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AN INVESTIGATION OF THE EXISTENCE  
OF A RANDOM WALK MODEL FOR  
THE NAIROBI STOCK MARKET  
PRICES

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WORKING PAPER 269

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June, 1976.

Views expressed in this paper are those of the author. They should not be interpreted as reflecting the views of the Institute for Development Studies or of the University of Nairobi.

STATE OF TEXAS  
COUNTY OF [illegible]  
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ABSTRACT

The behaviour of the Nairobi stock Market Prices are examined, under the assumption that the series follow a Random Walk Model.

An examination of the spectra of the first differences of the five series show the existence of significant cycles in the low as well as in the high frequency ranges. In addition important annual components and/or their harmonics do exist in some series.

It is concluded that the random walk model is not appropriate for the Nairobi stock market prices. It is further concluded that there is, therefore, no universal behaviour of stock market prices and that in some markets, such as the Nairobi Market, prices may be predicted enabling speculators to make profit.



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### INTRODUCTION

Recent studies of stock exchange prices (as well as speculative commodity prices) in western countries have indicated that stocks cannot be profitably predicted due to the random nature of changes in prices from one moment of time to another. In this view past analyses of some stock market prices have shown that the model that best handles this problem is the random walk model where a large number of speculators are continually attempting to predict prices at the next moment of time on the basis of their knowledge of the present prices.

Granger and Morgenstern [4, pp 1-2] analysed stock market prices and "found that short-run movements of the series obey simple random walk hypothesis... but that the long run components are of greater importance than suggested by this hypothesis." They also concluded that seasonal variations were of "little or no importance."

Further studies were made by Godfrey et al [2] who compared the New York and London Stock Exchange price behaviour. This study also supported the validity of the random walk model for the two markets at least within a certain frequency range. They also concluded that harmonics of the annual cycle were not significant.

Further, the universal character of the behaviour of the stock exchange prices is implied in all the past studies. In particular Granger and Morgenstern [4, p2] state that "there is, however, little likelihood that stock markets in other countries will behave differently."

It is the object of this paper to study the behaviour of the Nairobi Stock Exchange prices to see if conclusions that have been made **about** stock prices in western economies also apply to similar markets in predominantly agricultural economies.

### 2 THE RANDOM WALK MODEL

It is generally agreed that a large number of speculators participating on a stock exchange market attempt to predict prices at the next moment  $t+1$  on the basis of the prices at the present moment  $t$ . Thus their best predictor of  $P_{t+1}$  is  $P_t$  yielding a random walk model of the form

- 3 -

$$P_{t+1} = P_t + U_t \quad (1)$$

$$\text{or } P_t = P_{t-1} + U_t \quad (2)$$

where  $U_t$  - white noise with mean zero and constant variance  $\sigma_u^2$ . The implication of this model is that if a series is indeed represented by a random walk model, the first difference of the series will form a white noise process since

$$P_t - P_{t-1} = U_t \quad (3)$$

This being the case the spectrum of (3) is flat since the autocorrelation and the autocorrelation functions are zero at lags other than zero. The spectral estimate at the  $j$ th frequency is, therefore, given by

$$f_{uu}(w_j) = \sigma_u^2 \quad (4)$$

where  $w_j = \pi j M^{-1}$  and  $M$ =truncation point. For a normalized spectral density function the spectrum is

$$f_{uu}(w_j) = (2\pi)^{-1} \quad (5)$$

In practice the spectrum is not flat. However, appropriate tests can be carried out to ascertain whether or not possible peaks in the spectrum are significantly different from white noise.

### 3. THE NAIROBI STOCK EXCHANGE DATA

The data used in this analysis consist of the weekly Nairobi Stock Exchange Index (NASEI) constructed with January 1968 = 100 using 17 companies. There are, altogether, 303 observations recorded from October 1968 to the third week of January, 1976. The others are weekly middle prices of the East African Breweries (EAB), Block Hotels (BLOHO) and Kakuzi<sup>1</sup>. Each of these series consists of 152 observations. The first of these companies represent industry as whole while the last two represent the tourist industry and the agricultural industry, respectively. As a matter of comparison monthly hotel bed occupancy (HOB0), for a period of 141 months, was also analysed.<sup>2</sup>

### 4. RESULTS

Spectral methods are used in this analysis. The truncation point used for NASEI is 90 while 45 is used for the rest of the series. Parzen's window was used giving 16, 13, and 12 equivalent degrees of freedom, respectively, for the truncation points just mentioned.

The results of the five series are shown in figures 1-5. Figure 1 is the spectrum of the NASEI where the broken lines represent the lower and upper 95% confidence limits of the estimated spectral values and the

1. The data were provided by Dyer and Blair Ltd.
2. Source: "Kenya Statistical Digest".



horizontal continuous lines are the upper and lower 99% confidence limits on the assumption that the spectrum of this series represents a white noise process.

There is a sharp peak in the spectrum corresponding to 0.033 of a cycle per week. This component contributing 65% of total variance is significantly different from white noise at the 99% confidence level and judged by the 95% confidence limits one may not doubt the existence of an average cycle of 30 weeks in this series. However, it was found that by varying the truncation point the period of this series seems to change from a period of 28 weeks to about 33 weeks.

The peak corresponding to the 10 week cycle was significantly different from white noise at the 90% confidence level. This cycle happens to be the second harmonic of the 30 week cycle. The components whose frequencies are higher than 0.1 of a cycle per week fall within the definition of white noise. What is interesting, however, is the fact that although this is the case, peaks observed at higher frequencies have periods that are harmonics of the 30 week-cycle, suggesting the existence of a sine wave.

The spectrum of the middle prices of EAB (Figure 2) exhibit a 30 to 36 week cycle but with the whole spectrum dominated by a 10 week cycle. A 2.5-week cycle is also important. There is no doubt as to the presence of a sine wave since all the peaks at frequencies higher than 0.033 of a cycle per week occur at the harmonics of the 30-week cycle.

BLOND prices (figure 3) reveal some annual component represented by an important 24-week (6-month) cycle. The 2-week cycle is equally important. This series is greatly influenced, it seems, by the seasonal character of hotel bed occupancy which has a 6-month cycle with the rest of the peaks occurring at seasonal frequencies as shown in Figure 5. Large numbers of tourist arrive during the month of January and again during the month of August causing hotel owners to borrow during this time.

Kakuzi (figure 4) has the longest period compared to the other series. The length of this cycle ranges from 60-90 weeks or an average of about 72 two weeks. The peak correspond to this cycle is significantly different from white noise at the 90% confidence level. The rest of the peaks in the spectrum occur, approximately, at the harmonics of the 60-week cycle. The 2-week cycle which is significant at the 90% confidence level is also important.



FIGURE I  
SPECTRUM  
NAIROBI STOCK EXCHANGE  
INDEX

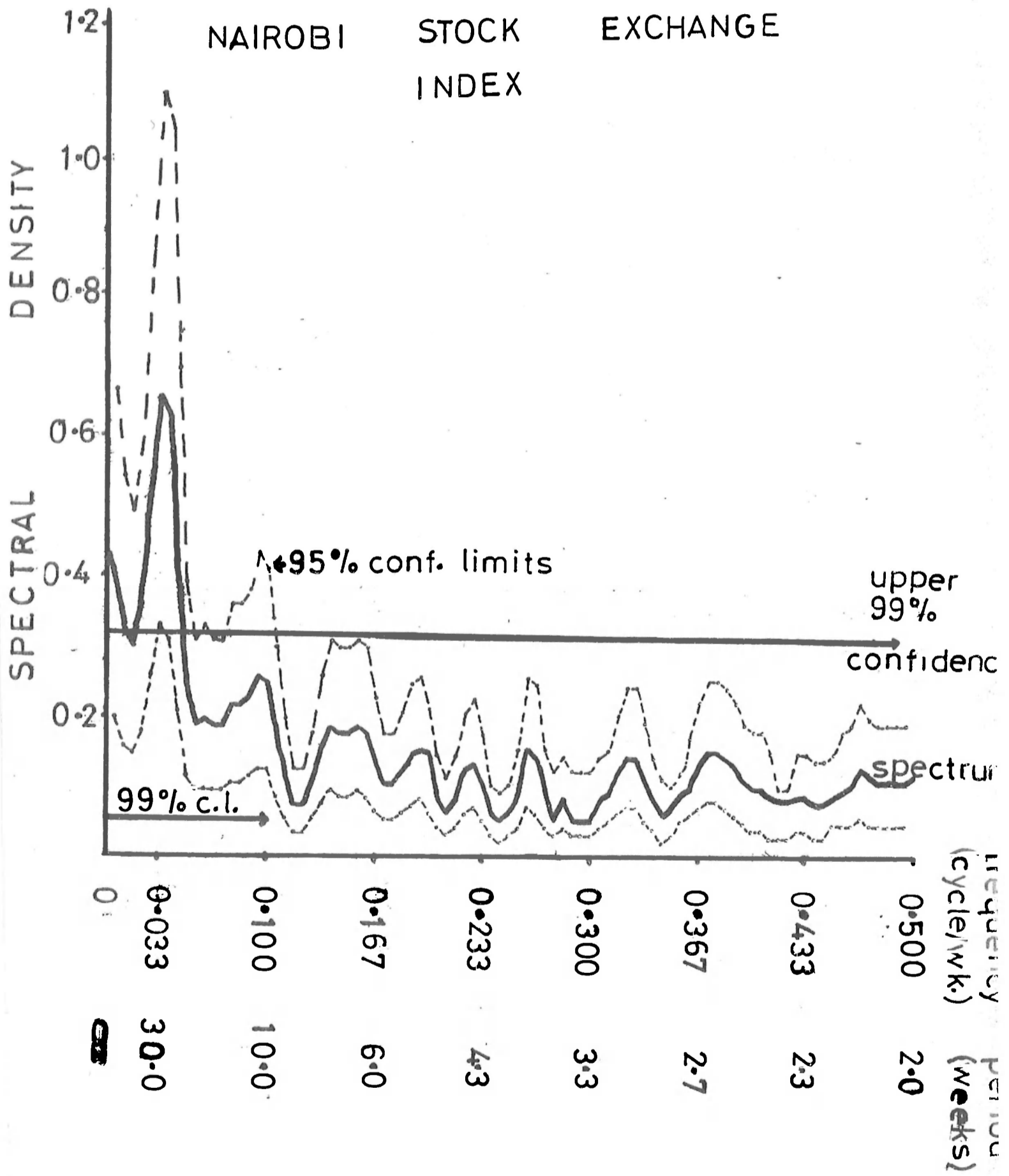


FIGURE 2

E. A. BREWERIES PRICE SPECTRUM

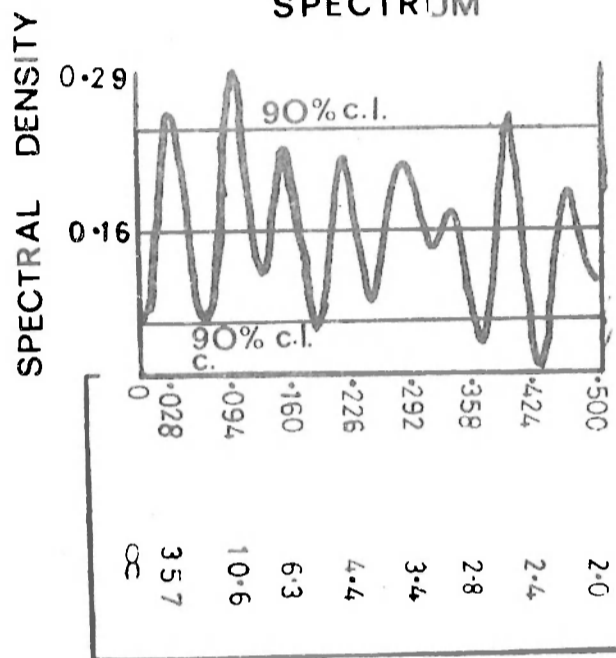


FIGURE 3

BLOCK HOTELS PRICE SPECTRUM

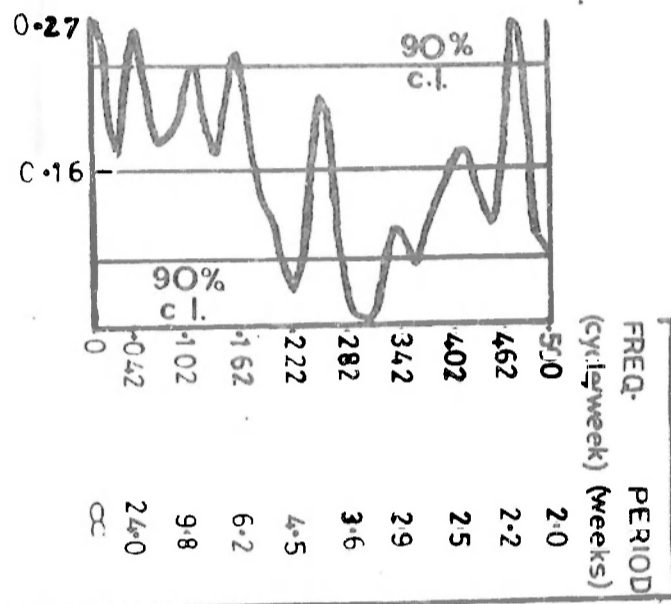


FIGURE 4

KAKUZI PRICE SPECTRUM

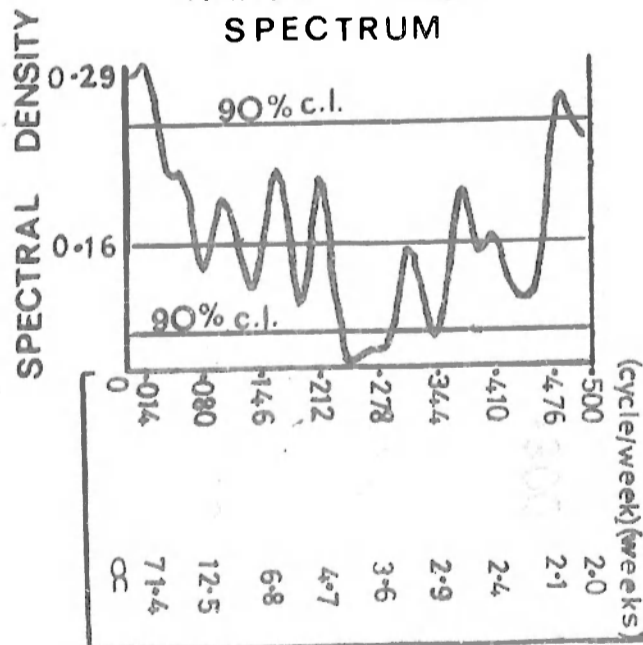
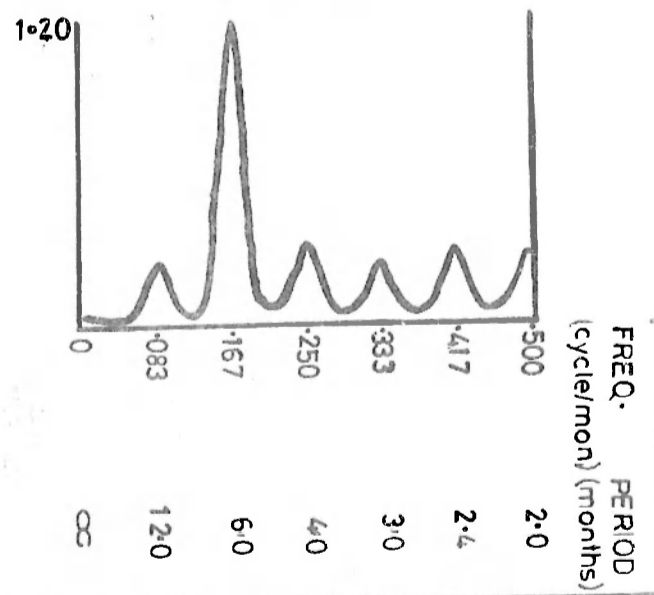


FIGURE 5

HOTEL BED OCCUPANCY SPECTRUM



For comparative purposes the results are presented in table 1. The table helps in the investigation of any coincidence between cyclical components of the price series and the "traditional" seasonal frequencies as represented by the HOB0 series. Since this series is monthly, the highest frequency that compares with other series is 0.125 of a cycle per week. Periods of all the series which are higher than 7.5 weeks fall at or near the seasonal frequencies. Of particular importance is the fact that all the five series have a cycle of about 24-36 weeks (6-9 months) in addition to a 10-week cycle (or 2.4-month cycle) corresponding to 0.1 of a cycle per week (or 0.4 of cycle per month).

Granger and Hatanaka [3, pp 65-69] analysed the Woolworth's stock prices and found a 2.8-month cycle (11-week cycle) although they thought this was an alias of a weekly cycle. In view of this study one would want to take their 2.8-month cycle as a confirmation of our 10-week cycle.

Cycles in the HOB0 series are of the same length as those of the BLOHO price series. All higher frequencies of the weekly series have common characteristics. The presence of important cycles at high frequencies in all the price series is of particular interest. They all have a 2.1-week cycle. However, the peak corresponding to the 2.1-week cycle of the EAB series is not significant as is the case with the peaks of the other series.

##### 5. CONCLUSIONS.

This study has revealed that all the series under study have an annual component. The annual components are represented by cycles of about 48 to 72 weeks. Where cycles of this length were not revealed (probably because of the length of the series) harmonics of the 48, 60 and 72 week cycles were found, the interesting thing being that in some cases the annual component is long than 12 months as in the case of the Kakuzi series. Peaks corresponding to the cycles of 6-9 months duration were significant. In general all the series can be approximated by a sine wave.

The results have also shown that, contrary to previous findings, short-run movements of the series are as important as long-run movements, since 2-week cycles have been found to be of significant importance.

These results strongly suggest that stock market prices on the Nairobi stock Exchange do not agree with the random walk hypothesis. This indicates that there is no universal law governing the behaviour of stock market prices. This further suggests that a price prediction model can be constructed enabling participants to make profit.

Table 1

- 8 -

IDS/WP 269

COMPARISON OF RESULTS

	Periods occurring at seasonal Frequencies						Periods at higher Frequencies					
NASEI		30*			10.6*	7.5	6	5	4.4	3.8		
BREWRIES. Prices		36*			10*		6	4.5		3 3.5	2.5*	2.1
KAKUZI Prices	72*				10.		6	5		3.3	2.7	2.1*
HOBO	48	24*	16	12	9.6	8						
BLOCK Prices		24*			9.5		6.4*		4	3	2.5	2.1*
Frequency cycle/week	.01-.02	.03-.04	.06	.08	.10	.13	.17	.20	.23-.25	.3	.4	.48

\* Significantly different from white noise at 90% confidence level.

The reason for the absence of the random walk model may be ascribed to the fact that the Nairobi Stock Exchange Market is very small. This makes it easy for a few important companies to dominate the market.

The seasonal character of the series originates from the seasonal nature of business in rural economies. Tourism reaches its highest peaks in January and August and the response of hotels is reflected on the stock Exchange market. The Breweries may act accordingly in order to quench the thirst of the newly arrivals while Kakuzi concerning itself with agricultural production is subjected to seasonal variation of the rural area.

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