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Development of Agricultural Core Commodity Terms-of-Trade and Their Impact on Economic Growth in Selected Third World Countries

INTRODUCTION

Economic development has often been explained as a consequence of international trade. A popular thesis points out a strong connection between the declining terms of trade of developing countries and the deterioration of their economic situation. This holds especially true for countries which are highly dependent on the export of few commodities. UNCTAD (see, for example, UNCTAD 1987, pp. 126-7) considers changes in terms of trade as an indicator for the economic position of less developed countries and based on this argument demands the stabilization of commodity prices at a high level.

This paper intends to investigate this relationship on a recent data basis in several examples of Third World Countries. Since we focus on the agricultural sector, we have selected four agricultural core commodities and seven countries whose export structure is mainly dominated by those commodities. In particular the commodity terms of trade ('ctot') and the income terms of trade ('itot') were examined. As a measure of development of the economies the national GDP rates are considered. Using the method of causality analysis the relations between these variables will be clarified.

In order to collect data for the empirical analysis, those Third World countries have been selected which highly depend on exports of agricultural core commodities, that is cacao, coffee, cotton, and tea. The time horizon as well as the number of appropriate countries is restricted by the lack of available data. Thus, the empirical basis is formed by a sample of seven countries over the period 1963 to 1985 (see Table 1).

The commodity terms of trade are calculated as the ratio of commodity prices (in US dollars) and the export unit values (in US dollars) of industrial countries. The income terms of trade are respectively formed as the product of the 'ctot' times the volume of exports. All data required, including the GDP rates, are reported in the IFS Yearbook 1987 published by the International Monetary Fund.

The discussion of which basis should be chosen for calculating terms of trade does not affect our investigation, because only the time path, and not absolute values, are examined. In this paper all data have been set to a 1980 basis for practical reasons.

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TABLE 1 *Export structure of selected Third World Countries (1982/83)*

Country	Commodity	as a percentage of total exports
Brazil*	coffee	10.64
Colombia	coffee	50.71
El Salvador	coffee	53.81
Kenya	coffee	25.81
Ghana	cacao	47.05
Paraguay	cotton	29.99
Sri Lanka	tea	32.06

*Notes**: Brazil has been selected as a country with a more diversified export structure, but still relying considerably on coffee exports.

Source: *Handbook of International Trade and Development Statistics*, 1986 Supplement.

RECENT DEVELOPMENTS

The general analysis of the terms of trade ('tot') development (as depicted in figures 1-7) shows a sharp increase of both 'tot' variables for all countries in the mid-1970s – with the exception of Paraguay – as a consequence of the first oil price shock. Paraguay is also the only country where the considered 'ctot' and 'itot' do not show a parallel development. In all the other cases, 'ctot' and 'itot' are roughly parallel, particularly for Kenya and Sri Lanka. In the late 1970s and the early 1980s, during the world recession, a strong decline of 'ctot' and 'itot' can be observed. Nevertheless a general trend pointing to a secular decline in 'tot' cannot be concluded based on the relative short period of observation from 1963 to 1985.

In Brazil and Paraguay this recession resulted in a weak decrease of GDP, meanwhile El Salvador and Ghana experienced a strong recession. On the other hand, Columbia, Kenya, and Sri Lanka seem to be rather unaffected.

However, direct conclusions concerning the impact of changes in 'tot' on changes in GDP cannot be derived from pure graphical comparison. Therefore more sophisticated methods of analysis such as causality tests are necessary.

METHODOLOGY

In order to throw light on the existence and directions of relationships in multivariate time series, the concept of causality has been developed based on the early work by Wiener (1956, pp. 165-90), Granger (1969), in particular, and Sims (1972).

According to Granger's definition, causality can be described as follows: Let the variables be r_t (ctot or itot at time t) and q_t (GDP at time t). Then, r does not cause q if and only if the linear predictor (Min. Variance) of q_{t+1} based on q_t, $q_{t-1}, \ldots, r_t, r_{t-1}, \ldots$ is identical to the linear predictor based on $q_t, q_{t-1}, \ldots$ alone.

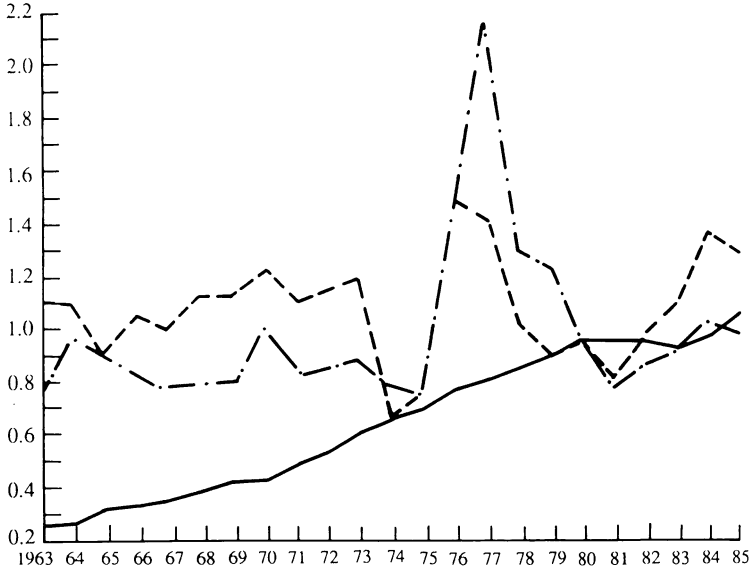

FIGURE 1 *Coffee-ctot, -itot, GDP in the case of Brazil*

——— GDP
- - - - - itot
—·—·— ctot

Using the term exogenous, Sims (1972) defines noncausality as: q_t is strictly exogenous relative to r_t, if the linear predictor of r_t based on $\ldots q_{t-1}, q_t, q_{t+1}, \ldots$ is equal to the linear predictor of r_t based on $q_t, q_{t-1}, \ldots$ alone. Sims (1972) also demonstrated the general equivalence of these two definitions.

In addition to others Geweke (1982) has developed a specific test which allows the decomposition of causality using the following system of equations.

$$q_t = \sum_{i=1}^{\infty} a_{1i}\, q_{t-1} + u_{1t}$$

$$q_t = \sum_{i=1}^{\infty} a_{2i}\, q_{t-1} + \sum_{i=1}^{\infty} b_{2i}\, r_{t-1} + u_{2t}$$

$$q_t = \sum_{i=1}^{\infty} a_{3i}\, q_{t-1} + \sum_{i=0}^{\infty} b_{3i}\, r_{t-1} + u_{3t}$$

$$r_t = \sum_{i=1}^{\infty} c_{1i}\, r_{t-1} + V_{1t}$$

$$r_t = \sum_{i=1}^{\infty} c_{2i}\, r_{t-1} + \sum_{i=1}^{\infty} d_{2i}\, q_{t-1} + V_{2t}$$

Let the variances of u_1, u_2, u_3, v_1 and v_2 be $\Sigma_1, \Sigma_2, \Sigma_3, T_1$, and T_2. As a measurement for 'r causes q', $F_{r>q} = \ln(\Sigma_1/\Sigma_2)$ is proposed. Motivations are the non-negativity

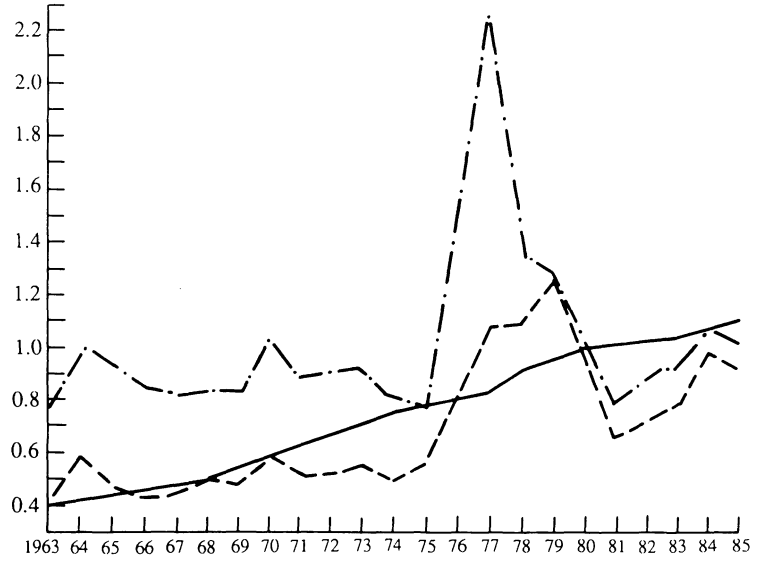

FIGURE 2 *Coffee-ctot, -itot, GDP in the case of Colombia*

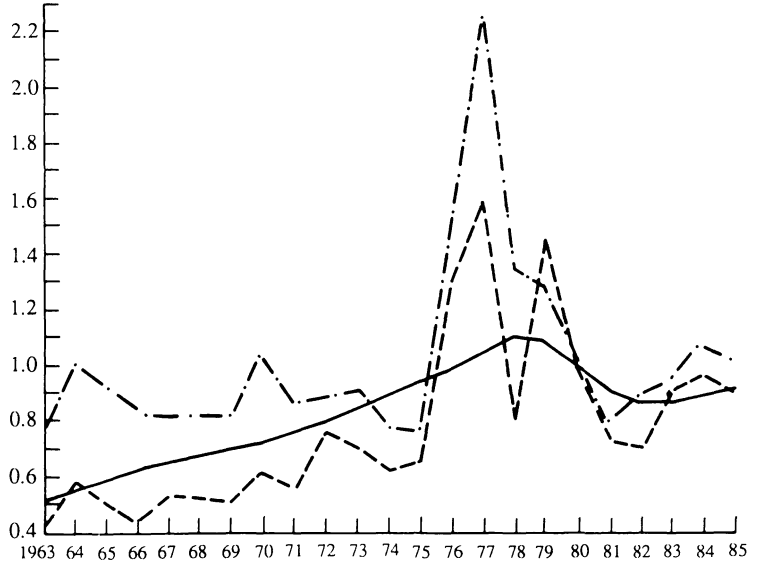

FIGURE 3 *Coffee-ctot, -itot, GDP in the case of El Salvador*

——— GDP
- - - - - itot
—·—·— ctot

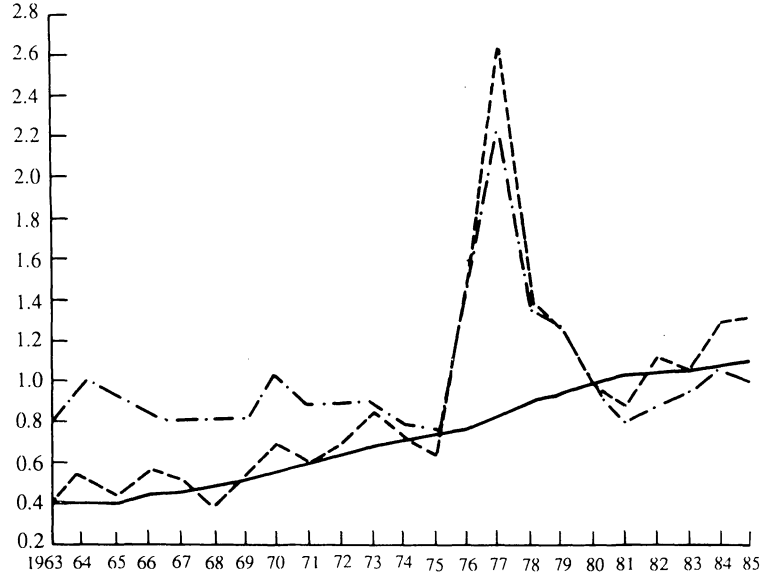

FIGURE 4 *Coffee-ctot, -itot, GDP in the case of Kenya*

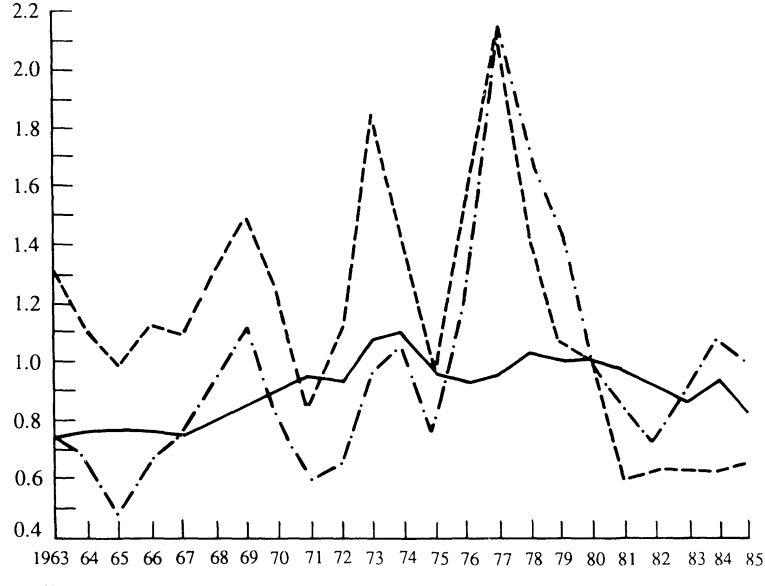

FIGURE 5 *Cacao-ctot, -itot, GDP in the case of Ghana*

——— GDP
- - - - - itot
—·—·— ctot

FIGURE 6 *Cotton-ctot, -itot, GDP in the case of Paraguay*

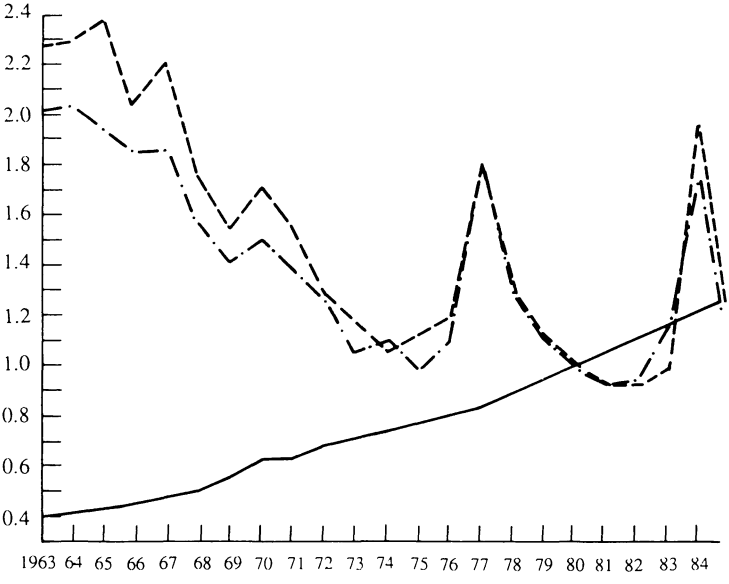

FIGURE 7 *Tea-ctot, -itot, GDP in the case of Sri Lanka*

——— GDP
- - - - - itot
—·—·— ctot

of this measure which is a monotonic transformation of $[1 - (\Sigma_2/\Sigma_1)]$, the 'strength of causality r> q' proposed originally by Granger. If r, q are Gaussian, then the maximum likelihood estimate of $F_{r>q}$ is easily constructed. By applying the Asymptotic Theory, the limiting distribution of the statistic $n*F_{r>q}$ is a chi^2 distribution (Geweke 1982).

Symmetrically, the measurement for 'q causes r' is defined as $F_{q>r} = 1n\ (T_1/T_2)$ and the instantaneous feedback between r and q as $F_{r*q} = 1n\ (\Sigma_2/\Sigma_3)$. Given wide sense stationarity andpurely nondeterministic data[2], Geweke (1982) also showed that the linear dependence between r and q, called $F_{r,q}$ can be decomposed into $F_{r>q}$, causality from $_{r>q}$, $F_{q>r}$, causality from $_{q>r}$ and instantaneous feedback $F_{r*q} = F_{q*r}$, i.e. $F_{r,q} = F_{r>q} + F_{q>r} + F_{r*q}$.

Other measurements of causality have been developed, as shown by Geweke *et al.* (1982). In spite of their popularity, causality tests have been the subject of great controversy. Using Geweke's measurement, however, the asymptotic distribution becomes somewhat problematical, especially in our case of relatively small sample sizes. If the F-test is used, the measurement of causality has to be sacrificed, but robust test results are gained. By performing F-tests, the predictive content of information is tested, which is what Granger's causality actually means.

A difficult problem concerns the lag length in the equation to perform the causality tests. Geweke (1982) describes this as a part of the general estimation procedure, since the true autoregressive function is unknown. In our investigation Akaike's final predictor error criterion, FPE, was used to determine the optimal lag length (Judge *et al.* 1982, pp. 713-16).

Finally, the serial correlation problem, which is especially serious distributed lag models estimated in autoregressive form, has to be addressed. Ignoring the serial correlation problems would result in inconsistent estimates of the parameters. Further, the F-Statistic can be overvalued substantially if serial correlation is present. The Durbin-Watson statistic tests only for first-order autocorrelation, furthermore it is biased in autoregressive models. Therefore, higher order serial correlation is checked here by the Ljung-Box Test.

RESULTS

The bivariate autoregressive models selected by the minimal FPE showed lag lengths of 1.1 in the cases of Brazil, Kenya and Sri Lanka for tests with 'ctot' as well as with 'itot'. For the countries El Salvador and Ghana lag lengths of 2.2 were indicated. However, for Colombia lag lengths of 1.1 and 3.3 were chosen respectively for the 'ctot' and the 'itot' tests, and in the case of Paraguay the optimal lag lengths came out to be 2.2 and 3.3. Serious serial correlation did not occur. In no case could the null hypothesis with zero serial correlation be rejected at a 5 per cent significance level.

Table 2 reports the results of the F-tests. In no case are instantaneous feedbacks indicated. Further, terms of trade and GDP showed no causal impact at all for Sri Lanka. In the case of all other countries, causal relations either between 'ctot' with respect to 'itot' and GDP or vice versa can be observed.

For Brazil economic development came out to be causal for both 'tot', while

for Colombia only the effect of economic development of 'ctot' is significant. For El Salvador, Kenya, and Ghana both mutual effects, that is, causal impact of economic development on 'tot' as well as vice versa, are apparent. For Paraguay only the causality from 'itot' versus economic development has been found.

SUMMARY AND CONCLUSIONS

Causality tests do not require any knowledge of the structural relations between variables. They only require some statistical properties. Therefore, causal findings should be regarded as an indication for further analysis.

In theory, terms of trade in general are neither purely exogenous nor endogenous. Changed 'tot' therefore only cause changes in GDP respecting economic growth, if the national production and demand structure stay unchanged. On the other hand a growing economy can cause more imports and accordingly decreasing 'ctot' and 'itot'. The causality analysis enables us to differentiate between the effects of the level of economic activity on 'tot' as well as the effects of changing 'tot' on economic development.

In the case of Brazil, economic activity influences the 'tot'. However, changes in 'coffee-ctot' or '-itot' were not causal for economic development. The low share of coffee exports in Brazil's total exports could be a possible explanation for this finding. In Colombia also, the economic situation affects the 'coffee-ctot'. Surprisingly neither the 'coffee-ctot' nor the '-itot' by themselves have any causal influences on economic development, though coffee exports are dominating total exports by more than 50 per cent.

Both effects are visible in the case of El Salvador. On the one hand, economic development respecting changed imports are affecting the 'coffee-ctot'. On the other hand, the 'coffee-ctot' and '-itot' are causal for economic development. This implies that the changes in data are influenced from abroad. In Kenya and Ghana, the economic activity shows causality towards coffee-and cacao-'tot', too. In the case of Kenya, only the disposable income generated by coffee exports and not the 'coffee-ctot' influences economic development. The case of Paraguay is different, GDP does not effect 'cotton-ctot', but a significant causality is still indicated from 'itot' towards economic activity. In Sri Lanka, the economic situation and the time path of 'tea-tot' seem totally independent.

Theoretically, the 'itot' are more relevant for economic development, but because of the quite similar time path of the examined agricultural 'ctot' and 'itot', causalities from 'ctot' towards GDP have also been found. These results clearly prove the important role of agricultural commodity exports for economic development.

In three selected countries, causality from economic activity on 'tot' and vice versa were indicated. If the negative 'tot' effects on the economy should overwhelm the economic growth, the extreme case of 'immiserizing growth' could occur. But only deeper investigation could confirm those presumptions.

Summarizing, it has to be pointed out that the 'popular' argument, that changed terms of trade of agricultural commodities affect economic development, cannot be supported in general. It also has to be taken into account that economic growth by itself often causes decreasing terms of trade. Hence,

TABLE 2 *Results of causality tests between terms of trade and national GDPs*

National GDP (commodity)	commodity terms of trade			income terms of trade		
	causality	df	F	causality	df	F
Brazil	B>ctot	1.20	.34–01*	B>itot	1.20	.15–01*
(Coffee)	B*ctot	1.19	.32	B*itot	1.19	.58
	B<ctot	1.20	.2	B<itot	1.20	.21
Colombia	C>ctot	1.20	.14–03*	C>itot	3.14	.6–01
(Coffee)	C*ctot	1.19	.67	C*itot	1.13	.89–01
	C<ctot	1.20	.12	C<itot	3.14	.16
El Salvador	E>ctot	2.17	.12–01*	E>itot	2.17	.42
(Coffee)	E*ctot	1.16	.96	E*itot	1.16	.62
	E<ctot	2.17	.31–02*	E<itot	2.17	.86–02*
Kenya	K>ctot	1.20	.11–02*	K>itot	1.20	.28–01*
(Coffee)	K*ctot	1.19	.19	K*itot	1.19	.61–01
	K<ctot	1.20	.16	K<itot	1.20	.20–01*
Ghana	G>ctot	2.17	.36	G>itot	2.17	.19–01*
(Cacao)	G*ctot	1.16	.58	G*itot	1.16	.31
	G<ctot	2.17	.99–02*	G<itot	2.17	.22–01*
Paraguay	P>ctot	2.17	.31	P>itot	3.14	.92
(Cotton)	P*ctot	1.16	.46	P*itot	1.13	.5
	P<ctot	2.17	.48	P<itot	3.14	.32–01*
Sri Lanka	S>ctot	1.20	.59	S>itot	1.20	.66
(Tea)	S*ctot	1.19	.88	S*itot	1.19	.98
	S<ctot	1.20	.35	S<itot	1.20	.35

Notes: df degrees of freedom
F FStatistic
* significant at 5 per cent level

developing countries must look for more differentiated arguments to call developed countries' attention to their situation.

NOTES

[1]Gaussian white noise (Judge *et al.*, 1982 pp. 668, 709):

$$E\begin{vmatrix} r_t \\ q_t \end{vmatrix} = 0, \quad \text{Var}\begin{vmatrix} r_t \\ q_t \end{vmatrix} = \Sigma_{rq} \text{ and } \text{Cov}\left(\begin{vmatrix} r_t \\ q_t \end{vmatrix}, \begin{vmatrix} r_{t+k} \\ q_{t+k} \end{vmatrix}\right) = 0.$$

[2]Wide sense stationarity implies that the means of q_t, and r_t do not depend directly on t and for all t and s,cov (q_t, q_{t+s}) and cov (r_t, r_{t+s}) depend on s but not on t. A series q_t is purely deterministic if the correlation of q_{t+p} and q_t vanishes as p increases in such a way, that at the limit the best linear forecast of q_{t+p} conditional on $\{q_{t-s}, S>0\}$ is the unconditional mean of q_{t+p} (Geweke 1982).

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DISCUSSION OPENING – S.R. JOHNSON

The issue addressed in the Kimmig/Stilz paper is highly important for the developing economies. Clearly, the ability of the developing economies to attract income from trade is an important factor in stimulating economic growth. Kimmlig and Stilz provide an empirical analysis investigating lead-lag relationships between commodity terms of trade, income terms of trade, and the GDP of the selected developing countries. Their conclusions do not support the popular wisdom. That is, the terms of trade for agricultural commodities are shown not to affect economic growth. This is a very powerful conclusion, if true, and concerns about results supporting the conclusion that may be in part attributed to the method, use of data, and available empirical information are identified for discussion.

First, there are several observations on the data and their use in the empirical analysis. The GDP figure used in the analysis is the total. Perhaps Kimmig and Stilz selected this based on a literal interpretation of the UNCTAD document to which the paper is addressed. But a more appropriate choice of an indicator of economic growth would have been *per caput* GDP. In addition to reflecting economic growth more directly, per caput GDP would have added variation during the period of analysis, perhaps allowing for a more informative application of the causality tests. Extending this argument, the authors might have instead applied the causality analysis rates of change in terms of trade compared to rates of change in per caput GDP. These transformations would also have probably eliminated the necessity to 'detrend or make the series mean stationary.'

A related suggestion on the data involves the calculation of commodity terms of trade and income terms of trade. As defined in the paper, the terms are calculated in US dollars and to the base 1980. The question is the country of reference relative to the commodity prices used. As the concern is economic growth of the developing countries, perhaps more detail on trade should have been incorporated, reflecting, for example, the value of imports, the consumption bundle, or domestic investment against the value of exports. These minor changes in the calculation of terms of trade could possibly have enriched the empirical results.

The second general set of comments concems the method of analysis. The data used for application of causality model were annual, 1963-1985. Although causality methods have been applied in data series of this length, all who use the method recognize their highly data-intensive nature. The underlying series for this analysis was relatively short. To obtain an impression for the data limitations it is only necessary to investigate the number of parameters that required calculation for application of the causality tests. This together with the pretesting for serial correlation involving higher order lags shows that, taken together, the number of parameters estimated for each country was near to or exceeded the number of observations. Conclusions drawn for parameters estimated under these circumstances with such little prior information, must be regarded with great caution. Addition of one or two years to the data series or slight changes in the specification of the model, for example, incorporating transformation for serial correlation, could significantly change the results. Information on the robustness of the results, for example, to changes in the data series by shortening or lengthening it, would have been useful.

In addition to concerns about the length of the data series, there is the general conceptual problem with 'causality' methods. Only the most devoted of those applying these methods believe that they can support conclusions on causality. In fact, the causality or lead-lag relationships are investigated within a particular parametric framework and the conclusions drawn relate to this specific parametric framework. Although the framework is general, the shortness of the data series suggests caution about the results. It is curious that with the information available in the national accounts for the countries examined, more prior information was not included, at least in terms of identifying investment, consumption, imports and even, perhaps, capital flows. This prior information in the form of alternative indicators of economic growth could have enhanced the results.

Third, although not developed in the paper, perhaps due to limitations on length, the presentation included a number of speculations on the reasons for the observed lack of casual relationship between terms of trade and economic growth. Implicitly, in this discussion, a structural model was being employed. If this structural model was to be employed for explaining the results, why was it not included in the direct estimation process? Some form of mixed structural/ time series analysis could have been more illuminating relative to the argument on terms of trade and economic growth.

Also, incorporation of more structure might have led to the identification of an additional major difficulty with the conclusions. That is, policy makers are continually adjusting to realizations of terms of trade and economic performance. Countries do not set a course based on expectations of terms of trade and follow it throughout. A simple structural model would have been useful to attempt to better identify what may have been changes or reversals in policies in these countries and their interactions with terms of trade and economic growth. For example, poorly timed policy choices by the countries studied could have frustrated 'positive' impacts of terms of trade for economic growth.

In summary, Kimmig and Stilz have brought attention to an important question on economic development and world commodity prices. General concerns with the analysis involve the strength of their conclusions relative to the

opportunities for investigating different transformations of the data series, the causality method and the available empirical information, and the opportunity for incorporating additional prior information in structuring the analysis. An alternative would have been to explore the UNCTAD argument within different models of economic growth and then conduct the causality analysis on the key variables. The authors are to be complimented for their selection of a topic of international importance and timeliness. Their paper raises more questions than it answers. But, perhaps, it will stimulate further research and an improved understanding of trade/growth relationships for the developing economies.