Fundamentals of Price Analysis in Developing Countries' Food Systems: A Training Manual to Accompany the Microcomputer Software Program "MSTAT"

by

Stephan Goetz and Michael T. Weber

Working Paper No. 29 1986

MSU INTERNATIONAL DEVELOPMENT PAPERS

Carl K. Eicher, Carl Liedholm, and Michael T. Weber
Editors

The MSU International Development Paper series is designed to further the comparative analysis of international development activities in Africa, Latin America, Asia, and the Near East. The papers report research findings on historical, as well as contemporary, international development problems. The series includes papers on a wide range of topics, such as alternative rural development strategies; nonfarm employment and small scale industry; housing and construction; farming and marketing systems; food and nutrition policy analysis; economics of rice production in West Africa; technological change, employment, and income distribution; computer techniques for farm and marketing surveys; farming systems and food security research.

The papers are aimed at teachers, researchers, policy makers, donor agencies, and international development practitioners. Selected papers will be translated into French, Spanish, or Arabic.

Individuals and institutions in Third World countries may receive single copies free of charge. See inside back cover for a list of available papers and their prices. For more information, write to:

MSU International Development Papers
Department of Agricultural Economics
Agriculture Hall
Michigan State University
East Lansing, Michigan 48824-1039
U.S.A.

FUNDAMENTALS OF PRICE ANALYSIS IN DEVELOPING COUNTRIES' FOOD SYSTEMS: A TRAINING MANUAL TO ACCOMPANY THE MICROCOMPUTER SOFTWARE PROGRAM "MSTAT"*

by

Stephan Goetz and Michael T. Weber

Department of Agricultural Economics
Michigan State University

1986

*This paper is published by the Department of Agricultural Economics, Michigan State University, under Food Security in Africa Cooperative Agreement DAN-1190-A-00-4092-00, jointly funded by the Bureau of Science and Technology (Office of Rural and Institutional Development) and the Africa Bureau (Office of Technical Resources), U.S. Agency for International Development, Washington, DC.

ISSN 0731-3438

Published by the Department of Agricultural Economics, Michigan State University, East Lansing, Michigan 48824-1039 U.S.A.

PREFACE

One of the goals of the Food Security in Africa Cooperative Agreement at Michigan State University is to improve knowledge of data and analysis needs for food security planning. Well-functioning markets and pricing mechanisms are essential elements in more secure food systems. The present paper has the dual objective of reviewing the fundamentals of price analysis in developing countries' food system applications, and of serving as a "training manual" to accompany the SEASON and other selected subprograms of the microcomputer software program "MSTAT".* The need for improved methods of research design, management and analysis is widely recognized as a major constraint in successfully accomplishing the goals of agricultural and food system research projects in developing countries. Part of the problem is due to the complexity of survey and experiment trial data, necessitating more sophisticated data management and analysis capabilities than are possible with hand calculators. Another part of the problem is inadequate training for many researchers in agricultural statistics, price analysis and experimental design.

Food and agricultural research projects now regularly specify the need for microcomputers, and data management and analysis software. Yet surveys of existing software available to meet the specific research data management and analysis needs of such researchers have shown that there are few, if any, low cost and comprehensive software packages available which address their unique needs.** There are even fewer software packages which

----

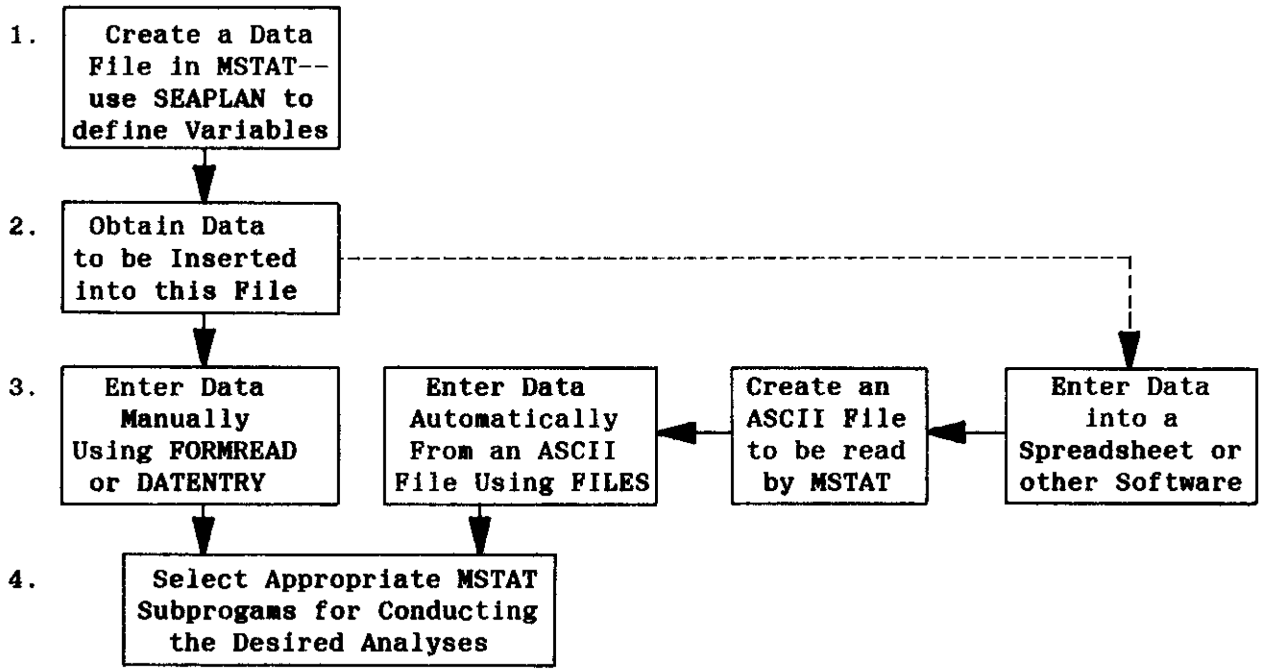
* See Appendix 1 for a description of MSTAT and information on how to obtain the software program. The SEASON subroutine was initially developed at Michigan State University by A. Rahn and later expanded for more general purposes by J. Anderson, S. Goetz, and M.T. Weber.
** Survey conducted by Michigan State University Agricultural Economics Department under the USAID-funded "Alternative Rural Development Strategies" Cooperative Agreement AID/ta-CA-38. See MSU International Development Working Papers Nos. 5, 12 and 17. See also Harsh and Weber (1985).

have companion training manuals on the underlying analytical methods and algorithms utilized. For this reason researchers at Michigan State University and the Agricultural University of Norway have developed "MSTAT" as an integrated microcomputer experimental design, experiment management, data management, and statistical and economic analysis software package. They are also developing and/or arranging training materials to accompany various analytical subprograms of "MSTAT". This allows the microcomputer to serve not only as a data processing tool, but also as an opportunity for researchers to sharpen their understanding of the underlying analytical methods implemented in the computer software.

This paper is written to stand alone as one such training manual and is designed to be useful independent of "MSTAT". It is, however, also written to illustrate where selected subprograms of "MSTAT" can be used to complete analytical calculations and/or manipulations. If the reader does not have MSTAT, all of the analytical procedures implemented can be completed by hand or by programming other commerical software programs for micro and/or mainframe computers.

The following chart illustrates the steps involved in utilizing "MSTAT" to complete selected price and market analyses. It is assumed that the user already has "MSTAT" and that it is correctly configured to run on his or her computer and printer. It is also assumed that the reader has examined carefully the "MSTAT" user manual and is familiar with steps required to execute the desired "MSTAT" subprograms. Also shown in the chart are the pages on which respective techniques are discussed and examples of MSTAT output, including the standard printout headers, are reproduced. A few of the figures in the text were either obtained from other publications or produced with another software package.

CHART 1
Steps in Using "MSTAT" to Complete Selected Price and Market Analyses



Subprograms*	Examples Where Utilized in this Manual
PRLIST	Table 5-2; page 110
PLOT	Figure 3-2, Part 1; page 42
CORR	Table 5-3; page 111 (also Appendix 3)
REG	Pages 51, ff.
STAT	Table 3-2, page 45
CALC	Table 3-1, page 40 (to calculate marketing margins)
SEAPLAN	Chapter 4, to set up seasonal analysis (no output)
SEACALC	Chapter 4, carries out computations (no output)
SEASONAL	Tables 4-1, 4-2, pp. 76 and 78
SEASTORE	Table 6-1, page 116
SEATABLE	Table 1-1, page 7

* Subprogram CURVES was not used in this manual, but it can be useful for plotting one or more variables by case number.

ACKNOWLEDGEMENTS

We would like to thank Dr. A. Rahn for providing us with a Time Series Analysis program, which now forms the core of the Season subprograms in MSTAT. With care and great patience J. Anderson expanded this original program and created the SEAPLAN, SEACALC, SEASTORE and SEATABLE subprograms for our more general purposes.

It would have been difficult to write this Training Manual were it not for the generosity of the following individuals, whose data sets enhanced the applicability and relevance of the examples presented: J. Dione and Dr. J.M. Staatz, L.M. Girado and F. Martin.

Finally, Drs. J.S. Holtzman, J.N. Ferris, A. Rahn, H. Riley and J.M. Staatz provided helpful comments on an earlier draft of the paper.

FUNDAMENTALS OF PRICE ANALYSIS IN DEVELOPING COUNTRIES' FOOD SYSTEMS: A TRAINING MANUAL TO ACCOMPANY THE MICROCOMPUTER SOFTWARE PROGRAM "MSTAT"

Table of Contents

Chapter **Page**

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

INTRODUCTION

In market-oriented economies, agricultural markets and marketing functions become increasingly important as the food system evolves. This paper focuses on how selected dimensions of markets and marketing functions can be studied and evaluated in Third World settings.

Purpose of the Paper

The specific purpose of this paper is to review fundamental price and related market analysis techniques which are and can be used in developing country food system applications. In so doing the objective is also to focus on identifying food system problems, techniques for improved interpretation of price analysis results and means of dealing with the all too common problem of data limitations. 1/ A second purpose of this paper, as detailed in the Preface, is to serve as a "Training Manual" to accompany "MSTAT".

Background to Fundamentals of Market and Price Analysis

There are a number of important reasons why analysts are interested in agricultural marketing and pricing issues. First, the market can be seen as providing various services or functions. These are the exchange functions of buying and selling products; physical functions which add utilities of time, location and form to the products through storage, transportation and processing, respectively; and facilitating functions such as standardization of qualities, market intelligence and information, the provision of credit, and finally, the bearing of risks. Analysts are interested in

----

1/ For a discussion of more advanced applications of statistical techniques (such as supply and demand models) to agricultural markets, see Shepherd (1963) or Tomek and Robinson (1982).

studying how participants in the market carry out these functions, with the ultimate goal of helping to improve the effectiveness and efficiency of the market.

Second, and related to the first point, analysts are interested in how the market functions as an interdependent and interrelated system; specifically, they want to know how well the various sets of production and marketing functions or activities within the entire food system are coordinated. For example, do consumers receive steady supplies of food throughout the year at reasonable prices; do processors receive adequate supplies of unprocessed foods or are there major supply bottlenecks in the system; are deliveries and sales of storable commodities distributed efficiently over the year; and are product markets integrated or connected over space?

A third reason is that annual and seasonal price levels and variations in the markets facing farmers are important dimensions which must be taken into consideration in the economic evaluation of new agricultural production technologies. These are only a few of the questions which the market analyst must address.

Without well-functioning markets and marketing activities in the food system from producers to consumers, there is not only wastage due to inefficiencies but there is also an impediment to passing on higher on-farm productivity to consumers in the form of lower real prices and higher, more stable supplies. Consequently, markets and selected marketing functions can miss the opportunity to play an important dynamic role of stimulating increases in production and consumption. At the same time, consumer preferences about quality and quantity of a commodity are not effectively passed back to producers in poorly functioning markets; this too implies lowered societal welfare.

It is important to stress that the analytical techniques reviewed in this paper can be most meaningfully applied if at least some elements of "market-orientation" underlie the market and market-related data. In a "market-oriented" economy with perfect information a key variable in the food system is the price of the commodity. Prices lead to revenues and revenues provide incentives to participants through rewards (profits) and penalties (losses). Prices therefore serve as an efficient means for seeking out production possibilities and potentials, as well as allocating scarce resources within an economy: those who allocate resources into activities most valued by consumers are rewarded and so the economy in principle moves towards a dynamic equilibrium which represents a social optimum.

Yet markets rarely operate with perfect information and an important analytical question is how can markets and market-related information be improved? In the short run, relatively well-functioning markets can be efficient allocators of goods that have already been produced, even if there is less than perfect information. For the longer run, and given uncertainty, markets have greater difficulty serving as guides to what should be produced, especially where production involves substantial time lags and large investments. Market and price analysis is especially important in these circumstances.

Furthermore, markets never operate in a vacuum; they are always affected by government action regarding the rules or property rights which institute the markets and economic activity in general. Market and price analysis is therefore needed to help improve the effectiveness of government participation in "market-oriented" economies. The term "market-oriented economy" in this circumstance is perhaps a misnomer. Nevertheless, it is used here to characterize those markets in which governments set the rules to allow prices to more or less fluctuate according to the dictates of supply and demand. At the other extreme, governments could mandate prices to achieve various political and/or social goals, and prices may then be prevented from efficiently equating supply and demand so that marginal costs equal marginal benefits to the society. In practice, this is often done through price floors and ceilings and pan-territorial and pan-seasonal pricing rules, such that prices are prevented from efficiently allocating supplies over space and time.

In between these two extremes of "market" and "administered" prices, there is of course a vast array of possible economic outcomes. For example, in many countries official markets are quite open or flexible, while in others there are both official and unofficial or parallel markets. In these cases it is obviously important to obtain and analyze data on both the parallel and official markets. In yet other cases, and especially in Africa, governments are reevaluating the role of administered prices and direct government controls, and are helping to restructure markets so that they become increasingly open to movements caused by the forces of supply and demand. This gives rise to the additional need for market and price analysis to help guide the search for improved policy and market rules that are effective in establishing a productive mix of private and public sector involvement in markets, and to help monitor the effectiveness of this mix over time.

Organization of the Paper

After arguing for the importance of using plots and graphs in analyzing data, the paper discusses how time series prices are inflated and deflated; how various averages for calendar and market years can be presented in a more meaningful manner; how different types of marketing margins can be analyzed and why this type of analysis is important; how time series data can be decomposed into four conceptual components; how spatial and temporal market integration can be assessed; and how gross historical storage margins can be evaluated and utilized. Finally, the last chapter presents methods for assessing the quality and usefulness of previously collected data. This is an important chapter because much data has already been collected without ever having been subjected to any type of systematic analysis. Experience also shows that analysis of existing data is critical to the process of improving the quality of data collected over the longer-run.

I. USING PLOTS AND GRAPHS TO BETTER UNDERSTAND AND ASSESS PRICE DATA

Once a time series of price or quantity data has been collected, the second most important step in the analysis is usually plotting the data either manually or by means of a computer program. There are three primary reasons why it is important to initially plot the data: first, only a plot can convey to the analyst a quick and easy "feeling for" or overview of the data; second, plotting can be used to find and remove "outliers"; and, third, it can be used to approximate missing values where necessary.

1.1. Data Plotting: An Important Step in Data Analysis

In any type of numeric analysis it is important to gain a rapid overview of the data to be analyzed. This is an important first step to understand how a market is behaving, to evaluate the reliability or consistency of the price data for that market, and whether or not it is worthwhile to continue to a more in-depth analysis of the data.

Consider first a simple plot of a monthly time series of retail prices for millet, sorghum, maize and rice in Bamako, Mali. The raw prices are shown in Table 1-1, and the plot of the data is shown in Figure 1-1. The plot of the time series, especially as a group of possibly related commodities, highlights some interesting aspects which are not immediately obvious from Table 1-1. First, the graph shows that rice has overall been the most expensive cereal (by a wide margin during 1982), followed by millet and sorghum (except in the first half of 1984, where sorghum was more expensive than millet), and maize, which is the least expensive commodity. As an aside, the graphs help to visualize potentially important questions such as how the consumption of millet and sorghum has changed, if at all, when sorghum was relatively more expensive. Of course, one would also need consumption data to establish any substitution effects. The graphs also

TABLE 1-1: CEREAL RETAIL MARKET PRICES IN BAMAKO (CFA/kg)*

CURRENT COMMODITY PRICE
FOR
MILLET IN BAMAKO (CFA/KG), 1982-85

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	81.0	77.0	78.0	82.0	82.0	85.0	90.0	91.0	94.0	95.0	87.0	87.0
1983	85.0	79.0	83.0	86.0	96.0	107.0	108.0	133.0	136.0	136.0	127.0	113.0
1984	120.0	118.0	126.0	140.0	144.0	163.0	156.0	149.0	151.0	155.0	122.0	112.0
1985	111.0	116.0										

CURRENT COMMODITY PRICE
FOR
SORGHUM IN BAMAKO (CFA/KG), 1982-85

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	72.0	71.0	71.0	72.0	74.0	84.0	89.0	86.0	83.0	80.0	81.0	77.0
1983	75.0	72.0	74.0	78.0	90.0	96.0	96.0	125.0	129.0	134.0	126.0	123.0
1984	125.0	126.0	132.0	146.0	147.0	175.0	152.0	144.0	155.0	154.0	123.0	106.0
1985	107.0	116.0										

CURRENT COMMODITY PRICE
FOR
MAIZE IN BAMAKO (CFA/KG), 1982-85

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	69.0	71.0	70.0	70.0	68.0	72.0	80.0	76.0	73.0	71.0	66.0	69.0
1983	67.0	68.0	69.0	72.0	78.0	87.0	79.0	96.0	105.0	106.0	110.0	105.0
1984	112.0	113.0	120.0	133.0	130.0	121.0	123.0	121.0	119.0	122.0	110.0	96.0
1985	98.0	103.0										

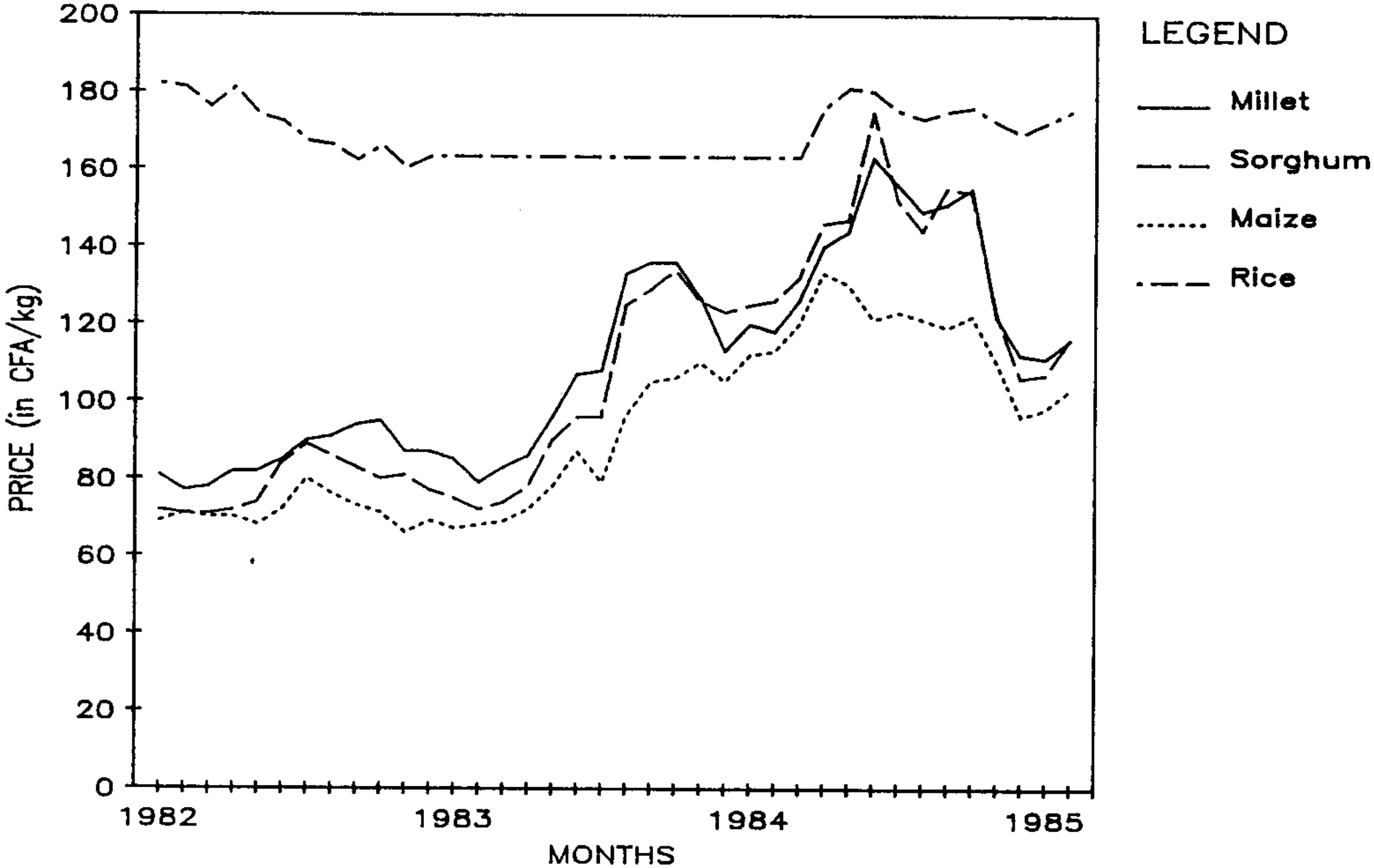
CURRENT COMMODITY PRICE
FOR
RICE IN BAMAKO (CFA/KG), 1982-85

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982	182.0	181.0	176.0	181.0	174.0	172.0	167.0	166.0	162.0	166.0	160.0	163.0
1983	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0	163.0
1984	163.0	163.0	163.0	176.0	181.0	180.0	175.0	173.0	175.0	176.0	172.0	169.0
1985	172.0	175.0										

Source: World Bank and PRMC, 03/85; J. Staatz

* These tables are produced by MSTAT (the headers were removed and the tables merged together after the MSTAT output was read into a word processor).

FIGURE 1-1:
CEREAL RETAIL MARKET PRICES IN BAMAKO (CFA/KG)



Data Source: Table 1-1

easily illustrate that the price of rice seemed to be tightly regulated over the sample period, while the prices of the other three commodities were allowed to fluctuate more or less freely over the three years shown; it is likely that these latter prices moved in parallel because the commodities are fairly close substitutes in consumption, and one would expect them to be closely correlated (other things being equal). Actual knowledge of the government's rice pricing policy in this period would help support or reject this contention. Again, this may not have been readily obvious, especially to the relatively untrained eye, without plotting the time series together.

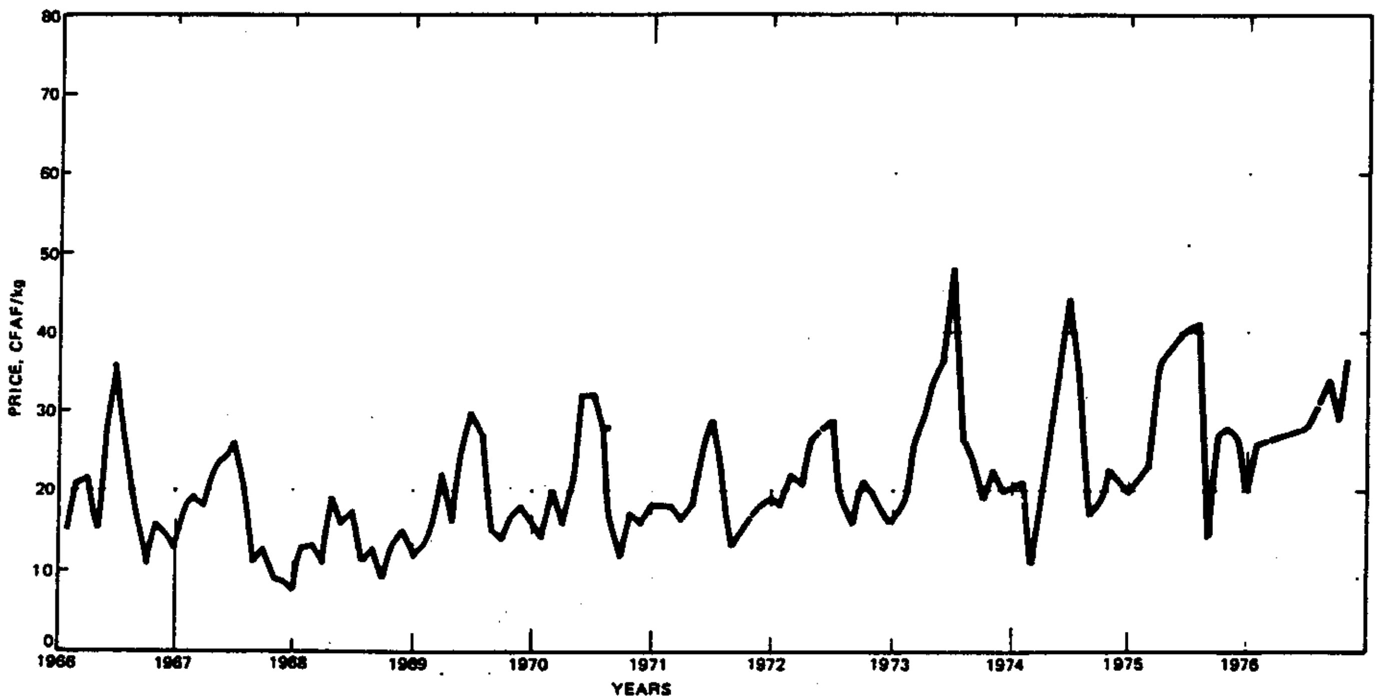
A third interesting aspect is that the prices of millet, sorghum and maize, all of which are storable commodities, tend to reach their seasonal lows in the January/February period; this is an unexpected result, since the actual harvest period is in November/December, and we would expect prices to reach their seasonal lows then, as will be discussed below. A similar expectation is possible for rice prices, once they were decontrolled in the post-January of 1984 period. This seasonal characteristic of price series for many agricultural commodities is examined and discussed in great detail in Chapter 4 of this paper.

The June 1984 observation for sorghum prices would appear to be somewhat "out of place" (i.e. an outlier--discussed below) if only that series had been plotted by itself. However, plotting the sorghum series along with that of millet, shows a similar "jump" in June and gives credence to that particular observation and it should probably not be adjusted. Again, this illustrates the usefulness of plotting the data together to get an initial relational overview. Finally, the plot gives a preliminary idea regarding the general direction in which the nominal (discussed below) price series are moving; these trends would not necessarily be apparent if only the tabular data (Table 1-1) were examined. The general trend in the nominal rice prices seems to be unchanging around a 170 CFA/kg price, while the trends for the remaining three commodities are in a general upward direction. Before final conclusions about the long-term trend of the prices are drawn, however, it would be essential to examine prices prior to 1982 and, possibly, to deflate the data as well.

Even though the primary discussion presented here pertains to four different commodites, it should be obvious that plotting the data even for a single commodity--for instance, where only one is available--is an essential element in the analyst's tool-kit. Figure 1-2 shows that while retail prices for yams in Tsevie over the period 1966-77 did not markedly trend either up or down, there was considerable and repetitive price variability within years (seasonality) which is worthy of further analysis.

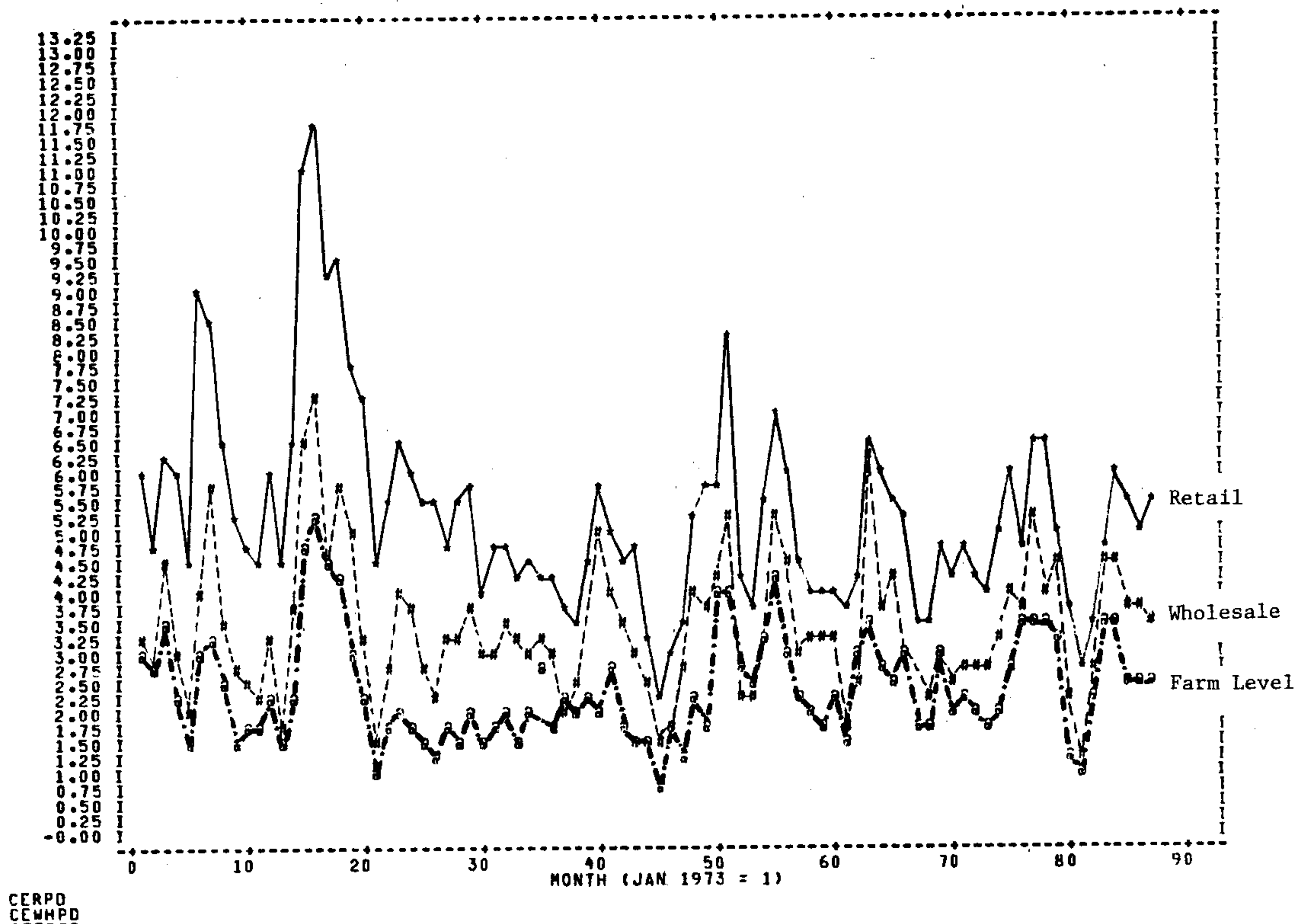
Figure 1-3 shows how price series of a commodity collected at three different market levels are plotted to illustrate the behaviour of marketing margins over time for the same commodity (tomatoes). Marketing margins, discussed at length in Chapter 4, reflect the value of services added to a commodity as it is transmitted to the consumer through the market system. In its gross form, a marketing margin can be reported as the marketing bill from production to consumption, calculated as the difference between consumer and producer prices (eg. urban retail price minus rural farm gate price). Alternatively, more refined margins may be calculated between farm gate/assembler, assembler/wholesaler and wholesaler/retailer levels. Similarly, a commodity transported from city A to city B is no longer the same good since a spatial attribute has been added to the good once it arrives in B. From Figure 1-3 it appears that the retail-to-wholesale and wholesale-to-farmgate margins for tomatoes have been narrowing over time: retail prices have been moving down while farm-gate

FIGURE 1-2: RETAIL MARKET PRICES FOR YAMS IN TSEVIE, TOGO (1966-77)



Source: World Bank (1981).

FIGURE 1-3: MONTHLY PRICE SERIES FOR TOMATOES AT RETAIL, WHOLESALE AND FARM LEVEL, CEARA, BRAZIL (1973-79)



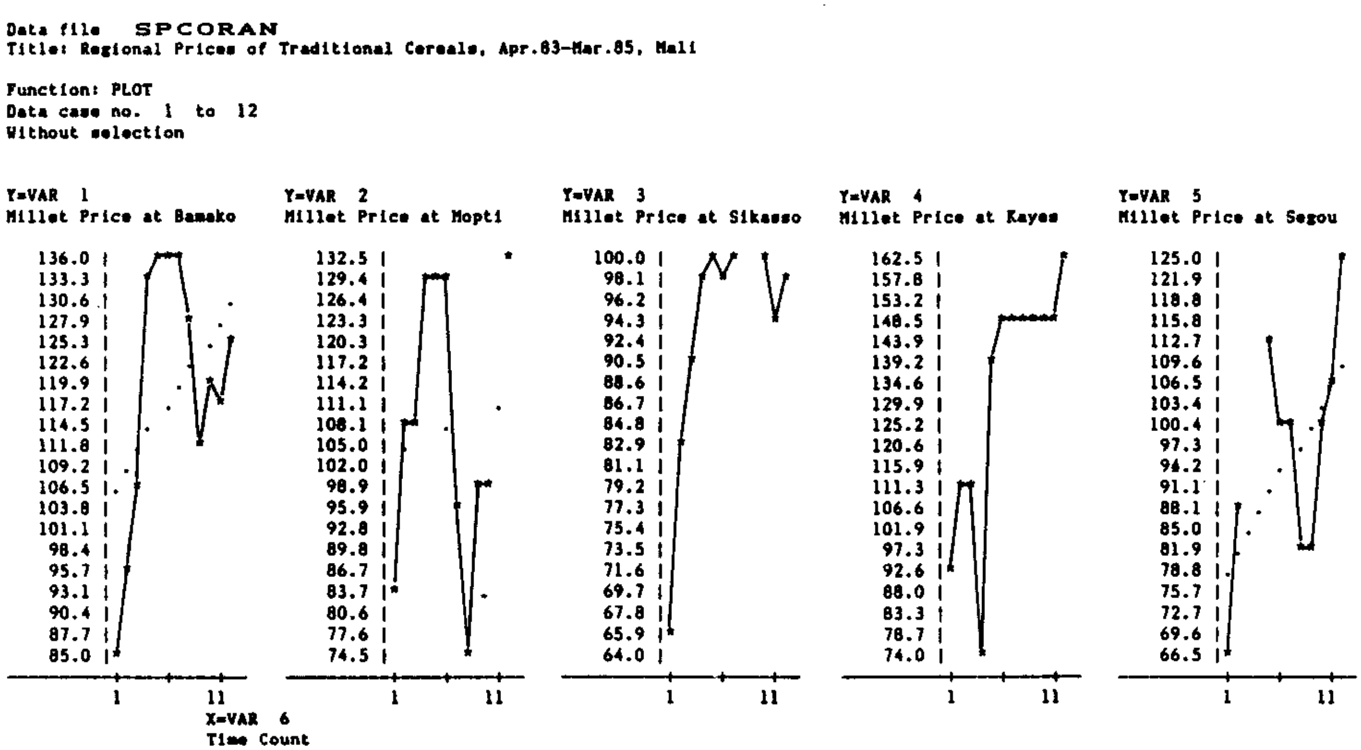
Source: Weber and Azevedo (1978)

prices have been heading upwards slightly. Further calculations and actual plotting of these margins would show whether this is in fact true.

Finally, plotting of price series gives an indication of yet another variable to be analyzed, namely that of spatial arbitrage, which is further examined in Chapter 5. Following the concept of spatial arbitrage, spatially separated but economically integrated markets should exhibit similar price patterns for the same commodity over a season. This is caused, as indicated by the name, by arbitrage between different markets.

Figure 1-4 shows prices of millet in five different markets in Mali over the period April 1983 - March 1984. The first interesting observation

FIGURE 1-4: SPATIAL MILLET PRICES IN MALI (1983 MARKET SEASON)



Data Source: Table 1-2, (page 20).

is that prices in all five markets generally moved upward over the 12-month sample period (as indicated by the dotted lines in the plots, which represent simple linear trends over time). In addition, the markets in general tend to exhibit similar price variations over the year--with the exception, perhaps, of Kayes. A detailed correlation analysis could show the extent or absence of spatial arbitrage; for now the plots give an initial indication of possible degrees of integration among different markets, as well as a rapid "feeling" for the data. The data used to generate the plots in Figure 1-4 are shown in Table 1-2 on page 20. This data series suffers from a problem often confronting data analysts in Third World settings, namely, that of missing observations. This topic is discussed in section 1-3 below.

1.2. Using Plots to Find and Adjust "Outliers"

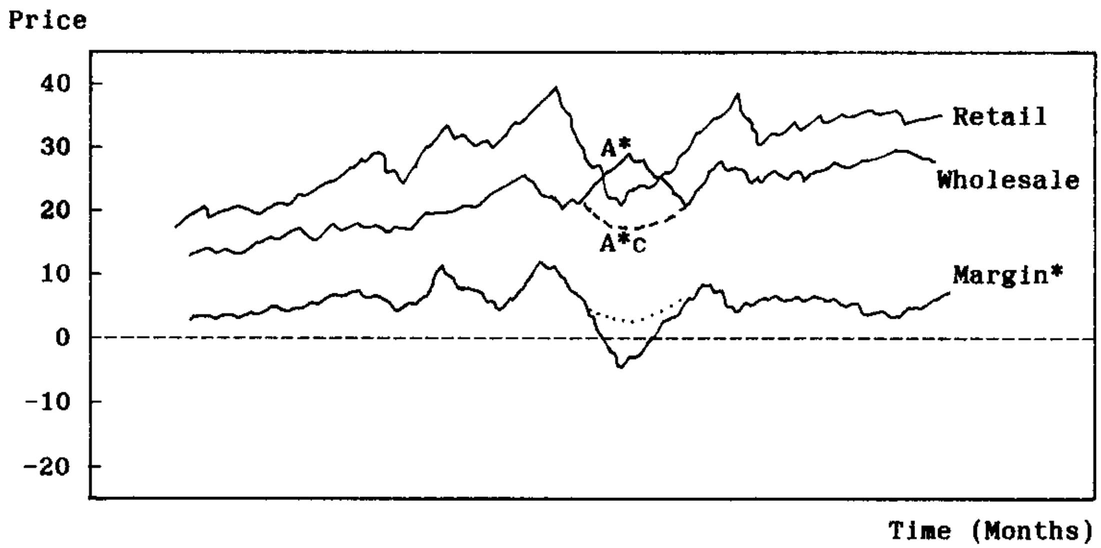
An "outlier" may be defined as an observation which (to the analyst's eye) represents a highly unusual situation or does not appear to belong in a time series; it stands out by being far removed from either the mean or the trend line of the series, and it is almost by definition a unique case. For example, if in a five year monthly series, four of the October observations were far removed from the general trend of the series, but one observation was fairly close, the analyst may want to "adjust" that particular observation; this would be done by increasing its value so as to move it further away from the trend and thereby bringing it more "in line" with the other observations for October.

Identifying and adjusting, if warranted, such outliers can be desirable because the results of the analysis may otherwise be unnecessarily biased. Recognizing (and flagging) the unique cases will also force the analyst to give a more careful and realistic interpretation of the results. Outliers may come about because of an unique event--for example, a single month of drastically reduced supplies because an important bridge was swept away-- or (and this is probably a common case) because the data collector or enumerator obtained incorrect information and/or recorded and transcribed it incorrectly. This difficulty is demonstrated in the original data of Table 1-1, where the December 1984 price for maize was initially given as 288 CFA/kg, which was not repeated elsewhere in the series and seemed to be an implausible value. This observation should therefore either be removed entirely from the series (i.e. listed as a "missing observation"), or alternatively be replaced with a value judged to be more in line with its adjacent ones. If left uncorrected, such an extreme observation would seriously bias, for example, an estimated regression equation fit to the data points. In order to remove the outlier, linearly interpolate between the previous (110) and the following observation (98) to obtain (110+98)/2 = 104, or examine the other two years (1982 and 83) to ascertain how prices behaved in December relative to the adjacent months. If this is done, however, conflicting "evidence" is obtained. Prices rose and then fell in Nov-Jan of 1982, but fell and then rose in 1983; incidentally, the same is true of the millet and sorghum prices in those months. On the other hand, Figure 1-1 shows that all of the other three commodities reached a low turning point in Dec 1984, and this information should be translated into the adjusted value for maize.

In the above case a simple trend extrapolation, coupled with information on the behaviour of the other three commodities in that month is probably the best subjective compromise. If information from more than only two other years had been available, then a comparison of adjacent months for maize prices may well have yielded superior results. This will be further discussed in Section 1-3 on missing observations. As it turned out, we were fortunate to have obtained a second series from a different source on the same variable which showed that the value of the outlier was in fact 96.0. This shows that the initial estimate of 104, corrected downwards to simulate the behaviour of the other two price series in that month, would have yielded a fairly close approximation of the "true" value of 96.0. At any rate, removing the outlier even with an estimate would have been superior to using the original value of 288 CFA/kg.

Sometimes the analyst is lucky enough to be faced with obvious outliers. For example, in the hypothetical case of Figure 1-5, the observation denoted by A* is nonsensical; it indicates that wholesalers buy their products more dearly than what they sell them for. While there are

FIGURE 1-5: HYPOTHETICAL RETAIL/WHOLESALE PRICES SHOWING AN OUTLIER



* = Retail minus wholesale price

important exceptions to this implausible result (discussed at length in Chapter 3), it may be desireable in this case to remove and replace observation A* with an adjusted wholesale price which is less than the retail price (such as A*c). It should be stressed that what could have happened here was that the monthly price at retail was collected on one day while the wholesale price may have been collected one day or week later (for that particular month). In this case the data collection procedure was not sufficiently precise to avoid this problem (this raises the question of why it only happened once!). This example also illustrates that when prices at different levels in the market channel are collected, for example, through purposive sampling 2/, checks should be made in the field that the data being collected are in fact "reasonable": are retail prices higher than prices at wholesale? If these discrepancies/inconsistencies are caught early in the data collection process, the quality of data and information collected can be improved and the analyst will be spared a great deal of frustration at a later point.

While there are many mathematical rules or formulae for dealing with outliers--for example, remove the outlier if it lies more than x units or standard deviations from the mean--there is absolutely no substitute for the analyst's subjective judgement as to when an outlier is really an outlier as determined by the magnitude of x, and the market conditions surrounding x. Similarly, there is no substitute for the analyst's decision concerning how the outlier should be adjusted--i.e. with which new number.

Particularly in environments where data are notoriously scarce and difficult to come by, it may be preferable to "adjust" an outlier rather than flagging it as a missing value. In other words, it is important to work with what one has. It is here that plots again serve a very useful function, as they give a good initial indication of what the replacement value might be. Once an outlier has been replaced with a more reasonable observation, it is important to "flag" or identify that value as having been adjusted. Finally, even though dealing with outliers is more an art that a "science", credible values can be generated using both the existing data, general knowledge about the special characteristics of a particular month, and a good deal of common sense. This procedure is best initiated by using plots.

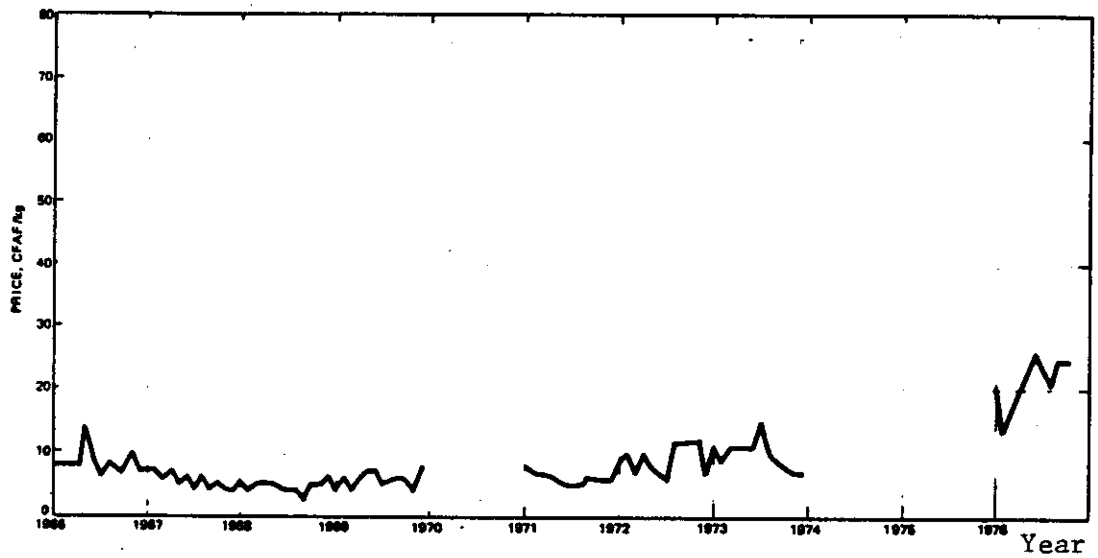
2/ In market system analyses purposive sampling is often carried out by starting with either farmers or retailers, and then surveying market participants who handle(d) the same commodity at adjacent market stages.

1.3. Using Plots to Approximate Missing Observations

The problem of missing observations is similar to that of dealing with outliers, but often worsened by the fact that more than one observation in a row is missing. An extreme example of this is shown for Manioc retail prices in Tsevie, Togo in Figure 1-6. In this series data for three out of eleven years are missing, there is no apparent repetitive variability within years to make any inferences about the missing information, and therefore this series is likely to be of very little usefulness. Unless complete series for Manioc in other regionally integrated markets can somehow be obtained, there is likely to be little sense in attempting to estimate the missing values. Figure 1-7, on the other hand, shows a case where the analyst had access to a complete, reliable price series, and one other series for the same commodity in a different city in which some observations were missing. Because we can hypothesize that the prices of the same commodity in two different cities tend to move in unison (due to spatial arbitrage), separated in principle only by transportation and other transfer costs, it may be possible to derive one series from an existing one by taking into account the appropriate marketing margin.

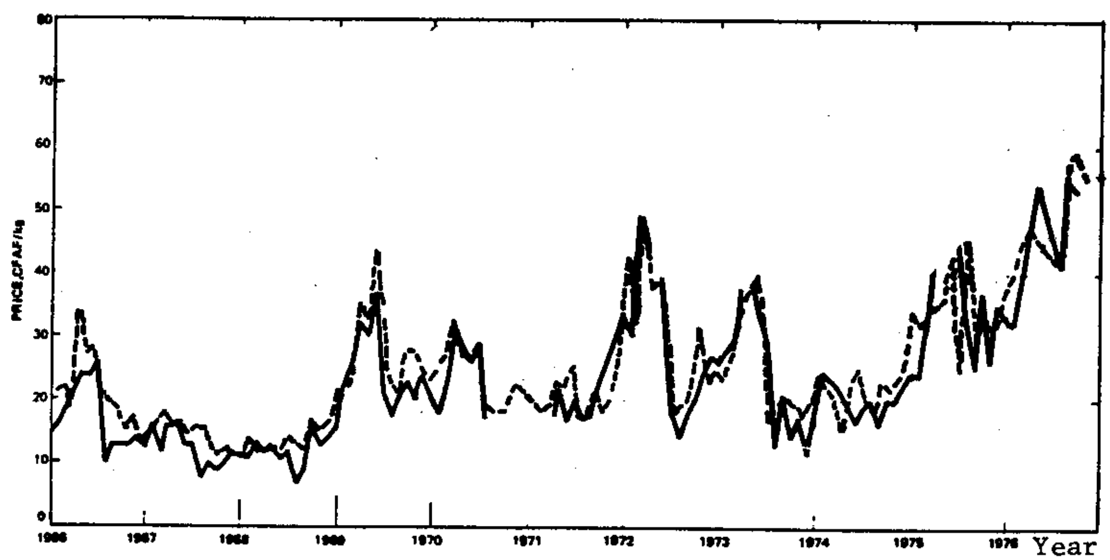
Table 1-2 shows the data from which the plots in Figure 1-4 were made. The data series are complete only for millet prices in Bamako and Kayes. In order to replace the missing values in the series for the other three cities, the following, necessarily subjective, procedure was followed. It can be seen from the plot on page 12 that each series generally tends to turn upwards in the last three months; this implies that the missing observation for the Mopti series is likely to be greater than 100.0 (the value for the last available month). Furthermore, of the other four markets, Mopti is closest to Segou and a major highway connects the two cities; for these reasons, and in the absence of further information about spatial

FIGURE 1-6: MONTHLY RETAIL PRICES FOR MANIOC IN TSEVIE, TOGO (1966-77)



Source: World Bank (1981).

FIGURE 1-7: MONTHLY MAIZE RETAIL PRICES IN TOGO, TWO CITIES (1966-77)



Source: World Bank (1981).

(Modified for the purposes of this paper)

——— = Tsevie
------ = Atakpame

TABLE 1-2: SPATIAL MILLET PRICES IN MALI (1983 MARKET SEASON)

Data file SPCORAN
Title: Regional Prices of Traditional Cereals, Apr. 1983-85, Mali

Function: PRLIST
Data case no. 1 to 12
Without selection

	Prices of Millet in:				
Month	Bamako	Mopti	Sikasso	Kayes	Segou
1	86.0	85.0	65.0	94.0	67.5
2	95.5	107.5	82.5	112.5	87.5
3	107.0	107.5	90.0	112.5	
4	132.5	130.0	97.5	75.0	
5	135.5	130.0	100.0	137.5	112.5
6	136.0	130.0	97.5	150.0	100.0
7	136.0	95.0	100.0	150.0	100.0
8	127.0	75.5		150.0	82.5
9	112.0	97.5		150.0	82.5
10	120.0	100.0	100.0	150.0	100.0
11	117.5		95.0	150.0	105.0
12	125.5	132.5	97.5	162.5	125.0

Data Source: Staatz/Dione

integration and directions of trade in millet, a simple extrapolation of 117 for month 11 in the Mopti series seems acceptable. Similarly, estimates of 95 and 105 for months 3 and 4, respectively, of the Segou series would smoothly connect observations 2 and 5 in that series. With the exception of Kayes, prices tend to increase in the first five months in the other three markets and this makes the replacement values for Segou more plausible.

It appears to be more difficult to find credible replacement values for the Sikasso series, since it does not seem to be highly correlated with any of the other four markets. Here a value of 100 in months 8 and 9 would seem defensible, provided no other information regarding spatial integration and seasonality is available. Obviously, if observations from other years were available, they could be used to help approximate the missing observation. In the case of this data, we had a corresponding observation of 100 in 1984 for one of the values missing in 1983 (see Table 5-2, page 106). In the absence of high inflation, the replacement values of 100 for 1983 are reasonable. However, it would be extremely helpful to plot the entire 1983-85 data series for Sikasso (as well as the other four markets) to see how prices tended to behave in the months before and after December. This again illustrates the importance of using plots.

There are also other methods for verifying and validating existing data; these are discussed in Chapter 7. To conclude, it is essential to somehow flag those values which were adjusted and/or missing and subsequently approximated. Once an outlier or missing value has been replaced and listed on a printout of the entire data set, it is human nature to treat "adjusted" data as equivalent to the other, seemingly properly collected, values. This is at best misleading and entirely inappropriate. Finally, account must also be taken of the data adjustment and replacement procedure, along with its frequency of use, when the results of price analyses are interpreted and documented.

II. PRESENTATION AND MANIPULATION OF TIME SERIES DATA

2.1. Inflating and Deflating Price Series

Another important step in price analysis is to inflate ("reflate") or deflate the "raw" or current price data in order to bring all values to a "common denominator" (eg 1973=100). While economists in general prefer to work with "real prices" relative to the prices of other commodities in the economy by deflating prices, the practioner in the field quickly realizes that deflated prices are usually meaningless to farmers and other marketing agents, who are understandably more concerned with current or "inflated" prices; this is true especially in countries with rapid inflation where past prices are extremely low, and results of price analyses are therefore often uncomprehensible when used in marketing extension programs. After such current time series have been deflated, they appear even more unrealistic. Furthermore, if there is a significant trend in the data, one would like to know whether it is caused by inflation or by a natural trend in the real prices; the deflating procedure can be used to answer this question.

Given the above, it is generally more desireable to make use of reflated prices in extension work, where the current year becomes the base year with an index value of 100. For reasons of completeness, however, both inflated and deflated series will likely be calculated, since the latter are generally of interest to the analyst.

There is also a statistical reason for deflating price series. Standard regression analysis with ordinary least squares assumes homoscedasticity of the random error term. This means that the variance of the random error term is constant and not correlated with the independent variable(s). In time series data two offsetting factors affect the variance of the error term: on the one hand, improved price measurement techniques over time should reduce the variance of the error term; on the other hand, if prices rise over time, then higher absolute deviations of prices from the trend line will lead to a higher variance of the error term. At any rate, deflating the data in general reduces the magnitude of the prices and therefore the variance of the error term if prices and errors are indeed colinear (see also Shepherd 1963 or Tomek and Robinson 1981). A further problem with time series data, which may be remedied by using both deflated and deseasonalized data, is that of auto-correlation among the error terms. Without these adjustments, errors in one period will depend on errors in other periods and this in turn will lead to a bias in the estimated variance of the regression coefficient.

Before discussing the actual computations necessary to inflate and/or deflate price series, mention should be made of the debate in the literature concerning the potential hidden biases that may result from the use of a price index in inflating or deflating a time series. 3/ First, in cases where the analyst has the luxury of having more than one price index series at his or her disposal, there is the important issue of selecting the most appropriate deflator or reflator. For example, if a producer price (or cost) index and a retail level food CPI (defined below) are available, the choice of the appropriate index series depends in large part on the purpose of the analysis. If one is trying to estimate a producer supply response equation at the farm level, such as

$$Qx = f\{Px, Py, Pi, etc\},$$

where Qx = quantity supplied of x,
Px = own price of the commodity,
Py = price of a substitute in production and
Pi = price of purchased inputs,

then the use of the CPI is likely to bias the coefficient estimate of the

---

3/ See, for example, Tomek and Robinson (1981) for a cursory discussion.

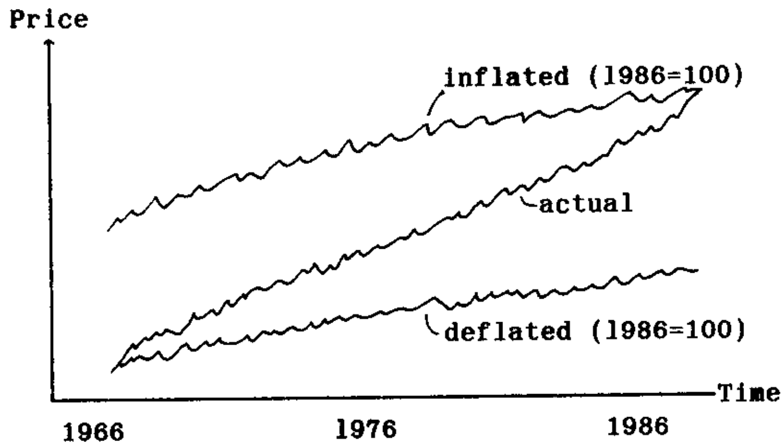
purchased inputs. On the other hand, if the producer price index series is used, the output price coefficients are likely to be biased. Obviously, a judgement will have to be made in this case.

Tomek and Robinson (1981, p. 322) cite two further possible biases resulting from indexation in linear regression analyses. First, the price of the commodity being inflated or deflated may have been used to generate the price index series. In that case, the coefficient estimates on such variables are likely to be biased, depending on the weight they received when they entered the price index calculation. A second problem is that spurious inferences may be built up if both the dependent and independent variables are deflated with the same index series. Nevertheless, these problems usually arise in more sophisticated regression studies, and need not necessarily concern us here, where the purpose is that of achieving "representative" real costs or prices over time.

The first step in inflating and deflating a time series is to obtain a consumer price index (CPI), which attempts to measure the change in the price of a so-called "market bundle of goods" purchased by the average consumer; it may include the price of different foods in the consumer's "food basket", the cost of clothing and housing, farm inputs, etc. As mentioned in the previous section, different CPI's may be available, measuring price increases of industrial or agricultural goods, or reflecting price changes for different groups of urban or rural consumers. In this case the analyst has to make a judgement as to which CPI is more appropriate; obviously, if the subject is wholesale prices, it makes sense to use a price index calculated at wholesale, if such an index is available. In many Third World settings there may be few options beyond an urban CPI for the principal city of the country. It then becomes important to understand how using this particular type of CPI may affect the analytical results.

The effect of inflating and deflating a price series is shown in Figure 2-1 below, where actual prices increased due to a natural trend. Computationally, inflating and deflating time series essentially involves an identical calculation. Suppose one has chosen a CPI with base year 1966 (1966=100) and the price observations for the commodity being studied are in current prices. In this case, dividing each monthly observation by its corresponding monthly CPI value will give rise to a deflated price series

FIGURE 2-1: ACTUAL, INFLATED AND DEFLATED PRICES



with base year 1966 (it will be necessary to multiply each value by 100 if the CPI is not in decimal form). To inflate the price series to the current year the CPI has to be converted such that the current year has an index value of 100. This is done by calculating the average CPI for the current year, dividing each original CPI value by this average, and then multiplying the result by 100. Since each value of the current year is divided by its annual average, the current year becomes the base year with index value 100. All this does in the above example is to shift the base year from 1966 to 1986. Dividing the original price observations by this new index, and after multiplying by 100, inflates the time series. In summary, the following calculations are needed:

1. $$\frac{\text{Nominal Price}}{\text{Index (Base year 1966=100)}} \times 100 = \text{Deflated price (1966=100)}$$

2. $$\frac{\text{Index (Base year 1966=100)}}{\text{Average CPI of 1986}} \times 100 = \text{New CPI Index with 1986=100}$$

3. $$\frac{\text{Nominal Price}}{\text{New CPI Index (Base year 1986=100)}} \times 100 = \text{Inflated price (1986=100)}$$

We have just seen how the base year of an index can be shifted to the present in order to calculate an inflated time series. A further computational difficulty arises when facing two indices based on different base years. For example, one index series (the old one) may run from 1963 to 1973 with 1963=100 as the base year while the other series (the newer one) runs from 1973 to 1983 with 1973=100 as the base year. Different base years are usually chosen as the weights of the commodities used to calculate a CPI change over time (see also Lapin, 1978).

Assume now that we want a new index series for the entire period (ie. 1963-1983) with 1973=100 as the overall base year. In this case we have to divide each value from 1963 to 1973 by the CPI value of the old series in 1973. This will give rise to a new value for 1973 in the old series, namely, 1973 will equal 100, and the remaining values in the old series will have been adjusted appropriately, while the values in the new series (1973-1983) will remain unchanged. This procedure is usually called "splicing" two index series.

Tables 2-1 and 2-2 on the following two pages show what happens when an actual monthly time series of wholesale tomato prices from Brazil is inflated and deflated by a yearly index. In the "reflated" series, with 1977=100 (the most recent year) all of the values are much larger. Note

TABLE 2-1:
COMPARISON OF RAW, INFLATED AND DEFLATED WHOLESALE TOMATO PRICES
(In Cruzeiros/kg, scaled by 10)*

Data file TOMATO
Title: MTW's tomato data from Brazil, 1973-77

Function: SEATABLE
Data case no. 1 to 60
Without selection

CURRENT COMMODITY PRICE (ACTUAL)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	16.6	13.6	17.9	18.0	13.7	27.1	25.9	19.6	16.3	14.8	18.9	14.5
1974	22.2	38.9	44.2	35.4	37.1	31.2	28.8	18.2	22.7	27.9	25.6	24.5
1975	24.4	21.5	25.9	27.8	20.0	23.9	24.6	22.7	23.7	23.0	23.4	22.2
1976	21.4	27.6	37.2	33.4	31.5	33.2	24.4	17.4	23.4	28.8	42.9	48.4
1977	50.8	74.4	40.6	37.2	55.8	70.8	62.3	47.4	44.6	43.3	46.2	44.9

INFLATED COMMODITY PRICE (1977=100)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	60.2	48.8	63.3	62.8	47.3	92.7	86.8	65.1	53.3	47.8	60.4	45.1
1974	67.0	112.8	121.6	94.1	96.9	80.5	73.3	45.5	56.0	67.7	60.8	56.9
1975	55.4	48.4	56.9	59.8	42.1	49.3	49.3	44.6	45.5	43.1	43.0	39.6
1976	36.6	45.5	59.2	51.4	47.2	47.9	33.8	23.3	30.6	37.0	53.9	58.6
1977	59.7	83.8	44.0	38.9	57.2	71.1	61.8	46.2	42.3	40.0	41.8	39.6

Past data values inflated using 1977 as the base CPI of 100.

DEFLATED COMMODITY PRICE (1973=100)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	17.8	14.5	18.8	18.6	14.0	27.5	25.7	19.3	15.8	14.1	17.9	13.4
1974	19.9	33.4	36.0	27.9	28.7	23.8	21.7	13.5	16.6	20.1	18.0	16.9
1975	16.4	14.3	16.9	17.7	12.5	14.6	14.6	13.2	13.5	12.8	12.7	11.7
1976	10.8	13.5	17.5	15.2	14.0	14.2	10.0	6.9	9.1	11.0	16.0	17.4
1977	17.7	24.8	13.0	11.5	16.9	21.1	18.3	13.7	12.5	11.9	12.4	11.7

Data Source: Weber and Azevedo (1978).

----

* It was necessary to scale (multiply) the price data by 10 because the MSTAT subroutine only allows a "###.#" data format in these particular tables.

TABLE 2-2: ACTUAL AND "REFLATED" CPI VALUES, BRAZIL

CONSUMER PRICE INDEX (1973=100)
BRAZIL

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	93.1	94.1	95.4	96.7	97.7	98.7	100.7	101.6	103.3	104.6	105.6	108.6
1974	111.8	116.4	122.7	127.0	129.3	130.9	132.6	134.9	136.8	139.1	142.1	145.4
1975	148.7	150.0	153.6	156.9	160.2	163.8	168.4	172.0	176.0	180.0	183.9	189.5
1976	197.4	204.6	212.2	219.4	225.3	233.9	243.4	252.0	257.9	262.8	268.8	278.9
1977	287.5	299.7	311.8	323.0	329.3	336.2	340.5	346.4	355.9	365.1	373.0	382.9

Year	Calendar Year Average
1973	100.000
1974	130.750
1975	166.917
1976	238.050
1977	337.608

"REFLATED" CPI (1977=100)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1973	27.6	27.9	28.3	28.6	28.9	29.2	29.8	30.1	30.6	31.0	31.3	32.2
1974	33.1	34.5	36.3	37.6	38.3	38.8	39.3	40.0	40.5	41.2	42.1	43.1
1975	44.0	44.4	45.5	46.5	47.5	48.5	49.9	50.9	52.1	53.3	54.5	56.1
1976	58.5	60.6	62.9	65.0	66.7	69.3	72.1	74.6	76.4	77.8	79.6	82.6
1977	85.2	88.8	92.4	95.7	97.5	99.6	100.9	102.6	105.4	108.1	110.5	113.4

Year	Calendar Year Average
1973	29.623
1974	38.728
1975	49.441
1976	70.511
1977	100.000

Past data values reflated using 1977 as the base CPI of 100.

Data Source: Weber and Azevedo (1978).

that for the inflated price series each monthly value in 1977 changes because an average yearly index, instead of monthly index values, is used in the inflating procedure. If inflation is very rapid and a monthly CPI is available, it may be desirable to inflate all prices to the most recent month, rather than most recent year. The same logic holds for deflating price series.

An analyst in the field could explain to farmers that in 1977 cruzeiros, a farmer would have received 60.2 crzs in Jan 1973, as compared to 59.7 in Jan 1977; in real terms--that is, based on the same common denominator--prices have not changed noticeably over the five year period. The same is true of the deflated series (i.e. 17.8 vs. 17.7 crzs) based on 1973=100. Since the period of analysis was fairly short, the farmer may well still remember that he or she received 17.8 crzs. in January 1973, and may be surprised that real prices have not changed at all.

Table 2-2 shows the index value used to deflate and "reflate" the tomato price series in Table 2-1. It is evident from the bottom part of the Table, that in the "reflated" series the year 1977 has received an index value of 100, and consequently, all of the values in the earlier years have become smaller since the index rose consistently over the five year period.

In some instances analysts are faced with monthly price data but have only yearly CPI series available for inflating or reflating their data. There is nothing conceptually wrong with deflating a monthly series with a yearly index, except that certain biases may arise which the analyst should take into consideration. Consider for example, the case where the actual (unknown) monthly CPI rose consistently over all months in the analysis, but is merely represented and used as a yearly CPI value. Then all of the monthly prices early in the year will be biased downwards, while those in the latter part of the year will be biased upwards after deflating or inflating the series. Again, there is nothing conceptually wrong with following such a procedure, since it does give some kind of indication of what "real" prices are like, but at least be aware of the implicit biases.

Finally, if the purpose of the analysis is to make forecasts or predictions, one may want to use the original series without inflating or deflating it. In this case it is assumed that "all things continue as before", including the level of inflation, so that the original data is more appropriate for the analysis.

2.2. Price Averages: Calendar, Market Year and Weighted Market Year

A useful and meaningful presentation of monthly time series price data is to show not only calendar year averages, but also market year or market season averages. In addition, weighted market year averages convey even more information as they are more representative of the level of prices which farmers actually receive. Unfortunately, it is often impossible to use this valuable technique in developing countries, simply because data on monthly quantities marketed is difficult to obtain. Nevertheless, this section goes through the basic analytical technique and presents an example.

Table 2-3 shows, first, the quantities of tomatoes marketed by farmers in the Ibiapaba microregion in the state of Ceara, Brazil over the period 1973-77. This quantity information will be used as weights when weighted market year averages are calculated. It is interesting to note, from the table, that quantities marketed each month vary significantly within each year. This can of course be explained by the nature of the process of producing tomatoes, which depends on climatic factors such as rainfall. Hence, even though tomatoes are not a storable commodity, there is some seasonality in the quantities. In the table, calendar year and market year

TABLE 2-3

FARM LEVEL QUANTITIES MARKETED IN THE IPIAPABA MICROREGION, BRAZIL, 1974-79
(in metric tons, divided by 10 #)

Data file TOMFGPRI
Title: Tomato Farm Gate Prices & Wholesale quantities Brazil, 1973-77

Function: SEATABLE
Data case no. 1 to 72
Without selection

This data starts JAN, 1974 and represents a AUG, 1974 to JUL, 1975 market year.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1974	48.9	43.4	18.5	15.5	13.0	21.2	23.4	29.3	49.4	36.3	24.2	34.7
1975	30.4	40.0	27.4	17.1	24.0	33.4	47.4	38.7	64.1	73.2	60.5	79.6
1976	92.4	89.7	72.0	47.7	46.3	57.2	71.0	107.5	147.2	141.1	120.2	95.4
1977	78.6	58.5	50.2	80.1	85.8	81.7	62.0	65.6	97.0	120.1	136.2	142.0
1978	162.3	156.0	125.0	108.8	82.8	92.4	130.8	156.1	156.4	137.6	147.0	133.2
1979	153.2	159.5	157.2	137.0	113.9	115.2	115.9	179.2	215.2	176.0	147.8	120.6

Year	Calendar Year Average	Market Year Average
1973		26.271 *
1974	29.817	32.800
1975	44.650	66.033
1976	90.642	92.358
1977	88.150	118.250
1978	132.367	140.183
1979	149.225	167.760 *

* Denotes a value computed from less than 12 months data.

QUANTITY AS A PERCENT OF MARKET YEAR TOTAL

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1974	26.6	23.6	10.1	8.4	7.1	11.5	12.7	7.4	12.6	9.2	6.1	8.8
1975	7.7	10.2	7.0	4.3	6.1	8.5	12.0	4.9	8.1	9.2	7.6	10.0
1976	11.7	11.3	9.1	6.0	5.8	7.2	9.0	9.7	13.3	12.7	10.8	8.6
1977	7.1	5.3	4.5	7.2	7.7	7.4	5.6	4.6	6.8	8.5	9.6	10.0
1978	11.4	11.0	8.8	7.7	5.8	6.5	9.2	9.3	9.3	8.2	8.7	7.9
1979	9.1	9.5	9.3	8.1	6.8	6.8	6.9	21.4	25.7	21.0	17.6	14.4

Data Source: Weber and Azevedo (1978, with updates).

See note in Table 2-1, which explains why scaling was necessary.

averages are also presented for each year. A market year, defined as the period from one harvest to the next, is an important unit of analysis, since producers often think and plan in terms of market seasons of their crops, rather than calendar years. Market years are traditionally defined as 12 months in duration, starting in the first month of harvest. In the case of the tomato data, the market year spans the months of August to July. Even though there can be two (sometimes three) crops of tomatoes over this 12 month period, we are considering the period August through July to be just one market season. August is the first month of harvest for the largest crop harvested each year.

The bottom portion of Table 2-3 simply expresses the quantity marketed in each month as a percent of the market year total (assuming no product carryover); this information is crucial in calculating weighted average market year prices, discussed below, and it also facilitates the identification of seasonality in the time series.

Once the analyst has obtained monthly data on quantities marketed, it is straightforward to calculate weighted average market year prices. Table 2-4 shows current commodity prices of tomatoes received at the farm level over the period 1975-79, and then gives calendar year, market year and weighted market year averages as summary statistics. The calendar year average is simply obtained by averaging the monthly observations over their respective calendar years. The market year average is likewise obtained except that the monthly observations are averaged over the market year rather than the calendar year. A glance at this column shows that there are substantial differences between these two averages in all years. If farmers indeed think in terms of, and respond to, market year average prices rather than calendar year averages, then using only calendar averages is likely to give biased results (depending on how planting decisions are made). The

TABLE 2-4

CURRENT TOMATO PRICES RECEIVED BY FARMERS IN THE IPIAPABA MICROREGION
(in Crzs./kg, multiplied by 10)

This data starts JAN, 1974 and represents a AUG, 1974 to JUL, 1975 market year.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1974	5.1	7.6	16.5	19.6	17.6	17.2	11.9	9.2	3.6	7.1	8.8	8.0
1975	6.5	5.8	8.4	6.6	9.0	7.2	9.1	10.6	8.5	11.3	14.5	10.4
1976	13.6	11.9	13.4	12.5	19.0	12.4	10.6	11.0	5.5	12.8	10.0	17.5
1977	15.0	34.4	37.5	25.0	24.4	31.3	42.5	30.0	23.6	21.9	20.6	24.3
1978	17.0	35.6	44.3	36.0	34.4	42.5	26.3	23.8	46.3	30.9	36.4	31.2
1979	26.9	36.3	51.3	66.3	65.2	68.5	67.5	28.0	26.4	53.3	93.3	97.7

Year	Calendar Year Average	Market Year Average	Weighted Market Year Average
1973		13.643 *	11.203 *
1974	11.017	7.442	7.256
1975	8.992	12.392	12.259
1976	12.517	22.242	18.977
1977	27.542	29.708	28.982
1978	33.725	45.883	44.533
1979	56.725	59.740 *	54.425 *

* Denotes a value computed from less than 12 months data.

Data Source: Weber and Azevedo (1978, with updates).

last column in the Table shows the weighted market year average, which is obtained as follows: each monthly price within a year is given a weight corresponding to the proportion of the year's total crop marketed in that month:

$$\text{Weight for Month(i)} = \frac{\text{Amount Marketed in Month(i)}}{\text{Total Quantity Marketed in that Market Year}}$$

Thus, prices in months where large quantities are marketed receive a relatively larger weight or importance, while prices in months where only small quantities were marketed receive accordingly smaller weights. As a consequence, the weighted average market price more closely represents the conditions existing when more of the crop was marketed; in other words, it is more representative of the price level which the majority of farmers faced when they sold their produce, and this is an important consideration in farm-income studies.

Consider, furthermore, the following illustrative case. If farmers were to market 100% of their commodity in a single month, the weighted average market year price would simply be the price in that month. Obviously, only that value is relevant in this case, and there is no need to examine the calendar year averages, which may be totally different and are, at best, irrelevant. The appropriate value to be used in supply response studies would in this case be the price prevailing in that particular month.

More generally, the analysis presented here raises the important question of "which prices" to use in supply response analyses. For example, do farmers make decisions based on prices prevailing at harvest (in the past) or during the planting period? Alternatively, do they use average prices in the three months surrounding the main harvest period, prices in the two or three month period prior to planting, or any combination of the above? Answers to these questions should help provide better results in supply response studies; it is essential to somehow use prices prevailing at or around the time when the planting decision is made. It is of course also possible that prices are less important motivating forces for crops that are not sold in large quantities.

Finally, in this chapter the averaging technique was applied to a commodity which is not typically "seasonal" in the sense that it is storable and produced only once each year. The technique would be even more meaningful when applied to commodities which are produced only once or twice each year and which are storable (eg. grain). It is hoped that current and future research efforts in developing countries will eventually generate data bases from which these kinds of analyses can be carried out. Also, computer software is now readily available to carry out the often tedious computations involved in a very short time.

III. MARKETING MARGIN ANALYSIS

Marketing margins, in their simplest form, can be defined as the difference between prices paid for a commodity (eg. bread) by consumers at the retail level, and prices received by farmers when they sell their commodity (eg. wheat) to assemblers or other first handlers. Measured in this form, the margins reflect the amount of services added to a commodity once it leaves the farm and sits on a shelf in a retail outlet in a form which is acceptable, useful, and appealing to consumers. Furthermore, this "gross" consumer-producer margin can be disaggregated to more precisely show the different services added by the marketing system. This disaggregation is discussed in the following section.

3.1. The Diversity of Prices Over Time, Form and Space

In order to conceptualize the diversity and various dimensions of prices, it is useful to visualize the marketing functions from producers (or even input suppliers) to consumers as a set of vertically related activities. Consider, for example, a certain quantity of maize which has been produced by a group of farmers in a rural village and is ready to be marketed. When the commodity is in this form at the village level, it is of virtually no value to consumers in a distant urban center. Indeed, before the maize can be made valuable to the urban consumers, three key attributes or dimensions have to be added to it.

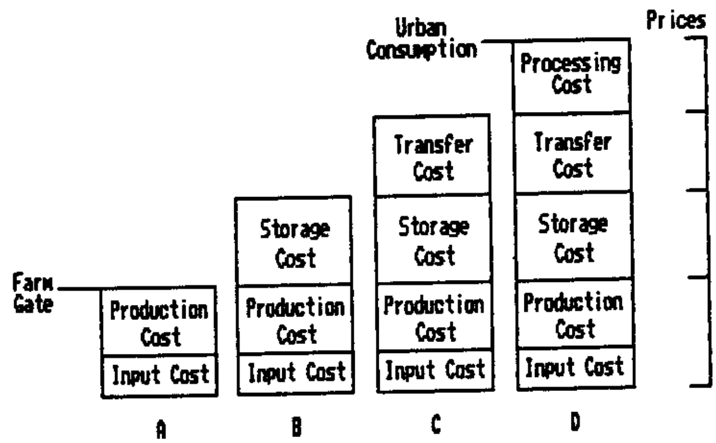
First, consumers want a reliable supply of maize and maize products over the year; this means that someone in the marketing system has to store the commodity and periodically release or sell it over the year. This is the time or temporal dimension which has to be added to the commodity, and it fundamentally changes the nature of the original maize: maize utilized or consumed in March of one year is no longer the same commodity as the maize harvested in October of the previous year. It is costly to store a commodity over time due to the time value of money (money received today is worth more than money received tomorrow), costs of storage facilities and quantitative and qualitative product losses during the storage period. Consequently, the person or entity that stores the maize is entitled to compensation for efforts and costs incurred. In other words, the maize in March of the following year should be more expensive than in October, the minimum difference being equal to the cost of owning and storing it over that period, assuming "normal" storage profits.

Secondly, the maize produced at the village level has to be transported or transferred to the urban center where it can be conveniently consumed. This is known as the spatial dimension, and the cost of adding this service to the original maize is similarly reflected in the price of the commodity when it sits on the retail shelf in the urban center. In a more precise sense, "transfer costs" include not only costs of transportation, but also costs of ownership and associated risks such as losses during transit. For these reasons, a commodity which has been transported from location A to B is technically no longer the same commodity (in effect, it confers a different level of utility to consumers in B since they do not have to incur the cost of travelling to A in order to pick it up), and its price should differ by the amount of transfer cost between the two locations.

Finally, when the maize is in its original unshelled form, it is of limited value to urban consumers who generally do not have the means of processing it into an edible form (eg. bread). Instead, consumers prefer to buy processed and easy-to-consume maize from retail stores. This gives rise to a third dimension of attributes, namely that of form. Form includes not only direct processing (eg. milling), but also factors such as packaging, labelling, cleaning, sorting, etc. Real resource costs are involved in adding these attributes to the original product, and the consumer (or someone else) has to pay for them. Obviously, risks and costs of ownership also arise while the product is being processed, and this will be reflected in the product's final price.

From the above, it follows that there should be a fairly wide diversity of prices for a single commodity, depending on when, where and in what form it is purchased. This is illustrated in Figure 3-1, where we are

FIGURE 3-1: THE DIVERSITY OF PRICES



dealing with the same commodity, but different added attributes or dimensions. For example, the price of D differs from that of C by the cost of processing C into D, and so on.

Column D in Figure 3-1 is useful for conceptualizing the structure of marketing margins for a particular commodity. In general, however, the processing stage changes the qualitative and quantitative nature of the product to such an extent that it is not permissible to simply subtract farm gate or farm level prices from retail prices to obtain the margin. In these cases it is necessary to make allowances for by-products and to use conversion factors when calculating precise marketing margins. This important procedure is discussed in Appendix 2; for the sake of simplicity, it will be assumed that conversion factors are close to 1.0 and that there are no major by-products in the remainder of this paper. 4/

3.2. Estimating Marketing Margins and Comparison to Value-Added

The analyst interested in the efficient operation of a marketing system would examine empirical marketing margins in a food system and compare them to the cost or value of services added to a commodity up to that level. This allows an assessment of the extent to which costs and profits in such a system are normal or excessive; similarly, comparisons could be made across different commodity sectors to draw conclusions about the relative efficiencies in carrying out similar tasks. Given the time and resource constraints facing most analysts and researchers, however, it is often impossible to obtain detailed accounting data from market participants from which precise cost or value-added figures at each level could be calculated. For these reasons, rapid diagnostic assessments are generally carried out to develop estimates of the values of services; a discussion of this methodology is beyond the scope of this paper, however. 5/ Instead, this section discusses how marketing margins can be calculated from prices collected at various key nodes in the food system and how they may be utilized to gain insights into the system's performance.

The first three columns of data in Table 3-1 represent monthly wholesale, retail and farm level prices for tomatoes in the city of Fortaleza in the state of Ceara, Brazil for the period Jan. 75 to Dec. 77 (the farm level price is from the Ibiapaba microregion of Ceara, the principal tomato

---

4/ For detailed reviews of marketing margin assessments and calculations the reader is refered to Mittendorf and Hertag (1982), OECD (1981) and Smith (1981).

5/ Holtzman (1986-forthcoming) discusses the implementation of rapid reconnaissance surveys.

TABLE 3-1
PRICE AND MARGIN DATA FOR TOMATOES, CEARA, BRAZIL, 1973-77

LIST OF VARIABLES

VAR	TYPE	NAME/DESCRIPTION
1	numeric	Wholesale prices in Fortaleza (in crzs./kg)
2	numeric	Retail prices in Fortaleza (in crzs./kg)
3	numeric	Farm level prices in Fortaleza (in crzs./kg)
4	numeric	Retail-Farm margin for tomatos (in crzs./kg)
5	numeric	Retail-Wholesale margin for tomatos
6	numeric	Wholesale-Farm margin for tomatos
7	numeric	Time count for plot and regression
8	numeric	Consumer Price Index for Brazil
9	numeric	Quantities marketed at wholesale (in Metric Tons)

[Data Source: Weber and Azevedo (1978)]

CASE NO. (Months)	VARIABLES, BY NUMBER 1	2	3	4	5	6	7	8	9
1	2.22	4.06	2.50	1.56	1.84	-0.28	1	94.78	518.8
2	2.12	3.72	2.44	1.28	1.60	-0.32	2	98.18	463.1
3	3.24	5.58	3.13	2.45	2.34	0.11	3	100.10	504.8
4	5.42	7.08	4.25	2.83	1.66	1.17	4	102.20	507.6
5	4.54	6.23	3.00	3.23	1.69	1.54	5	103.50	597.3
6	3.08	4.74	2.36	2.38	1.66	0.72	6	105.30	582.0
7	3.57	4.46	2.19	2.27	0.89	1.38	7	108.20	643.5
8	3.57	4.33	2.06	2.27	0.76	1.51	8	111.00	557.9
9	3.65	4.62	2.43	2.19	0.97	1.22	9	113.40	647.9
10	2.13	4.49	1.70	2.79	2.36	0.43	10	116.40	635.0
11	3.14	5.17	3.56	1.61	2.03	-0.42	11	120.40	591.1
12	7.69	8.23	4.43	3.80	0.54	3.26	12	124.30	708.5
13	4.78	7.61	3.60	4.01	2.83	1.18	13	128.50	740.9
14	5.62	7.24	3.44	3.80	1.62	2.18	14	132.60	667.7
15	4.14	7.19	4.25	2.94	3.05	-0.11	15	137.40	692.6
16	2.30	5.01	2.63	2.38	2.71	-0.33	16	141.30	619.7
17	3.29	5.15	2.38	2.77	1.86	0.91	17	145.10	687.3
18	4.52	7.14	4.63	2.51	2.62	-0.11	18	148.80	618.7
19	3.81	6.45	3.09	3.36	2.64	0.72	19	153.10	660.7
20	4.15	7.46	3.64	3.82	3.31	0.51	20	157.30	808.9
21	4.31	6.87	3.12	3.75	2.56	1.19	21	159.70	916.9
22	4.39	6.65	2.69	3.96	2.26	1.70	22	165.50	959.1
23	5.42	8.60	3.63	4.97	3.18	1.79	23	171.70	880.5
24	7.48	10.70	5.13	5.57	3.22	2.35	24	181.60	728.9
25	7.15	8.95	6.63	2.32	1.80	0.52	25	188.50	630.8
26	9.91	12.53	6.52	6.01	2.62	3.39	26	192.90	580.4
27	8.12	13.04	6.85	6.19	4.92	1.27	27	199.60	682.6
28	9.36	10.60	6.75	3.85	1.24	2.61	28	208.30	883.9
29	5.18	8.39	2.80	5.59	3.21	2.38	29	220.40	989.8
30	2.90	6.46	2.64	3.82	3.56	0.26	30	237.40	821.7
31	7.11	8.85	5.33	3.52	1.74	1.78	31	249.80	727.0
32	11.79	12.56	9.33	3.23	0.77	2.46	32	263.70	733.4
33	12.97	17.28	9.77	7.51	4.31	3.20	33	283.00	900.1
34	11.01	16.32	7.48	8.84	5.31	3.53	34	300.60	933.2
35	11.54	15.56	7.71	7.85	4.02	3.83	35	313.30	828.2
36	11.99	18.65	8.00	10.65	6.66	3.99	36	333.90	895.3

producing area of Ceara). The subsequent three columns (4 through 6) show retail-farm, retail-wholesale and wholesale-farm marketing margins for tomatoes, which were calculated by simply subtracting one appropriate price series from another: for example, the fourth column, the retail to farm level margin, is obtained by subtracting prices at the farm level from prices at retail. As indicated above, this margin reflects the value of services added to the tomatoes once they have left the farm and are made available to consumers in urban areas. The three margins, between retail and farm, retail and wholesale, and wholesale and farm levels, are plotted and further analyzed in Figure 3-2, parts 1-3 below.

A number of interesting relationships are apparent from these plots. First, with an average of 2.51 crzs./kg over the period of analysis, the retail to wholesale spread is considerably larger than that between wholesale and farm level (1.43 crzs./kg). This implies that relatively more services are added to tomatoes between retail and wholesale levels, as compared to wholesale and farm levels. Since we are dealing with a commodity which is neither stored nor processed extensively, most of the margin between retail and wholesale can most likely be explained by the cost and risk of holding a highly perishable commodity at the retail level (overhead costs, spoilage, etc.). In fact, this appears to be a common characteristic of margin behavior for perishable fruits and vegetables. Further empirical investigations would be necessary, however, to verify whether retailers add further services to the tomatoes, such as cleaning, sorting, and possibly some form of packaging, before definite conclusions are drawn. In addition, the analyst would have to ascertain whether retailers have more bargaining power over wholesalers so that they can extract economic profits from the latter (see also Section 3-3 below). This shows that it is insufficient to examine only the market price data; indeed, the analyst cannot avoid

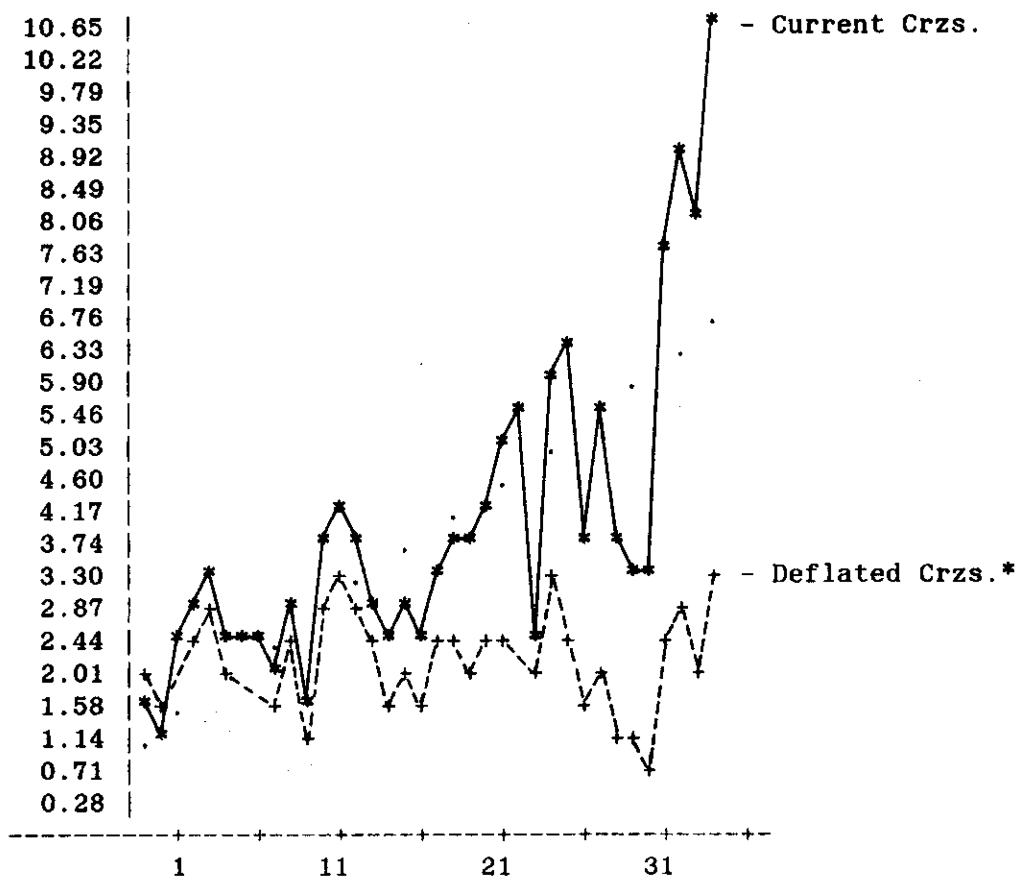
FIGURE 3-2 PART 1

PLOT OF RETAIL-FARM MARGIN FOR TOMATOES OVER TIME

Data file   MMCH3
Title: Marketing margin analysis file

Function: PLOT
Data case no. 1 to 36
Without selection

Y=VAR 4
Retail-Farm margin for tomatoes



X=VAR 7 (months)
Time count for plot and regression

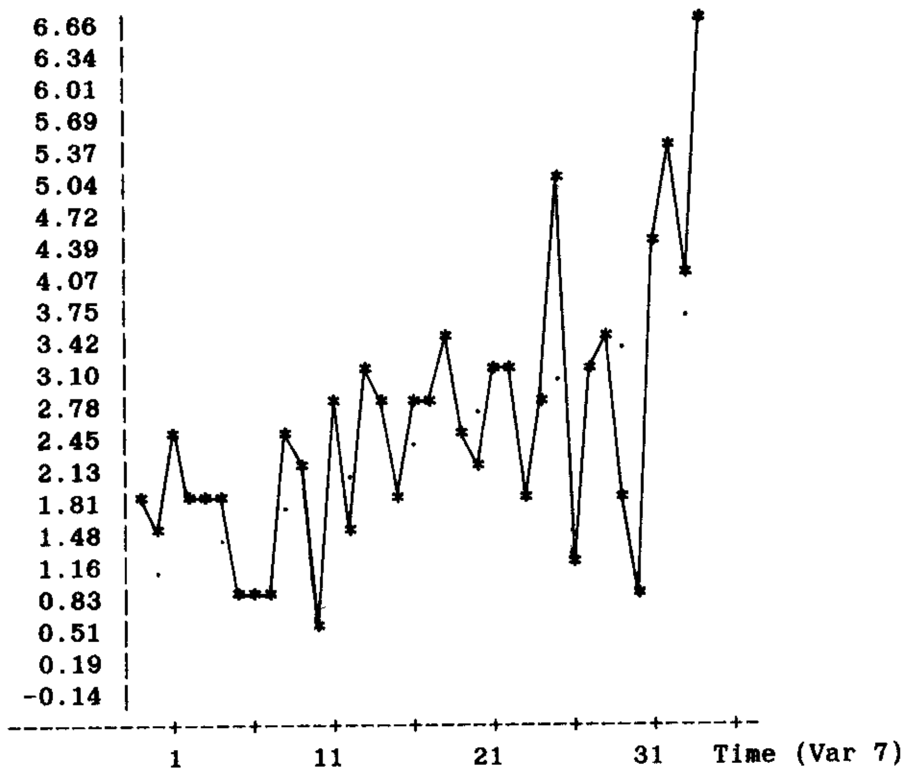
X-AXIS DIVISIONS=	37	XMIN=	1	XMAX=	36	DX=	1				
Y-AXIS DIVISIONS=	25	YMIN=	1.28	YMAX=	10.65	DY=	0.43				
N=	36	X-BAR=	19	VAR.X=	111	Y-BAR=	3.94	VAR.Y=	4.51		
r=	0.756	a=	1.121	b=	0.15	s=	0.023	t=	6.73	P%=	.000

----

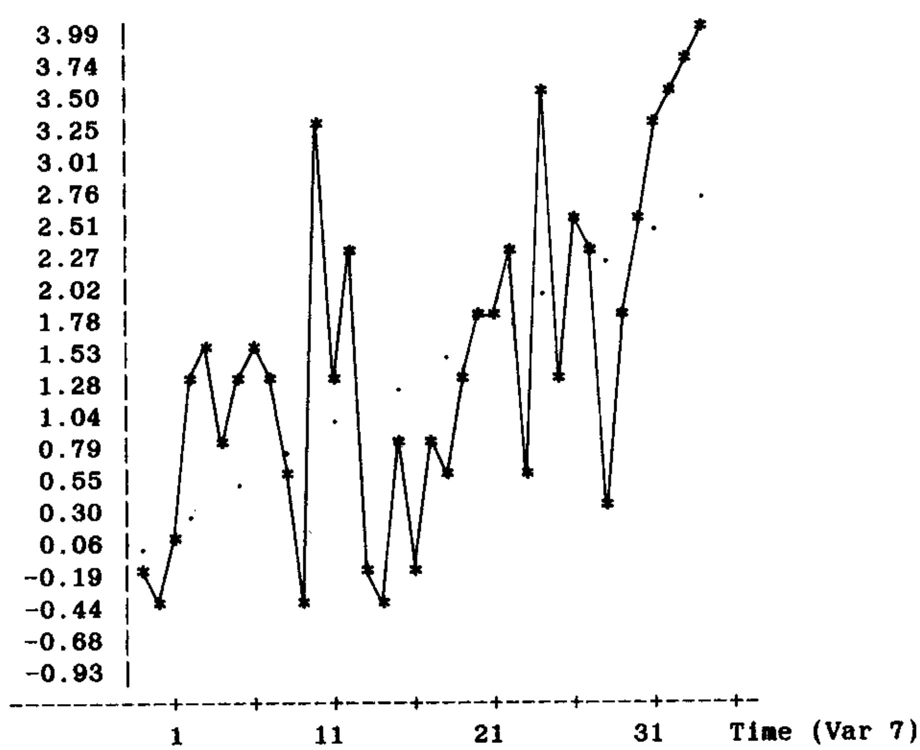
* The line showing deflated crzs. was added manually after the plot of current crzs. (using PLOT) was read into a word processor.

FIGURE 3-2, PARTS 2 & 3: PLOTS OF MARKETING MARGINS

Retail-Wholesale Margin for Tomatoes (Var 5)



Wholesale-Farm Margin for Tomatoes (Var 6)



investigating the actual structure and operation of the marketing system, if the objective is to arrive at a comprehensive assessment.

A second interesting aspect of Figures 3-2, and the analyses contained therein, is that the variability in the retail-wholesale margin series is lower than that in the wholesale-farm level series. This obtains when the standard deviation of each series is divided by the mean value of that series to form the coefficient of variation. This yields (1.34/2.51=) 0.53 in the first case, and (1.27/1.43=) 0.89 for the latter case (see Table 3-2). In other words, within the marketing system more of the inherent instability in tomato prices is absorbed between the farm and wholesale level, with prices to consumers at the retail level being relatively more stable. This is true in spite of the fact that average margins are lower between wholesale and the farm level, and it too gives certain indications of the structure in the market--such as bargaining power--which is worthy of further empirical investigation. On the other hand, we can compare the variability in the retail price series to that of the <u>overall</u> marketing margin series, to see whether price instability is absorbed more by consumers, or, at least in the short-run, by marketing agents. With respective coefficients of variation of 0.48 for the retail price as compared to 0.54 for the overall margin, it appears that price shocks are absorbed relatively more by middlemen than by consumers. This result is supported by Tweeten (1979, p. 57), who indicates that, for developed countries,

> [s]tudies of margins reveal that in the short run the marketing sector serves as a shock absorber, lowering its margin when farm prices rise and raising its margin when farm prices fall. This dampens the impact of changing farm prices on food prices. But given time, higher costs of food at the farm level are completely passed to consumers.

A third noteworthy feature of the data and plots, which supports the observation that middlemen absorb relatively more price instability, is

TABLE 3-2: SUMMARY STATISTICS FOR MARKETING MARGIN DATA

Data file MMCH3
Title: Marketing margin analysis file

Function: STAT
Data case no. 1 to 36
Without selection

Variable Number	N of Cases	Minimum	Maximum	Sum	Mean	Variance	Standard Deviation	Standard Error
Wholesale prices in Ceara								
1	36	2.120	12.970	207.610	5.767	10.044	3.169	0.528
Retail prices in Ceara								
2	36	3.720	18.650	297.970	8.277	15.586	3.948	0.658
Farm level prices in Ceara (TOMATOES)								
3	36	1.700	9.770	156.090	4.336	4.805	2.192	0.365
Retail-Farm margin for tomatoes								
4	36	1.280	10.650	141.880	3.941	4.514	2.125	0.354
Retail-Wholesale margin for tomatoes								
5	36	0.540	6.660	90.360	2.510	1.791	1.338	0.223
Wholesale-Farm margin for tomatoes								
6	36	-0.420	3.990	51.520	1.431	1.621	1.273	0.212
Consumer Price Index for Brazil								
8	36	94.780	333.900	6111.760	169.771	4465.208	66.822	11.137
Quantities marketed								
9	36	463.100	989.800	25545.800	709.606	20209.209	142.159	23.693
Deflated retail/farm level spread								
11	36	1.225	3.190	82.510	2.292	0.386	0.621	0.104

that margins between wholesalers and farmers are negative in 6 out of 36 months analyzed. Unless there are inaccuracies in the data, this implies that wholesalers bought and sold tomatoes at a loss in these six months. For example, in Jan 75 they bought their supplies at 2.50 from farmers, but were only able to sell them at 2.22 crzs./kg to retailers. In part this could be explained by the fact that some individuals in the market system carry out both wholesaling and retailing functions, so that they are willing to buy tomatoes at a loss from farmers so long as they can recuperate that loss at the retail level. It is particularly interesting that these negative values are found more towards the beginning of the series (i.e. 1975 and 76); this could imply that the quality of the data series improved over time or that major structural reorganizations took place in 1977, with a greater degree of specialization between wholesaling and retailing functions, so that specialized wholesalers could no longer afford to buy tomatoes at a loss from farmers. An entirely different explanation is presented in Section 3.4. below.

Fourth, the data in Table 3-2 show that of the total average per unit price measured at retail (8.28), 52.4% goes to the farm level component, while 47.6% is paid to the marketing sector. This latter percentage can be further disaggregated to show that 30.3% of the final price accrues to retailers, while 17.3% is received by wholesalers; this information was calculated from the statistical summary in Table 3-2. Calculating these relative magnitudes will help researchers better identify where research monies may be spent so as to yield high returns in terms of reducing inefficiencies in the food system, so that retail prices may be reduced. It is of course also desirable to disaggregate the food bill at the input supplier/producer interface (or level), if the necessary data are available.

Finally, it appears from Figure 3-2 as if the marketing margins increased drastically over the period of analysis. In general, there are two key offsetting developments in marketing margins during the course of economic growth and progress. And, that there has been considerable growth in the quantities of tomatoes marketed at wholesale, is evident from information plotted in Figure 3-2, Part 4. On the one hand, the demand for marketing services has a positive income elasticity of demand; this means that as incomes grow during the course of development, more marketing services are demanded and therefore margins tend to increase to reflect the higher value of services added to the commodities (eg. cleaning, sorting, packaging, grading and more processing). On the other hand, however, unit margins generally tend to decline as a marketing system evolves due to the fact that inefficiencies within the system are removed and increasing economies of scale in providing the services are achieved. In the case shown in Figure 3-2, Part 1, we see that while actual margins (measured in current crzs.) rose rapidly from 1975-77, deflated margins were fairly constant within the 0.70-3.30 crzs. range. Consequently, actual margins rose as the result of a rise in the general level of prices--implying increasing nominal costs of providing marketing services--and it could well be that the tomato subsector was experiencing the two offsetting factors mentioned above. This example also illustrates the usefulness of deflating time series prices to establish whether or not prices have changed in real terms (Chapter 2).

Thus far we have only considered bottlenecks and scale economies over the years. However, it is evident from the plots in Figure 3-2 that there is also considerable intra-annual variation in margins (i.e. seasonality) which may be caused by temporary but annually recurring supply shortages or bottlenecks. This possibility is taken up in more detail in Chapter 4.

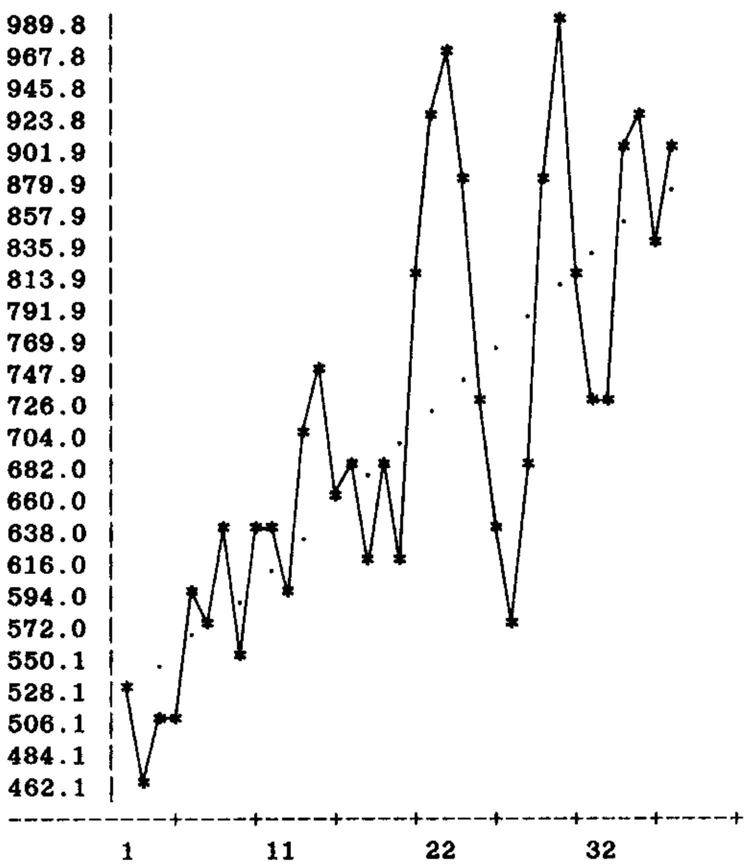
FIGURE 3-2, PART 4

PLOT OF TOMATO QUANTITIES MARKETED OVER TIME (METRIC TONS)

Data file MMCH4
Title: Marketing margin analysis file

Function: PLOT
Data case no. 1 to 36
Without selection

Y=VAR 9
Quantities marketed



X=VAR 7
Time count for plot and regression

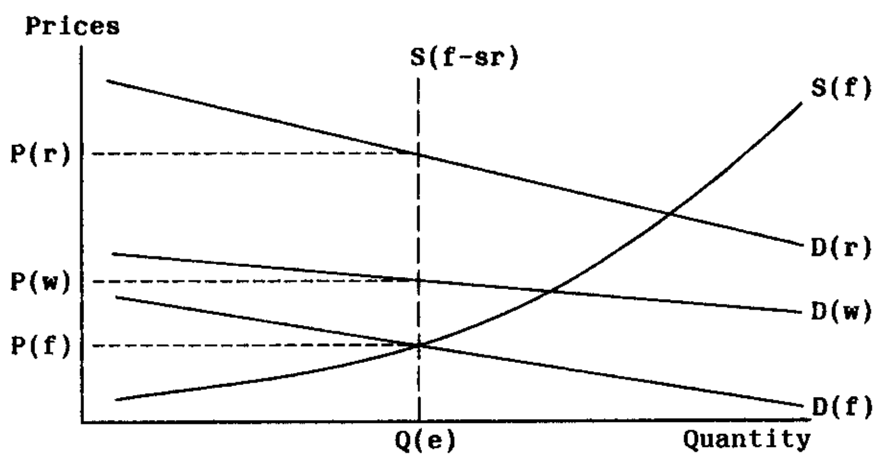
X-AXIS DIVISIONS= 36 XMIN= 1 XMAX= 36 DX= 1
Y-AXIS DIVISIONS= 25 YMIN= 463.1 YMAX= 989.8 DY= 22.0
N= 36 X-BAR= 19 VAR.X= 111 Y-BAR= 709.6 VAR.Y= 20209.2
r= 0.763 a= 519.079 b= 10.3 s= 1.495 t= 6.89 P%= .000

3.3. Uses of Regression Analysis (Types of Margins)

Marketing margins can be further analyzed using linear regression techniques. Here analysts are especially interested in factors such as how the margins behave over time, and as quantities put through the system increase or decrease. For example, when quantities produced at the farm level rise markedly, do margins rise as a result of bottlenecks and other constraints in supplying the marketing services? Alternatively, can economies of scale be achieved in providing the marketing services--for example in processing activities such as the milling or cleaning of rice--so that unit margins are reduced as quantities marketed increase?

These concepts are illustrated graphically in Figure 3-3. In this figure, S(f) refers to the long-run supply response curve at the farm level, S(f-sr) refers to short-run or immediate supply, and D(r), D(w), and D(f) refer to demand at retail, wholesale and farm level, respectively.

FIGURE 3-3: MARKETING MARGIN CONCEPTS



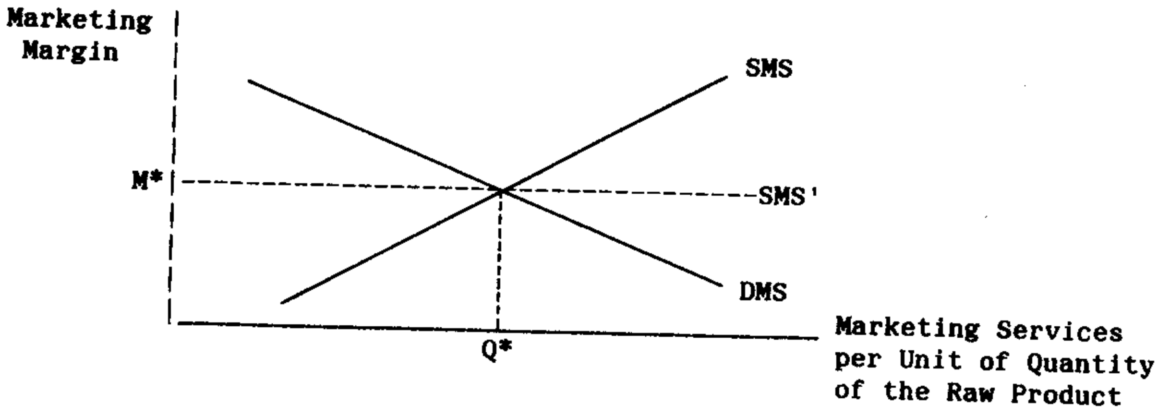
Because of the way in which the demand curves are drawn, and because we know that D(w) is derived from the primary demand curve at retail, D(r), while D(f) in turn is derived from D(w), we can make the following statements about how unit margin costs change as quantities supplied increase:

margins between retail and wholesale would decrease (due to economies of scale) while margins between wholesale and the farm level would widen. By way of an example, this could be explained by reduced unit processing costs, in the former case, and higher unit assembly costs in the latter: assemblers may have to travel larger distances to collect the increased supplies from marginally located farmers. Obviously, it would also be possible to draw a set of demand curves that are parallel--implying constant per unit margins--while the other two form some kind of wedge. These considerations are now discussed in more detail.

As is true for most commodities, the value (price) and quantity of marketing services applied to a product are determined by the interaction of the demand for and supply of marketing services per unit of quantity of the (raw) product. In particular, we would expect the demand function for marketing services to depend on consumer income, desires for product form and purchase convenience, other consumer preferences and a trend factor. The supply of marketing services, on the other hand, will depend on costs of providing the services, technology, the degree of competition in the marketing sector, etc. It follows that we can consider marketing margins to be the "price" of marketing services, which are determined by the interaction of the demand (DMS) for and supply (SMS) of marketing services, as is shown in Figure 3-3A.

In Figure 3-3A the "equilibrium" marketing margin is given as M*, and the amount of marketing services per unit of quantity of the raw product as Q*. If we calculated M* as the value of marketing services applied to the product between the farm gate and retail levels, then it corresponds exactly to P(r) - P(f) in Figure 3-3. This shows how marketing margins drive a wedge between the demand functions for the product at retail and at the farm level. In effect, the margin forces the demand function at the farm

FIGURE 3-3A:
DETERMINATION OF PRICES AND QUANTITIES OF MARKETING SERVICES



level downwards, and the larger the marketing margin, the greater the vertical distance between retail and farm level demand functions.

It is important to note that the horizontal axis in Figure 3-3A measures marketing services <u>per unit</u> of quantity of the raw product, and as such has nothing to do with the horizontal axis in Figure 3-3, which measures total units of the raw product. Therefore, when we move along the quantity axis in Figure 3-3, the gaps or margins between D(r), D(w) and D(f) would remain constant (i.e. the three lines would be exactly parallel) so long as the quantity of marketing services per unit of the raw product does not change. Because the three demand functions are not parallel, however, we implicitly assumed that there were shifts in the underlying DMS and SMS functions in Figure 3-3A when the demand functions were drawn. It is also possible for the SMS function to be downward sloping if there are economies of scale in providing marketing services. In that case, outward shifts in the DMS function (brought about, for example, by an increase in consumer income over time) would entail lower marketing margins as the amount of marketing services per unit of the raw product increases.

These margin concepts are now applied to the tomato data used earlier (Table 3-1). While the analysis is applied primarily to the gross retail-farm level margin, it could easily be extended to examine margins between retail, wholesale and farm levels; in fact, such a more refined analysis is likely to yield superior results.

The simplest case of marketing margin (MM) behavior is constancy over time. For example, if MM = c (constant), margins do not change over time or as quantities put through the system rise or fall. For the above tomato data, we can simply use the average (mean) gross margin, between retail and farm level, yielding:

$$MM = c = \underset{(11.42)}{3.941} \qquad (1)$$

We can test whether this margin is significantly different from zero by forming the t-statistic (mean value/standard error), which yields 3.941/ 0.345 = 11.42. Consequently, the margin is significantly different from zero at a 5 % level of significance. Alternatively, we can formulate a regression model and see whether the nominal marketing margin changes significantly over time. This gives us an intercept term (a), as well as a slope coefficient (b) on the time variable, both of which can be tested to ascertain whether they are significantly different from zero (t-values in brackets):

$$MM = a + b\ TIME = \underset{(1.80)}{1.12} + \underset{(6.73)}{0.15}\ TIME \qquad R\text{-}sq = 57.1\% \qquad (2)$$

This model indicates that the intercept term "a" is 1.12 crzs./kg (not significantly different from zero); this term has no economic meaning in simple trend estimates since it depends entirely on when the data series begins. The significant coefficient estimate of 0.15 on TIME shows that the (nominal) margin increased by 0.15 crzs./kg in each month over the period analyzed. Assuming that the historical trend continues into the future, this simple trend estimation for the MM series can be used for short-term forecasts.

An alternative common hypothesis is that margins change uniformly with a CPI, i.e. a general change in the level of prices. This formulation, as is that in equation (2), is particularly useful when it is difficult to forecast margins using only the price data: instead one uses a CPI--for which there presumably exist better means of forecasting--as a proxy variable for predicting margin changes. This is done in equation (3).

$$MM = a + b\,CPI = -0.52 + \underset{(8.61)}{0.03}\,CPI \qquad R\text{-sq} = 68.6\% \tag{3}$$

This equation indicates that a one index unit increase in the CPI entails a 0.03 crzs./kg increase in the margin. This result is obviously sensitive to the way in which the CPI is measured or indexed (1975=100 in this case). With an R-square value of 68.6%, this model shows a fairly satisfactory "fit".

To test whether there are any scale effects in providing marketing services the margin can be regressed on quantities marketed as the independent variable. 6/ This yields:

$$MM = a + b\,Q = -3.04 + \underset{(5.10)}{0.009}\,Q \qquad R\text{-sq} = 43.3\% \tag{4}$$

Here a one metric ton increase in quantities marketed entails a 0.009 crzs./kg increase in the unit marketing margin. Over the range of commodities marketed in 1975-77, this implies a marketing margin of 1.13 crsz./kg for the lowest quantity (463.1 metric tons), and 5.87 for the highest quantity (989.8 mt) marketed in any one month. From this we could initially conclude that unit marketing margins do in fact increase as commodities shipped through the market system rise. This may, however, be a premature conclusion. If we examine the plot of quantity over time in Figure 3-2 we

----

6/ Note that an increase in aggregate volumes marketed does not imply that scale economies are achieved, if the higher volumes are simply spread over a larger number of market participants. For this reason it is essential to verify whether the number of participants has changed over time.

see that quantities marketed have risen rather consistently over the 36 month period of analysis (more precisely, by 10.3 metric tons/month if we examine the trend line). Similarly, the CPI has risen steadily over the same period, so that if we chose the model in equation (4) as the most appropriate one, we may in fact only be explaining a positive association between quantities and the CPI component implicit in the marketing margin, and not the behaviour of the real margin per se. In order to verify this possibility, the deflated margin (MMDEF) was regressed on quantities in equation (4'):

$$\text{MMDEF} = \underset{}{1.43} + \underset{(1.68)}{0.001}\ Q \qquad \text{R-sq} = 7.7\% \tag{4'}$$

In this case a one metric ton increase in quantities marketed leads to only a 0.001 crzs./kg change in the real marketing margin. Over the range of quantities marketed in the period of analysis, the equation yields 1.89 (for 463.1 mt) and 2.42 (for 989.8 mt). It would therefore be rather difficult to argue that real margins change noticeably as quantitites marketed vary (at least for small variations in Q), and therefore this formulation is inappropriate. Furthermore, the t-statistic indicates significance of the estimated coefficient on Q only at the 10% level, and the R-sq value is extremely low.

More generally, it is difficult to select the "uniquely best" model from equations (1) through (4), since all 4 yielded significant coefficient estimates, and economic theory does not give us any a priori grounds on which we could select one as superior over the others. Therefore, further empirical investigations would have to be initiated to provide more conclusive results. This could include interviewing key participants in the tomato marketing system; investigating how bargaining power and marketing costs and technologies affect margin behaviour; and examining how consumer incomes and living patterns influence margins.

For illustrative purposes, equation (5) below was estimated using all of the above independent variables:

$$(5) \qquad MM = a + b\ TIME + c\ CPI + d\ Q$$

$$= -3.12 - \underset{(-1.63)}{0.11}\ TIME + \underset{(3.95)}{0.04}\ CPI + \underset{(1.88)}{0.004}\ Q \qquad R\text{-}sq = 72.2\%$$

Here it should be noted that the coefficient estimates on TIME and quantity (Q) are highly instable when compared to the results of equations (2) and (4): on TIME the coefficient estimate changed from 0.15 to -0.11, while on Q it changed from 0.009 to 0.004. This instability of coefficients implies considerable collinearity among these two variables, leading to upward biased estimates of the variances of the coefficients, and therefore to invalid t-tests. It may also be noted that including a TIME variable, as in equation (5), is identical to detrending the dependent variable.

In a further attempt, MM was regressed on only the CPI and Q variables in equation (6):

$$(6) \qquad MM = a + b\ CPI + c\ Q$$

$$= -1.66 + \underset{(5.41)}{0.03}\ CPI + \underset{(1.24)}{0.003}\ Q \qquad R\text{-}sq = 70.0\%$$

It is noteworthy that the coefficient estimate for the CPI variable is the same as in equation (3)--namely 0.03--and that the estimate of the coefficient on quantity is statistically insignificant with a t-value of 1.24. From this exercise, it seems prudent to conclude that equation (3) is best suited for modeling and predicting the behaviour of marketing margins: over the period of analysis, margins rose in concordance with the CPI. A corollary of this result is that deflated margins were more or less constant over the 1975-77 period.

As a final illustrative exercise, margins between retail and wholesale and wholesale and farm level were regressed separately on quantities. With

R-WMM defined as the former and W-FMM defined as the latter variable, the following results were obtained:

(7) $$R\text{-}WMM = -0.9050 + \underset{(3.47)}{0.0048}\ Q \qquad R\text{-}sq = 26.1\%$$

(8) $$W\text{-}FMM = -2.1329 + \underset{(3.95)}{0.0050}\ Q \qquad R\text{-}sq = 31.5\%$$

We may note three facts: First, summing the two equations vertically, i.e. R-WMM + W-FMM, we obtain the same result as in equation (4), as we would expect. Second, even though the t-values indicate significance of the coefficient estimates, the R-sq values are not impressive in either case. Third, as already indicated above, a one metric ton change in quantities sent through the marketing system, entail only a small increase in the margin at each stage (approximately 0.005 crsz/kg) in nominal terms, and even less in deflated or real terms (0.0005 crsz./kg). We can therefore quite safely conclude that while the three demand curves, D(r), D(w) and D(f) cannot necessarily be treated as exactly parallel over the range of quantities (= 463.1 to 989.8 metric tons) examined here, quantities are not as important as the CPI in explaining the behaviour of marketing margins. Consequently, we would conclude that marketing margins depended largely on the CPI, but were fairly constant in real terms over the 1975-77 period.

The above regression analyses can be extended to examine the relative competitive positions of retailers, wholesalers and farmers. 7/ The most straightforward method of testing whether retailers can influence prices at retail, or whether they simply add a per unit mark-up to the price they pay wholesalers, is to formulate the following regression model:

(9) $$RP = a + b\ WP$$

$$= 1.433 + \underset{(18.27)}{1.187}\ WP \qquad R\text{-}sq = 90.8\%$$

7/ See also Gatere (1979), Chapter 6.

In this equation RP refers to prices at retail, which are hypothesized to be functionally dependent on wholesale prices (WP). Now, if we estimate the equation and find that the coefficient b (=1.187) does not differ significantly from 1.0, the effective equation for retail prices becomes:

(9') $$RP = a + WP = 1.433 + WP$$

This indicates that retail prices are identical to wholesale prices, except for a constant per unit mark-up (of 1.43 crzs.) which, in principle, reflects the services added to the product by retailers. In other words, retailers are "price-takers", and change their prices only when prices at the wholesale level change (that is, a one unit change in prices at wholesale leads to a one unit change in prices at retail). Alternatively, if b is found to be significantly different from unity (i.e. 1.0), then a one unit change in prices at wholesale does not lead to the same one unit change in retail prices; in this case retailers either make profits or absorb losses when the prices they pay to wholesalers fluctuate.

In our example above, we form the following null hypothesis and two-tailed t-test to verify whether the coefficient b is significantly different from one:

Null Hypothesis: Ho: b = b' (where b' = 1)

t-statistic: $$t(a/2,df) = \frac{b - b'}{\text{Standard Error of } b}$$

We will reject Ho if the absolute value of the calculated t-statistic exceeds the tabulated t-value at a level of significance a/2 (divide by 2 because it is a two-tailed test) for 34 (= N - 2) degrees of freedom. 8/

8/ Technically speaking, a Z-test could be used because the degrees of freedom exceed 30 in this example. The reader may want to consult any elementary statistics textbook such as Bhattacharyya and Johnson (1977) for further details and to verify the tabulated t-statistic obtained from a t-table using 30 degrees of freedom (see, eg., the above text, p. 599).

We find that the calculated t-statistic equals [(1.187-1.000)/0.065 =] 2.877, while the tabulated t-statistic at 34 degrees of freedom and a level of significance of 5% equals 2.040. Based on this data sample, therefore, we reject Ho and conclude (on a preliminary basis) that tomato prices at retail increase (and decrease!) by more that one unit when prices at wholesale increase (decrease).

It is of course possible to construct other hypothesized price relationships to test for the extent of competition in the market system in a preliminary manner. For example, an equation such as WP = a + b FP could be used to examine price behaviour at wholesale, and the equation FP = a + b RP could be used to verify whether or not there is a systematic relationship between prices paid by consumers and prices received by farmers.

Finally, other independent or "explanatory" variables could be used in the regression equations to examine their influence on prices. For example, in his study of fruits and vegetable markets in Kenya, Gatere (1979, pp. 81-83) used the number of wholesale firms (sellers) in the market and the market shares of the four largest wholesalers at a given point in time, along with total quantities marketed at wholesale, in an equation explaining the behaviour of wholesale prices. Obviously, this kind of analysis requires considerably more information than that contained in price and quantity time series data. 9/

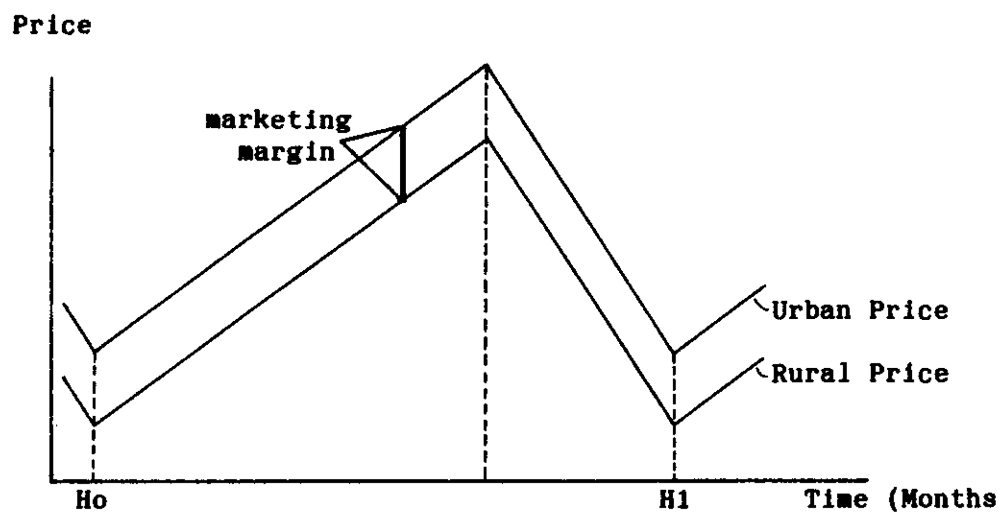
9/ More detailed information is also required to calculate so-called "technical" and "economic" efficiency indices for marketing systems (see, for example, Calkin and Wang, 1980, p. 42). The reader is cautioned that it is very difficult to summarize the efficiency of a marketing system in a single numerical value, and that it can be very misleading to make cross-country comparisons using these indices. These indices may be useful when comparing, within the same country, different marketing channels for the same or similar commodities, but it then becomes crucial to use comparable cost figures when constructing the indices. A more theoretical approach to estimating marketing efficiency using production possibility frontiers is presented in Weston (1976); this approach is difficult to apply in empirical work, however.

3.4. Rural-Urban Product Flows and their Reversals

Thus far the analysis has assumed that the flow of seasonally produced commodities is strictly from rural to urban markets throughout the year or marketing season. For a storable commodity, this implies that rural and urban prices move exactly in tandem (parallel) over the year, differing, in the most simple case, only by the cost of transfering the commodity. In addition, the two series rise over the season following the harvest period (Ho) to reflect the real costs of storage, and fall sharply prior to the subsequent harvest (H1) as the anticipation of new output depresses prices. This is illustrated graphically in Figure 3-4 below.

In reality, this model would appear to be a gross over-simplification. Instead one often finds in developing countries that governments regulate prices of storable commodities over the market season so that urban consumers do not suffer from drastic price changes. This regulatory pricing policy is sometimes implemented by importing supplementary quantities of the food commodity from international markets in the period between harvests when prices reach their seasonal peaks as shown in Figure 3-4. An alternative model is shown in Figure 3-5, the upper portion of which was taken from Timmer et al. (1983, p. 179). In this figure, GPC represents a government-imposed urban price ceiling, above which prices may not rise in urban areas. This can lead to an interesting modification of the stable urban-rural price relationship illustrated in Figure 3-4. Following the initial harvest period (Ho), prices in rural and urban areas begin to move together to reflect storage charges. Eventually, the urban price reaches the GPC and becomes a flat line, while rural prices continue to rise towards their seasonal highs. Now, if there is a reversal of product flows once the difference between rural and urban prices exceeds the cost of transfer from urban to rural areas, then prices in rural areas will become

FIGURE 3-4: RURAL AND URBAN PRICE BEHAVIOUR IN THE ABSENCE OF CONTROLLED URBAN PRICES



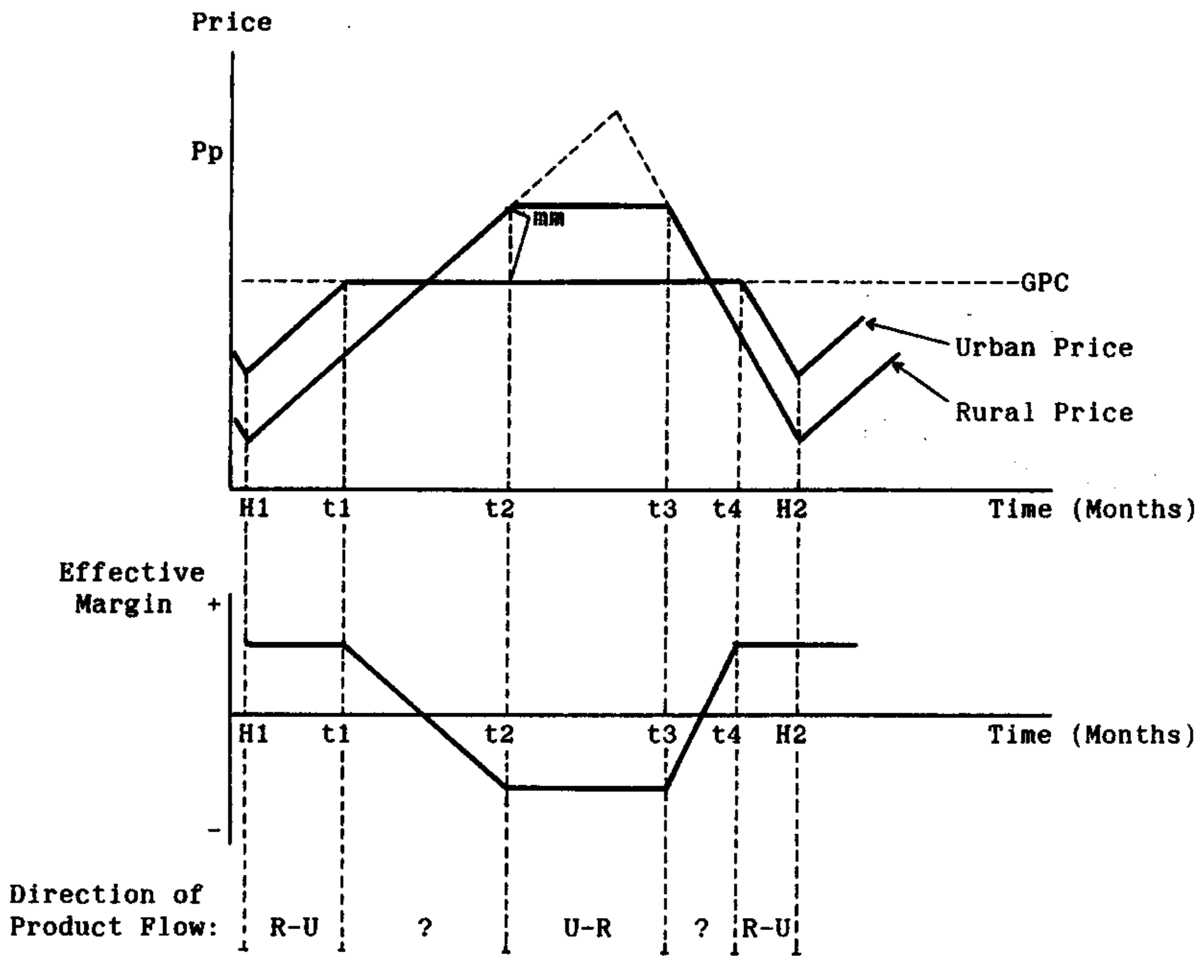
functionally dependent on urban market prices (i.e. flat) once again; this is shown as point t2 in Figure 3-5. As a result we have the behaviour of prices shown in Figure 3-5. (see also Timmer, op. cit.). Incidentally, this type of model may be relevant whenever it becomes profitable to import commodities from overseas; that is, we do not necessarily have to assume that the government is regulating the price (Harriss, 1979, p 207). 9/

This modified, more realistic description of actual price behaviour in many developing countries poses a considerable challenge to the analyst. In particular, we should expect a reversal of product flows through marketing channels, i.e. from urban to rural areas in the period t2 to t3, when rural prices are sufficiently high to cover marketing costs from urban to rural areas (this assumes it costs the same to ship the commodity, at least a part of which is now imported, in either direction). In the interim "gray" periods, t1 to t2 and t3 to t4, however, relative price differences are such that it does not pay to ship any quantity of the commodity in either

---

9/ For a small country, the supply function of the commodity is perfectly elastic and the world price in effect takes on the role of a GPC.

FIGURE 3-5: RURAL AND URBAN PRICE BEHAVIOUR WITH GOVERNMENT PRICE CEILINGS (GPC) IN URBAN AREAS



direction, simply because rural-urban price differentials are not large enough to cover transfer costs, or because there is uncertainty about the direction and magnitude of price changes in the near future. In other words, it does not pay any market participant to engage in spatial arbitrage. If Figure 3-5 is a true representation of reality, then we can no longer apply the above margin analysis, because we do not know whether rural-urban price differentials reflect transfer costs, and whether the margin can simply be represented as the difference between urban and rural prices: the rural price is no longer functionally dependent on the urban price (which is the same as saying that demand at the farm level is no longer derived from demand at retail), and we simply do not know how prices are related or determined (see also Harriss, 1979, p. 207, Timmer, *op. cit.*).

Timmer (1974) examined this phenomenon by calculating monthly marketing margins over a wide area in Indonesia, to which he applied regression ANOVA's by using margin subsets divided according to the agricultural calendar. His results confirmed the model shown in Figure 3-5 in some cases.

A somewhat more simple method of analyzing the problem of product flow reversals is to plot the margins between key market nodes over time, as is shown in the bottom of Figure 3-5. Then, if there is a pattern in the margin series similar to that in the figure, further statistical analyses for the data in periods H1-t1, t2-t3 and t4-H2 may be carried out. For example, observations in all years for periods H1-t1 and t4-H2 can be tested against an estimated (average) marketing margin in a t-test to verify whether or not they are significantly different. Similarly, margin observations in periods t2-t3 can be tested against the negative value of the estimated average marketing margin.

It should be emphasized that this reversal phenomenon is most likely with storable, seasonally produced commodities, and that it is always preferable to plot the data first to see whether or not further analyses are warranted. It is plausible, for example, that margins continue to fall (i.e. become more negative) at t2 until prices in rural areas reach their peaks. In this case we would conclude that rural prices are only functionally dependent on urban prices when the latter exceed the former by the cost of transfer. In other words, products may flow from rural to urban areas, but not vice versa.

This last point should again strongly caution the analyst that calculating marketing margins from observed data is only the first step in price analysis. It is important to also observe the actual operation of the marketing system in order to verify, for example, whether spatial arbitrage does in fact take place. Otherwise, the inferences drawn from the data may be incorrect and lead to poor policy recommendations. This is discussed further in Chapter 5.

IV. SEASONAL ANALYSIS: DECOMPOSING MONTHLY TIME SERIES DATA

Seasonal analyses of monthly, historical price or quantity data series for food and agricultural commodities constitute a further important part of market analysts' work. 11/ In particular, this analysis seeks to sort out repetitive seasonal or intra-annual variations in the data series, from which behavioural inferences and other conclusions can be drawn. As indicated in earlier chapters, and assuming that there are no pan-seasonal pricing rules enforced by a government agency, the prices of storable commodities normally rise between two adjacent harvest periods to reflect the real costs of storage. 12/ Alternatively, if there is some type of seasonality in the production and marketing of non-storable crops, it is normal to expect that prices and quantities produced or marketed will vary inversely over a year (assuming demand is constant throughout the year). Similarly, if there are bottlenecks in providing marketing services at certain times of the year when peak-level quantities are marketed, marketing margins generally reflect that higher demand on the services of the system. These are only a few examples of when and why it is important to analyze the degree and nature of seasonal price and quantity changes. This chapter begins by discussing the various components of a complete seasonal analysis, and then presents various applications using actual data.

Any series of monthly price or quantity observations over time can be decomposed into four conceptual parts according to the following "classical

---

11/ This chapter (and the SEASONS subprogram) deals only with monthly time series data. Where warranted it is also possible to conduct the seasonal analysis on quarterly, weekly or daily data. Wildt (1976) discusses the use of dummy variables in decomposing quarterly data.

12/ Note that even if there is pan-seasonal pricing, the government parastatal might be able to handle only a small percentage of the marketed surplus, and therefore only marginally influence prices. Alternatively, irregular food imports may offset seasonal price increases.

model" (see also Lapin, 1978, Ch. 12, or Pindyck and Rubinfeld, 1981, Ch. 15), which indicates that each of the four components on the right hand side is uniquely related to the actual observation on the left hand side.

$$Y(i) = T(i)\ C(i)\ S(i)\ R(i)$$

where
- Y(i) = the time series observation in month i on the commodity studied (price or quantity),
- T(i) = the trend component in month i,
- C(i) = the cyclical component in month i,
- S(i) = the seasonal component in month i, and
- R(i) = a random disturbance in month i not caused by any of the 3 above factors.

This "multiplicative model" could also be written in an additive form by taking logarithms of both sides, but since the subsequent analysis uses indices, it is convenient to look at it in the form given; also, there is no substantial difference between the multiplicative and additive forms of the model. Each of the four components will be discussed in detail below, and they are shown graphically in Figure 4-4 (page 73). 13/

4.1. Trend

A time series may contain a natural or secular trend over time, which may be increasing or decreasing. For example, as the population of a country grows, it is common to observe an increase in the quantity marketed of a particular food in response to growing demand. At the same time, if the supply of the food does not keep up with the growing demand, real or deflated prices of that commodity can be expected to rise (or, alternatively, assuming no government price supports, prices may fall if supply grows faster than demand). A further example is that of a constant year to year

---

13/ Degand and Haese (1983) use additive monthly dummy variables and the Cochrane-Orcutt partial adaptation method (p. 87) to arrive at a seasonal decomposition. They apply these techniques, along with the classical decomposition discussed here, to bean prices in Burundi.

increase in the cost of an input such as energy, and it is of course important to distinguish such a trend from other short term movements which may be caused by cyclical, seasonal or random variations.

The trend factor is calculated quite simply by performing an ordinary least squares regression (minimizing the sum of the squared residuals) of the raw observation on a time dummy variable which is incremented by 1 for each consecutive time period (month). This gives the mathematical relationship,

$$Y = a + b\ TIME$$

where
Y = the actual observation,
a = the intercept
b = the slope value
TIME = the time dummy variable.

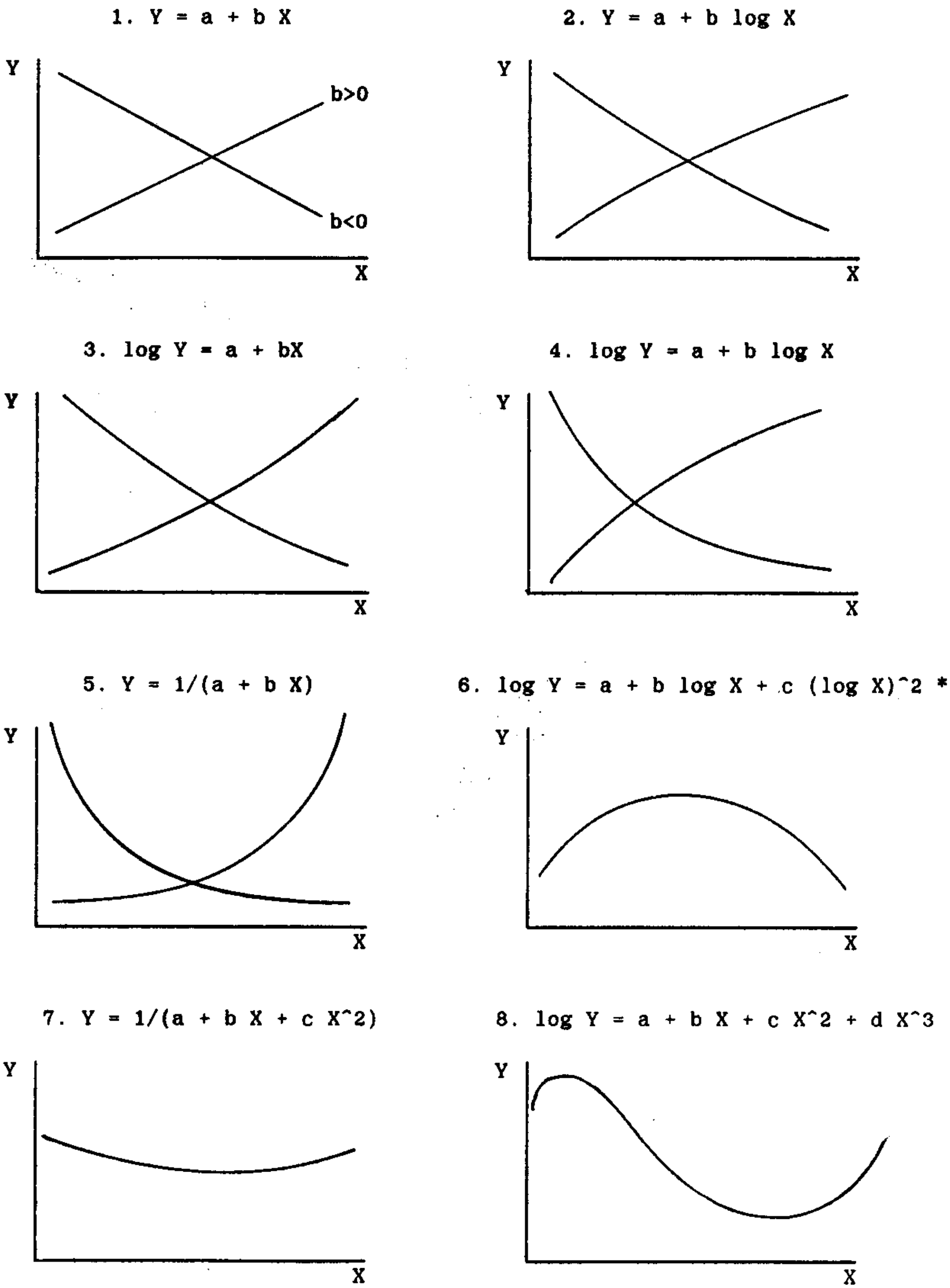
As indicated earlier, the intercept value (a) has little economic meaning since it depends entirely on when the series starts. The b- or slope-value shows by how much the Y-value increases or decreases from one month to the next. This type of model is probably the most simple way of obtaining trend forecasts for the dependent variable, which is done by plugging appropriate values for time into the estimated equation. For example, suppose the interest is in forecasting the price of Y five years into the future. One way to proceed (probably not the best) would be to add 60 (= 5 years x 12 months) to the total number of observations and substitute that sum into the above equation to find the projected price. The degree of confidence in the predicted value will depend on the standard error of the overall regression as well as the amount of time covered by the prediction; that is, the further into the future, the less reliable the prediction. An unfortunate drawback of simple trend estimates is that they are incapable of picking up any turning points or seasonality in the time series. Also note that the classical model now yields Y' = T, where Y' represents the calculated rather than the actual observations, and C, S and R have theoretically been eliminated.

It is also possible to select alternative functional forms for the trend estimation if the data do not seem to follow a linear path. In this case the raw observations can be transformed so that an appropriate model is obtained, depending on how the data series behaves. Some of the more common models are shown in Figure 4-1. It must be stressed, however, that the seasonal analysis computations which follow all rely on a simple linear trend estimation (case 1. in the figure).

A word of caution is necessary with respect to standard t- and F-tests on the estimated equations: because time series data usually seriously violate the standard OLS assumptions (homoscedasticity, no autocorrelation, etc), these tests must be interpreted with extreme caution, and it may sometimes even be better to ignore them. Similarly, the detrending options of some computer software packages, which in effect remove the trend from the data series by dividing it by the trend values, should be used judiciously since positive autocorrelation in the data will lead the t-tests to claim that there is a significant trend when in fact there is none.

In summary, it is useful to estimate the trend component as a first step to determine the direction in which the series has been moving in the past, how it is likely to move in the future, and this also allows point estimates to be made for future values of the dependent variable. More importantly for this chapter, the trend is an important variable which is used in calculating the cyclical index, discussed below. A deflated trend on a price series, finally, should in principle reflect the general trend in prices caused by factors other than inflation.

FIGURE 4-1: COMMON FUNCTIONAL FORMS USED IN ESTIMATING TRENDS

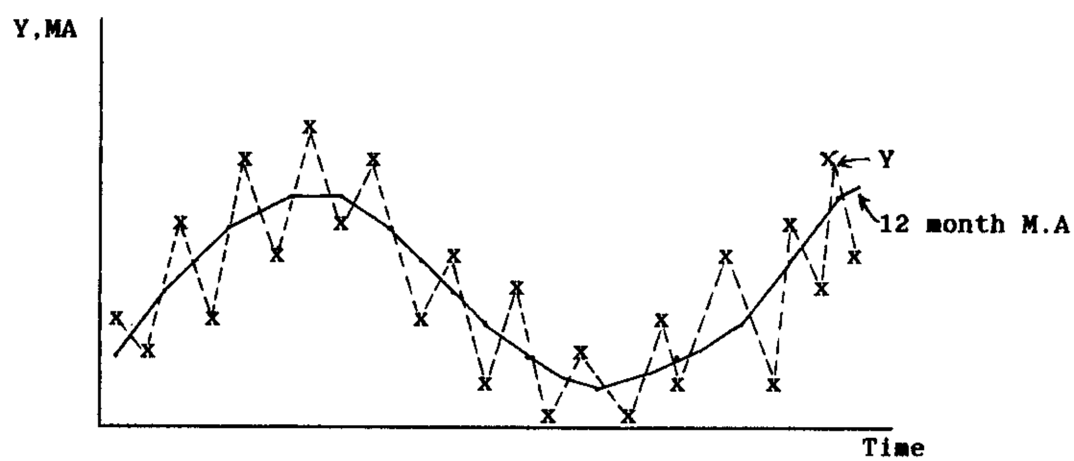


<u>Source</u>: See, for example, Ezekiel, M. and K.A. Fox (1959)
* The symbol ^ means the preceding term is "raised to the power of".

4.2. Moving Averages

A further calculation neccesary in seasonal analysis is that of moving averages. These averages are not only important for their own sake, as will be seen shortly, but also for calculating the seasonal index, to be discussed in section 4.3. In the n-period moving average technique, individual observations in a time series are replaced by the average of the n/2 values in the preceeding periods and the n/2 values in the subsequent periods. As a result, an observation in period t will depend on some of the previous and subsequent values of that variable, or, alternatively, the observation will carry a weight of 1/n instead of 1. This means that if an individual observation is unusually large or small, the averaging procedure will bring that value more in line with the other values in the series, and short-term "blips" or fluctuations are largely eliminated. This is illustrated in Figure 4-2 below.

FIGURE 4-2: MOVING AVERAGES AS A SMOOTHING PROCEDURE



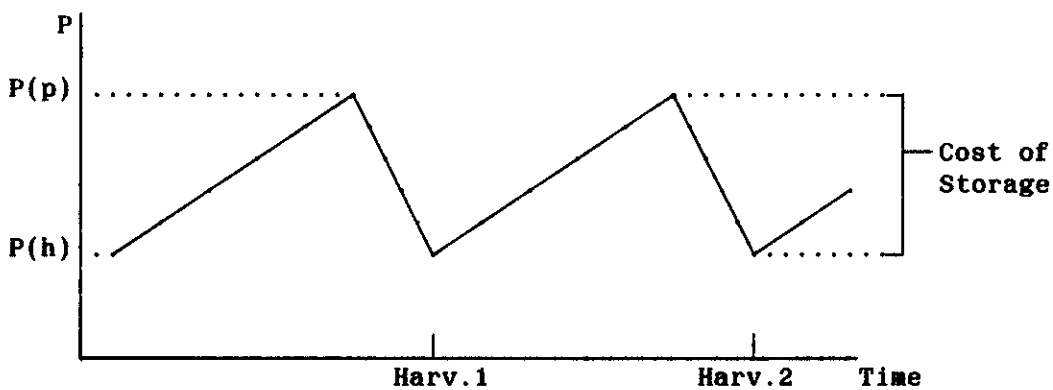
The value of this technique therefore lies in its ability to remove some of the shorter-term fluctuations in the series, which in turn allows the analyst to focus on important longer term factors such as cycles and trends. If the moving average is calculated on a 12-month basis for monthly data, then it should in effect also remove most of the seasonality in the data along with the random components. Note that the larger is n (the period of time over which the moving average is calculated), the smoother the resulting series will be. If n is chosen to equal N, the total number of observations, then the resulting series will be a straight line.

In terms of computations, a problem arises when n is an even number. In the case of a 12-month moving average, for example, an additional calculation is needed in order to center the moving average exactly on each month. To do this, the moving average is calculated by summing the 1st through 12th months and the 2nd through 13th months, adding these two averages and then dividing by 24. This is the same as summing the 1st through 13th months where the 1st and 13th months are each given a weight of 1 while the 2nd through the 12th month are each given a weight of 2, and then dividing the total by 24. Because of this procedure there is no moving average for the first and last 6 observations in the series; there is simply not enough information for the variable in the initial and final 6 periods to calculate a moving average. Finally, eliminating or accounting for the seasonal and random components leaves $Y = T \times C$ in terms of the classical model. The moving average may also be expressed in terms of actual, inflated or deflated data.

4.3. Seasonal Index

Seasonal movements in price and quantity time series are especially prevalent in, but not limited to, agricultural products. Biological cycles of nature (rainy periods, sunlight hours, time lags in crop and livestock production) exert strong influences on agricultural production processes and are reflected, via quantities, in the behaviour of prices over time (see also Tomek and Robinson, 1982). This natural seasonality on the supply side is often compounded by cultural events on the demand side (Thanksgiving Turkeys in the U.S., demand for mutton at the end of Ramadan in Islamic countries). Assuming that governments do not mandate pan-seasonal prices, the general seasonal pattern expected in prices of a storable commodity which is produced and harvested only once each year (as indicated in Chapter 3), is a yearly low immediately after the harvest period and a general rise in prices, proportional to storage costs, over the year until the next harvest season is approached. Graphically this may be demonstrated as shown in Figure 4-3.

FIGURE 4-3: SEASONALITY IN PRICES OF A STORABLE COMMODITY



P(p) = peak season price, P(h) = price at harvest

It is obvious that if the seasonal fluctuations can be discerned and measured, it will be easier to make predictions about prices and to understand their behaviour over the year. It will also allow assessment of the extent to which seasonal price movements reflect storage costs. Thus far only storable commodities have been referred to as having strong seasonal patterns. As will become clear in the section with applications below, however, there is seasonal price (and quantity) behaviour even in non-storable commodities which are produced, although usually to varying degrees, throughout the year.

Computing a seasonal index, following the "ratio to moving average" approach, is straightforward once a 12-month moving average has been calculated. The calculation is (with variables as defined on page 65 of this chapter), simply,

$$\text{Seasonal Index} = \frac{Y}{\text{Moving Avge.}} = \frac{T\ C\ S\ R}{T\ C} = S\ R$$

The seasonal component therefore contains some random elements, which will be eliminated when a grand seasonal index is calculated as explained in Section 4.5. A seasonal index value of 106.5, for example, indicates that the price in that month is 6.5% above the overall average in the period of analysis (and vice versa for index numbers below 100). If the seasonal component remains fairly constant from one year to the next, then the differences among seasonal indices of the same months in different years should be caused solely by random disturbances. Also note that because of the way in which it is calculated, the seasonal index is relatively free of inflationary biases, and it does not make much sense to talk about a deflated or inflated seasonal index.

Finally, it is possible to deseasonalize a data series in order to remove seasonal influences. This in turn facilitates the identification of longer term cyclical movements in the series. The computation is carried out by dividing the original data series by the seasonal index (and then multiplying by 100). Alternatively, it may be more straightforward to directly calculate the cyclical index, if this is of interest. Also, analysts are generally more interested in the seasonality of a series, so it usually does not make sense to remove this component, except for special purposes. A few other important uses of the seasonal index, such as forecasting, are discussed in section 4.6. (Applications)

4.4. Cyclical Index

Cyclical variations in time series are more difficult to explain and understand since they in general do not follow an easily predictable path. A cycle may be defined as a pattern which reappears with some regularity over time; it can cover any number of years within a cycle, and it may be caused internally (self-reinforcing) or it may be caused by external shocks such as drought and other climatic factors, or general business and investment cycles. Discerning cyclical behaviour is complicated by the fact that it is often impossible to separate true cycles from random influences. Furthermore, cycles generally do not fit neatly into a yearly pattern, and they tend to vary in intensity (amplitude) from one peak or trough to the next.

A good example of cyclical movements is the production cycle of livestock in many countries; it takes time to build up herds and this often reinforces erratic cyclical price behaviour caused by factors other than supply disturbances. For example, when hog prices are high due to excess demand or insufficient supply, farmers start to build up herds so that supply eventually catches up with demand. More often than not, however, supply continues to expand once supply equals demand, since farmers are unwilling to disinvest in their herds and facilities, and so prices are depressed. After a few months disinvestment may begin to take place as some farmers are forced out of business, and sooner or later there will be excess demand once again; prices will rise, and so the cycle begins once more. Thus, in contrast to more or less predicatable seasonality, cyclical oscillations are erratic and difficult to predict in advance.

A commonly used technique for calculating the cyclical index, C, is that of dividing the moving average by the trend:

$$\frac{\text{M.A.}}{\text{Trend}} = \frac{T \times C}{T} = C$$

To the extent that the moving average still contains random components, C will also contain these disturbances and it will not be a "pure" cyclical index.

Finally, we can briefly discuss how the random disturbance could in theory be isolated:

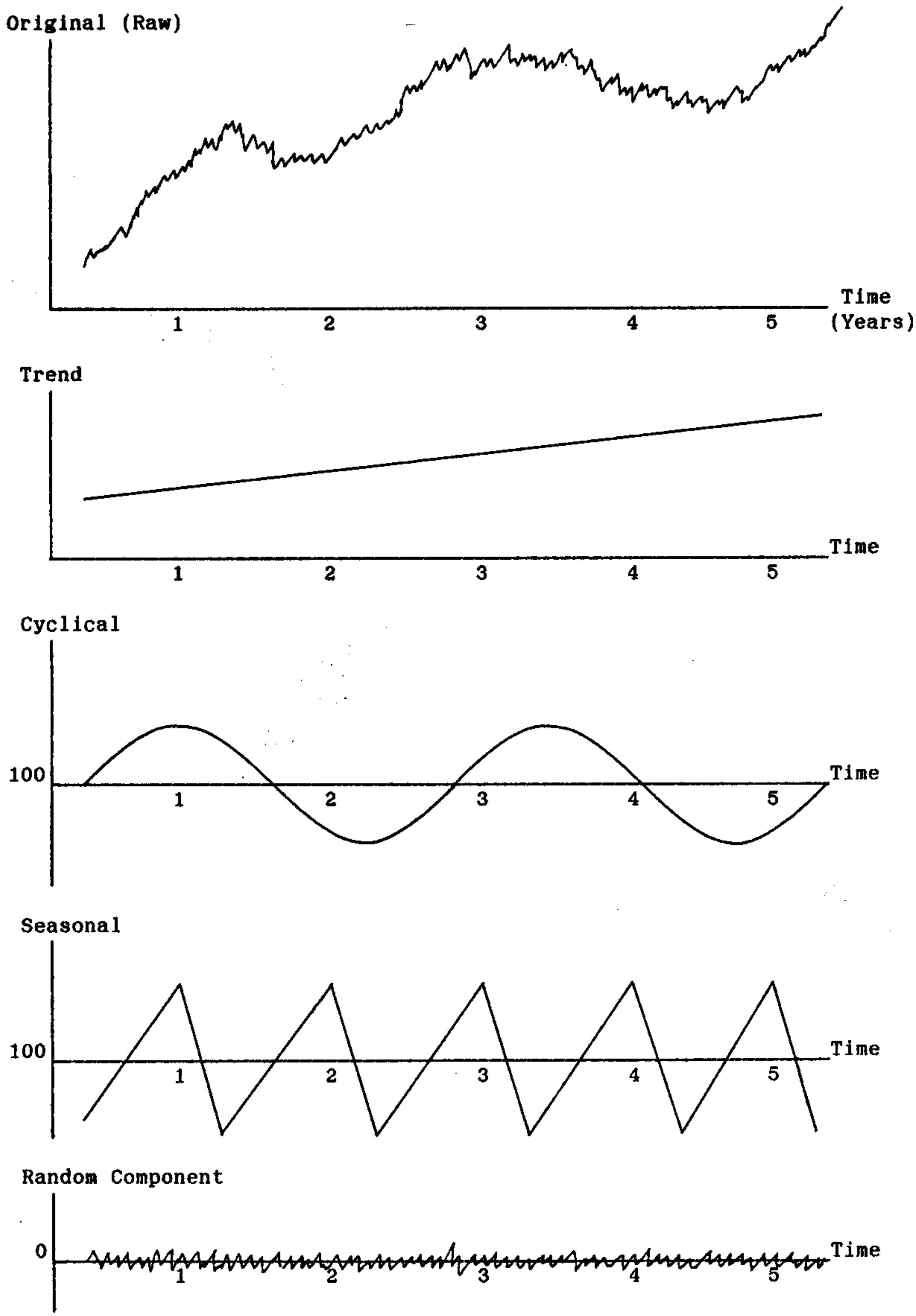
$$\text{Random Component} = \frac{T\ C\ S\ R}{T\ C\ S} = R$$

However, since we can never perfectly single out T, C and S, this measure is merely a residual. The applications section (4.6) gives an example of an actual cyclical index along with its graph. By way of summarizing this section on seasonal analysis, Figure 4-4 shows the trend, cyclical, seasonal and random components of a hypothetical time series.

4.5. Grand Seasonal Index

The Grand Seasonal Index (GSI) is a very useful summary statistic, showing how prices or quantities behaved over the period of analysis in the different months under study. It is calculated by finding the average seasonal index for each month over the period of analysis, and then adjusting those averages so that they sum to 1200. Because of this averaging procedure, the GSI should in principle be purged of all random variations in the time series data. The grand seasonal index can be presented in a table along with a barchart diagram so that the seasonal pattern is readily apparent. This is shown for actual data in the following section on applications in Table 4-4 and Figure 4-7, where further uses and interpretations of the GSI are also discussed.

FIGURE 4-4: GRAPHICAL DECOMPOSITION OF A HYPOTHETICAL TIME SERIES
(Monthly Data)



4.6. Applications

In this section a complete seasonal analysis is presented and interpreted for the millet price series in Bamako shown in Table 1-1 (Chapter 1). The reader should note here that a seasonal analysis is both useful and meaningful, and possible to carry out even if the data series consists of only 38 monthly observations (a minimum of 24 months is necessary if 12-month moving averages are to be calculated). This is followed by an analysis of monthly quantities of cows slaughtered at the Liniers market in Buenos Aires, Argentina, over the 11-year period spanning 1972-82. The final application of the seasonal analysis technique is to the tomato data for the period 1975-77 from Brazil, originally presented in Chapter 3.

Consider first the 38-month series of millet prices in Bamako, Mali. When this series was regressed on a simple trend variable (starting with and incremented by one for each month) in order to obtain the trend, which was also used in the subsequent calculation of the cyclical index, the results shown in Table 4-1 were obtained. This implies that, over the 38-month period of analysis, a trend is present which increases the price (dependent variable) by 1.90 CFA/kg in each month; this is of course an undeflated or nominal series. The t-statistic of 8.065 indicates that the B coefficient estimate is significantly different from zero. In other words,

TABLE 4-1: REGRESSION RESULTS FOR MILLET PRICES IN BAMAKO, 1982-85

NO OF OBS =	38	STD ERR OF EST =	15.894
MEAN OF Y =	110.553	STD DEV OF Y =	26.267
A =	73.573	T =	8.065
B =	1.896	STD ERR OF B =	0.235

we have:

$$P(m) = 73.57 + 1.896\ M$$
$$(8.065)$$

where P(m) is the price of millet in month m and M indicates the monthly value. Predicting the price of millet 2 years (or 24 months) into the future, under the assumption that the present trend will continue, we obtain a value of P(m) = [73.573 + 1.896 * (38 + 24)] = 191.13 CFA/kg for February 1987. Incidentally, this trend line is plotted along with the actual prices in Figure 4-5. From the graph observe that actual prices fluctuated considerably around this trend line, and therefore no large degree of confidence can be attached to this predicted value. It is of course possible to calculate a confidence interval for this figure by using the information on the standard error of the estimated equation and the variability of Y provided in Table 4-1.

Next consider the results in Table 4-2, which show the actual price variable, the trend, 12-month moving average, as well as the seasonal and cyclical indices for this millet price series. As indicated at the beginning of this chapter, there is no moving average for the first and last six observations in the series, and therefore the seasonal and cyclical indices also have no corresponding values for these months. Observe in Table 4-2, that there is some consistent repetitive pattern in the seasonal index series, while the cyclical index shows a sine-wave type of pattern. All of this is brought out very clearly in Figures 4-5 and 4-6, where these four variables have been plotted over time. Examining Figure 4-5, in which the moving average has been transposed upon the actual price series, observe how the moving average quite nicely eliminates most of the irregular fluctuations in the actual prices. Similarly, even though it is fairly short, the seasonal index series in Figure 4-6 shows a clearly repetitive

TABLE 4-2: SEASONAL ANALYSIS COMPONENTS FOR MILLET PRICES IN BAMAKO, 1982-85

Data File MIL-BAMA
Title: Millet Prices in Bamako (CFA/kg), 1982-85

Function: SEASONAL
Data case no. 1 to 38
Without selection

The data starts JAN, 1982 and represents a DEC, 1982 to NOV, 1983 market year

OBSERV. NUMBER	ACTUAL DATA	TREND	MOVING AVERAGE	SEASONAL INDEX	CYCLICAL INDEX
1	81.00	75.47			
2	77.00	77.37			
3	78.00	79.26			
4	82.00	81.16			
5	82.00	83.06			
6	85.00	84.95			
7	90.00	86.85	85.92	104.75	98.93
8	91.00	88.74	86.17	105.61	97.10
9	94.00	90.64	86.46	108.72	95.39
10	95.00	92.54	86.83	109.40	93.84
11	87.00	94.43	87.58	99.33	92.75
12	87.00	96.33	89.08	97.66	92.48
13	85.00	98.23	90.75	93.66	92.39
14	79.00	100.12	93.25	84.72	93.14
15	83.00	102.02	96.75	85.79	94.84
16	86.00	103.92	100.21	85.82	96.43
17	96.00	105.81	103.58	92.68	97.89
18	107.00	107.71	106.33	100.63	98.72
19	108.00	109.60	108.88	99.20	99.33
20	133.00	111.50	111.96	118.79	100.41
21	136.00	113.40	115.38	117.88	101.74
22	136.00	115.29	119.42	113.89	103.58
23	127.00	117.19	123.67	102.70	105.53
24	113.00	119.09	128.00	88.28	107.49
25	120.00	120.98	132.33	90.68	109.38
26	118.00	122.88	135.00	87.41	109.86
27	126.00	124.78	136.29	92.45	109.23
28	140.00	126.67	137.71	101.66	108.71
29	144.00	128.57	138.29	104.13	107.56
30	163.00	130.46	138.04	118.08	105.81
31	156.00	132.36	137.63	113.35	103.98
32	149.00	134.26	137.17	108.63	102.17
33	151.00	136.15			
34	155.00	138.05			
35	122.00	139.95			
36	112.00	141.84			
37	111.00	143.74			
38	116.00	145.64			

FIGURE 4-5:
CURRENT COMMODITY PRICE AND MOVING AVERAGE, MILLET PRICES, BAMAKO

Data file MIL-BAMA
Title: Millet prices in Bamako (CFA/kg), 1982-85

Function: PLOT
Data case no. 1 to 38
Without selection

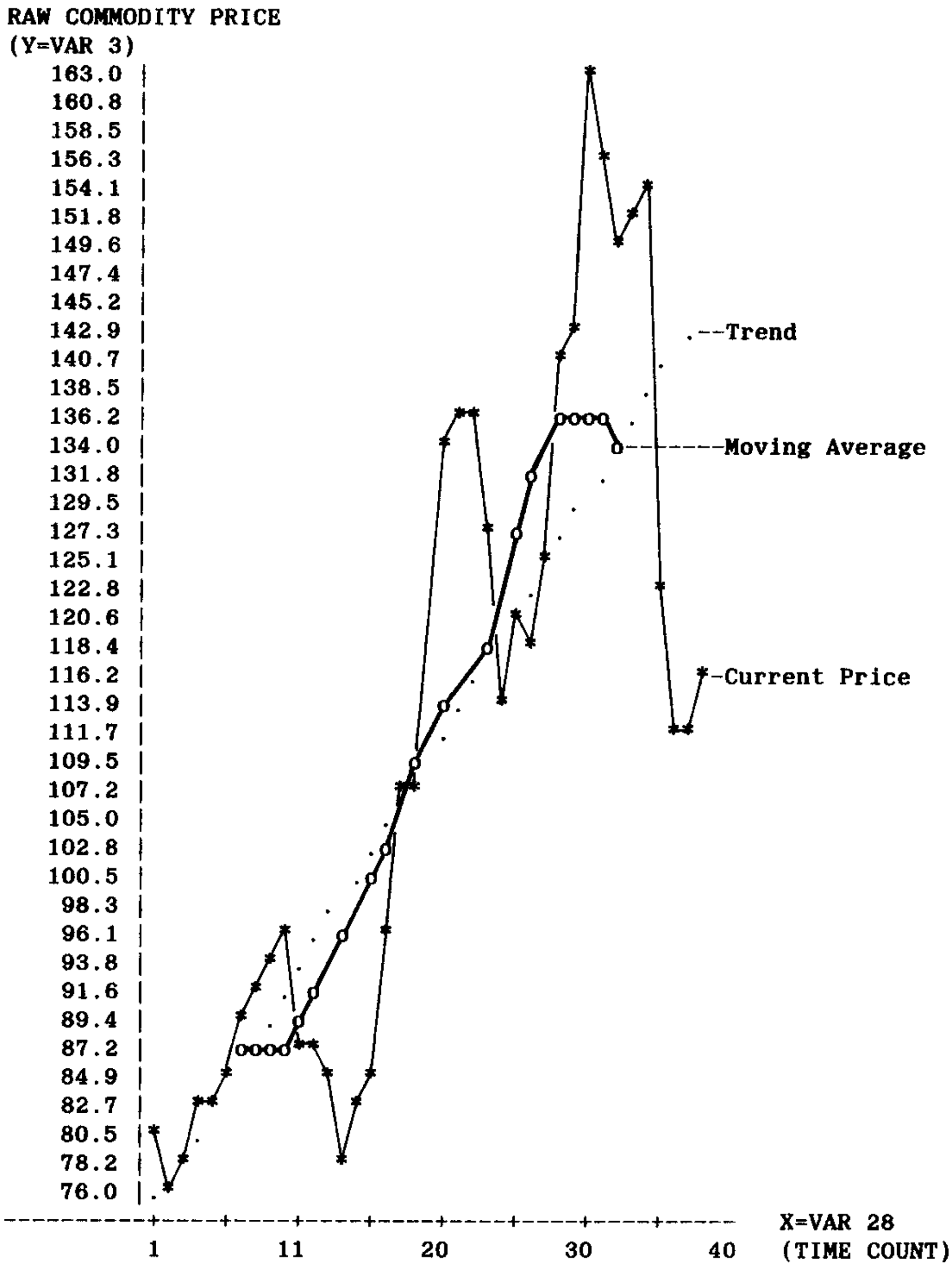
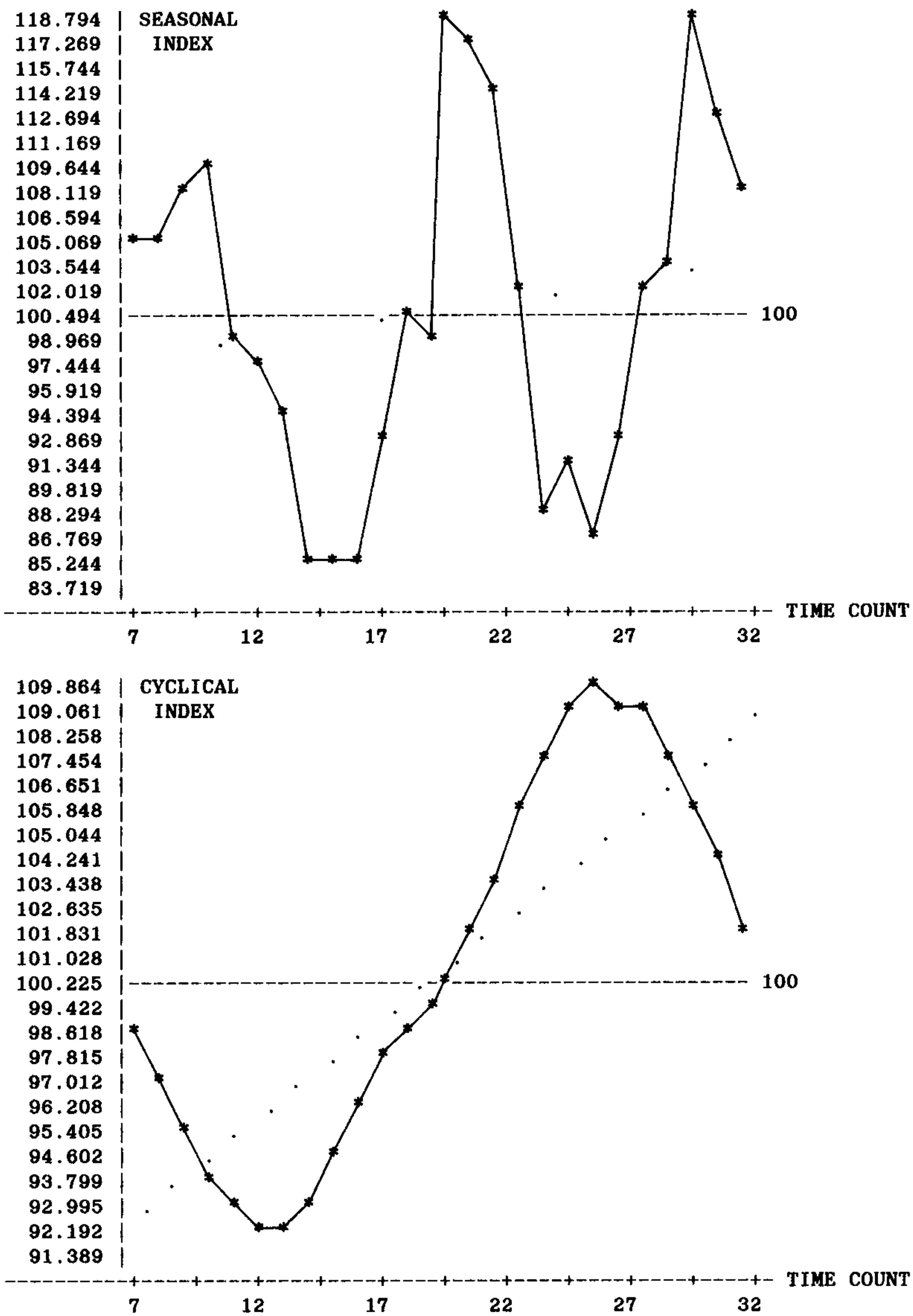


FIGURE 4-6: SEASONAL AND CYCLICAL INDEX FOR MILLET PRICES, BAMAKO



seasonal pattern--undoubtedly reflecting at least in part storage costs--while the cyclical index closely follows a sine-wave, with no apparent consistent yearly pattern. It is also interesting to note that for the 26th observation (or month), the cyclical and seasonal indices almost completely offset each other, with the former being below the average index of 100 by 10 units, and the latter being above the average by 10 units. In the vicinity of the 15th month (i.e. March of 1976), on the other hand, the two indices strongly reinforce one another in a downward direction, implying relatively low millet prices. In this period seasonal and cyclical factors worked so as to complement each other in driving prices downwards.

The usefulness of the seasonal index in examining price (and quantity) series does not end here, however. A further important analysis can be carried out by presenting the seasonal index in monthly tables, and then calculating the mean, trend and t-statistic for the indices of the same months. This is not only essential for more refined forecasting which takes into consideration seasonal influences, but also important for understanding how the behaviour of market participants changes over time. This is done by analysing the trend in the monthly seasonal values, which indicates whether prices (or quantities) marketed are increasing or decreasing over time in any particular month. Table 4-3 shows such an example for the seasonal millet price index obtained above.

Note the mean and the trend value of the seasonal index for each month. In addition, the t-statistic for the trend value indicates whether or not the trend value is significant. In particular, the trend value for the months of June and December are interesting, since they indicate that prices are increasing in June and decreasing in December (at an index rate of 17.5 and -9.4, respectively). However, these results must be interpreted with extreme caution because the series analyzed was very short. For

TABLE 4-3: SEASONAL INDEX FOR MILLET PRICES IN BAMAKO, 1982-85

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1982							104.8	105.6	108.7	109.4	99.3	97.7
1983	93.7	84.7	85.8	85.8	92.7	100.6	99.2	118.8	117.9	113.9	102.7	88.3
1984	90.7	87.4	92.4	101.7	104.1	118.1	113.4	108.6				
1985												
Mean	92.2	86.1	89.1	93.7	98.4	109.4	105.8	111.0	113.3	111.6	101.0	93.0
Trend	-3.0	2.7	6.7	15.8	11.4	17.5	4.3	1.5	9.2	4.5	3.4	-9.4
t	-1.7	1.6	2.6	4.0	3.4	4.2	0.8	0.2	3.0	2.1	1.8	-3.1

example, in the months where three index values were available (July and August), the t-statistics are very low, while they were more or less significant in most of the other months, where only two values were available for calculating the mean and the trend. This shows the very strong influence of the number of degrees of freedom in calulating the variability in the monthly values, which is used in obtaining the t-statistic (which is simply the trend value divided by the standard error of the series, which in turn is a function of the number of observations). For this reason, a more detailed presentation of the use of seasonal indices in making projections is deferred until we take up the analysis of slaughtered cow quantities, where considerably more observations are available.

We come, finally, to the grand seasonal index and its bargraph, shown in Table 4-4 and Figure 4-7. As already indicated, the grand seasonal index (GSI) is another useful statistic, which conveniently summarizes the behavior of the variable analyzed within years, that is, its seasonal pattern. Assuming historical patterns and trends continue in the future, it can also be used to determine whether or not the seasonal pattern exhibited by the series is indeed significant, at a certain level of confidence. If there was a significant trend in the original data series (i.e. the T-statistic in Table 4-1 was statistically significant for reasons other that positive autocorrelation), and if this trend does not continue into the future, the GSI's in the latter months of the year will be biased upwards (and biased downwards in earlier months) when forecasts into the future are made. If the analyst somehow establishes that strong past trends will not continue in the future, it would be desireable to first detrend the data series (for example, using CALC in MSTAT) and then recalculate the GSI for forecasting purposes.

Consider first the data in Table 4-4. The first column, the average seasonal index, is obtained by averaging the seasonal indices for each month, and essentially duplicates the information provided in Table 4-3. The second column shows the standard error associated with each monthly mean (again, the reader is cautioned that because the series was extremely short, very little confidence can be attached to these figures; instead the discussion is primarily for illustrative purposes). The third column then presents the grand seasonal index. It is obtained by manipulating the average seasonal indices so that they sum to exactly 1200 (i.e. 12 months times an average index value of 100). This calculation is necessary because the average seasonal indices will not sum to 1200 due to the error terms. Yet, the grand seasonal index, by definition, must sum to 1200. It is apparent from Table 4-4 that the discrepancy between the average and grand seasonal index series is not very large. The last three columns, finally, show the corrected standard error (calculated from the GSI), and the GSI plus or minus one standard error. These last two columns are helpful in establishing whether or not the seasonal pattern in the index series is statistically significant. More specifically, if the grand seasonal index deviates from the average index value of 100 by more than one standard error in either direction (i.e. up or down), then we are approximately 70%

TABLE 4-4: GRAND SEASONAL INDEX FOR MILLET PRICES IN BAMAKO, 1982-85

MONTH	AVERAGE SEASONAL INDEX	STANDARD ERROR	GRAND SEASONAL INDEX	CORRECTED STANDARD ERROR	GSI + CSE	GSI - CSE
JAN	92.17	2.11	91.82	2.09	93.92	89.73
FEB	86.06	1.90	85.74	1.89	87.62	83.85
MAR	89.12	4.71	88.78	4.67	93.46	84.11
APR	93.74	11.20	93.39	11.12	104.51	82.27
MAY	98.40	8.10	98.03	8.03	106.07	90.00
JUN	109.35	12.34	108.94	12.25	121.19	96.69
JUL	105.77	7.13	105.37	7.08	112.44	98.29
AUG	111.01	6.91	110.59	6.86	117.45	103.73
SEP	113.30	6.47	112.87	6.42	119.29	106.45
OCT	111.65	3.17	111.22	3.15	114.37	108.08
NOV	101.01	2.38	100.63	2.36	102.99	98.27
DEC	92.97	6.63	92.62	6.58	99.20	86.04

confident that the seasonal index is significant. This means that if the specified condition is met even for a single month, the index had a significant seasonal pattern in 7 out of the last 10 years. Alternatively, one could also add and subtract two standard errors from each month's index value, and if this calculation showed that the index value plus or minus two times its standard error for a single month was greater than or less than 100, it would exhibit a seasonal pattern in 9.5 out of 10 years. In other words, the pattern would be statistically significant at the 5 % level. 14/

There are of course problems with making these statements about "statistical significance". First, we are working with very few observations (degrees of freedom), which reduces the reliability of the estimates and makes interpretations such as "in 7 out of the last 10 years" seem odd.

14/ See Foote and Fox (1952) for additional discussion on measuring and testing for significance of seasonal patterns; these authors also present methods of calculating the significance of seasonality between months using ANOVAs.

Second, in most countries we are dealing with data from dynamically evolving economies in which structural changes (such as in transport and storage facilities, rolling stock, market information, etc.) are widespread and numerous; for this reason some analysts would prefer not to talk of probabilities obtained through random sampling in the classical statistical sense. Especially when dealing with forecasts, therefore, it is important to state analytical results with caution. Notwithstanding such problems, these statistical concepts are used in the remainder of this paper. The justification is that even though data series are limited and structural conditions may well be changing in an economy, it is deemed preferable to cautiously use existing data rather than "guess" at future outcomes.

Figure 4-7 shows the graph of the grand seasonal index in a very useful form. Here the 100% line represents the average value of the time series over the period of analysis, and the bargraphs indicate by how much each month's seasonal index value lies above or below this overall average. The graph also makes it easier to see that in the months of January, February and March, the seasonal index is significantly below the 100% average at a 5% level. For example, in January, add two times the standard error of 2.1 (= 4.2) to the GSI value for that month (91.8) to obtain 96.0. This figure is still below that of 100, so that in 9.5 out of 10 years we would--under the above caveats--expect the seasonal pattern to be significant. Similarly, for September and October, the GSI's are greater than 100 when two times the standard error is subtracted from each month's value.

The standard errors of each monthly GSI also serve the purpose of showing the variability in each month's index. For example, there is a higher degree of confidence associated with the February index (with a standard error of 1.9), than with the June index (12.2). This kind of information is important when seasonal indices are used for forecasting

FIGURE 4-7: GRAPH OF THE GRAND SEASONAL INDEX FOR MILLET PRICES IN BAMAKO, 1982-85

Data File MIL-BAMA
Title: Millet Prices in Bamako (CFA/kg), 1982-85

Function: SEASONAL
Data case no. 1 to 38
Without selection

```
         |
%  117.0+
         |
o        |                                                XXX
f  110.8+                                                 XXX   XXX
         |                              XXX         XXX   XXX   XXX
A        |                              XXX         XXX   XXX   XXX
n  104.5+                               XXX   XXX   XXX   XXX   XXX
n        |                              XXX   XXX   XXX   XXX   XXX
u   100%+===============================XXX===XXX===XXX===XXX===XXX===XXX========
a   98.3+                               XXX   XXX   XXX   XXX   XXX   XXX
l        |                        XXX   XXX   XXX   XXX   XXX   XXX   XXX
         |                        XXX   XXX   XXX   XXX   XXX   XXX   XXX
A   92.0+                   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
v        | XXX              XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
e        | XXX        XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
r   85.7+ XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
a   GSI  | 91.8  85.7  88.8  93.4  98.0 108.9 105.4 110.6 112.9 111.2 100.6  92.6
g   CSE  |  2.1   1.9   4.7  11.1   8.0  12.2   7.1   6.9   6.4   3.1   2.4   6.6
e   79.5+--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+---
  Months   J     F     M     A     M     J     J     A     S     O     N     D
```

GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

The 100% Line in the barchart represents the average of 110.553 units over the 3 year period of analysis of commodity data.
Each monthly index value indicates by how many percentage points each month's value lies above or below the overall average.
The standard error of 2.1 for Januray indicates that the Januray value can be expected to fall within plus or minus 2.1 percentage points of its mean 70% of the time (for example in 7 out of 10 years), assuming historical patterns continue in the future.*

----

* This message is printed by the SEASONAL program. Note again that the period of analysis is very short and that the confidence limits are only approximate.

purposes, as will be discussed in the seasonal analysis of number of cows slaughtered below.

Finally, it is often useful to examine the cyclical index of a time series before deciding over which period of time the grand seasonal index should be calculated. For example, if the production cycle of a commodity spans three years, analysts are more comfortable with calculating the GSI over groups of years (such as 3, 6 or 9, etc. years), using the beginning of the cycle as their first month of analysis. Especially in cases where longer time series are available, and the cyclical pattern underlying the data is known, it is useful to calculate and examine the cyclical index first, and then chose the appropriate time frame of analysis for the GSI. It is obviously important to understand the factors underlying the cyclical pattern. In the millet price example there were only 38 monthly prices, but we were fortunate in that the period over which the GSI was calculated happened to fall into an almost complete cycle (see Figure 4-6).

To complete this section, Figure 4-8 shows the grand seasonal indices for millet, sorghum, maize and rice prices in Bamako, calculated over the period 1982-1985. Of these four graphs, that for millet shows the closest approximation of price behaviour as would be expected for a seasonally produced, storable commodity. In particular, with the exception of the month of June, it shows a gradual and smooth increase in the price of millet from February through September, and then a much more rapid drop in October through January, as the next harvest period is approached. The barchart diagram for rice shows a very atypical pattern of prices over the year for a storable commodity. This can most likely be explained by commercial or concessional rice imports and/or a poor data series. For example, with a constant value of 163.0 CFA /kg in 1983, we cannot expect to learn much from this data.

FIGURE 4-8: COMPARISON OF GRAND SEASONAL PRICE INDICES IN FOUR GRAIN MARKETS, BAMAKO, MALI

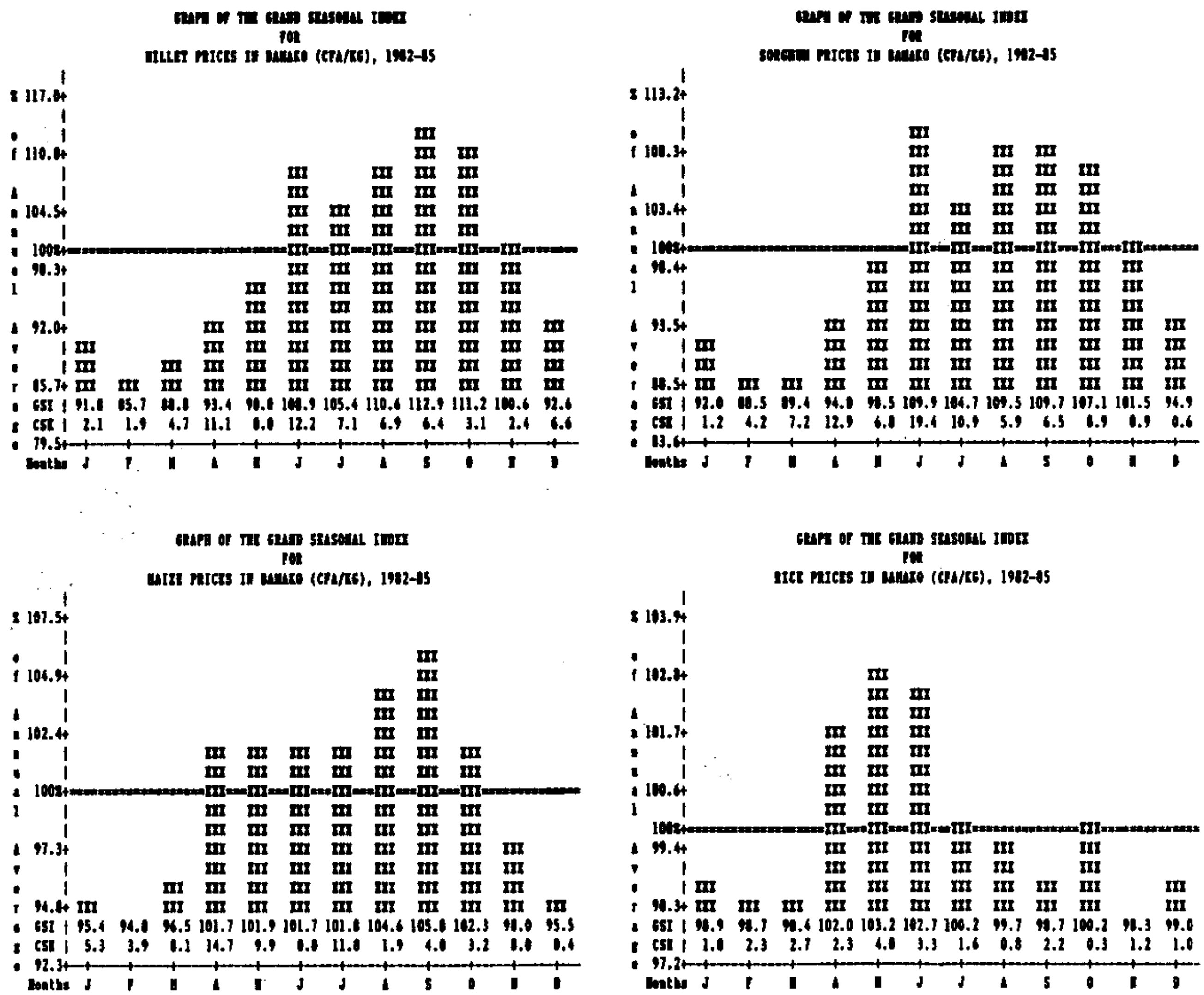


Table 4-5 below shows the average daily numbers of cows slaughtered each month in Buenos Aires, Argentina. It may seem peculiar that average daily rather than total monthly quantities are given in this table, and, in fact, the original data was given on a monthly basis. When a series on quantities is decomposed in a seasonal analysis, however, it is essential to express monthly values on an average daily basis. Otherwise, there will be inherent biases in the seasonal indices since the months in a year have different numbers of days. For example, if the February values were to be expressed on a monthly basis, there would be an inherent downward bias in the index series of that month, simply because February has fewer days than the other months, and therefore less quantities can be slaughtered. If the monthly values are expressed on an average daily basis, on the other hand, this inherent bias is removed, and the seasonal index reflects what the analyst is really after. Obviously, this kind of problem does not arise with price data, since prices are expressed as monthly averages and do not depend on the number of days in a given month.

This quantity slaughtered series was decomposed seasonally, and the results are shown in Table 4-6 and Figure 4-9. Note first, from the bar-graph, that a seasonal peak was reached in the May-June period for slaughterings. This is a function of the production process of young calves, since it is in these months that the young animals are weaned and the older cows are sent off for slaughtering.

Therefore, there is considerable seasonality in this data, even though cows are produced (to varying degrees) throughout the year, and are not "storable" as, for example, grain is. Secondly, we see that the seasonality is statistically significant at the 5% level in at least one month (eg. June), and therefore the overall series has a significant seasonal pattern.

TABLE 4-5:
DAILY QUANTITIES OF COWS SLAUGHTERED, LINIERS MARKET, ARGENTINA (1972-82)

Data file COWSLGHT
Title: Daily Quantities of Cows Slaughtered

Function: SEATABLE
Data case no. 1 to 132
Without selection

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1972	344.9	388.6	571.2	648.7	570.4	475.6	534.9	339.4	279.3	314.7	427.1	349.2
1973	379.1	384.8	476.3	480.5	625.8	480.8	386.0	367.6	119.5	177.2	398.3	513.5
1974	432.8	386.2	456.4	454.5	480.3	471.2	359.3	214.4	254.2	382.8	277.0	215.7
1975	322.1	346.1	313.4	371.1	332.5	506.0	584.6	545.1	459.9	489.6	443.7	587.2
1976	582.3	741.4	661.6	894.6	893.6	963.7	710.2	531.6	514.4	390.7	564.3	605.9
1977	572.9	636.5	835.2	840.2	993.3	999.0	769.1	642.2	526.7	475.9	786.7	757.4
1978	806.9	801.1	856.8	975.4	999.9	971.5	814.3	839.5	572.5	478.9	695.7	652.1
1979	835.2	819.1	872.8	966.1	999.5	882.8	726.8	423.1	381.7	437.1	470.7	391.4
1980	496.2	505.8	498.2	546.0	639.0	574.3	619.7	381.9	362.2	290.1	409.0	543.3
1981	491.1	514.8	648.4	802.6	668.7	792.3	791.5	503.3	500.3	421.4	468.7	579.6
1982	468.1	506.7	872.9	681.7	750.9	679.7	539.7	435.3	378.0	331.9	505.7	418.3

Year	Calendar Year Average
1972	437.000
1973	399.117
1974	365.400
1975	441.775
1976	671.192
1977	736.258
1978	788.717
1979	683.858
1980	488.808
1981	598.558
1982	547.408

Source: Calculated from Junta Nacional de Carnes, various issues (1972-1983)/Luis Girado.

TABLE 4-6: GRAND SEASONAL INDEX FOR DAILY QUANTITIES OF COWS SLAUGHTERED

MONTH	AVERAGE SEASONAL INDEX	STANDARD ERROR	GRAND SEASONAL INDEX	CORRECTED STANDARD ERROR	GSI + CSE	GSI - CSE
JAN	94.84	10.49	94.96	10.52	105.48	84.44
FEB	98.57	7.64	98.69	7.66	106.35	91.03
MAR	113.21	18.44	113.35	18.49	131.84	94.87
APR	121.21	12.49	121.36	12.52	133.88	108.83
MAY	128.43	20.78	128.59	20.84	149.42	107.75
JUN	127.06	8.21	127.21	8.23	135.44	118.98
JUL	112.68	13.50	112.82	13.54	126.36	99.28
AUG	84.08	16.30	84.18	16.34	100.52	67.84
SEP	69.25	16.17	69.33	16.21	85.54	53.12
OCT	70.18	19.64	70.27	19.69	89.95	50.58
NOV	87.49	10.23	87.60	10.26	97.86	77.35
DEC	91.52	17.88	91.64	17.92	109.56	73.72

FIGURE 4-9: GRAPH OF THE GRAND SEASONAL INDEX FOR DAILY QUANTITIES OF COWS SLAUGHTERED

```
        |
%  137.7+
        |
o       |
f  124.0+                         XXX   XXX
        |                   XXX   XXX   XXX
A       |                   XXX   XXX   XXX
n  110.4+             XXX   XXX   XXX   XXX   XXX
n       |             XXX   XXX   XXX   XXX   XXX
u   100%+=============XXX===XXX===XXX===XXX===XXX===============================
a   96.7+       XXX   XXX   XXX   XXX   XXX   XXX
l       | XXX   XXX   XXX   XXX   XXX   XXX   XXX
        | XXX   XXX   XXX   XXX   XXX   XXX   XXX                     XXX   XXX
A   83.0+ XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX               XXX   XXX
v       | XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX               XXX   XXX
e       | XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX               XXX   XXX
r   69.3+ XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
a   GSI | 95.0  98.7 113.4 121.4 128.6 127.2 112.8  84.2  69.3  70.3  87.6  91.6
g   CSE | 10.5   7.7  18.5  12.5  20.8   8.2  13.5  16.3  16.2  19.7  10.3  17.9
e   55.7+--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+---
  Months   J     F     M     A     M     J     J     A     S     O     N     D
```

GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

Again, we only had 10 observations from which to calculate the GSI, and therefore this "statistical significance" should be interpreted with extreme caution.

In the remainder of this section the seasonal index, shown in Table 4-7, is used for forecasting purposes and to determine if seasonal indices are changing over time. Assume an interest in forecasting the number of heads slaughtered in March and September of 1987. One method is to substitute the numbers 195 and 201 into the estimated trend equation which was used in the seasonal decomposition (not shown) to calculate the cyclical index. These numbers represent March and September of 1987, respectively, when January of 1972 is given the value 1. The results obtained with this calculation are simply the straight-line trend extrapolations of the series, and they of course do not reflect any seasonal variations. In order to correct for this deficiency, multiply the forecast March value by 1.132 and that of September by 0.692, which are the respective GSI values for these months. Under the assumption that the seasonal pattern continues as before, this would yield a highly superior forecast as compared to the value obtained from the trend line, since it takes into consideration historical seasonal variations. Obviously, this assumption of historical continuity may not be valid if underlying structural economic factors are changing rapidly.

Further analyses can be carried out with the trend and t-values at the bottom of Table 4-7. Here the values for March, September and November are especially interesting, since they indicate that the seasonal pattern has been shifting during the period of analysis. For example, the trend value of 2.4 for March shows that the annual rate of change in that month's index was 2.4 index units over the period of analysis. In other words, the index, which is already greater than 100, has been moving further away from the

TABLE 4-7: SEASONAL INDEX FOR DAILY QUANTITIES OF COWS SLAUGHTERED

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1972							122.0	77.2	64.1	74.1	101.7	82.7
1973	91.0	93.5	117.3	122.1	161.9	122.6	96.2	91.1	29.7	44.2	101.1	132.6
1974	112.2	102.1	120.9	116.0	121.5	124.7	99.6	60.5	73.3	113.4	84.5	66.8
1975	96.5	96.9	82.6	94.6	82.3	118.7	129.2	113.6	90.0	89.5	74.9	92.5
1976	88.3	111.7	99.4	134.8	134.5	143.7	105.9	79.8	76.9	58.0	83.5	88.9
1977	83.6	91.9	119.7	119.8	139.0	136.9	103.1	84.2	68.4	61.3	100.5	96.9
1978	103.1	101.0	106.7	121.2	124.8	122.5	103.1	106.0	72.2	60.4	87.7	82.6
1979	106.8	107.6	118.6	133.1	139.8	127.1	108.5	65.8	62.2	75.3	85.9	75.2
1980	98.6	101.8	100.8	112.0	133.5	119.0	126.8	78.1	73.1	56.6	78.0	101.6
1981	89.2	91.4	113.0	137.2	112.8	132.7	132.4	84.4	82.7	69.1	77.1	95.5
1982	79.1	87.6	153.1	121.4	134.3	122.7						
Mean	94.8	98.6	113.2	121.2	128.4	127.1	112.7	84.1	69.2	70.2	87.5	91.5
Trend	-1.1	-0.6	2.4	1.4	-0.3	-0.0	1.7	-0.1	2.1	-1.4	-1.9	-0.5
t	-1.0	-0.7	1.2	1.0	-0.1	-0.0	1.1	-0.1	1.2	-0.6	-2.0	-0.2

average of 100 by approximately 2.4 units annually, which implies that the seasonal price increases in March have become more pronounced in percentage--not absolute--terms in more recent months relative to the earlier months (based on Ferris, 1983). If the trend estimate for the index in that month had been negative, the indication would be that prices in that month are becoming less variable over time. However, note also that the t-statistic (1.2) for that trend value is not highly significant. Examining the November index series, on the other hand, it is apparent that it too is becoming more variable, since the negative trend estimate implies that the index series is moving further away from 100. And in this case it is in fact a statistically significant pattern. The data in the table further indicate that only the months of May and September are showing less pronounced seasonal variations, since the mean index value for May is above 100 and the negative trend coefficient estimate implies that it is moving closer to 100, while the opposite is true for the month of September. Neither of these estimated coefficients are significant, however. Finally, observe that there has been no overall change in the variability of the seasonal index for June.

To conclude this chapter we will consider once more the questions raised in Chapter 3 in the marketing margin analyses of tomato prices. The issue is whether a high monthly volume of tomatos marketed in the city of Fortaleza, Brazil entails an increase in marketing margins due to bottlenecks and excessive pressures on the marketing system. A related question is, do overall prices respond to increases or decreases in quantities supplied? These questions can now be addressed using the seasonal analysis concepts.

The following three steps are recommended to address these issues.

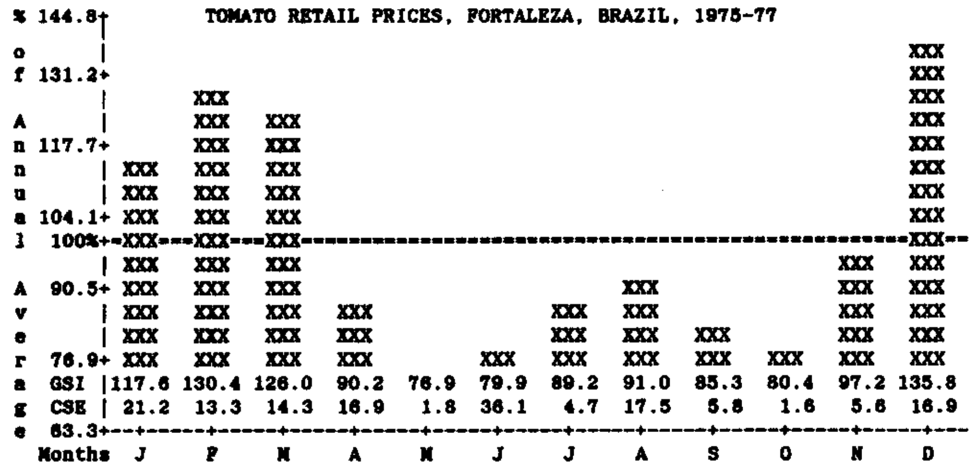
(a) Look carefully at the most complete set of data available for each level of the tomato production and marketing chain.

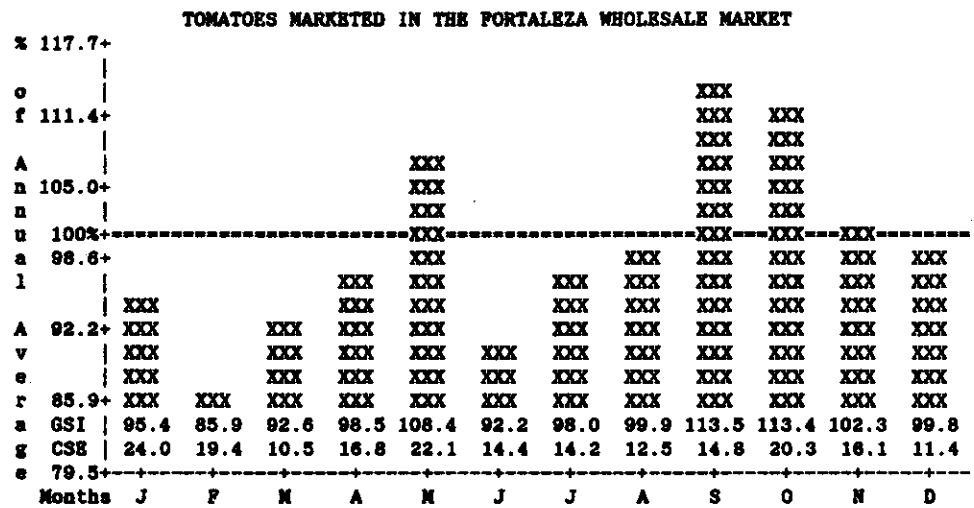
(b) If possible, examine price/quantity and margin relationships at both urban and rural levels.

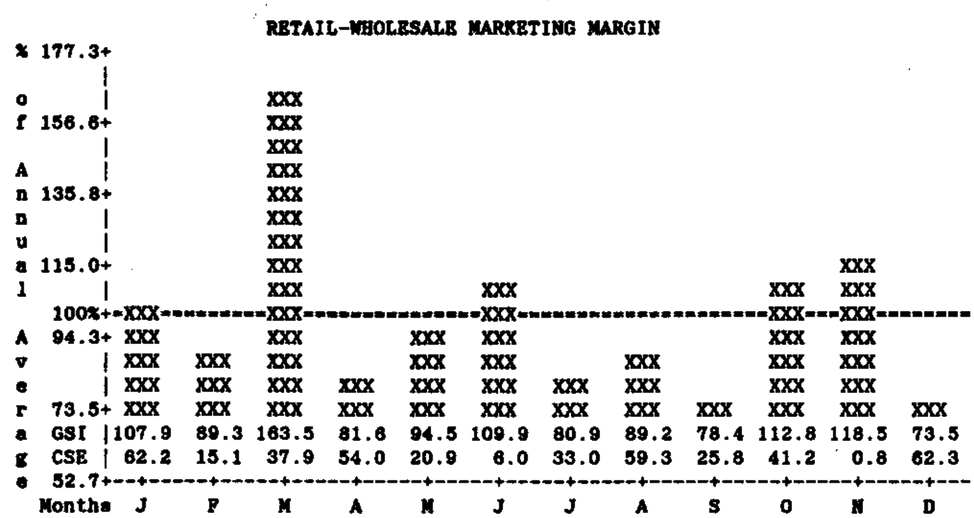
(c) Begin with graphic and seasonal-type analyses, then proceed to more precise testing of hypothesized functional relationships (eg. correlations).

Figure 4-10 shows grand seasonal index graphs of tomato retail prices, tomatos marketed at wholesale in Fortaleza, and retail to wholesale margins, respectively. First, we may note that there is a fairly consistent inverse relationship between the seasonal indices of retail level prices and quantities marketed. In other words, and as expected, when quantities supplied are low, prices are high and vice versa (assuming that demand is stable throughout the year). On the other hand, a comparison of marketing margins and quantities marketed does not reveal a highly correlated relationship, that is, margins are not necessarily higher when more quantities are sent through the system. To the contrary, it looks more like an inverse

FIGURE 4-10: COMPARISON OF GRAND SEASONAL BARGRAPHS







relationship--lagged by one month--exists, with higher margins dominating in periods when supplies are at their seasonal lows and vice versa; consequently the "bottleneck" hypothesis suggested above is not supported by this data. Before definite conclusions are drawn here, however, it would be important to examine which other commodities are shipped through the same marketing system, and when. For example, it is possible that other fruits and vegetables compete with tomatoes at some parts in the season, so that tomato margins rise for this reason, and not because high quantities are being shipped. It is also possible that middlemen take higher profits in periods when supplies of tomatoes are low. In this regard, it is also noteworthy that the seasonality in the margins does not appear to have any obvious contemporaneous relationship to the seasonality in prices at retail.

These results reemphasize the urgency of conducting price analyses in conjunction with diagnostic surveys. It is insufficient to examine only the given price/quantity data since often alternative conflicting results may be generated from them. In the above example the analyst would have to investigate the relative concentrations of buyers and sellers (see Chapter 3) and the full set of business activities they are involved with at different levels in the marketing system in order to obtain more conclusive results.

Finally, it would also be interesting to compare the seasonality in sets of alternative variables, such as that in wholesale prices, quantities marketed at wholesale, and the wholesale-retail margin, or, in farm prices, farm level quantities marketed and the farm-wholesale margin. Here the choice of variables to compare in the analysis depends on precisely which relationships the analyst is attempting to test. A useful method of presenting the results of the seasonal analyses on price and quantity variables to market participants and policy makers is to superimpose the seasonal quantity index on the seasonal price index series in the same diagram. If this were done for the price and quantity seasonal indices in Figure 4-10, it would show not only that prices and quantities are inversely related, but also that the variability in the quantity index series (around the mean of 100) is smaller than that in the price index series. These presentations can be supported statistically by correlating the original price and quantity data series with each other and reporting the estimated correlation coefficient along with its level of significance.

V. CORRELATION ANALYSIS: MARKET AND PRICING EFFICIENCY

As indicated in earlier chapters, the efficiency and effectiveness of markets and marketing functions are of primary concern to food system analysts and policy makers in almost all countries. If a careful examination and analysis of the market and its institutions reveals major inefficiencies, lacking services, non-competitive conditions or bottlenecks, then it is important for analysts to advise private sector and government marketing organizations of problems and opportunities for change. For example, if it is found that prices rise by more than the actual cost of storage from one harvest period to the next one, there may be reason to believe that it is too costly and risky for individuals to store commodities, and the government could perhaps provide improved and subsidized storage technology to the market participants. If middlemen are making excessive profits, the government could encourage the entry of new participants by removing institutions such as market licenses and/or taxes which may currently be discouraging some individuals from setting up their own wholesale or retail operations. Alternatively, if retail prices in market A are completely uncorrelated with those in market B, the government may consider building better roads between the markets or providing improved market information through radio price-reporting services in order to encourage and improve spatial arbitrage.

In assessing the efficiency of a marketing system in order to make recommendations for possible changes, unfortunately, it is a common problem in Third World countries that there are few detailed and accurate records available from farmers or marketing agents. Consequently, more indirect methods of analysis have been developed in order to carry out such evaluations. The two most important of these -- assessing market efficiency over time and over space -- are discussed below; both rely on observed market prices rather than detailed budgetary data collected from individual market members. As will be argued in Section 5.4., however, it is never sufficient to examine only the given data; as was emphasized in earlier chapters, it is always necessary to examine existing conditions in the market, even if that is done only through rapid diagnostic assessments and surveys. Furthermore, before analyzing temporal efficiency, it is necessary to estimate storage costs for the commodity in question. This procedure is discussed in the following section.

5.1. Calculating Storage Costs

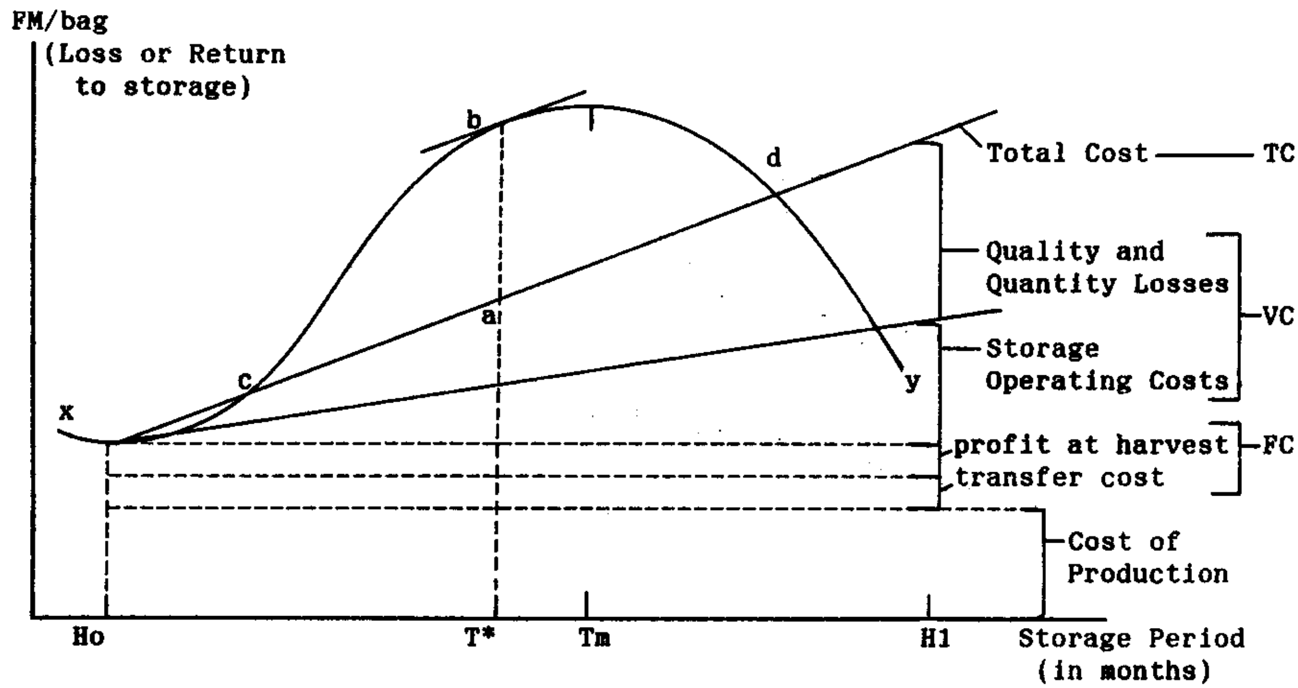
A calculation of actual or estimated storage costs is important not only for the temporal efficiency assessment, but also for its own sake. All too often market participants are labelled as "parasitic speculators" because they allegedly hoard commodities after harvest in order to make excessive profits later in the season at the expense of consumers. Storing commodities does involve real resource costs, however, and before market agents engaging in the storage function can be judged as acting inappropriately, the costs of storage involved have to be calculated and compared to actual seasonal price changes. Only then will it be possible to make informed and intelligent recommendations to marketing agents and policy-makers.

Storage costs are usually disaggregated into (a) operating costs and (b) qualitative and quantitative losses of the product during storage. Operating costs can be further divided into fixed costs of storage, such as overhead and handling expenses which do not depend on the length of time a product is in storage, and variable costs which include interest on the working capital which is tied up in the stored commodity (see also Homann and Zettelmeyer, 1980, p. 25). These latter costs depend on the length of time over which the commodity is stored, as do the quantitative and qualitative storage losses. These latter losses, which are real economic costs since they reduce the value of the stored commodity, are often extrapolated in some form over the storage period. For example, the quality of the product may deteriorate at an increasing rate over the storage period, depending on the nature of the product, and this would be an important consideration in determining the optimal storage period. Quantitative losses, on the other hand, may be largely incurred during the handling phase, when the product is first placed into the storage facility. Alternatively, a part of the product may be stolen or eaten by insects, etc. These relationships are shown in Figure 5-1.

The diagram shows that the fixed costs (FC) are constant over the storage period, while the variable costs (VC) slope upwards in a linear fashion. This also implies that if the commodity were to be stored for 8 months, then the fixed costs per month would be lower than if it were stored for only 4 months, because they would be spread out over a larger number of months. Price (measured in FM/kg) is shown as curve xy and is assumed to increase to a maximum at time Tm and then begins to decrease as the subsequent harvest period (H1) approaches.

The optimal storage period in the diagram is given by T*, which yields net maximum returns to storage of ab. At this length of storage, the difference between the price and the total cost of storage is maximized, as indicated by the equality of the slopes of the cost and price lines. Obviously, the agent engaging in the storage function would incur losses by storing for a period which is shorter (longer) than that indicated by c (d). The analysis presented here is quite general and can easily be used for marketing agents, who store the commodity for more than 12 months, by

FIGURE 5-1: ECONOMIC COSTS AND BENEFITS OF STORAGE



Source: Adapted from Homann and Zettelmeyer (1980), p. 27

extending the sine wave-like price line into later months. In this case the costs of production would be replaced with "acquisition costs". With this conceptual framework in mind, we can go through the details of calculating storage costs as shown in the worksheet of Table 5-1.

Section A in Table 5-1 states all the assumptions (or facts) used in calculating the storage costs of millet in our example, Mali (with currency units of FM). The assumptions (rows 1-3) are that the storage facility, with a life expectancy of 10 years (without repairs) and a capacity of 50 bags of millet, has to be built at a cost of 240.00 FM before the millet can be stored. Of course there may be situations where this initial investment is not necessary (for example, if an old building without alternative uses is available for storage); in that case, there would be no investment costs involved in calculating the storage charges. Rows 4 and 5,

Table 5-1: WORKSHEET FOR CALCULATING STORAGE COSTS

		Months of Storage (post-harvest)									
		1	2	3	4	5	6	7	8	9	10
A. ASSUMPTIONS											
1 Investment in Storage Facility	FM	240	240	240	240	240	240	240	240	240	240
2 Life Expectancy	years	10	10	10	10	10	10	10	10	10	10
3 Capacity of Facility	bags	50	50	50	50	50	50	50	50	50	50
4 Period of Storage	months	1	2	3	4	5	6	7	8	9	10
5 Interest on Investment	%/year	10	10	10	10	10	10	10	10	10	10
6 Interest on Working Capital	%/year	15	15	15	15	15	15	15	15	15	15
7 Market Price at Harvest	FM/bag	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
8 Market Price in Release Month	FM/bag	28.0	30.0	35.0	40.0	52.0	61.0	70.0	78.0	69.0	52.0
9 Handling and Treatment	FM/bag	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
10 Weight Loss	%/prd.	2.0	2.9	3.5	4.1	5.0	6.0	7.2	8.5	9.9	11.0
11 Quality Loss	%/prd.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
12 Costs of Production	FM/bag	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
13 Transfer Cost (to Market)	FM/bag	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
B. OPERATING COSTS/UNIT/MONTH											
14 Depreciation on Storage Facility	FM/b/m	0.48	0.24	0.16	0.12	0.10	0.08	0.07	0.06	0.05	0.05
15 Interest on Investment @ 10%	FM/b/m	0.20	0.10	0.07	0.05	0.04	0.03	0.03	0.02	0.02	0.02
16 Interest on Working Capital @15%	FM/b/m	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
17 Handling and Treatment	FM/b/m	1.00	0.50	0.33	0.25	0.20	0.17	0.14	0.12	0.11	0.10
18 Total Operating Capital	FM/kg/m	2.07	1.33	0.95	0.81	0.73	0.67	0.63	0.59	0.57	0.56
C. STORAGE COST PER PERIOD (CUMULATIVE)											
19 Operating Costs	FM/kg	2.07	2.66	2.85	3.24	3.65	4.02	4.41	4.72	5.13	5.60
20 Weight and Quality Losses	FM/kg	0.84	1.17	1.58	2.04	3.12	4.27	5.74	7.41	7.52	6.24
21 Total Storage Cost per Period	FM/kg	2.91	3.83	4.43	5.28	6.77	8.29	10.15	12.13	12.65	11.48
22 Storage Cost + Harvest Price	FM/kg	32.91	33.83	34.43	35.28	36.77	38.29	40.15	42.13	42.65	41.84
D. PROFIT (LOSS) WHEN COMMODITY IS SOLD											
23 Market Price at Release	FM/kg	28.00	30.00	35.00	40.00	52.00	61.00	70.00	78.00	69.00	52.00
24 - Cost of Production	FM/kg	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
25 - Transfer Cost	FM/kg	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
26 - Total Storage Cost per Period	FM/kg	2.91	3.83	4.43	5.28	6.77	8.29	10.15	12.13	12.65	11.48
27 NET PROFIT FROM PROD'N & STORAGE	FM/kg	11.09	12.17	16.57	20.72	31.23	38.71	45.85	51.87	42.35	26.16
28 NET GAIN OVER SALE AT HARVEST	FM/kg	-4.19	-3.83	0.57	4.72	15.23	22.71	29.85	35.87	26.35	10.16

Source: Adapted from Homann and Zettelmeyer, 1980. p. 36

respectively, indicate the interest rate paid on the investment (assumed to be government-subsidized at 10%) and the interest on working capital. The latter refers to the fact that the storage agent has money tied up in the stored crop which could be loaned to a friend or rural banker at 15% per annum. Rows 7 and 8 show the price prevailing at harvest and the price in each subsequent (post-harvest) month. Ideally, these prices would be historical averages so that the analysis could be used for making future storage decision. The costs of "handling and treatment" in row 9 refer to the transport and handling costs of getting the crop to the store and applying a sprout suppressant, dehumidifying agent, etc. This is assumed to be a fixed cost which is only incurred once. Any labour used for handling can be valued at the rural wage rate. Rows 10 and 11 show the quantitative and qualitative product losses on a percentage basis. They are expressed cumulatively, i.e. there is an initial 1 % quality loss when the millet is first stored, and then there are no further additional losses except for quantitative ones. Rows 12 and 13, finally, show the costs of producing the millet as well as the costs of transferring it to the market on the release date. The costs of production are not necessary if the interest is only in calculating storage costs; in this case the "net" profits from storage in line 27 would refer to storage gains before production costs are netted out.

Section B of the worksheet shows the storage operating costs per bag of millet per month. Row 14 is calculated as:

$$(14) \quad \begin{matrix}\text{Depreciation}\\ \text{per bag}\\ \text{per month}\end{matrix} = \frac{\text{Investment}}{\text{Life Expectancy} \times \text{Capacity} \times \text{\# of Months stored}}$$

The rationale behind this calculation is that the storage facility is built solely for the purpose of storing the millet. Therefore, we have to charge the cost of the facility against the revenue obtained from storage: if we store the millet for only one month, that month has to bear the entire burden of the depreciation charge for that year, but if we store for n months, that individual nth month only has to bear 1/n times the cost of depreciation. Consequently, we have the non-linear decline in depreciation charges shown in row 14.

Row 15 shows the interest charged on the investment, which is calculated as:

$$\text{(15)}\quad \text{Interest on Investment per bag per month} = \frac{\text{Investment} \times \text{Interest Rate}}{\text{Capacity} \times \text{Storage months} \times 12}$$

As indicated earlier, this charge reflects the fact that the storing agent has money tied up in the investment, which he could have put to alternative (interest-bearing) uses.

The interest on working capital in row 16 is similarly calculated as:

$$\text{(16)}\quad \text{Interest on Working Capital per bag per month} = \frac{[\text{Harvest Price} + \text{Handling/bag}] \times \text{Interest}}{12}$$

This interest represents the opportunity cost of the money foregone by not having sold the crop at harvest. It is incurred at a fixed rate in each month, until the crop is sold off. Line 17 measures the cost of the initial handling and treatment, spread evenly over each month in which the commodity is stored. The handling component includes transfer of the commodity both into and out of storage. The "treatment" may also include crop drying costs during storage. Hence it is calculated as:

$$\text{(17)}\quad \text{Handling \& Treatment per bag per month} = \frac{\text{Total Cost per Facility and Year}}{\text{Capacity} \times \text{Storage months}}$$

Line 18, the total operating capital needed for storage is then obtained by adding lines 14-17 vertically. The cumulative operating costs in line 19 are calculated by multiplying each item in line 18 by by the corresponding number of months of storage to obtain cumulative costs. To this we then add the weight and quality losses in line 20 to obtain the total cost per period of storage. Line 20 is calculated as:

(20) Losses/bag/period = Release Price x (% Weight + % Quality Loss)/100

It is then very straightforward to calculate the net profit from production and storage and net gain over sale at harvest rows (27 and 28) in the table. The latter is obtained by calculating the profit which could have been obtained at harvest (in this case 30 - 12 - 2 FM) and subtracting that number from row 23. From row 28 we see that the optimal month for selling the millet (assuming prices do in fact increase as specified in row 23) would be the 8th post-harvest month, which would yield a net return of 35.87 FM. It must be cautioned, however, that no risk premiums have been added to this figure, and so storage agents may chose to sell in an earlier month. This would be true especially if the agents' risk aversion functions increase at an increasing rate as the months pass by, and/or if they cannot afford to hold stocks in storage because they need the money. 15/ With this information on how to calculate storage costs, we are now in a position to discuss the concept of assessing temporal market efficiency.

5.2. Correlation Over Time

In this analysis, prices or price changes from one harvest period to the next are compared to storage costs for the same time period. In

---

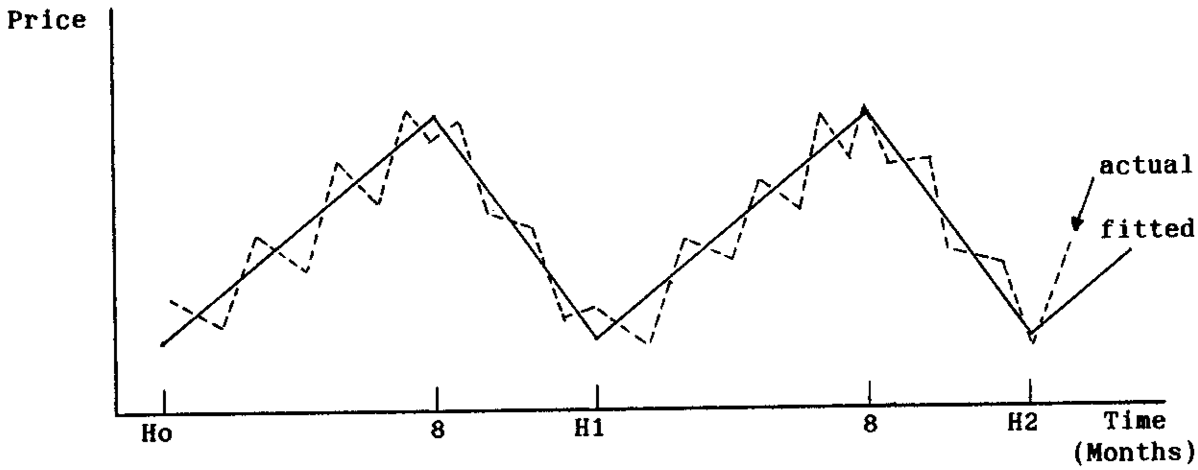
15/ In countries where commercial storage is available, the user of the storage facility may have to pay fixed rates for specified time periods (eg. 3 months); here the storage cost calculations have to be modified accordingly.

general, we would expect prices to rise so that storage costs, including risks to individuals, are just covered. If prices rise by more than storage costs, and assuming that the costs were calculated correctly, then the storage function is not carried out efficiently since someone or something is preventing a reallocation of the storable commodity to the future, which creates relative scarcity and therefore higher prices in the future. Alternatively, if prices do not rise to cover storage costs, there must be some other reason such as seasonal demand, government price regulations, or imports/food aid which renders storage unprofitable.

We have already reviewed the grand seasonal index, which is an important summary indicator of the seasonality in prices due to storage behaviour. For storable commodities, which are produced only once or twice each year, we would expect this index to rise after harvest and fall prior to the subsequent one. Ideally, however, the analyst would conduct the following more refined analysis. Consider a 10 year monthly price series for a storable commodity which rises consistently for eight months following the harvest period (eg. March - October), and then falls rapidly over the next four months (November - February in this example) in every single year. In this idealized situation, it would be possible to estimate monthly storage costs and then regress either the actual time series or the monthly price changes in that series on the storage costs in order to verify whether or not they are significantly correlated. More specifically, the analyst would select only the 8 months following the harvest from each of the 10 years of data for the regression since the interest is primarily in in the upward-sloping portion of the series, which supposedly reflects the rising storage costs. This is illustrated in Figure 5-1.

In reality, however, it will be almost impossible to come up with such an idealized series, where the turning points always fall on the same months

FIGURE 5-2: IDEALIZED CORRELATION ANALYSIS OVER TIME



so that the regression analysis can be easily carried out. Furthermore, even the grand seasonal indices will often not exhibit a smooth seasonal pattern which reflects storage costs. In situations where the GSI does not rise smoothly after the harvest period, analysts generally limit themselves to simply calculating the differences between prices at harvest and each post-harvest month, in order to gain insights into the potential riskiness and profitability of holding crops beyond the harvest. These methods are discussed in greater detail in Chapter 6.

In rare cases where the GSI does rise smoothly in post-harvest months, however, it could be regressed on a linearly increasing price series which reflects monthly storage charges. Since most of the random variations in the historical data series are eliminated when the GSI is calculated, it should in principle rise to reflect the storage cost component. The resulting regression coefficient could be used as an approximate indicator of how efficiently the storage function is carried out.

5.3. Correlation over Space

A further important dimension of efficiency is that of arbitrage over space--that is, between different markets. If markets are indeed competitive, efficient and integrated, we would generally expect prices for the same product in two different markets within the same region to exhibit similar patterns of price behaviour; this can be assessed by calculating correlation coefficients between the price series. In contrast to assessing temporal efficiency, the correlation technique can be applied more easily and universally in the case of spatial efficiency tests. Perfectly co-linear price movements--brought about, for example, by a monopoly or pan-territorial and pan-seasonal pricing rules--would result in a correlation coefficient of 1.0, but it is unrealistic to expect this in practice. A more likely coefficient is one of 0.90 (or 0.80), which indicates that 81% (or 64%) of the price variation in one market is correlated or associated with that in the other market. 16/

A commonly used technique to display or visualize the degree of spatial integration is to draw lines between cities on a map with, for example, correlation coefficients that are greater than or equal to 0.80. This method, which has been applied in several studies conducted by the Stanford Food Research group (see, for example, Southworth, 1981), highlights very nicely those markets that are more or less well connected, and those between which there may be a serious lack of arbitrage. From this kind of analysis the researcher is in a better position to judge where further research efforts are likely to yield the highest returns.

The data in Table 5-2, showing millet prices in five major market nodes in Mali, is used to illustrate this technique. No attempt was made to

---

16/ Note that the correlation coefficient, also known as Pearson's product moment correlation coefficient or simply "r", is a scale-free measure of the covariance between two variables. In order to estimate the proportion of variability in one variable (i.e. price) which is associated with or explained by the variability in another, it is necessary to square the correlation coefficient reported by statistical computer packages such as MSTAT (CORR). Hence, a correlation coefficient of r = .5 implies that 25% of the variation in one price series is associated with that of the other.

approximate the missing observations in order to demonstrate that the correlation analysis can be carried out even when the data series are incomplete (using MSTAT). The results of the correlation analysis are summarized in Table 5-3 (see also Appendix 3). For example, the correlation coefficient of 0.783 for prices in Bamako and Mopti indicates that 61.3% of the variation in prices in one market is associated with that in the other market. In Figure 5-3 the five market nodes are drawn, with the different lines linking them indicating the strength of association.

The correlation results show that four markets appear to be fairly strongly connected: Bamako-Mopti, Bamako-Segou, Sikasso-Segou and Segou-Mopti; in these markets the squared correlation coefficients exceed 60%. It is not surprising that the Bamako-Segou-Mopti axis shows such a high coefficient, since these market nodes are connected by a major highway. The high figure for Sikasso-Segou is somewhat surprising, however, since these market nodes are connected only by secondary roads, so that we would expect high transport costs to minimize spatial arbitrage between them. In fact, closer investigation shows that the secondary roads are well-travelled and that there is fairly widespread exchange of market information between the two nodes.

More generally, spatial correlation coefficients of less than .90 are always suspect, and more detailed examination of the relationships between prices and the costs of transportation services are then necessary. The term "strongly connected" is only used here to classify the markets in a relative sense according to the sizes of the correlation coefficients; it does not imply that there is in fact a high degree of spatial connection.

The market node at Kayes is weakly connected with markets in Bamako, Segou and Mopti, even though a major railroad links Bamako and Kayes (and Dakar, Senegal). One may hypothesize that prices in Kayes are more strongly

TABLE 5-2: SPATIAL PRICE DATA USED IN THE CORRELATION ANALYSIS

Data file SPCORAN6
Title: Regional Prices of Traditional Cereals, Apr. 1983-85, Mali

Function: PRLIST
Data case no. 1 to 23
Without selection

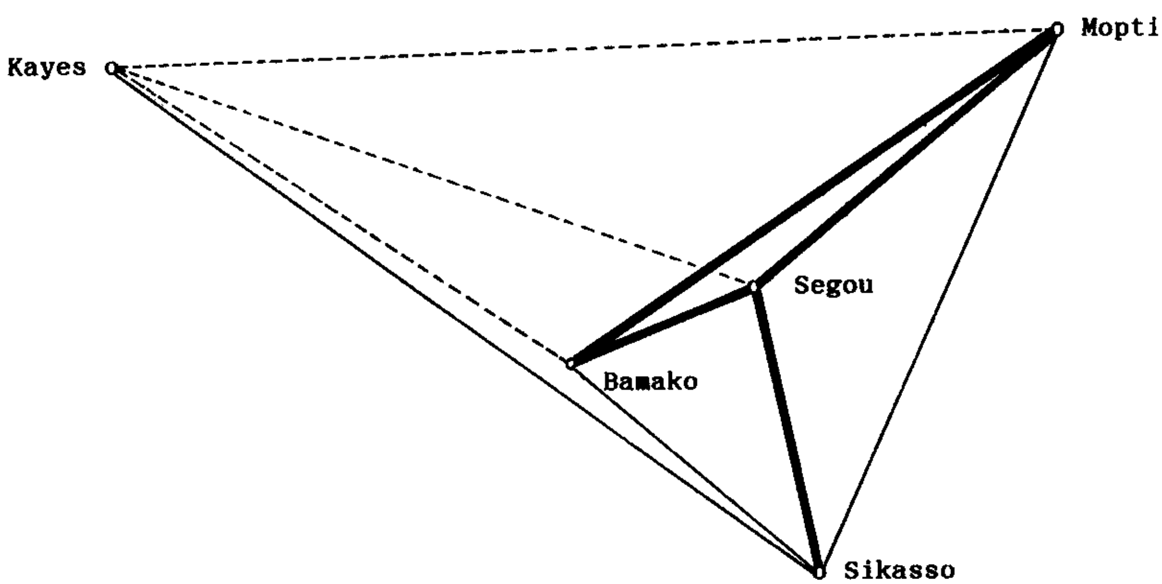
CASE NO.	Bamako	PRICES OF MILLET IN: Mopti	Sikasso	Kayes	Segou
1	86.0	85.0	65.0	94.0	67.5
2	95.5	107.5	82.5	112.5	87.5
3	107.0	107.5	90.0	112.5	
4	132.5	130.0	97.5	75.0	
5	135.5	130.0	100.0	137.5	112.5
6	136.0	130.0	97.5	150.0	100.0
7	136.0	95.0	100.0	150.0	100.0
8	127.0	75.5		150.0	82.5
9	112.0	97.5		150.0	82.5
10	120.0	100.0	100.0	150.0	100.0
11	117.5		95.0	150.0	105.0
12	125.5	132.5	97.5	162.5	125.0
13	139.5	125.0	100.0	162.5	125.0
14	144.0	142.5	100.0	175.0	125.0
15	163.0	150.0	100.0	150.0	125.0
16	156.0	150.0	110.0	150.0	135.0
17	149.0	150.0	110.0	150.0	140.0
18	157.0	165.0	100.0	125.0	135.0
19	155.0	140.0	100.0	110.0	135.0
20	122.0	110.0		125.0	85.0
21	112.0	115.0	100.0	90.0	90.0
22	111.0	100.0	100.0	125.0	120.0
23	117.0		100.0	125.0	

Data Source: Staatz/Dione

TABLE 5-3: CALCULATED CORRELATION COEFFICIENTS

	Bamako	Mopti	Sikasso	Kayes	Segou
Bamako	1.000				
Mopti	0.783	1.000			
Sikasso	0.741	0.613	1.000		
Kayes	0.406	0.173	0.451	1.000	
Segou	0.805	0.841	0.780	0.384	1.000

FIGURE 5-3: SPATIAL PRICE CONNECTIONS IN FIVE MALIAN MILLET MARKETS



% of Variation in Prices
Associated with the other Market:*

———— > 60% -- "strong connection"

———— 20 - 60% -- medium

--------- < 20% -- weak

---

* Note that the correlation coefficients in Table 5-3 were squared to obtain these results.

influenced by cross-border trade with Senegal, than by prices determined in Bamako. It should also be noted that the coefficient of 20.34 between Kayes and Sikasso is likely to be spurious. The three cut-off points for categorizing the coefficients as showing weak, medium and strong association or integration were arbitrarily selected, and the value of 20.34 is close to 20 and probably should have been moved into the category for weak linkages.

This type of analysis therefore gives the researcher an initial idea of the extent of spatial integration among among different markets in a country. It would obviously also be necessary to consider the direction of price determination in these markets by categorizing the various nodes according to whether they are in regions of surplus or deficit production. For example, if substantial amounts of millet are imported and distributed through Bamako at some times of the year, prices elsewhere would be functionally dependent on prices in Bamako (see also the discussion of margin reversals in Chapter 3). It is also important to be aware of linkages across international borders, such as between Mali and Senegal, Guinea Bissau, the Ivory Coast and Burkina Faso. It is equally important not to treat these coefficients as "absolute truths", since they may in many cases be spurious. For these reasons, further fieldwork is generally essential before conclusive policy implications are drawn. This leads us to the question "when are correlation coefficients significant?".

5.4. Interpretation of Results: When are they Significant?

It is important to realize that correlation coefficients are not proof, but rather rough indicators of integration and efficiency. A preliminary price analysis may indicate that prices in two markets are highly correlated (eg. 81%), while closer examination of the region's geography reveals that the two markets are separated by impassable mountain ranges, such that there is no trade between them. In this case the correlation between the markets may be spurious; the market may have well-connected indirect market channels, with each being connected by road to a third market; or it may be caused by monopoly powers of traders. Similarly, government legislation may mandate relative prices in the region so that they always move in the same direction. It is therefore necessary to take not only a broad perspective, but to use a good deal of common sense and field observation when interpreting the correlation coefficients as well. For example, if there is not even a foot path between the two markets, and barring other indirect linkages, one would not expect to find much arbitrage taking place between them. Furthermore, the sizes of correlation coefficients are sensitive to both high seasonal price variations and inflated prices. Consequently, it is better to work with deflated prices and, if possible, with periods where seasonal influences were not excessively pronounced. 17/

Finally, and as was stressed in the chapter on marketing margins, results of statistical analyses which use observed market data (i.e. prices) can only be viewed as partial or preliminary measures of performance in a food system. Both public and private decision-makers need further information on which to base their actions; this may include knowledge regarding progressiveness, productivity, dissemination of information, and stability of employment and output levels. A somewhat arbitrary element is of course also introduced by the choice of categorical cut-off points for judging weak, medium and strong market connections.

17/ If there is substantial inflation in the markets under investigation, the correlation coefficients will largely pick up the co-variations in the series due to the inflationary component. In these cases it is preferable to work with deflated prices.
See also Harriss (1979) and Jones (1974) for further discussion of the use of correlation coefficients. Timmer (1986b) attempts to develop a more sensitive indicator of market connection using various explanatory variables. See Appendix 4 for a discussion of this indicator.

VI. ANALYSIS OF STORAGE MARGINS FOR STORABLE COMMODITIES

A fundamental decision facing most farmers and market agents who produce or otherwise own non-perishable, storable commodities is the question of when in the market season their product should be sold. A related question is how much to sell at any given point in time. If prices over the market year were known with certainty in advance, decisionmakers would simply calculate estimated monthly storage costs, subtract these from the monthly increase in prices over the price at harvest, and then find the month in which net storage margins are maximized for the quantities that farmers wish to sell. In practice, however, future prices are of course not known in advance, and storage decisions have to be based on price expectations. As was pointed out above, a seasonal analysis is useful since the seasonal index generally reflects annual storage and marketing patterns for storable commodities. Yet because prices in some years do not always go up after harvest, analysis should go one step further and examine the patterns of historical price changes for each month over the harvest month.

In order to simplify the presentation in this chapter, we will initially assume that storing agents (particularly farmers) have a single-valued objective function of maximizing returns from storing one particular crop. In reality, farmers face cash flow problems during the market season, forcing them to release the crop out of storage at various (non-optimal) times of the year. In addition, they often own multiple liquid assets such as livestock (especially small ruminants) and labor, and their overall storage decisions then become portfolio management strategies. This is often further complicated by the fact that livestock can only be sold profitably at specific times, while off-farm labour opportunities are similarly limited to certain periods of the year. Finally, farmers' risk preference functions may be such that they prefer to sell off equal portions of their stored crop during the market year, rather than wait for the optimal storage period. This is addressed briefly in section 6.4. 18/

6.1. Calculating and Evaluating Gross Historical Margins

The historical price increases or decreases in each month following the harvest of each year are calculated by simply subtracting the price prevailing at harvest from each post-harvest month's price. When these calculations are carried out over a number of years, it is possible to develop and use probabilistic estimates of gross storage margins over future market years. This will give an indication as to when the output should be sold so as to maximize net returns from storage. It also aids in developing a measure of the riskiness involved in storage decisions.

The nominal 15-year (1970-84) millet price series at retail in Bamako shown in Table 6-1 is used to illustrate this technique. It is preferable to use prices received by agents who actually carry out the storage function, since these give more precise measures of the profitability of storing commodities. Nevertheless, under the assumption that marketing margins are constant over time, prices at retail will give a good approximation of the gross historical storage margin. Note also, in Table 6-1,

---

18/ Sherman (1984) deals specifically with the storage decision environment of farmers in Manga, Burkina Faso, and discusses factors affecting the decision to sell stored grains. Delgado (1985) examines the extent of seasonality in crop prices in the same country. Ellsworth and Shapiro (1985) analyze how farmers (as consumers and producers) are affected by, and take advantage of, seasonal price movements in Burkina Faso. Timmer and Silitonga (1985) examine problems of stabilizing corn and rice prices in the context of food security at the household level in Indonesia. A more general treatment of seasonal price variability is given by Sahn and Delgado (1985). Finally, the reader interested in a comprehensive and advanced treatment of supply response (including storage decisions) in the context of commodity price stabilization on a macro-scale is refered to Newbery and Stiglitz (1981).

TABLE 6-1:
MILLET CONSUMER PRICES IN BAMAKO, RETAIL, 1970-84 (FM/kg)

Data file MILBAM70
Title: Millet Consumer Prices in Bamako, Retail, 1970-84
Function: SEATABLE
Data case no. 1 to 180
Without selection

This data starts JAN 1970 and represents a DEC 1970 to NOV 1971 market year.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1970	3.7	4.2	3.0	4.2	4.5	5.5	5.1	3.4	3.6	3.9	4.2	5.3
1971	5.7	5.0	5.0	4.9	5.4	5.4	5.4	5.8	5.8	7.0	5.8	5.8
1972	5.9	5.9	6.5	5.8	7.1	7.4	7.2	6.9	6.9	8.3	7.7	9.1
1973	9.3	8.7	9.0	10.9	15.1	17.1	14.8	14.9	12.7	13.2	11.0	8.1
1974	7.4	7.9	8.7	7.9	8.5	9.3	8.9	8.8	8.8	8.0	7.4	8.0
1975	7.5	7.5	7.7	7.3	6.8	6.9	7.1	6.9	7.7	7.6	7.1	7.1
1976	5.9	6.9	6.4	6.0	6.8	7.2	6.6	6.5	7.2	7.2	7.6	7.8
1977	7.7	8.6	8.2	7.6	9.8	10.4	9.6	12.7	13.1	14.6	16.0	21.0
1978	15.6	15.6	14.0	14.9	14.5	17.4	20.3	19.1	16.9	18.4	16.5	13.1
1979	11.6	10.6	9.6	9.6	9.6	10.7	9.8	10.6	12.8	10.9	11.0	12.2
1980	13.0	14.8	16.7	16.6	17.0	19.9	21.6	22.3	22.1	21.8	20.7	17.4
1981	17.0	17.2	18.2	18.4	19.9	19.9	22.9	22.7	23.0	21.6	27.0	19.4
1982	16.2	15.4	15.5	16.3	16.9	18.0	18.1	18.7	18.7	19.0	17.4	17.3
1983	16.9	15.7	16.6	17.2	19.1	21.4	21.5	26.5	27.1	27.2	25.4	22.5
1984	24.0	23.5	25.1	27.9	28.8	32.5	36.0	29.7	30.1	30.9	24.4	22.5

Year	Calendar Year Average	Market Year Average	Weighted Market Year Average
1969		4.118 *	4.118 *
1970	4.217	5.542	5.542
1971	5.583	6.783	6.783
1972	7.058	12.150	12.150
1973	12.067	8.308	8.308
1974	8.300	7.342	7.342
1975	7.267	6.783	6.783
1976	6.842	10.508	10.508
1977	11.608	17.017	17.017
1978	16.358	10.825	10.825
1979	10.750	18.225	18.225
1980	18.658	20.433	20.433
1981	20.600	17.467	17.467
1982	17.292	20.992	20.992
1983	21.425	27.950	27.950
1984	27.950	22.500 *	22.500 *

* Denotes a value computed from less than 12 months data.

Data Source: Staatz/Dione and World Bank.

that the market year price averages differ considerably from the calendar year averages in all years. This underscores the importance of calculating and using market year averages, as was discussed earlier in Chapter 2. The weighted market year average is identical to the market year average in this table, simply because no information on quantities marketed was available. Therefore, this last column assumes that the quantities marketed over the year were evenly distributed, which is likely to be unrealistic.

Table 6-2 presents the gross historical storage margins, calculated by subtracting each month's price from that prevailing at the first month of harvest, which in this case is defined as the month of December. A preliminary review of the upper portion of Table 6-2 reveals three interesting facts. First, there are four years in which gross storage margins were negative; in other words, it would not have been profitable to store millet even for a single month in these four years. Secondly, there were three years in which prices rose consistently relative to the harvest month, so that gross margins were positive. Whether or not net margins or returns to storage were positive depends, of course, on the size of storage costs relative to the gross storage margins. Thirdly, some years show a mixture of positive and negative storage margins. More importantly, in these years the negative margins tend to fall into the early post-harvest months, while the positive margins are found towards the end of the market season. This particular phenomenon is discussed further in the next section.

Next examine the two bottom sections of Table 6-2, which summarize the information on the gross storage margins for the entire period and the five most recent years, respectively. Over the entire 14-year period of analysis (one year is lost due to the fact that the harvest period falls into December) mean gross storage margins were, on average, negative for the first four months following the harvest. Then the margins became positive and

TABLE 6-2:
RAW STORAGE PRICE CHANGES, MILLET, BAMAKO (1970-84)*

Data file MILBAM70
Title: Millet Consumer Prices in Bamako, Retail, 1970-84
Function: SEASTORE
Data case no. 1 to 180
Without selection

YEAR	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1970	0.0	0.4	-0.3	-0.3	-0.4	0.1	0.1	0.1	0.5	0.5	1.7	0.5
1971	0.0	0.1	0.1	0.7	0.0	1.3	1.6	1.4	1.1	1.1	2.5	1.9
1972	0.0	0.2	-0.4	-0.1	1.8	6.0	8.0	5.7	5.8	3.6	4.1	1.9
1973	0.0	-0.7	-0.2	0.6	-0.2	0.4	1.2	0.8	0.7	0.7	-0.1	-0.7
1974	0.0	-0.5	-0.5	-0.3	-0.7	-1.2	-1.1	-0.9	-1.1	-0.3	-0.4	-0.9
1975	0.0	-1.2	-0.2	-0.7	-1.1	-0.3	0.1	-0.5	-0.6	0.1	0.1	0.5
1976	0.0	-0.1	0.8	0.4	-0.2	2.0	2.6	1.8	4.9	5.3	6.8	8.2
1977	0.0	-5.4	-5.4	-7.0	-6.1	-6.5	-3.6	-0.7	-1.9	-4.1	-2.6	-4.5
1978	0.0	-1.5	-2.5	-3.5	-3.5	-3.5	-2.4	-3.3	-2.5	-0.3	-2.2	-2.1
1979	0.0	0.8	2.6	4.5	4.4	4.8	7.7	9.4	10.1	9.9	9.6	8.5
1980	0.0	-0.4	-0.2	0.8	1.0	2.5	2.5	5.5	5.3	5.6	4.2	9.6
1981	0.0	-3.2	-4.0	-3.9	-3.1	-2.5	-1.4	-1.3	-0.7	-0.7	-0.4	-2.0
1982	0.0	-0.4	-1.6	-0.7	-0.1	1.8	4.1	4.2	9.2	9.8	9.9	8.1
1983	0.0	1.5	1.0	2.6	5.4	6.3	10.0	13.5	7.2	7.6	8.4	1.9
1984	0.0											

Statistics for above Table

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Mean	0.0	-0.7	-0.8	-0.5	-0.2	0.8	2.1	2.6	2.7	2.8	3.0	2.2
S.D.	0.0	1.7	2.1	2.8	3.0	3.6	4.1	4.6	4.3	4.3	4.3	4.6
Low	0.0	-5.4	-5.4	-7.0	-6.1	-6.5	-3.6	-3.3	-2.5	-4.1	-2.6	-4.5
High	0.0	1.5	2.6	4.5	5.4	6.3	10.0	13.5	10.1	9.9	9.9	9.6
Rises	0.0	5.0	4.0	6.0	4.0	9.0	10.0	9.0	9.0	10.0	9.0	9.0
Falls	0.0	9.0	10.0	8.0	9.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0

Statistics for Last 5 Years of above Table

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Mean	0.0	-0.3	-0.4	0.7	1.5	2.6	4.6	6.3	6.2	6.4	6.3	5.2
S.D.	0.0	3.2	3.7	5.5	6.2	7.3	8.7	10.9	10.1	10.3	10.0	10.0
Low	0.0	-3.2	-4.0	-3.9	-3.1	-2.5	-1.4	-1.3	-0.7	-0.7	-0.4	-2.0
High	0.0	1.5	2.6	4.5	5.4	6.3	10.0	13.5	10.1	9.9	9.9	9.6
Rises	0.0	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Falls	0.0	3.0	3.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

----

* Note that the data set has been "rotated" in this table (printed by the SEASTORE subroutine) to reflect the fact that the first potential month of storage is December, and that no gains from storage can be made in this first month. Also, because the data set ends in December 1984, it is impossible to calculate storage returns for the subsequent year (1985).

rose consistently until they reached a peak of 3.0 FM/kg in October. At the same time, however, the standard deviation (shown in the S.D. row) also rose consistently, indicating increasing variability in the margin series. For example, a 70% confidence interval for the mean value of October would span from -1.3 to 7.3 FM/kg (i.e. the mean plus and minus one standard deviation), so that it would not be uncommon for the gross margin to turn out negative.

The second two rows show the historical maximum and minimum values for the gross storage margins, respectively. Notice that the lowest (negative) margin of -7.0 occured in March (1977), while the highest was in July (1983) with a value of 13.5 FM/kg. The last two rows, finally, show the number of times that prices rose and fell in each month over the entire period of analysis (implying positive and negative margins). Overall, the months of June and September showed the best possibilities for storage profits, with prices rising in 10 out of 14 years.

The bottom portion of Table 6-2 conveys the same information, except that it applies only to the last 5 years. The reasoning here is that the more recent years may be more representative of current and future market conditions, so that they should be examined separately. Here the mean gross storage margins are negative only in the first two months--instead of four--following the harvest. This indicates that in the more recent years storage has become potentially (because we do not know storage costs) profitable sooner after harvest. In other words, the time lag which takes place before prices begin their seasonal rises to reflect storage costs, has been reduced by two months, relative to the entire series.

This pattern is also borne out when comparing the grand seasonal indices for the years 1970-84 and 1982-85. The former GSI is reproduced in Figure 6-1 below, while the latter was shown on page 82 of Chapter 4. We also noted from Figure 4-8 of Chapter 4 (page 84), that the seasonal pattern for the millet series most closely resembled that which we expect for a storable commodity. The same is not true for the GSI shown in Figure 6-1, however, since here we see that prices are still fairly high in December, and that the prices do not rise uniformly over the market year. The interesting conclusion, therefore, is that millet prices in recent years conform more to the theoretical model of price behaviour for storable commodities. This may imply that the marketing system is becoming more efficient and competitive in recent years, since prices follow a more smooth seasonal pattern; however, this pattern sets in rather late in the market season (in February instead of December), and this is definitely worthy of further empirical investigation. For example, it may take a long time before farmers sell their crops to market agents who in turn store the crops, or, alternatively, farmers may not sell them at all until late after harvest. Yet another explanation for the prolonged lag period could be that the harvest comes in only slowly over an extended period of time, so that the new crop does not affect prices until later in the season. It is also possible, finally, that there is a lack of market information about the size of the incoming crop, so that farmers and market agents hold off with their selling and buying decisions. This kind of information is crucial, but often not available until later in the post-harvest season.

Before definitive conclusions as to the optimal storage period for millet can be drawn from Table 6-2, it would be necessary to calculate the absolute magnitude of storage costs, and to see whether these costs rise in a linear or non-linear fashion, as discussed in Chapter 5. By using the information on storage costs, it would be possible to determine not only if and until when the crop should be stored to maximize returns to storage, but also to attach a confidence interval to that estimate, i.e. to see what

FIGURE 6-1: GRAND SEASONAL INDEX FOR RETAIL MILLET PRICES, BAMAKO (1970-84)

Data file MILBAM70
Title: Millet Consumer Prices in Bamako, Retail, 1970-84
Function: SEASONAL
Data case no. 1 to 180
Without selection

```
       |
% 109.6+
       |
o      |                                                       XXX
f 105.9+                               XXX                     XXX
       |                               XXX   XXX   XXX   XXX   XXX
A      |                               XXX   XXX   XXX   XXX   XXX
n 102.3+                               XXX   XXX   XXX   XXX   XXX   XXX
n      |                               XXX   XXX   XXX   XXX   XXX   XXX
u  100%+===============================XXX===XXX===XXX===XXX===XXX===XXX=======
a  98.6+                         XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
l      |                         XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
       |                         XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
A  94.9+                         XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
v      |                         XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
e      | XXX                     XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
r  91.3+ XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX   XXX
a  GSI | 92.9  91.9  92.3  91.3  99.1 106.5 105.5 105.4 105.7 107.1 102.6  99.6
g  CSE | 10.7   8.4   8.2   5.9   9.9  12.3  13.1  13.5  10.4  11.0  13.0  15.6
e  87.6+--+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+---
  Months J     F     M     A     M     J     J     A     S     O     N     D
```

GSI. IS THE GRAND SEASONAL INDEX
CSE. REPRESENTS THE CORRECTED STANDARD ERROR

the approximate chances of actually realizing a positive return are. In inflationary environments it is also possible that storage analyses using constant (i.e. either deflated or reflated) prices leads to different optimal storage periods, since more weight is put on the earlier months after harvest. It is then important to conduct the analysis using either deflated or reflated prices (the latter are preferable in marketing extension work, as was discussed in Chapter 2). 19/

6.2. Using Percent Returns to Storage

There is, fortunately, a more direct and rapid method for examining the effects of alternative storage periods. This method is especially appropriate where a large portion of the storage costs arise due to the opportunity cost of the money which is tied up in the stored commodity, and only a small portion is attributable to costs of storage facilities, handling, quantity losses, etc. In this method, the percentage rate of return to storage in each month is computed by dividing the difference between the harvest and post-harvest price in each subsequent month by the harvest price. This is shown in Table 6-3 below for the data from Table 6-1.

Now consider, for example, a situation where the opportunity cost of a unit of money to an agent owning a storable commodity is 22%. If crops were stored through September and October over the period 1970-83, he or she would on average have gained 0.9% and 4.3% above their opportunity cost, respectively, on the money tied up in storage. Only storing the crop until August, the agent would have on average only broken even. Also, with an opportunity cost of 22% for money, it would on average not have been profitable for the agent to store up to any other month (i.e. to release

---

19/ Subprogram SEASTORE within MSTAT has the capability to calculate storage changes for current, deflated and/or reflated prices.
The reader is again reminded that it is difficult to make precise forecasts in rapidly evolving economies, and storage recommendations should be couched in careful terms.

TABLE 6-3: RATE OF RETURN FROM STORAGE FOR MILLET, BAMAKO (1970-84)

YEAR	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1970	0.0	7.5	-5.7	-5.7	-7.5	1.9	1.9	1.9	9.4	9.4	32.1	9.4
1971	0.0	1.7	1.7	12.1	0.0	22.4	27.6	24.1	19.0	19.0	43.1	32.8
1972	0.0	2.2	-4.4	-1.1	19.8	65.9	87.9	62.6	63.7	39.6	45.1	20.9
1973	0.0	-8.6	-2.5	7.4	-2.5	4.9	14.8	9.9	8.6	8.6	-1.2	-8.6
1974	0.0	-6.3	-6.3	-3.8	-8.7	-15.0	-13.7	-11.3	-13.7	-3.8	-5.0	-11.3
1975	0.0	-16.9	-2.8	-9.9	-15.5	-4.2	1.4	-7.0	-8.5	1.4	1.4	7.0
1976	0.0	-1.3	10.3	5.1	-2.6	25.6	33.3	23.1	62.8	67.9	87.2	105.1
1977	0.0	-25.7	-25.7	-33.3	-29.0	-31.0	-17.1	-3.3	-9.0	-19.5	-12.4	-21.4
1978	0.0	-11.5	-19.1	-26.7	-26.7	-26.7	-18.3	-25.2	-19.1	-2.3	-16.8	-16.0
1979	0.0	6.6	21.3	36.9	36.1	39.3	63.1	77.0	82.8	81.1	78.7	69.7
1980	0.0	-2.3	-1.1	4.6	5.7	14.4	14.4	31.6	30.5	32.2	24.1	55.2
1981	0.0	-16.5	-20.6	-20.1	-16.0	-12.9	-7.2	-6.7	-3.6	-3.6	-2.1	-10.3
1982	0.0	-2.3	-9.2	-4.0	-0.6	10.4	23.7	24.3	53.2	56.6	57.2	46.8
1983	0.0	6.7	4.4	11.6	24.0	28.0	44.4	60.0	32.0	33.8	37.3	8.4
1984	0.0											

Statistics for above Table

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Mean	0.0	-4.8	-4.3	-1.9	-1.7	8.8	18.3	18.6	22.0	22.9	26.3	20.5
S.D.	0.0	10.0	12.3	17.7	18.5	26.6	31.3	30.7	32.9	30.1	33.6	37.2
Low	0.0	-25.7	-25.7	-33.3	-29.0	-31.0	-18.3	-25.2	-19.1	-19.5	-16.8	-21.4
High	0.0	7.5	21.3	36.9	36.1	65.9	87.9	77.0	82.8	81.1	87.2	105.1
Rises	0.0	5.0	4.0	6.0	4.0	9.0	10.0	9.0	9.0	10.0	9.0	9.0
Falls	0.0	9.0	10.0	8.0	9.0	5.0	4.0	5.0	5.0	4.0	5.0	5.0

Statistics for Last 5 Years of above Table

	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
Mean	0.0	-1.6	-1.1	5.8	9.9	15.8	27.7	37.2	39.0	40.0	39.1	34.0
S.D.	0.0	19.1	23.0	35.0	39.8	49.7	59.1	65.4	67.3	63.0	65.2	71.6
Low	0.0	-16.5	-20.6	-20.1	-16.0	-12.9	-7.2	-6.7	-3.6	-3.6	-2.1	-10.3
High	0.0	6.7	21.3	36.9	36.1	39.3	63.1	77.0	82.8	81.1	78.7	69.7
Rises	0.0	2.0	2.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Falls	0.0	3.0	3.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

the crop before September). Again, the standard deviations associated with these rates of return from storage are fairly large, and the actual realized returns may well turn out to be negative in some future years.

In certain situations, this method is therefore of considerable advantage, since it does not require an ex ante calculation of storage costs. In addition, the analyst does not have to know the farmer's or decision-maker's real opportunity cost of money; instead, the results can be presented to storage agents, who then decide for themselves for how long they want to store their commodity. It is also extremely easy to incorporate risk premiums into this kind of analysis, since they are often expressed on a percentage basis (eg. 5%). In this case, is is possible to either subtract the risk premium from the calculated rate of return and then compare the result to the agent's opportunity cost, or to directly add the premium to the opportunity cost. Finally, this method is also useful for either approximating shadow interest rates (i.e. what the marginal social time preference rate really is, rather than that charged by banks, which is often much lower), or comparing rates charged by banks and governments to agents who hold stored crops. In a perfectly competitive world, we would expect interest returns on storage to reflect interest rates paid and received elsewhere in the economy.

6.3. Methods Using "Probabilistic" Analyses 20/

It is also possible to combine storage costs and gross historical storage margins into a more unified framework from which "probabilities" of storage profits and losses can be calculated. This kind of analysis may be especially useful in marketing extension work, since it can make the analytical results more meaningful to farmers, as well as other market

----

20/ This section is based in large part on Mears (1980) participants who store commodities. For example, if this information is expressed on a percentage basis, such as "there were losses 20% of the time or in 2 years out of 10", it will be more readily understood by farmers and other storage agents.

First, the following formula summarizes how monthly storage costs can be calculated (see also Chapter 5):

$$C = \frac{(r + i)\,P(h)}{12} + S$$

where C = monthly cost of storing crop per kg,

P(h) = market price at harvest per kg (can include handling cost),

r = rate of loss in storage per year,

i = annual interest rate, and

S = cost of storage per kg per month.

We can then formulate the following ratio,

$$\frac{P(m)}{P(h) + C(m)} = 1.0$$

where P(m) = the price prevailing when the crop is sold and C(m) denotes the cost of storing the crop to month m. Now, if the left hand side expression is less (greater) than 1.0, a storage loss (gain) was incurred. Once this calculation has been made for each post-harvest month of each year, form the following ratio,

$$\text{"Probability" of Gain for Sale in Month } m = \frac{\text{Number of Months with a Gain in Month } m}{\text{Total Number of Years}}$$

This ratio gives decision-makers in the market system a good summary idea of the chance of making net storage gains in a given month.

The analysis can be carried further to generate profit rates of storage for individual years as well as over a number of years. In particular, the following calculations would then be necessary.

$$U(m) = \frac{P(m) - P(h) - C(m)}{P(h)} \times 100$$

where U(m) = the rate of profit or the rate of return for holding the crop, including a return on capital for taking risks, and m is the number of months after harvest.

Alternatively, calculate the rate of profit over a period of years, which is defined as:

$$U(m) = \frac{\sum_{y=1}^{t} [P(m) - P(h) - C(m)]}{\sum_{y=1}^{t} [P(h)]} \times 100$$

In this case, U(m) is the rate of profit or rate of return for storing, including the return to capital and risk-taking from holding the crop each year for m months and selling an equal quantity during month m during each year of the period of analysis. These profit rates can be converted to annual yields by multiplying the right hand side of the equation by 12/m and to monthly yields by multiplying by 1/m; in this form they are convenient summary indicators of potential storage profitability, based on the historical data.

6.4. Marketing Strategies Derived from Storage Margin Analyses 21/

From the results in Table 6-2, it is also possible to develop and examine various marketing strategies for farmers and marketing agents, and

---

21/ This section is based largely on Ferris (1983).

to see how these compare against one another, as well as a strategy of not storing at all, over time. For the sake of simplification, assume that the figures in Table 6-2 represent net storage margins, including all costs of storage, since this is what an analyst in the field who is making recommendations would ideally work with. Alternatively, we could assume that the agent holding the crop incurs zero (opportunity) costs for providing the services.

First consider the following strategy or decision-rule for storing the millet crop, which is harvested in December: store the crop to the month in which average net margins are highest. The correct month in which to release the crop would then be October, with an average historical margin of 3.0 FM/kg and a 64% percentage (= 9 out of 14 years) that the net margin in that month will be positive. In actuality, the decisionmaking agent may, based on subjective beliefs about risks and returns, store his or her crop only until July or August, since these months historically have the same 64% chance of exhibiting positive margins and they have on average provided a return (2.6 and 2.7 FM/kg respectively) which is close to that of October. 22/

A second, alternative strategy may be to store the crop until that month in which the probability of a positive return is the highest. From Table 6-2, we would then have two choices, June and September, which showed a 71% (= 10 out of 14 years) chance of providing a net return greater than zero. Since an additional 0.7 FM/kg could be earned above the June release period by storing until September, the decision-maker may decide to wait.

22/ Again, this is not a probability in the sense that it is obtained through random sampling from a constant population. Instead, it is a simple percentage calculated from historical data, and forecasts into the future have to be made with caution.

A third decision-rule might look as follows: select two different selling (release) dates which are at least two months apart but have similar net margins and high chances of providing a positive gain to storage, and then divide sales of millet equally between them. In this case the months of June and September would be ideal candidates, yielding a weighted average price of 2.45 FM/kg.

Finally, a fourth strategy may involve a "safe" storage program, where the stored crop is sold off evenly at ten times druing the year. In other words, 10% of the total crop would be sold in February, 10% in March, and so on until all is sold in December. Here it would be anticipated that a higher return is given up in exchange for a lower, more certain return. In effect, this yields an average net gain 1.5 FM/kg but only a 56% chance of receiving a positive return over the year.

These four possible strategies, of which there are of course many alternatives and different combinations, and their results are summarized and contrasted in Table 6-4. It is readily apparent that while strategy number 1 yields the highest average storage margin, it does so at a relatively greater risk of producing negative margins (36%). Consequently, assuming that storage costs have already been netted out, the best strategy to pursue for the farmer may be number 2; it would also be superior to not storing any of the millet crop.

TABLE 6-4: COMPARISON OF ALTERNATIVE MILLET STORAGE STRATEGIES*

	Month of Sale	Average Margin Over Sale at Harvest	Historical Chance of a Positive Margin
Strategy # 1: Store to month with highest margin.			
	October	3.0 FM/kg	64%
Strategy # 2: Store to month with highest chance of positive margin.			
	September	2.8 FM/kg	71%
Strategy # 3: Store to months with same high chance of a positive storage margin, which are at least two months a part.			
	June/Sept	2.5 FM/kg	71%
Strategy # 4: Sell equal amounts over a 10 month storage season.			
	Feb.- Dec.	1.5 FM/kg	56%

---

* Based on historical data.

VII. PRAGMATIC APPROACHES TO OBTAINING AND ASSESSING PREVIOUSLY COLLECTED DATA

In price analysis, longer time series are necessary to determine repetitive economic patterns and trends. Experience also shows that the analysis of either historical or current data, whatever its quality, is an important part of the process of improving over the longer-run the quality and validity of price and quantity data collected. Many problems with data collection methods--even in optimally designed data gathering schemes--do not materialize until careful analyses are completed. Especially important are internal consistency checks of data series as well as comparative studies across markets, time periods and various levels of the food system.

In many developing countries their are often a surprising wealth of "hidden" secondary data and on-going collection efforts available to the researcher, which have received little analytical attention (see, for example, Timmer et al., 1983). Because of the substantial costs associated with implementing new primary surveys, researchers are well-advised to make every effort to find and examine existing data before deciding to invest in an original data collection activity.

When researchers do approach ministries or other government institutions for time series data, however, common responses are "We have a time series, but we do not use it because we did not collect it"; "We have lost the files where the previous data were kept"; or "No one has ever asked us for the data from earlier years, and we do not know where to find it". The purpose of this final chapter is to suggest steps for obtaining, and provide guidelines for evaluating the quality of, such secondary data within the framework of the analyses reviewed in previous chapters. At the same time, the guidelines are also intended to alert analysts to payoffs and potential pitfalls associated with using existing data.

Broadly speaking, the methodology for evaluating data series presented here may be broken down into two steps: first, obtaining and assessing the strategy used for collecting the data and, second, undertaking analytic-descriptive assessments of the data.

7.1. Data Collection Strategy

The first challenge or difficulty in reviewing data collection methods is to discover who is collecting (or has collected) data. Many analysts tend to underinvest in seeking out sources of data because this requires persistence in visiting agencies and finding knowledgeable people who can adequately inform them about data collection activities. Investments in obtaining and utilizing existing data are also not as interesting (and sometimes not as productive) as designing a primary study.

There are two main sources of public data in developing countries: 1) public sector "official and usually on-going data collections" at the national, state and local level; and 2) public and semi-public agencies that undertake periodic or one-time focused primary data collection and analysis activities. Examples of each of these potential sources are as follows:

A. Public Sector Official Statistics	Typical Types of Data
- Ministry of Agriculture	- Farm and Wholesale Prices - Area Planted, Yields and Total Production
- Ministry of Commerce	- Retail and Wholesale Prices - Import and Export Quantities
- Ministry of Finance	- Retail and Wholesale Prices - Price and Quantity Indices
- Ministry of Industry	- Input Prices and Quantities - Macroeconomic Aggregate Data
- Ministry of Planning	- Retail Prices, many other National Statistics
- National or Development Banks	- Retail, Wholesale and Farm Prices

B. <u>Public (or Semi-Public) Agencies Conducting Focused Studies</u>

Public (or Semi-Public) Agencies Conducting Focused Studies	Typical Types of Data
- Regional and Local Development Agencies	- Prices and Quantities in Selected Regions and Times: Farm, Wholesale, Retail Levels; Investments and Output Levels
- Local and National Research Agencies Research Stations, Universities, Consulting Firms	- same as above
- International Technical Assistance and Funding Agencies	- same as above
- Foreign Universities, Research Institutes and Consulting Firms	- same as above

Even though background documentation on data collected by these various groups is notoriously difficult to obtain, it is important to try. If such documentations are available, consider the following aspects of evaluating existing secondary data.

Who, or which institution first initiated the data collecting activity, and by whom was it then implemented? Different groups evidently have vested interests in the way data is publicized; for example, a government agency may have an incentive to understate prices paid for food by consumers, and the same may be true of extension agents or co-ops which report on farm-level prices received by producers. Furthermore, how extensive was the collection activity, and what, if any, were the sampling procedures utilized? Were interviews conducted, or were prices and quantities simply obtained by observing transactions in the markets? Were actual purchases made, and if so, how precise were the weighing procedures used in determining prices per units of quantity of the product? If the data was indeed collected through surveys by enumerators, what were the inherent biases in the listframes chosen, what type of sampling was conducted (eg. random or non-random purposive techniques), and what was the degree of supervision and control, as well as the incentive system, facing the enumerators?

Answers to some of these questions, if they can in fact be obtained, provide key initial insights into the potential quality of the data. If there is no backgound documentation, it may still be possible to interview workers in the agency at the national or perhaps local level who were involved with the data collection activity, and this may shed more light on the quality of the data. A crucial question here is how precise does the data collection methodology have to be in order to generate useful and reliable data? Part of the answer depends on the questions to be addressed in the research, and how important data accuracy is to decision makers who need the results. These are difficult issues and there are usually no simple answers to questions of data quality. Also, a common problem is that "developed country standards" are often applied to data collection and measurement tasks in developing countries. This may be a costly mistake since accurate data may not be necessary or warranted for the decisions to be made. It is easy to overlook the fact that developed country data series also went through long developmental processes and were improved only through lengthy iterative cycles of collection and analysis.

A final suggestion for assessing data is straightforward empiricsm. With the widespread availability of computers, it is too easy to overlook this simple yet valuable approach. Look at the data (e.g. by plotting) and carefully examine its internal consistency, even if the data collection methodology appears weak. See what results are obtained before rejecting the data; this is important especially if historical insights are needed and there are no other sources of data.

7.2. Analytical Assessment Procedures

As indicated at the outset of this paper, a useful initial evaluation of a data set is a simple plot. This is especially true if the analyst already has access to a data series which is reasonable and in some way relates to the series which is currently being evaluated. For example, the series may relate to the same variable, but were collected by two different agencies; in this case cross-checks for consistency can be made. Or, more importantly, the two series may pertain to the same commodity, but were collected in two spatially related markets. An example of two such series, which we expected to be linked by transport costs, was already discussed in Chapter 1 in Figure 1-7.

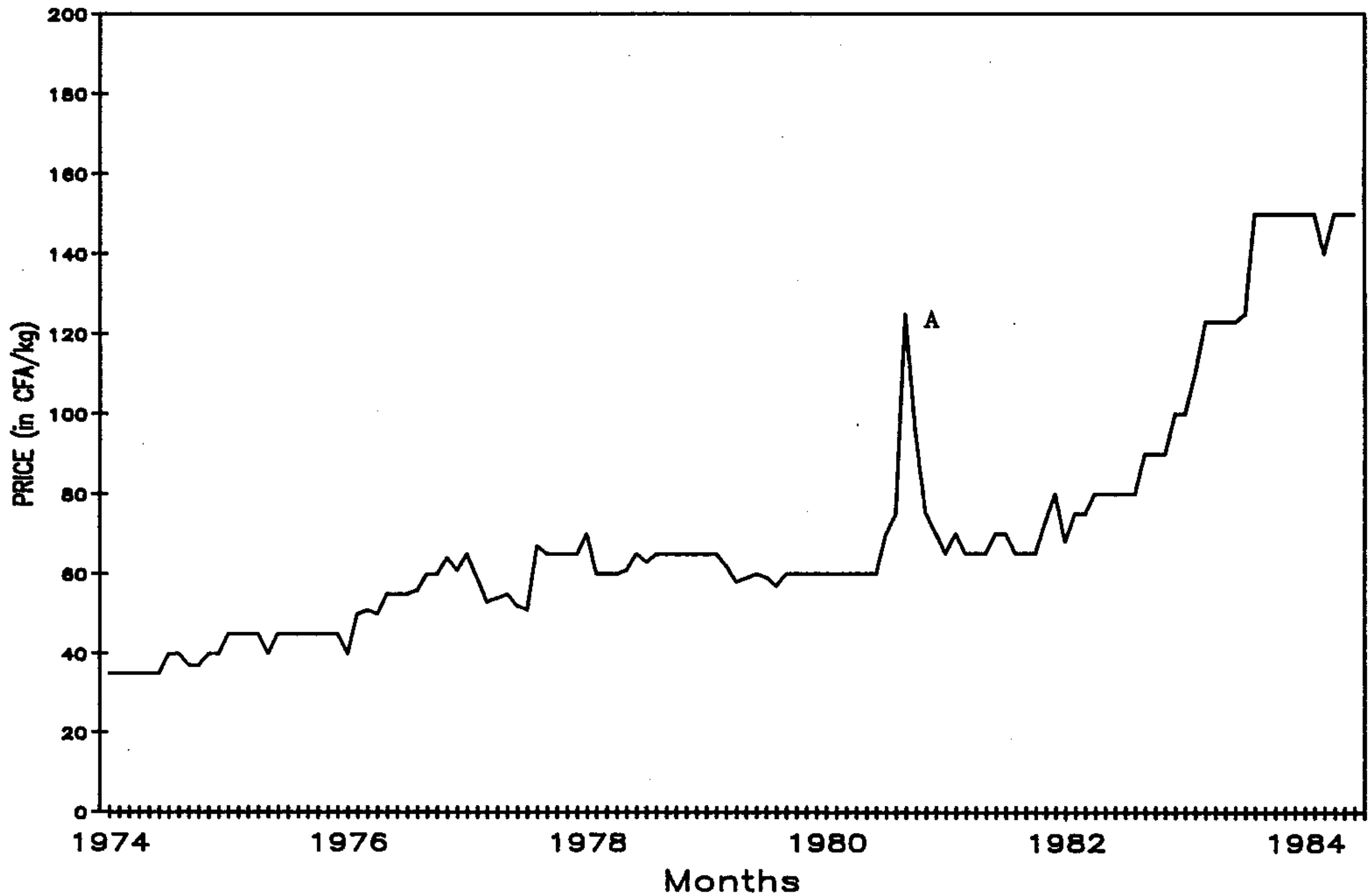
An example of a data series collected by a government agency is shown in Figure 7-1 below. When the data is first plotted it does not appear to exhibit typical fluctuations which are characteristic of many price time series. Nevertheless, upon closer examination, it does show some seasonal variation, and it would be worthwhile to subject the series to a seasonal decomposition, as discussed in Chapter 4. Also, the outlier observation flagged with an "A" in the figure could be verified, and adjusted if necessary, by showing the plot to key participants in the market system and asking them whether or not it is a "reasonable" observation. 23/

More generally, it should be possible to verify the plausibility of existing data series by using the techniques reviewed in this paper along with a good deal of common sense and reference to basic economic relationships. In essence, this turns around the analyses reviewed earlier and, instead of asking "what does the data tell us about conditions in the marketing system"?, it poses the question, "what ought the data tell us about the system based on what is theoretically expected?" If a data series is judged to be conceptually sound, empirical tests of the data can be

---

23/ In some instances it will be necessary to "clean-up" the secondary data set by removing inconsistent and outlying observation (see Ch 1). Also, it is often useful to calculate and work with trimmed or "Windsorized" sample means. See Bhattacharyya and Johnson (1977, p. 31) for a formal discussion and Ouedrago (1983) for an interesting application.

FIGURE 7-1: MILLET PRICES, DAKAR MARKET (1974-84)



Data Source: Martin (1985)

completed. The results can then be examined for validity by talking with food system participants and knowledgeable observers. The question is do empirical results of analysis with historical price data agree with reality as perceived by these individuals?

It is also possible and sometimes advisable to design independent spot checks on existing data collection activities. For example, a researcher might decide to utilize a retail price series from an ongoing Ministry of Commerce or Ministry of Plan price information unit. Simultaneously, an independent spot check on current prices could be completed by periodically interviewing retailers of the same type in the same geographical areas sampled by the Ministry. While such results may say little about the prior performance of the agencies data collection activities, it does give an indication of their performance under current conditions. And if current patterns in the data are also present in earlier years of the same data, some judgements might be made about the entire data series.

Once a secondary data series has been judged to be empirically and conceptually reasonable, it can be used for further analyses such as seasonal decompositions and/or estimation of supply and demand equations. Alternatively the procedures discussed here can help a researcher decide whether to utilize data coming from an existing organization, or to invest scarce resources in collecting such data in his or her own new study. In both cases it is important to keep in mind possible limitations of data in making final conclusions and recommendations.

Notwithstanding these caveats, we believe there are very high payoffs to using existing data, and to applying the fundamental methods of price analysis presented in this manual. Improved markets and pricing mechanisms evolve only gradually over time, and better informed analysts can have an important role in fomenting this evolution.

BIBLIOGRAPHY

Bhattacharyya, G.K. and R.A. Johnson, Statistical Concepts and Methods, John Wiley and Sons, New York, 1977.

Calkins, P.H. and H. Wang, "Improving the Marketing of Perishable Commodities: A Case Study of Selected Vegetables in Taiwan", Technical Bulletin # 9 (78-86),, Asian Vegetable Research and Development Center, February 1980

Casley, D.J. and D.A. Lury, Data Collection in Developing Countries, Clarendon Press, Oxford, 1981.

Degand, J. and L. D'Haese, "Etude Economique du Marche des Produits Vivriers au Burundi. Analyse Chronologique des Prix du Haricot" (Market Economic Analysis of Food Products in Burundi. Time Series Analysis of Bean Prices), Tropicultura, Vol. 1, No. 3, 1983

Delgado, C.L., "Seasonal Price Spreads in Burkina Faso: Their Predictability and Related Policy Issues", IFPRI/FAO/AID Workshop on Seasonal Causes of Household Food Insecurity, Policy Implications and Research Needs", Annapolis, Maryland, December 10-13, 1985. [DRAFT]

Ellsworth, L. and K. Shapiro, "Seasonality in Burkina Faso Grain Marketing: Farmer Strategies and Government Policy", IFPRI/FAO/AID Workshop on Seasonal Causes of Household Food Insecurity, Policy Implications and Research Needs, Annapolis, Maryland, December 10-13, 1985. [DRAFT]

Eicher, C.K. and D. Baker, "Research on Agricultural Development in Sub-Saharan Africa: A Critical Survey", MSU International Development Paper, No. 1, East Lansing, Department of Agricultural Economics, Michigan State University, 1982.

Ezekiel, Mordecai and Karl A. Fox, Methods of Correlation and Regression Analysis, 3rd Edition, John Wiley and Sons, Inc., 1959.

FAO, Assessment and Collection of Data on Post Harvest Food Grain Loss, Economic and Social Development Document No. 13, Rome, 1980.

FAO, Market Information Services, Agricultural Services Bulletin No. 57, FAO, Rome, 1983.

FAO, Food and Agricultural Statistics in the Context of a National Information System, Statistics Division, Rome, 1985 (provisional)

Ferris, J.N., "An Analysis of the Seasonal Cash Price Pattern on Michigan Corn, Wheat, and Soybeans", Agricultural Economics Staff Paper #79-6, revised November 1983.

Foote, R.J. and K.A. Fox, "Seasonal Variation: Methods of Measurement and Tests of Significance", Agriculture Handbook No. 48, USDA, Washington, September 1952.

Gatere, K. "Market Efficiency in Kenya: A Study of the Marketing System for Fruits and Vegetables", unpubl. PhD Dissertation, University of Alberta, 1980.

Girado, L.M. "A Study of the Seasonal Patterns in the Argentine Cattle Market", unpubl. Plan B Research Paper, Michigan State University, 1985

Harriss, Barbara, "There is Method in my Madness: Or is it Vice Versa? Measuring Agricultural Market Performance", Food Research Institute Studies, Vol. XVII, No. 2, pp 197-218, 1979.

Harsh, S.B. and M.T. Weber, "The Use of Microcomputers in the Agricultural Sector in Developing Countries", in Microcomputers For Development, edited by Munasinghe, Dow and Fritz. Sri Lanka: Computers and Information Technology Council of Sri Lanka, and the National Academy of Sciences, U.S.A., 1984.

Holtzman, J.S. "Rapid Reconnaissance Guidelines for Agricultural Marketing Research", MSU International Development Working Paper, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, 1986--forthcoming.

Homann, Juergen and Winfrid Zettelmeyer, Potato Storage - An Example at the Small Scale Farm Level in Kenya, Deutsche Gesellschaft fuer Technische Zusammenarbeit, GTZ [German Agency for Technical Cooperation], Eschborn, 1980.

Jones, W.O. "Regional Analysis and Agricultural Marketing Research in Tropical Africa: Concepts and Experience", Food Research Institute Studies, Vol. 13, 1974, pp. 3-28.

Junta National de Carnes, Santesis Estadistica, Secretaraa de Agricultura y Ganaderaa, Buenos Aires, Argentina, various issues, 1972-83.

Lapin, Lawrence L. Statistics for Modern Business Decisions, 2nd. edition, Harcourt Brace Jovanovich, Inc., New York, 1978.

Manig, W. "Die Preisbewegung bei Getreide und ihre Bedeutung fuer die Vermarktung in Aethiopien, dargestellt am Beispiel des Baco-Gebietes (Price Movements of Grains and their Impact on Marketing in Ethiopia, exemplified by the Baco-Area), Zeits. Ausl. Landwirtschaft, Vol. 14, No. 1 (Jan.-March) 1975, pp. 68-86.

Martin, F., "L'evolution de la politique cerealiere au Senegal de 1974 a 1984" (Development of Cereals Policy in Senegal from 1974 to 1984), Draft Paper, mimeo, (undated--1985)

Mears, Leon, "Profitability of Holding Rice after Harvest in Indonesia", Bulletin of Indonesian Economic Studies, Vol. XVI, No. 3, pp 94-114, 1980.

National Research Council, Post Harvest Food Losses in Developing Countries, National Academy of Sciences, Washington, 1978.

Newbery, D.M.G. and J.E. Stiglitz, The Theory of Commodity Price Stabilization: A Study in the Economics of Risk, Clarendon Press, Oxford, 1981.

OECD, Food Margin Analysis: Aims, Methods and Uses, Paris, 1981 (Organization for Economic Cooperation and Development)

Ouedraogo, I.S. "A Socioeconomic Analysis of Farmers' Food Grain Marketing Linkages and Behaviour in Eastern Upper Volta", unpubl. PhD Dissertation, Michigan State University, 1983.

Pindyck, R.S. and D.L. Rubinfeld, Econometric Models and Economic Forecasts McGraw-Hill Book Company, New York, 2nd Edition, 1981.

Sahn, D.E. and C. Delgado, "A Review of the Magnitude, Causes, and Implications of Seasonal Price Variability", IFPRI/FAO/AID Workshop on Seasonal Causes of Household Food Insecurity Policy Implications and Research Needs, Annapolis, Maryland, December 10-13, 1985. [DRAFT]

Sherman, J.R., "Grain Markets and the Marketing Behaviour of Farmers: A Case Study of Manga, Upper Volta", Center for Research on Economic Development, University of Michigan, 1984.

Shepherd, G.S., Agricultural Price Analysis, Iowa State University Press, Ames, Iowa, 5th Edition, 1963.

Smith, L.D. "A Methodology for Measuring Marketing Costs and Margins for Foodstuffs in Developing Countries", FAO, Rome, May 1981.

Southworth, R. "Food Crop Marketing in Atebubu District District, Ghana" unpubl. PhD Thesis, Stanford University, 1981

Timmer, C. Peter, "A Model of Rice Marketing Margins in Indonesia", Food Research Institute Studies, Vol. XIII, No. 2, pp 145-167, 1974.

Timmer, C.P., W.P. Falcon and S.R. Pearson, Food Policy Analysis, John Hopkins University Press, Baltimore, 1983.

Timmer C.P. and C. Silitonga, "The Interplay of Seasonal Stabilization of Rice and Corn Prices in Indonesia", IFPRI/FAO/AID Workshop on the Seasonal Causes of Household Food Insecurity, Policy Implications and Research Needs, Annapolis, Maryland, December 10-13, 1985. [DRAFT]

Timmer, C.P. "Private Decisions and Public Policy: The Price Dilemma in Developing Countries Food Systems", MSU International Development Paper, No. 7, East Lansing, 1986a--forthcoming.

Timmer, C.P. (editor) The Corn Economy of Indonesia, Cornell University Press, 1986b--forthcoming.

Tomek, William G. and Kenneth L. Robinson, Agricultural Product Prices, edition, Cornell University Press, Ithaca, 1981.

Tweeten, Luther G., Foundations of Farm Policy, University of Nebraska Press, Lincoln, 2nd. edition, 1979.

Unnevehr, L.J., "Cassava Marketing and Price Behavior on Java", unpubl. PhD Thesis, Stanford University, 1982.

Weber, M.T. and R. Azevedo, "Analysis of the Fresh Market Potential for Proposed Tomato Production in the Ibiapaba Integrated Rural Development Project", Fortaleza Brazil: Department of Agricultural Economics, Federal University of Ceara, 1978. (In Portuguese)

Weston, H. "The Estimation of Marketing Efficiency", European Journal of Marketing, Vol. 10, No. 5, pp. 218-239, 1976.

World Bank, "Agricultural Pricing in Togo", Staff Working Paper, No. 467, July 1981.

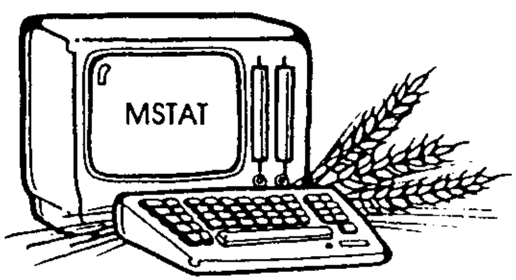
Wildt, A.R., "Estimating Models of Seasonal Market Response Using Dummy Variables", Journal of Marketing Research, Vol. 14, pp. 34-41, 1977.

APPENDIX 1

Description of "MSTAT"

MSTAT

A MICROCOMPUTER PROGRAM FOR THE DESIGN, MANAGEMENT AND ANALYSIS OF AGRONOMIC EXPERIMENTS



MICHIGAN STATE UNIVERSITY

- DEPARTMENT OF CROP AND SOIL SCIENCES

- DEPARTMENT OF AGRICULTURAL ECONOMICS

- INSTITUTE OF INTERNATIONAL AGRICULTURE

AGRICULTURAL UNIVERSITY OF NORWAY

- DEPARTMENT OF FARM CROPS

GENERAL DESCRIPTION OF MSTAT

MSTAT is an integrated microcomputer program which will assist agricultural scientists in most of the steps involved in doing agricultural research. MSTAT will generate experimental designs, manage and transform data and analyze experiments from both a biological and economical perspective. It is written from a user's perspective, has extreme flexibility and operates in an interactive mode.

DISCIPLINES THAT WILL USE MSTAT

MSTAT can be used by persons with no previous microcomputer experience. The program is menu driven and is user friendly. It does not require any programming skills to operate. MSTAT will run on most of the microcomputers being used by agricultural scientists.

Agronomists, plant breeders, economists, entomologists, pathologists, weed specialists and statisticians are some of the disciplines which can use MSTAT. In addition to the research applications, MSTAT can be used in universities to teach statistics and research management.

NEED FOR MSTAT

Data collection, management and analysis need to be correctly and efficiently organized in order to avoid typical data handling problems. MSTAT provides programs for a step-wise process of identifying and solving agricultural problems. MSTAT has programs which allows the agricultural scientists to get closer to their data.

EQUIPMENT SPECIFICATIONS

1. 64 K RAM (or more)
2. CP/M or MS-DOS operating system
3. Microsoft BASIC (MBASIC, BASICA, etc.)
4. Printer

PRICING INFORMATION (U.S. dollars)

1. Commercial organization	300.00*
2. Individual	100.00*
3. University/Non-profit	100.00*
4. Extra manuals	25.00*
5. License fee (each add'l machine)	50.00

*foreign postage extra

ORDERING PROCEDURE

1. Please enclose this information on each order:
   -computer name and model
   -operating system (CP/M or MS-DOS)
   -disk size and format
   -printer model

2. Send P.O. or Check payable to MSU to:
   Dr. Russell Freed, MSTAT Director
   Dept Crop and Soil Sciences
   Michigan State University
   324B Agriculture Hall
   East Lansing, MI 48824-1114

3. For additional information please write or phone the MSTAT office:

   (517) 353-1752

MSTAT SUBPROGRAMS IN VERSION 3

Program	Function
ACSERIES	Maintains breeding information
ADDON	Adds two similar MSTAT files end-on-end
ANOVA-1	Computes a one-way analysis of variance
ANOVA-2	Computes a two-way analysis of variance
ANOVALAT	Computes a lattice analysis of variance
ASCII	ASCII disk file maintenance
BLANK	Creates blank data cases
BRBOOK	Prints books for breeding material
BRLABEL	Prints labels for breeding material
BRLIST	Updates generation and prints pedigree
CALC	Computes conversion of data using BASIC equations
CHISQR	Computes chi-square for data in contingency tables
CONFIG	Maintains default settings
CONTRAST	Computes coefficients for orthogonal polynomial equations
CONVERT	Converts MSTAT 2.0 files to 3.0 files
CORR	Computes simple correlations and regressions
CURVES	Prints one or more curves on the same figure
DATENTRY	Data entry procedures
DEFINE	Creating new variables
ECON	Marginal returns analysis
EXPBOOK	Prints field books based on EXPPLAN
EXPLABEL	Prints labels based on EXPPLAN
EXPMAP	Prints field maps of EXPPLAN
EXPPLAN	Generates RB designs
FACTOR	Computes factorial or split-plot anal of variance
FILES	Utility functions for MSTAT data files
FORMREAD	Data entry from survey forms
FREQ	Computes freq & histograms of data variables
GROUPIT	Groups data values into specific group categories
HIERARCH	Hierarchical analysis of variance
LIST	Editing data
MEAN	Computes and stores means in an ASCII file
MULTIREG	Computes multiple regression
NEWTXT	Renaming variables and titles, redefining display formats
NONORTHO	Computes a nonorthogonal analysis of variance
PLOT	Creates an X-Y scatter plot of any two variables
PRLIST	Printing a data file
PROBABIL	Presents various probability values on the screen
PROBIT	Calculates ED50, LogED50, slope, intercept, etc
RANGE	Calculates separation of means
REGR	Computes within & between group regr analysis & ANOVA
SEACALC	Calculates values for price analysis
SEAPLAN	Defines variables for a price file
SEASONAL	Produces indices and **Seasonal** analysis for a price file
SEASTORE	Produces tables of storage analysis for a price file
SEATABLE	Produces tables of price changes
SELECT	Creates files of selection statements
SORT	Sorts data with 15 levels of keys
STAT	Computes summary statistics of variables
TABTRANS	Tabular transformation of data
VARBOOK	Prints field books of VARPLAN
VARLABEL	Prints labels based on VARPLAN
VARMAP	Creates and prints field maps of VARPLAN
VARNAME	Creates varietal name and accession number files

APPENDIX 2 (CHAPTER 3)

Calculating Marketing Margins When There Are By-Products*

In many situations it is not possible to simply subtract farm-level prices from prices at retail to obtain marketing margins because a portion of the product is lost as it is converted into its final form. Examples include (a) livestock, where bones and other parts of the animal are removed before it is sold as meat at retail; and (b) paddy rice, where parts of the plant are removed during the milling procedure.

In these cases, the following five steps are necessary to calculate the effective marketing margins.

1. Determine conversion factors between farm weight and retail weight.
2. Calculate farm price in retail-weight-equivalent (= Gross Farm Value).
3. Estimate any by-product values in terms of the retail weight of the principal product.
4. Deduct by-product values from Gross Farm Value to calculate Net Farm Value.
5. The difference between the retail price and the Net Farm Value is the marketing margin.

<u>Example</u> (Application)

Assumptions:

Retail Price of Beef = 150 c/lb
Farm Gate Price of Beef = 60 c/lb
Conversion Factor = 1.8
By-product Value of beef = 18 c/lb

<u>Step 1</u>:
Conversion Factor: 1.8 lbs of beef at the farm level yields 1.0 lb of beef at the retail level

<u>Step 2</u>:

```
   60 c/lb
x  1.8 (conversion factor)
------
= 108 c/lb  (Gross Farm Value of Beef)
```

<u>Step 3</u>: By-product Value of Beef = 18c/lb

<u>Step 4</u>:

```
  108 c/lb
-  18 c/lb
------
=  90 c/lb  (Net Farm Value of Beef)
```

<u>Step 5</u>: Subtract Net Farm Value of Beef from Retail price to obtain the effective marketing margin.

```
  150 c/lb
-  90 c/lb
------
=  60 c/lb
```

Therefore, the true marketing margin per pound of beef is 60 c/lb, and not 90 c/lb (the difference between the retail and farm level price).

---

* Based on Ferris; see also Smith (1981).

APPENDIX 3: CALCULATIONS UNDERLYING THE RESULTS IN TABLE 5-3 (CH. 5) (SPATIAL CORRELATION ANALYSES, MILLET, MALI DATA)

```
Data file SPCORAN6
Title: Regional Prices of Traditional Cereals, Apr. 1983-85, Mali
Function: CORR
Data case no.  1  to  23
Without selection

 Millet Price at Bamako
Variable   1 Average =     129.60 Variance =       436.44
 Millet Price at Mopti
Variable   2 Average =     120.86 Variance =       583.55

Number =  21
Covariance =     395.29 Correlation =    0.783
Intercept  =     3.48          Slope =   0.906 Standard Error =   0.165
Student's T value     5.492 Probability =    .000

 Millet Price at Bamako
Variable   1 Average =     129.75 Variance =       455.75
 Millet Price at Sikasso
Variable   3 Average =      97.25 Variance =        90.72

Number =  20
Covariance =     150.66 Correlation =    0.741
Intercept  =    54.36          Slope =   0.331 Standard Error =   0.071
Student's T value     4.681 Probability =    .000

 Millet Price at Bamako
Variable   1 Average =     128.52 Variance =       409.42
 Millet Price at Kayes
Variable   4 Average =     133.98 Variance =       657.42

Number =  23
Covariance =     210.76 Correlation =    0.406
Intercept  =    67.82          Slope =   0.515 Standard Error =   0.253
Student's T value     2.037 Probability =    .054

 Millet Price at Bamako
Variable   1 Average =     129.98 Variance =       439.64
 Millet Price at Segou
Variable   5 Average =     108.88 Variance =       470.05

Number =  20
Covariance =     365.76 Correlation =    0.805
Intercept  =     0.74          Slope =   0.832 Standard Error =   0.145
Student's T value     5.748 Probability =    .00

 Millet Price at Mopti
Variable   2 Average =     125.28 Variance =       505.80
 Millet Price at Sikasso
Variable   3 Average =      97.22 Variance =       100.65
```

Number = 18
Covariance = 138.32 Correlation = 0.613
Intercept = 62.96 Slope = 0.273 Standard Error = 0.088
Student's T value 3.104 Probability = .006

Millet Price at Mopti
Variable 2 Average = 120.86 Variance = 583.55
Millet Price at Kayes
Variable 4 Average = 133.64 Variance = 706.18

Number = 21
Covariance = 111.16 Correlation = 0.173
Intercept = 110.62 Slope = 0.190 Standard Error = 0.249
Student's T value 0.766 Probability = 1.0

Millet Price at Mopti
Variable 2 Average = 121.08 Variance = 633.79
Millet Price at Segou
Variable 5 Average = 109.08 Variance = 495.29

Number = 19
Covariance = 471.12 Correlation = 0.841
Intercept = 19.08 Slope = 0.743 Standard Error = 0.116
Student's T value 6.406 Probability = .000

Millet Price at Sikasso
Variable 3 Average = 97.25 Variance = 90.72
Millet Price at Kayes
Variable 4 Average = 132.83 Variance = 728.56

Number = 20
Covariance = 115.94 Correlation = 0.451
Intercept = 8.54 Slope = 1.278 Standard Error = 0.596
Student's T value 2.144 Probability = .045

Millet Price at Sikasso
Variable 3 Average = 97.50 Variance = 103.91
Millet Price at Segou
Variable 5 Average = 113.38 Variance = 414.02

Number = 17
Covariance = 161.72 Correlation = 0.780
Intercept = -38.37 Slope = 1.556 Standard Error = 0.323
Student's T value 4.823 Probability = .000

Millet Price at Kayes
Variable 4 Average = 138.45 Variance = 528.58
Millet Price at Segou
Variable 5 Average = 108.88 Variance = 470.05

Number = 20
Covariance = 191.19 Correlation = 0.384
Intercept = 58.80 Slope = 0.362 Standard Error = 0.205
Student's T value 1.762 Probability = .095

APPENDIX 4: A MORE REFINED MEASURE OF PRICE INTEGRATION*

In Timmer's (1986b) statistical model of price integration, a central market serves as the ultimate determinant of market prices elsewhere in the country. The model is operationalized by regressing the first difference in logarithms of monthly prices in local markets on four explanatory variables:

$$(1) \quad P(t) - P(t-1) = a + b\,[P(t-1) - R(t-1)] + c\,[R(t) - R(t-1)] + d\,R(t-1) + e\,X(t-1) + u(t)\ ,$$

where P(t) = the logarithm of the rural or farm price in month t,

R(t) = the logarithm of the central or urban price, in month t,

X(t) = a vector of other variables which influence local price price formation independently of central prices, lagged appropriately, and

u(t) = a random error term.

After it has been econometrically estimated, equation (1) can be converted to equation (2), which facilitates the interpretation of the coefficients:

$$(2) \quad P(t) = a + (1 + b)\,P(t-1) + c\,[R(t) - R(t-1)] + (d - b)\,R(t-1) + e\,X(t-1)$$

(1 + b) and (d - b) represent the historical effects of rural and urban prices, respectively, on current local price formation (measured in a distributed lag form). If historical central market prices have a large influence on local price formation, we can be confident that rural and

---

* This appendix is based entirely on Timmer (1986b--forthcoming)

urban markets are well-connected since supply and demand conditions in the central market are effectively communicated to the rural markets. Coefficient c measures the degree to which price changes in urban markets affect local market prices (P). If c = 1.0 and marketing margins are calculated in percentage terms, there is a one-to-one correspondence in urban and rural price changes (this analysis is similar to that on page 56 in the manual, where we were only concerned with price levels, and not monthly changes in price levels).

Finally, Timmer proposes the following index of market connection (IMC), which is calculated as:

$$IMC = \frac{1 + b}{d - b} \qquad (3)$$

Small values of the IMC (such as IMC < 1.0) indicate a high degree of market connection, since lagged urban prices are then relatively more important than lagged rural prices in determining current rural prices. As Timmer points out, the IMC can be large even if c = 1, and in that case the difference between c and the IMC represents the difference between long-run and short-run price integration, respectively.

MSU INTERNATIONAL DEVELOPMENT PAPERS

		Price
IDP No. 1	Carl K. Eicher and Doyle C. Baker, "Research on Agricultural Development in Sub-Saharan Africa: A Critical Survey," 1982 (346 pp.).	$ 8.00
IDP No. 1F	Carl K. Eicher et Doyle C. Baker, "Etude critique de la recherche sur le developpement agricole en Afrique subsaharienne," 1985 (435 pp.).	$10.00
IDP No. 2	Eric W. Crawford, "A Simulation Study of Constraints on Traditional Farming Systems in Northern Nigeria," 1982 (136 pp.).	$ 5.00
IDP No. 3	M.P. Collinson, "Farming Systems Research in Eastern Africa: The Experience of CIMMYT and Some National Agricultural Research Services, 1976-81," 1982 (67 pp.).	$ 4.00
IDP No. 4	Vincent Barrett, Gregory Lassiter, David Wilcock, Doyle Baker, and Eric Crawford, "Animal Traction in Eastern Upper Volta: A Technical, Economic and Institutional Analysis," 1982 (132 pp.).	$ 5.00
IDP No. 5	John Strauss, "Socio-Economic Determinants of Food Consumption and Production in Rural Sierra Leone: Application of an Agricultural Household Model with Several Commodities," 1983 (91 pp.).	Out of Print
IDP No. 6	Beverly Fleisher and Lindon J. Robison, "Applications of Decision Theory and the Measurement of Attitudes Towards Risk in Farm Management Research in Industrialized and Third World Settings," 1985 (106 pp.).	$ 5.00
IDP No. 7	C. Peter Timmer, "Private Decisions and Public Policy: The Price Dilemma in Food Systems of Developing Countries," 1986 (58 pp.).	$ 5.00
IDP No. 8	Michael L. Morris, "Rice Marketing in the Senegal River Valley: Research Findings and Policy Reform Options," 1987 (89 pp.).	$ 5.00
IDP No. 9	Carl Liedholm and Donald Mead, "Small Scale Industries in Developing Countries: Empirical Evidence and Policy Implications," 1987 (141 pp.).	$ 6.00
IDP No. 10	Derek Byerlee, "Maintaining the Momentum in Post-Green Revolution Agriculture: A Micro-Level Perspective from Asia," 1987 (57 pp.).	$ 5.00

MSU INTERNATIONAL DEVELOPMENT WORKING PAPERS

WP No. 1	Daniel Galt, Alvaro Diaz, Mario Contreras, Frank Peairs, Joshua Posner and Franklin Rosales, "Farming Systems Research (FSR) in Honduras, 1977-81: A Case Study," 1982 (48 pp.).	Out of Print
WP No. 2	Edouard K. Tapsoba, "Credit Agricole et Credit Informel dans le Region Orientale de Haute-Volta: Analyse Economique, Performance Institutionnelle et Implications en Matiere de Politique de Developpement Agricole," 1982 (125 pp.).	Out of Print
WP No. 3	W.P. Strassmann, "Employment and Construction: Multicountry Estimates of Costs and Substitution Elasticities for Small Dwellings," 1982 (48 pp.).	Out of Print
WP No. 4	Donald C. Mead, "Sub-contracting in Rural Areas of Thailand," 1982 (52 pp.).	Out of Print
WP No. 5	Michael T. Weber, James Pease, Warren Vincent, Eric W. Crawford and Thomas Stilwell, "Microcomputers and Programmable Calculators for Agricultural Research in Developing Countries," 1983 (113 pp.).	$ 5.00
WP No. 6	Thomas Stilwell, "Periodicals for Microcomputers: An Annotated Bibliography," 1983 (70 pp.).	See IDWP #21
WP No. 7	W. Paul Strassmann, "Employment and Housing in Lima, Peru," 1983 (96 pp.).	Out of Print
WP No. 8	Carl K. Eicher, "Faire Face a la Crise Alimentaire de l'Afrique," 1983 (29 pp.).	Free
WP No. 9	Thomas C. Stilwell, "Software Directories for Microcomputers: An Annotated Bibliography," 1983 (14 pp.).	See IDWP #22
WP No. 10	Ralph E. Hepp, "Instructional Aids for Teaching How to Use the TI-59 Programmable Calculator," 1983 (133 pp.).	Out of Print

MSU INTERNATIONAL DEVELOPMENT WORKING PAPERS - CONTINUED

		Price
WP No. 11	Michael L. Morris and Michael T. Weber, "Programmable Calculator (TI-59) Programs for Marketing and Price Analysis in Third World Countries," 1983 (105 pp.).	Out of Print
WP No. 12	Valerie Kelly, Robert D. Stevens, Thomas Stilwell, and Michael T. Weber, "An Annotated Directory of Statistical and Related Microcomputer Software for Socioeconomic Data Analysis," 1983 (165 pp.).	$ 7.00
WP No. 13	Chris Wolf, "Guidelines for Selection of Microcomputer Hardware," 1983 (90 pp.).	$ 5.00
WP No. 14	Eric W. Crawford, Ting-Ing Ho, and A. Allan Schmid, "User's Guide to BENCOS-- SuperCalc Template for Benefit-Cost Analysis," 1984 (35 pp.).	$ 3.00
	Copy of BENCOS Template in IBM PC-DOS 1.1 Format, on single sided double density diskette (readable on most MS-DOS systems).	$15.00
WP No. 15	James W. Pease and Raoul Lepage with Valerie Kelly, Rita Laker-Ojok, Brian Thelen, and Paul Wolberg, "An Evaluation of Selected Microcomputer Statistical Programs," 1984 (187 pp.).	$ 7.00
WP No. 16	Stephen Davies, James Seale, Donald C. Mead, Mahmoud Badr, Nadia El Sheikh, and Abdel Rahman Saidi, "Small Enterprises in Egypt: A Study of Two Governorates," 1984 (100 pp.).	Out of Print
WP No. 17	Thomas C. Stilwell, "Microcomputer Statistical Packages for Agricultural Research," 1984 (23 pp.).	$ 3.00
WP No. 18	Thomas C. Stilwell and P. Jordan Smith, "An Annotated Directory of Citation Database, Educational, System Diagnostics and Other Miscellaneous Microcomputer Software of Potential Use to Agricultural Scientists in Developing Countries," 1984 (34 pp.).	$ 3.00
WP No. 19	Amalia Rinaldi, "Irrigation in Southern Africa: An Annotated Bibliography," 1985 (60 pp.).	$ 4.00
WP No. 20	Daniel C. Goodman, Jr., Thomas C. Stilwell, and P. Jordan Smith, "A Microcomputer Based Planning and Budgeting System for Agricultural Research Programs," 1985 (75 pp.).	$ 5.00
WP No. 21	Thomas C. Stilwell, "Periodicals for Microcomputers: An Annotated Bibliography," Second Edition, 1985 (89 pp.).	$ 5.00
WP No. 22	Thomas C. Stilwell, "Software Directories for Microcomputers: An Annotated Bibliography," Second Edition, 1985 (21 pp.).	$ 3.00
WP No. 23	Alan Hrapsky with Michael Weber and Harold Riley, "A Diagnostic Prescriptive Assessment of the Production and Marketing System for Mangoes in the Eastern Caribbean," 1985 (106 pp.).	$ 5.00
WP No. 24	Donald C. Mead, "Subcontracting Systems and Assistance Programs: Opportunities for Intervention," 1985 (32 pp.).	Out of Print
WP No. 25	Carl Liedholm, "Small Scale Enterprise Credit Schemes: Administrative Costs and the Role of Inventory Norms," 1985 (23 pp.).	Out of Print
WP No. 26	James J. Boomgard, Stephen P. Davies, Steve Haggblade, and Donald C. Mead, "Subsector Analysis: Its Nature, Conduct and Potential Contribution to Small Enterprise Development," 1986 (57 pp.).	Out of Print
WP No. 27	Steve Haggblade, Carl Liedholm, and Donald C. Mead, "The Effect of Policy and Policy Reforms on Non-Agricultural Enterprises and Employment in Developing Countries: A Review of Past Experiences," 1986 (133 pp.).	Out of Print
WP No. 28	John T. Milimo and Yacob Fisseha, "Rural Small Scale Enterprises in Zambia: Results of a 1985 Country-Wide Survey," 1986 (76 pp.).	Out of Print
WP No. 29	Stephan Goetz and Michael T. Weber, "Fundamentals of Price Analysis in Developing Countries' Food Systems: A Training Manual to Accompany the Microcomputer Software Program 'MSTAT,'" 1986 (148 pp.).	$ 7.00

MSU INTERNATIONAL DEVELOPMENT WORKING PAPERS - CONTINUED

		Price
WP No. 30	John S. Holtzman, "Rapid Reconnaissance Guidelines for Agricultural Marketing and Food System Research in Developing Countries," 1986 (75 pp.).	$ 5.00
WP No. 31	Nicholas William Minot, "Contract Farming and Its Effect on Small Farmers in Less Developed Countries," 1986 (86 pp.).	$ 5.00

MSU INTERNATIONAL DEVELOPMENT REPRINT PAPERS

RP No. 1	Carl Liedholm, "The Private Sector Connection to Development," 1986 (19 pp.).	Out of Print
RP No. 2	James D. Shaffer with Michael Weber, Harold Riley and John Staatz, "Influencing the Design of Marketing Systems to Promote Development in Third World Countries (21 pp.).	$ 3.00
RP No. 3	Carl K. Eicher, "Famine Prevention in Africa: The Long View," 1987 (18 pp.).	$ 3.00
RP No. 4	Michael L. Morris, "Cereals Marketing in the Senegal River Valley (1985)," 1987 (126 pp.).	$ 6.00
RP No. 5	Mandivamba Rukuni and Carl K. Eicher, "The Food Security Equation in Southern Africa," 1987 (32 pp.).	$ 3.00
RP No. 6	Eric Crawford and Mulumba Kamuanga, "Economic Analysis of Agronomic Trials for the Formulation of Farmer Recommendations," 1988 (41 pp.).	$ 3.00
RP No. 6F	Eric Crawford et Mulumba Kamuanga, "L'Analyse Economique des Essais Agronomiques Pour la Formulation des Recommandations aux Paysans," 1987 (33 pp.).	$ 3.00
RP No. 7	Eric W. Crawford, "Economic Analysis of Livestock Trials," 1988 (38 pp.).	$ 3.00
RP No. 7F	Eric Crawford, "L'Analyse Economique des Essais Zootechniques," 1987 (36 pp.).	$ 3.00
RP No. 8	Eric Crawford and Valerie Kelly, "A Field Study of Fertilizer Distribution and Use in Senegal, 1984: Summary Report," 1987 (32 pp.).	$ 3.00
RP No. 9	Kelly Harrison, Donald Henley, Harold Riley and James Shaffer, "Improving Food Marketing Systems in Developing Countries: Experiences from Latin America," 1987 (135 pp.).	$ 5.00
RP No. 10	Mark Newman, Eric Crawford and Jacques Faye, "Policy Relevant Research on the Food and Agricultural System in Senegal," 1987 (30 pp.).	$ 3.00
RP No. 10F	Mark Newman, Eric Crawford et Jacques Faye, "Orientations et Programmes de Researche Macro-Economiques sur le Systeme Agro-Alimentaire Senegalais," 1987 (37 pp.).	$ 3.00
RP No. 11	Eric Crawford, Curtis Jolly, Valerie Kelly, Philippe Lambrecht, Makhona Mbaye, and Matar Gaye, "A Field Study of Fertilizer Distribution and Use in Senegal, 1984: Final Report," 1987 (111 pp.).	$ 6.00
RP No. 11F	Eric Crawford, Curtis Jolly, Valerie Kelly, Philippe Lambrecht, Makhona Mbaye, et Matar Gaye, "Enquete sur la Distribution et l'Utilisation de l'Engrais au Senegal, 1984: Rapport Final," 1987 (106 pp.).	$ 6.00
RP No. 12	Mark D. Newman, P. Alassane Sow and Ousseynou NDoye, "Private and Public Sectors in Developing Country Grain Markets: Organization Issues and Options in Senegal," 1987 (14 pp.).	$ 3.00
RP No. 13	R. James Bingen and Jacques Faye, "Agricultural Research and Extension in Francophone West Africa: The Senegal Experience," 1987 (23 pp.).	$ 3.00
RP No. 13F	R. James Bingen et Jacques Faye, "La Liaison Recherche-Developpement en Afrique de l'Ouest Francophone: L'Experience du Senegal," 1987 (32 pp.).	$ 3.00
RP No. 14	Mark D. Newman, "Grain Marketing in Senegal's Peanut Basin: 1984/85 Situation and Issues," 1987 (16 pp.).	$ 3.00

MSU INTERNATIONAL DEVELOPMENT REPRINT PAPERS - CONTINUED

RP No. 15	Mark D. Newman, Ousseynou NDoye and P. Alassane Sow, "Tradeoffs Between Domestic and Imported Cereals in Senegal: A Marketing Systems Perspective," 1987 (41 pp.).	$ 3.00
RP No. 16	R. James Bingen, "An Orientation to Production Systems Research in Senegal," 1987 (88 pp.).	$ 5.00
RP No. 16F	R. James Bingen, "Orientation de la Recherche sur les Systemes de Productions au Senegal," 1987 (94 pp.).	$ 5.00
RP No. 17	J.L. Posner, "A Contribution to Agronomic Knowledge of the Lower Casamance (Bibliographical Synthesis)," 1988 (47 pp.).	$ 4.00
RP No. 18	Valerie Auserehl Kelly, "Acquisition and Use of Agricultural Inputs in the Context of Senegal's New Agricultural Policy: The Implications of Farmer's Attitudes and Input Purchasing Behavior for the Design of Agricultural Policy and Research Programs," 1988 (30 pp.).	$ 3.00
RP No. 18F	Valerie Auserehl Kelly, "Acquisition et Utilisation d'Intrants Agricoles dans le Contexte de la Nouvelle Politique Agricole du Senegal: Implications des Attitudes et du Comportement d'Achat d'Intrants des Exploitants pour l'Elaboration d'une Politique Agricole et de Programmes de Recherches," 1988 (35 pp.).	$ 3.00
RP No. 19	Valerie Auserehl Kelly, "Farmers' Demand for Fertilizer in the Context of Senegal's New Agricultural Policy: A Study of Factors Influencing Farmers' Fertilizer Purchasing Decisions," 1988 (47 pp.).	$ 4.00
RP No. 19F	Valerie Auserehl Kelly, "Demande d'Engrais de la Part des Exploitants dans les Contexte de la Nouvelle Politique Agricole au Senegal: Une Etude des Facteurs Influencant les Decisions d'Achat d'Engrais Prises par les Exploitants," 1988 (58 pp.).	$ 4.00

Copies may be obtained from: MSU International Development Papers, Department of Agricultural Economics, 7 Agriculture Hall, Michigan State University, East Lansing, Michigan 48824-1039, U.S.A. All orders must be prepaid in United States currency. Please do not send cash. Make checks or money orders payable to Michigan State University. There is a 10% discount on all orders of 10 or more sale copies. Individuals and institutions in the Third World and USAID officials may receive single copies free of charge.