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Relationship between agricultural growth and farm imports in LDCs: a Sims' causality test based on 35 countries

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ABSTRACT

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Previous empirical studies on the relationship between agricultural growth and farm imports in the LDCs suffer from serious methodological defects, which to some extent may invalidate their results and interpretations. This study used Sims' causality test to examine interactions between agricultural output and agricultural imports for 35 LDCs individually. It was found that there was no causality from agricultural output to agricultural imports for a majority of countries under study. For countries where agricultural growth did have a causal effect on agricultural imports, the effect was positive in some countries and negative in others.

INTRODUCTION

The debate over whether agricultural growth in less developed countries (LDCs) enhances or reduces their farm imports has attracted substantial attention among agricultural economists and government policy-makers. At issue is the wisdom of the U.S. policy to promote agricultural development in developing countries. Concerns have been raised that an increase in

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agricultural production in LDCs may reduce the demand for U.S. farm exports and/or produce export competition. Therefore, the policy to aid LDC agricultural growth is harmful to the U.S. farm sector that has become increasingly dependent on the international market. However, an opposite view has also been advanced by some scholars. They argue that LDC agricultural development benefits U.S. farm exports because the development helps to stimulate broad-based income growth in these countries, which is often followed by dietary enrichment and food import expansion (Kellogg et al., 1986; Houck, 1987). In a more generalized framework, considering both the tradable and nontradable markets, Anderson (1989) shows that the net result of agricultural development in LDCs may well be beneficial to the economic interests of developed economies whose farm sectors are export-oriented. A number of empirical studies have been conducted to investigate the relation between LDC overall agricultural growth and their agricultural imports (e.g. Anderson, 1989; Bautista, 1990; Kellogg et al., 1986; Lee and Shane, 1987; Houck, 1987). Most of these studies found a positive or otherwise an insignificant negative relationship between the two variables, supporting the view of harmony between U.S. farm interests and U.S. foreign agricultural assistance policy.

However, several problems exist with these studies that may cast doubt on the empirical findings and their implications. Firstly, while these studies purport to examine the possibility of agricultural growth causing an increase in agricultural imports, most of them employed classical regression or simple correlation techniques. It has been noted that such techniques can only indicate correlations between variables and are generally unable to reveal causality (Grabowski et al., 1990; Pierce and Haugh, 1977). Second, theories linking agricultural growth to imports are, at best, incomplete. Incorrectly imposing a priori restrictions from theory on an empirical model can render the estimates inconsistent and statistical tests meaningless (Hsiao, 1981). For instance, no study has taken into account possible feedbacks from agricultural imports to agricultural growth. Third, most estimations were based on agricultural growth and import data aggregated over all countries under study. But the LDCs are very diverse, and the relation between agricultural growth and imports can be substantially different from one country to another. Thus, such an aggregation may be highly questionable (Paarlberg, 1986).

This study analyzes causal relations between agricultural growth and farm imports in LDCs using Sims' causality test, which it is hoped will add some new empirical evidence to the on-going debate. The empirical approach used is free of the problems discussed above – no theoretical restrictions are imposed, and the causal analysis is applied to each of 35 LDCs individually.

SIMS' CAUSALITY TEST

Sims (1972) developed an easily testable concept of causality based on Granger's causality theory (Granger, 1969). In a bivariate model consisting of two time-series X and Y, linear regression equations can be specified as follows:

$$Y = \mathrm{f}(X, \text{past lags of } X, \text{future lags of } X) \tag{1}$$

$$X = \mathrm{f}(Y, \text{past lags of } Y, \text{future lags of } Y) \tag{2}$$

Sims stated that if causality runs from X to Y only, the coefficients on the future lags in (1) as a group should not be significantly different from zero. In other words, one can conclude that Y does not cause X if the future lags in (1) are jointly insignificant. Conversely, significant coefficients on the future lags in (1) would indicate Y causing X. In the same manner, the joint significance of the future lags of Y in (2) determines whether or not X causes Y. Furthermore, if the coefficients of future lags are significant in both (1) and (2), the causality between X and Y is bidirectional; if the coefficients of future lags are insignificant in both (1) and (2), then no causality exists between X and Y. The hypotheses of causality and its direction can be tested using conventional F statistics. Though Sims' causality test is not widely used, there are recent examples of its application in economic research (e.g. Chow, 1987).

In a causality test, economic theory is only loosely used to choose the variables to be related (Hsiao, 1981). Data are allowed to reveal their dynamic regularities with little a priori theoretical restriction. Since all variables are treated as endogenous and unconstrained, it avoids imposing false restrictions on the model, which is a common problem in econometric modeling (Hsiao, 1981). This feature is especially appealing when the underlying economic theory is inadequate for empirical model specification. Although causal analysis is nonstructural in nature, it is useful for obtaining empirical evidence on competing theories and in providing an empirical basis for the construction of structural models (Sims, 1980).

EMPIRICAL MODEL AND ESTIMATION PROCEDURE

Annual data on agricultural imports, agricultural output (value-added), and total population, for a sample of 35 LDCs from 1961 to 1988, were obtained from the FAO Database/Trade Section and World Tables, both of which are maintained in the World Bank's 'BESD' system. The selection of countries was based on data availability. Agricultural output was in constant values while agricultural imports were measured in U.S. dollars in current prices, which was consequently deflated by the World Agricultural

Import Unit Value Index from FAO Agricultural Trade Yearbooks at the 1985 price. These two time-series were then scaled to the per-capita level by total population in each country. Finally, since economic data often exhibit a tendency to increase in variance as the levels increase, all data were transformed into logarithms to remove the trend in variances (Harvey, 1981).

In implementing equations (1) and (2), per-capita agricultural imports were regressed on the past, current and future values of per-capita agricultural output in each country, and then the reverse. Three past and future lags were specified for each regression (considering the annual data). A constant and a time-trend were included in the regression.

It is crucial in the causality test that the residuals of the time-series regression are free of serial correlation (Sims, 1972). Both Durbin–Watson (DW) and Q statistics were used in detecting departures from serial independence among the residuals. DW statistics alone would be inadequate when the serial correlation is of higher orders (Sims, 1972). A Q statistic (Box and Pierce, 1970) was calculated for each regression to detect any higher order correlation among the residuals. Whenever serial correlations were found, the original time series were treated by a filter $(1 - 0.75 L)^2$, where L is the lag operator. Sims (1972) indicates that this filter approximately flattens the spectral density of most economic time-series. Regressions were re-run on the prefiltered time-series (without the time trend) [1] and the residuals re-checked by DW and Q statistics. The results show that the filtering effectively reduced the autocorrelation in most cases. For a few cases where the problem still persisted, additional past lags were added to the regression, one at a time. This process continued until either (1) DW statistics were close to two and Q statistics were insignificant at 10% level, or (2) a reasonable level of degrees of freedom could not be sustained. Ten out of a total of 70 regressions fell into the second category. They are regressions of agricultural imports on agricultural output for Botswana, Kenya, Malawi and Rwanda, and the reversed regression for Argentina, Botswana, Chile, China, the Philippines and Turkey. For these regressions, the accuracy of F-tests, hence the causal inferences, can be doubtful. [2] For the other 60 regressions, the residuals were approximately white noise. Further, the insignificant Q statistics are also an indication that the model was correctly specified (see Pindyck and Rubinfeld, 1981 pp. 548–550).

[1] The filter approximately reduces the constant to zero and the time trend to a constant.

[2] Autocorrelated residuals would result in over-estimated causality. Namely, causality may be inferred by the tests but actually does not exist (Pierce and Haugh, 1977).

4. RESULTS AND DISCUSSIONS

The regressions were run using ordinary least squares, and the causality test results are reported in Table 1. Most regressions have relatively high R-squares, and, as expected, the regressions on pre-filtered data in general have lower R-squares. The coefficients of the future lags were examined according to Sims' (1972) suggestion that the magnitudes of future coefficients not be ignored whether or not they are significant as a group. It turned out to be rather consistent that the largest coefficients occurred on past lags for regressions with insignificant future lags and on future lags for regressions with significant future lags. [3]

The results in Table 1 show that causal relations between agricultural outputs and agricultural imports existed for 20 countries and no causality was found for the remaining 15 countries under study. Within those 20 countries, ten countries were shown to have one-way causality from agricultural output to imports. They are Bangladesh, Chile, Egypt, Ethiopia, Honduras, Indonesia, Kenya, Malawi, Mexico and Panama. Another six countries exhibited a one-way causality from agricultural imports to output, including Bolivia, Botswana, Gambia, Ghana, India, South Korea and Togo. Finally, for three out of the 20 countries, Argentina, Ecuador and Sri lanka, the causality tested bidirectional. As indicated earlier, the causality from output to imports for Argentina and Chile, and the reversed causality for Botswana, may not be as reliable because of the serial dependence in the regression residuals.

For countries that exhibited causal relations between agricultural output and agricultural imports, another issue of interest is to measure quantitatively the dynamic effects of the output (imports) on the imports (output). For this purpose, the long-term elasticities were calculated using the estimated coefficients. For regressions using filtered data, the equations were transformed back to levels before the calculation.

Among countries with one-way causality from agricultural output to agricultural imports, negative long-term elasticities of imports with respect to output were found for Bangladesh, Chile, Ethiopia, Indonesia and Panama, suggesting that agricultural output growth in these countries may have led to a reduction in their agricultural imports. On the other hand, positive long-run elasticities were found for Argentina, Ecuador, Egypt, Honduras, Kenya, Mexico and Sri Lanka, suggesting that agricultural output growth in these countries may have led to an increase in their agricultural imports.

[3] A complete set of the regression results is available upon request.

TABLE 1

Sims' test of causality between agricultural output and agricultural imports

Country	Regression of IMP on AGPT F-ratio	Regression AGPT on IMP F-ratio	Causality
Argentina	4.21 (3,8) [b]	3.98 (3,8) [c]	IMP ⇄ AGPT
Bangladesh	0.72 (3,13)	3.17 (3,8) [c]	IMP ← AGPT
Bolivia	2.77 (3,13) [c]	0.87 (3,8)	IMP → AGPT
Botswana	5.19 (3,13) [a]	1.94 (3,8)	IMP → AGPT
Brazil	1.41 (3,8)	1.20 (3,9)	none
Chile	0.71 (3,13)	3.65 (3,8)	IMP ← AGPT
China	0.67 (3,12)	0.21 (3,8)	none
Côte d'Ivoire	0.65 (3,11)	1.98 (3,7)	none
Ecuador	5.32 (3,9) [b]	7.12 (3,9) [a]	IMP ⇄ AGPT
Egypt	1.99 (3,13)	7.57 (3,13) [a]	IMP ← AGPT
El Salvador	0.61 (3,8)	0.12 (3,12)	none
Ethiopia	2.01 (3,13)	6.14 (3,13) [a]	IMP ← AGPT
Gambia	3.89 (3,13) [b]	1.32 (3,12)	IMP → AGPT
Ghana	6.15 (3,5) [b]	1.02 (3,9)	IMP → AGPT
Honduras	1.43 (3,12)	3.77 (3,6) [c]	IMP ← AGPT
India	7.24 (3,12) [a]	2.79 (3,13)	IMP → AGPT
Indonesia	0.88 (3,12)	8.68 (3,12) [a]	IMP ← AGPT
Kenya	0.71 (3,10)	4.52 (3,9) [c]	IMP ← AGPT
South Korea	4.73 (3,11) [b]	1.00 (3,8)	IMP → AGPT
Malawi	0.59 (3,9)	6.04 (3,9) [a]	IMP ← AGPT
Mexico	2.37 (3,8) [c]	7.75 (3,12)	IMP ← AGPT
Pakistan	1.33 (3,13)	1.49 (3,13)	none
Panama	1.09 (3,12)	4.33 (3,12) [b]	IMP ← AGPT
Philippines	0.09 (3,8)	1.74 (3,8)	none
Rwanda	3.20 (3,4)	0.97 (3,5)	none
Senegal	1.89 (3,11)	2.55 (3,11)	none
Sri Lanka	3.78 (3,8) [c]	3.90 (3,13) [b]	IMP ⇄ AGPT
Swaziland	1.07 (3,12)	2.02 (3,8)	none
Tanzania	2.29 (3,10)	0.47 (3,12)	none
Thailand	0.09 (3,12)	1.46 (3,13)	none
Togo	4.94 (3,6) [c]	0.70 (3,9)	IMP → AGPT
Tunisia	1.27 (3,9)	1.53 (3,8)	none
Turkey	1.00 (3,13)	1.99 (3,8)	none
Venezuela	0.41 (3,11)	2.23 (3,11)	none
Zambia	1.55 (3,13)	0.27 (3,12)	none

IMP, per-capita agricultural imports; AGPT, per-capita agricultural output. F-ratio is for the test of the hypothesis that the coefficients of the future values are jointly zero. Numbers in parentheses are the degrees of freedom. [a] Significant at 1% level; [b] significant at 5% level; [c] significant at 10% level.

Thus it may be concluded that the positions held by either side of the aforementioned debate can only be justified for a limited number of countries. Furthermore, given the absence of one-way causality from agricultural output to imports for most countries under study (25 out of 35), it would appear that views expressed on neither side of the debate are supported by the empirical evidence. It implies that, in general, the U.S. foreign agricultural assistance policy has neither benefited nor undermined U.S. agricultural export interests.

Among those countries with causality from agricultural imports to agricultural output, negative long-term elasticities of output with respect to imports were found in Botswana, Ecuador, Gambia, Ghana, India, Korea and Sri Lanka. Positive long-term elasticities were found in Argentina, Bolivia and Togo. Although it is unclear theoretically how farm imports affect domestic agricultural growth, it is plausible that they can either impede or foster domestic agriculture, depending on whether they pose a competition or supplement to the domestic farm sector. These empirical results may indicate that, for the first group of countries, farm imports compete with the domestic agriculture, while, in the second, they play a supplementary role.

For all countries with causality between agricultural output and imports, a generalization is difficult, either by size of the economy, level of economic development, or any other conceivable criterion. This would strongly suggest that the causal effects are country dependent. Discussions about the effects of agricultural growth on farm imports would be more meaningful on a country specific basis, and aggregations over all LDCs may be inappropriate.

As a final note, the evidence of causality from agricultural imports to agricultural output found in some countries suggests that the models treating the imports as an exogenous variable may be incorrectly specified, hence may result in biased and inconsistent estimates.

CONCLUSION

The current debate on whether agricultural growth in LDCs benefits or hurts U.S. agricultural exports has significant implications for the U.S. policy of foreign agricultural assistance. Reliable empirical evidence is essential for policy decisions. Previous empirical studies on the relationship between agricultural growth and farm imports in the LDCs suffer from serious methodological defects, which to some extent may invalidate their results and interpretations. This study used Sims' causality test to examine the interactions between agricultural output and agricultural imports for 35

LDCs individually. The problems associated with previous researches were thus avoided.

With the techniques used, no causality was found from agricultural output to agricultural imports for the majority of countries under study. For countries where agricultural growth did have a causal effect on agricultural imports, the effect was positive in some countries and negative in others. Thus the views on neither side of the debate were substantiated by the empirical evidence of this research, and U.S. foreign agricultural aid may actually have no effect on the U.S. farm exports.

To understand better the relation between agricultural growth and agricultural imports, further research may be needed ot establish structural models that identify relevant variables and different agricultural commodity groups, and to address the specific situations of specific countries.

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