of their residuals) is computed to be .167. Real income
om export crops is still seen to be more unstable (but not markedly
)) relative to food crops, the difference in their instability values
eing 2.3 percentage points.

We may now use equation (6) above to calculate the export
hare associated with minimum instability in total crop income.
ased 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:

	1949-80	1949-69	1970-80
etween Y_{nf} and P	.975	.914	.338
etween Y_{nx} and P	.970	.845	.695

[4] In the context of food security, defined as the ability to meet target
onsumption levels (Valdes and Siamwalla, 1981), the implication of a shifting
end line is that target consumption levels over time are not being set along a
rictly linear trend owing to changes in the economic environment.

the calculated S_x^* 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 ΔCV_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_f and CV_x values (11.3 vs. 12.4, from Table 1); and (3) the insignificant correlation between Y_f and Y_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 ÷ 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.[5] 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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[5] This 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
uations of primary product exports during the decade.

It is interesting to note that this decline in export crop income
.bility was not accompanied by a continuation of the increasing
)rt share in total crop income, which actually levelled off in the
)s. Export crop production presumably became less attractive
ive to food crop production as a result of the changed policy
/onment which actively promoted food crop production at the
e time that the gains to agricultural export producers from ex-
ige rate liberalization and favorable world commodity prices
e being siphoned off through various "stabilization" tax mea-
s. Thus, it would seem that the reduction in export crop income
ibility 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
rable 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
ibility due to the large increase in export crop share in the 1950s
1960s does not validate the prevalent apprehension among LDC
cymakers about the increased instability in agricultural income
ng 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
insion in developing countries. This has clear implications for
cultural development strategy that should not be lost to LDC
cymakers.

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
ride guidance to LDC governments in selecting policy instruments
development strategies that are consistent with their own overall
pectives. While this paper has focussed, rather narrowly, on
income instability, considerations affecting the choice of food-
ort crop output-mix related to some of the other major concerns
levelopment policy (such as employment and income distri-
on) also warrant systematic analysis.

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DATA APPENDIX

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

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

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