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RESEARCH NOTES

PRICE SERIES CORRELATION AND MARKET INTEGRATION: SOME FURTHER EVIDENCE

A commonly employed method for measuring the integration between agricultural markets in developing countries is that of correlating time-series of price data for different market places and products. This procedure builds on the rationale that if markets are perfectly competitive and spatially well integrated, differences in prices between markets will reflect transport and processing cost only and the bivariate correlation coefficient between a pair of such time-series of prices will be equal to one. According to this reasoning, a lower correlation will reflect bottlenecks arising, *e.g.*, from lack of market information, lack of product homogeneity or monopoly power.

The studies that have been undertaken with this method have yielded very different results. Such studies have been carried out mainly in two areas: India and West Africa.¹ The 'best' results have been obtained for India. Thus, Ralph Cummings presents a modal correlation coefficient of 0.85 for 27 wheat markets in Northern India (1956-64)² and Uma Lele reports that *all* coefficients calculated for Delhi and five Punjab wheat markets lay above 0.90 (1955-65).³ Gupta gives the following modal coefficients for Uttar Pradesh markets: rice: 0.79, wheat: 0.71, jowar: 0.85, peanuts: 0.91.⁴ Thakur found that 71 per cent of all correlations between seven Gujarat wheat markets exceeded 0.75 (1965-71).⁵ Lower figures have, however, also been reported. Thus, Lele found the number of correlation coefficients for Tamil Nadu rice and paddy markets that exceeded 0.8 to be as low as three (out of 507).⁶

West African studies generally give much lower figures. Thus, William Jones in 1968 reported from Nigeria that out of 4,836 correlation coefficients computed for seven products, only 19 reached the 0.90 level or more while 424 were zero or negative. The product showing the best correlation was *gari* where more than one-third of the coefficients were 0.80 or higher. For cowpeas, some 30 per cent were equal to 0.70 or more. No yam coefficient was as high as 0.80 and a maximum of one per cent of the coefficients for the remaining product (rice, sorghum, millet and corn) reached this level.⁷ Alan

1. An overall evaluation of most of these studies is made in Barbara Harriss, "There is Method in My Madness: Or Is It Vice Versa? Measuring Agricultural Market Performance", *Food Research Institute Studies*, Vol. XVII, No. 2, 1979.

2. Ralph W. Cummings, Jr.: Pricing Efficiency in the Indian Wheat Market, Impex India, New Delhi, 1967, pp. 88 and 95.

3. Uma J. Lele: Food Grain Marketing in India: Private Performance and Public Policy, Cornell University Press, Ithaca, New York, 1971, p. 89.

4. R. C. Gupta: Agricultural Prices in a Backward Economy, National, Delhi, 1973, pp. 118-125.

5. D. S. Thakur, "Foodgrain Marketing Efficiency: A Case Study of Gujarat", *Indian Journal of Agricultural Economics*, Vol. XXIX, No. 4, October-December 1974.

6. Lele: *op. cit.*, pp. 84-98 and 245-246.

7. William O. Jones, "The Structure of Staple Food Marketing in Nigeria as Revealed by Price Analysis", *Food Research Institute Studies*, Vol. VIII, No. 2, 1968, pp. 110-111.

Thodey reports better figures for cowpeas in Western Nigeria (almost all coefficients above 0.80) but equally low ones for rice and corn (almost all below 0.70)⁸ and Elon Gilbert in Northern Nigeria found the modal coefficient for cowpeas to be 0.65, for rice 0.55, for sorghum 0.45, and for millet 0.35.⁹ Hays likewise reports that correlation coefficients for sorghum and millet in Northern Nigeria in only one per cent of the cases exceed 0.80.¹⁰ Kohlers in a study of Nigeria for single years (1971, 1973 and 1975) mostly arrived at statistically insignificant coefficients during the first and last years but for 1973 found that most coefficients were significant and that half of them exceeded 0.80.¹¹ Elliot Berg for Upper Volta analysed the three years 1962, 1963 and 1976. For the early years he only found that 20 per cent of his coefficients were significant at the 0.05 level but for 1976, 90 per cent of the coefficients exceeded 0.90 and were significant.¹² Finally, Southworth, Jones and Pearson analysed 16 markets in the Atebubu district of Ghana (1965-72) and found that in the case of corn 88 per cent of all coefficients were 0.75 or higher but that for rice, yam and kokonte the figures were significantly lower: 31, 21 and 15 per cent respectively.¹³

The interpretation of correlation coefficients calculated in this manner, from raw price data, is not without problems, however. In some of the aforementioned studies, correlation was found to be highest between markets which had no physical contact or during periods when one should expect contacts to be less intense. Hence, criticism of the calculations has not been lacking. George Blyn¹⁴ has pointed out that there may be common, underlying trends in the series which provide an upward bias to the results. Inflation or population growth, for example, may give rise to linear trends, and such trends show perfect correlation even if the markets in question are not at all integrated. Moreover, seasonal variations may be synchronized, for example, due to a common climatic pattern with planting and harvesting taking place at the same time near all the markets included in the sample. This would lead to (spurious) correlation, even when there is no or little contact between markets. As a remedy, Blyn suggests that the data should instead be grouped into twelve groups, one for each month, that a trend should be fitted to each of these series and that the residuals within each group should thereafter be correlated. He has also undertaken to calculate monthly coefficients from Cummings' data,

8. Alan R. Thodey: *Marketing of Staple Foods in Western Nigeria*, Vol. 1: Summary and Conclusions, Stanford Research Institute, Menlo Park, California, 1968.

9. Elon H. Gilbert: *Marketing of Staple Foods in Northern Nigeria: A Study of Staple Food Marketing Systems Serving Kano City*, Ph. D. Dissertation, Stanford University, Stanford, 1969, p. 249.

10. H. M. Hays, Jr.: *The Marketing and Storage of Food Grains in Northern Nigeria*, Samaru Miscellaneous Papers No. 50, Institute of Agricultural Research, Samaru, Zaria, 1975, p. 72.

11. D. Kohlers, "Niger", in *CILSS/Club du Sahel: Marketing, Food Policy and Storage of Food Grains in the Sahel: A Survey*, Vol. 2: Country Studies 1, Center for Research on Economic Development, University of Michigan/U.S. Agency for International Development, Ann Arbor, Michigan, U.S.A., 1977, pp. 35-44.

12. Elliot Berg, "Upper Volta", in *CILSS/Club du Sahel: op. cit.*

13. V. Roy Southworth, William O. Jones and Scott R. Pearson, "Food Crop Marketing in Atebubu District, Ghana", *Food Research Institute Studies*, Vol. XVII, No. 2, 1979, p. 189.

14. George Blyn, "Price Series Correlation as a Measure of Market Integration", *Indian Journal of Agricultural Economics*, Vol. XXVIII, No. 2, April-June 1973.

showing that this produced an average which was below the Cummings' (modal) 0.85:0.68.

The correlation method has also been criticised by Barbara Harriss on the grounds that a high correlation between two markets does not necessarily mean that these two markets are well integrated in the sense that a competitive network of traders exists which ensures that agricultural goods move between market places in swift response to price differences that exceed transport costs.¹⁵ High correlation could just as easily indicate stable margins and monopolistic imperfection in the marketing system as competitive conditions and efficiency. Also, low correlation does not have to be an indication that markets are not well integrated. We will come back to this below.

The purpose of the present paper is to use price data from an economy where, on other grounds, an efficiently integrated marketing system for agricultural products is believed to exist, that of Haiti, to calculate monthly correlation coefficients in the same manner as carried out by Blyn with Cummings' data, to show that coefficients of approximately the same size emerge, that a seasonal pattern which resembles the one found by Blyn is present and, finally, to discuss what these patterns may indicate with respect to the structure of the marketing network. Before we proceed, however, we will provide a brief overview of the Haitian marketing system and its efficiency.

The Haitian Internal Agricultural Marketing System

In Haiti, a network of public market places exists which handles the marketing of all crops that are not exported and also ensures that those products that the Haitian peasants cannot manufacture themselves but which are in constant demand in the country-side reach rural areas. In 1975 it was possible to identify a total of 519 market places of this type with 50 persons or more on a normal market day.¹⁶ These markets cover the entire country.

The most important person in this network of rural and urban market places is the *Madam Sara*, an itinerant intermediary who travels back and forth between different markets, ensuring that agricultural products reach urban agglomerations and that non-agricultural everyday necessities reach the peasants. *Madam Sara* is a wholesale dealer. Together with the retailing *revendeuses* she is considered to do an efficient job of connecting market places in most of Haiti and of ensuring that excess demand in one market does not co-exist with excess supply in a nearby one.

Five types of evidence exist as to the efficiency of the Haitian internal agricultural marketing system: the profit margins among the intermediaries, the freedom of entry in the system, the possibilities of making short-cuts in the marketing chains, the process of price determination and the non-price com-

15. Harriss, *op. cit.*, pp. 202-203.

16. See Jerry LaGra, Guy Fanfan and Wesner Charleston; *Les marchés publics d'Haiti*, Document No. 16, Projet Analyse et Diagnostic du Systeme de Commercialisation Interne des Produits Agricoles en Haiti, Institut Interamericain des Sciences Agricoles de l'OEA (IICA), Représentation en Haiti Port-au-Prince, 1975.

petition carried on by the intermediaries.¹⁷ Profit margins appear to be low throughout in the system. No systematic quantitative investigations have been carried out, but existing data do not indicate that the intermediaries appear to make any profits much in excess of what could be considered as an imputed wage for their labour input in the marketing process. Thus, regularly working *revendeuses* appear to receive perhaps 10 to 20 per cent on their investment, before the imputed wage has been deducted, and the profits of the *Madam Sara* appear to be in the same range. Even these figures are probably too high, however, since they presumably are not *net* figures, *i.e.*, they do not, for example, take the value of the labour input into account. If a wage figure is imputed, the margins could be considerably lower.

There is also considerable freedom of entry in the marketing system. At the lowest level there are always irregularly working *revendeuses* who only step in when profit margins appear to be rising and demand is high. This requires very little capital. At a somewhat higher level in the system we find irregularly working intermediaries who decide to work full time at the retail level. Above these are *revendeuses* with a little more capital who, when the market is favourable, turn to some wholesale activities as well. Finally, we have *revendeuses* with some wholesale experience who decide to establish themselves as a *Madam Sara* instead and who possess or can otherwise obtain the necessary capital for these operations. Thus, even though a certain minimum capital is required to be a *Madam Sara*, there is always enough upward mobility in the system when demand is high to ensure that excessive profits will not persist for long.

The third piece of evidence as to the degree of competition within the marketing system can be found in the opportunities that exist for making short-cuts in the marketing chain at all levels. This is done by omitting one or more links in the chain and simply proceeding to the next level instead. Consumers may buy from all levels and producers can in principle sell to anyone from the *Madam Sara* to the final consumer. Competitiveness is essential for the intermediaries to survive.

Fourthly, prices are made in the single market place in a fashion that appears almost to be taken out of the standard textbook description of perfect competition. Instead of price-fixing arrangements, it is the interaction of supply and demand, and of haggling procedures in cases where the quality of the produce or the unit of measurement cannot be easily determined, that determines what the producer receives and the price that the consumer has to pay.

Finally, non-price competition ensures the efficiency of the marketing system. Price competition is so intense that sellers and buyers alike are forced to make special arrangements to ensure that they are not without goods. To stay in business, the middlemen enter into what is known as *pratik* relations with their customers and sellers. This is done by means of mutual concessions from buyers and sellers. In this way the intermediaries both save time in their

17. A detailed evaluation of the evidence is given in Mats Lundahl: *Peasants and Poverty: A Study of Haiti*, Croom Helm, London, 1979, Chapter 4.

search for goods and make certain that they are not left without goods in times of scarcity or without a buyer when the market is glutted. However, in forming *pratik* relationships the intermediaries also find themselves in a competitive situation where concessions of various kinds have to be offered before the relationship is secured and with it delivery or purchase.

Analysis of Haitian Prices

The price data that we will use presently were extracted by the Institut Interaméricain des Sciences Agricoles (IICA) in Haiti between 1973 and 1975 from official data.¹⁸ The data cover the period 1965-74, but are not complete. Reasonably complete (monthly) data, however, only exist for a few products and for short periods. In the present instance, we have chosen to work with five products: rice, grain millet, grain corn, ground corn and red beans for the 1969-74 period. These are the crops and the period for which data are fairly complete. Even so, however, missing data had to be filled in by means of linear interpolation of up to four consecutive months. When data for the last month in the series were lacking these were obtained by taking those observations for the same month for the preceding years that had not been filled in by means of linear interpolation and calculating the average price for this month. The same operation was then performed on the last month for which there was an observation for the last year. It was then assumed that the December price for 1974 followed the estimated average trend. The number of markets for each product was 19 for rice, 8 for grain millet, 20 for grain corn, 11 for ground corn and 15 for red beans.

The average correlation coefficients for the 'raw' series were lower than those obtained by Cummings and Lele for Indian wheat but more or less of the same magnitude as those reported by Gupta and Thakur for other agricultural products in India and higher than the figures obtained in most of the African studies; rice: 0.82, grain millet: 0.72, grain corn: 0.77, ground corn: 0.83 and red beans: 0.77. This is a strong indication of the low reliability of 'raw' correlations. Provided that the Haitian marketing system is an efficient one, we would have expected higher figures.

The coefficients that were obtained after grouping and detrending data in the same manner as Blyn are shown in Table I, which also provides a comparison with Blyn's results. It is immediately evident that the average coefficient for each of the products is approximately in the same range as the one calculated by Blyn for India.¹⁹ The Haitian, supposedly well-integrated, market system does not give rise to higher correlation between the residuals after removal of the trend for each month. The Haitian data also corroborate the finding by Blyn that correlation appears to be lower during the harvest months when most of the deliveries are made. For all the foodgrains there is a tendency for the correlation to fall towards the end of the year (a little earlier

18. The data are collected in Institut Interaméricain des Sciences Agricoles de l'OEA (IICA): *Les prix des produits agricoles dans les marchés haïtiens*, Annexe 3 and Annexe 4, Representation en Haïti, Port-au-Prince, 1975. See also Jerry LaGra, Wesner Charleston and Guy Fanfan: *Prix des produits agricoles dans les marchés haïtiens*, IICA, Port-au-Prince, 1975.

19. For significance at the five per cent level a value of approximately 0.81 is required.

TABLE I—AVERAGE CORRELATION COEFFICIENT FOR GIVEN MONTHS FOR DIFFERENT PRODUCTS—ALL PAIRS OF MARKETS: HAITI, 1969-74, PUNJAB AND DELHI, 1956-64

| Month | Haiti | | | | | Nine Indian markets | |
|--------------|-------|--------------|------------|-------------|-----------|---------------------|--|
| | Rice | Grain millet | Grain corn | Ground corn | Red beans | Wheat | |
| January .. | 0.55 | 0.44 | 0.65 | 0.46 | 0.74 | 0.95 | |
| February .. | 0.52 | 0.85 | 0.64 | 0.54 | 0.72 | 0.88 | |
| March .. | 0.56 | 0.92 | 0.78 | 0.70 | 0.73 | 0.94 | |
| April .. | 0.70 | 0.95 | 0.80 | 0.75 | 0.73 | 0.68 | |
| May .. | 0.78 | 0.96 | 0.79 | 0.71 | 0.71 | 0.42 | |
| June .. | 0.76 | 0.96 | 0.74 | 0.68 | 0.66 | 0.44 | |
| July .. | 0.68 | 0.94 | 0.83 | 0.81 | 0.65 | 0.50 | |
| August .. | 0.71 | 0.90 | 0.81 | 0.84 | 0.25 | 0.71 | |
| September .. | 0.61 | 0.87 | 0.66 | 0.77 | 0.15 | 0.30 | |
| October .. | 0.50 | 0.48 | 0.34 | 0.34 | 0.28 | 0.56 | |
| November .. | 0.43 | 0.28 | 0.15 | 0.21 | 0.32 | 0.80 | |
| December .. | 0.41 | 0.11 | 0.19 | 0.22 | 0.43 | 0.95 | |
| Average .. | 0.60 | 0.72 | 0.62 | 0.59 | 0.53 | 0.68 | |

Sources: Haitian figures computed by the authors; Indian data: George Blyn, "Price Series Correlation as a Measure of Market Integration", *Indian Journal of Agricultural Economics*, April-June 1973, p. 57.

for red beans). This is not what one should expect *a priori*: "Viewed as a whole, trading activity in Haiti's rural market places reaches its peak about December, declines very sharply in the first months of the year, climbs to spring climax around Easter, and then remains relatively stable (sometimes with a slight rise and fall in the late summer) until the November-December peak once more."²⁰ In fact, the pattern shown by the correlation coefficients for the five products included in our sample runs contrary to the pattern one should expect. If the correlation of the residuals had been a reliable measure of the degree of market integration, one would expect coefficients to be higher during times of abundant supply when there is sufficient goods to move between markets in response to price differentials than during the off-season when supply is meagre and erratic. During periods of abundance it should be easier for the intermediaries to obtain produce which can be transported from low price to high price areas than when only small quantities are put on the market.

The explanation for this somewhat surprising finding, which, however, is analogous to Blyn's results, is probably that trade is not uni-directional. William Jones has constructed a 'gold point' model of trade where two markets, A and B, both produce and consume a particular commodity. Thus, trade in both directions between A and B is possible, and the price in market A may exceed or fall short of the price in B by an amount equal to the transport costs between the two markets, *i.e.*, the price in A can vary with as much as *twice* the transport costs *without* affecting the price in B.²¹ This is not accounted

20. Sidney W. Mintz, "The Employment of Capital by Market Women in Haiti", in Raymond Firth and Basil S. Yamey (Eds.): *Capital, Saving and Credit in Peasant Societies*, George Allen and Unwin, London, 1964, p. 271.

21. Jones, *op. cit.*, pp. 116-117.

for in the correlation analysis which implicitly assumes that trade flows in only one direction between the two markets and that the range of price variation possible is limited to the transport costs between the two markets.

In Haiti, the situation appears even more complicated. The market system is basically vertical, *i.e.*, a product does not usually travel between two markets at the same level in the market hierarchy. If it is to move from market C to market D on the same level, it usually does so only via market E on a higher or lower level.²² If then, in addition, there is (indirect) two-way trade, between markets at the same level, the price in C may vary by twice the transport costs between C and E plus between E and D before affecting the price in D. In this situation correlation coefficients do not provide any guidance as to the degree of integration between markets on the same hierarchical level. A very detailed knowledge of the trading patterns is needed before anything regarding the integration of the system can be inferred from our price data. During the non-harvest season, on the other hand, trade is more likely to be uni-directional with goods flowing from areas where storage takes place to deficit areas.

The reason for the mainly 'vertical' trade pattern is to be found in the behaviour of the *Madam Sara*. They generally specialise in travelling along a *given* route which takes them upwards and downwards in the hierarchy of market places rather than in horizontal or circular directions. In this way, they keep coming back to the same markets and can therefore more easily establish lasting reliable contacts with customers and producers.²³

This finding puts us in a rather unfortunate position regarding the possibilities of extracting information regarding market integration and competition from price data. Unless we have sufficient knowledge both of transport costs between different markets, of the structure (direction) of trade and of the share of different markets in the supply in a given market place, there is not much that can be done, especially not with correlation analysis. The conclusion reached by Barbara Harriss, "Until the technique is greatly refined, its diagnostic use should be abandoned"²⁴ appears to be correct, not only as far as correlation of 'raw' price data is concerned, but also, when it comes to correlating residuals after removing trend elements and seasonal factors.

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22. The Haitian market system contains three or four different 'levels'. The differences between the levels mainly consist in the range of goods supplied at each level, with a wider variety on the higher levels. (A summary of different classifications and the characteristics of each level is given in Mats Lundahl, "The State of Spatial Economic Research in Haiti: A Selective Survey", *Anthropologica*, N. S., Vol. 22, No. 1, 1980.)

23. *cf. ibid.*, p. 147.

24. Harriss, *op. cit.*, p. 203.

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