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SEASONAL RICE PRICES IN INDONESIA, 1953–69: AN ANTICIPATORY PRICE ANALYSIS†

In the year 1665 a poor paddy harvest occurred on Java following a severe drought, and the short crop sparked an increase in rice prices of 300 percent (*17*, p. 1). In 1961, almost three centuries later, a drought sent rice prices in Jakarta skyrocketing 156 percent (adjusted for inflation) over a period of six months. Jakarta, the capital of Indonesia, is the principal urban rice market on Java. This unexpected seasonal price increase was preceded in 1960 by an equally unexpected but small seasonal price rise of only 11 percent. These incidents are recounted here not because they are extraordinary events in the chronicle of Indonesia's past. On the contrary, unstable production and volatile rice markets with their attendant social and political difficulties are a constant theme throughout Indonesian history. The social and political impact of this economic instability is a consequence of the dominance of rice in the food economy of Indonesia. Chart 1 provides some idea of the importance of rice by comparing the per capita production (on a milled rice basis) of Indonesia's staple sources of calories—milled rice, maize, cassava, and sweet potatoes (*1*, p. 132). The chart understates the supremacy of rice in Indonesian diets since Indonesia imports additional rice and exports a portion of the maize and cassava crops.

Despite the importance of Indonesia, with the world's fifth largest population, there is a surprising lack of research and evidence concerning even the most prominant economic problems associated with its largest staple food crop. An attempt is made in this paper to identify and measure the main factors influencing temporal rice price formation in Indonesia. The investigation focuses particularly on one of the most sensitive and intransigent issues in Indonesian political economy—the mercurial seasonal price movements alluded to above.

In recent years, research into agricultural marketing problems in developing countries has been enhanced by the generation of empirical evidence for testing various propositions concerning market structure, performance, and efficiency (see particularly *22*, *25*, *43*). Similar research in Indonesia, however, has been inhibited by the actual or apparent lack of data with which to test appropriate hypotheses. Concerning temporal price formation in Indonesia, the lack of

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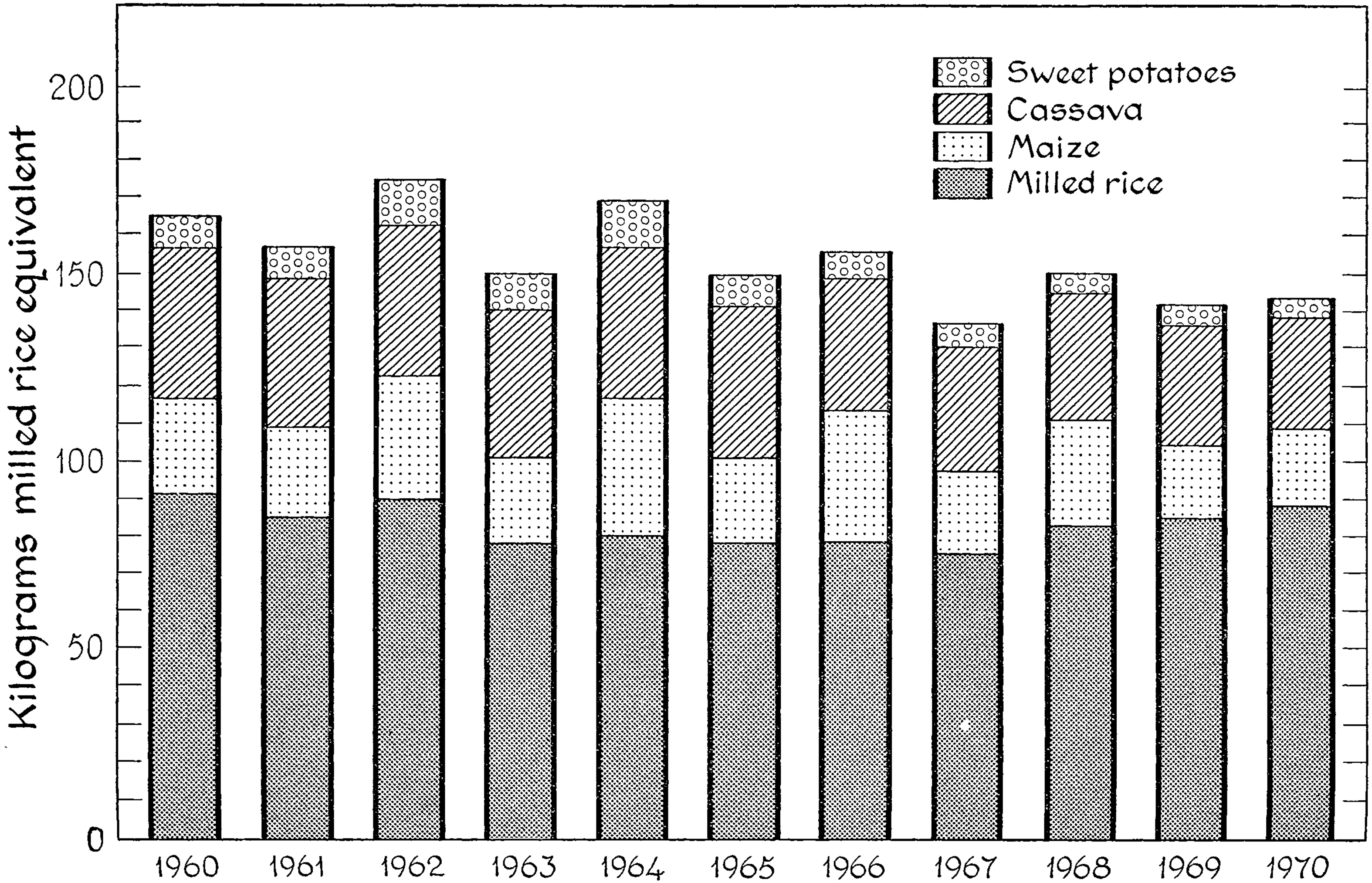
CHART 1.—COMPARATIVE PER CAPITA PRODUCTION OF BASIC CARBOHYDRATES, 1960–70*



* Reproduced from Saleh Afiff and C. Peter Timmer, "Rice Policy in Indonesia," *Food Research Institute Studies*, X, 2, 1971, p. 132.

data is, to a large extent, more apparent than real. Research into this area requires a time series record of prices and production or marketings. The published record of monthly prices contained in the Central Bureau of Statistics' (CBS) *Indikator Ekonomi, Monthly Statistical Bulletin,* while improving in quality and coverage, is still short, an apparent obstacle to empirical investigation. The period prior to the existence of this publication back to 1948, however, is covered by an unpublished record of monthly rice prices in various Indonesian markets collected by the Bureau of Logistics (BULOG).

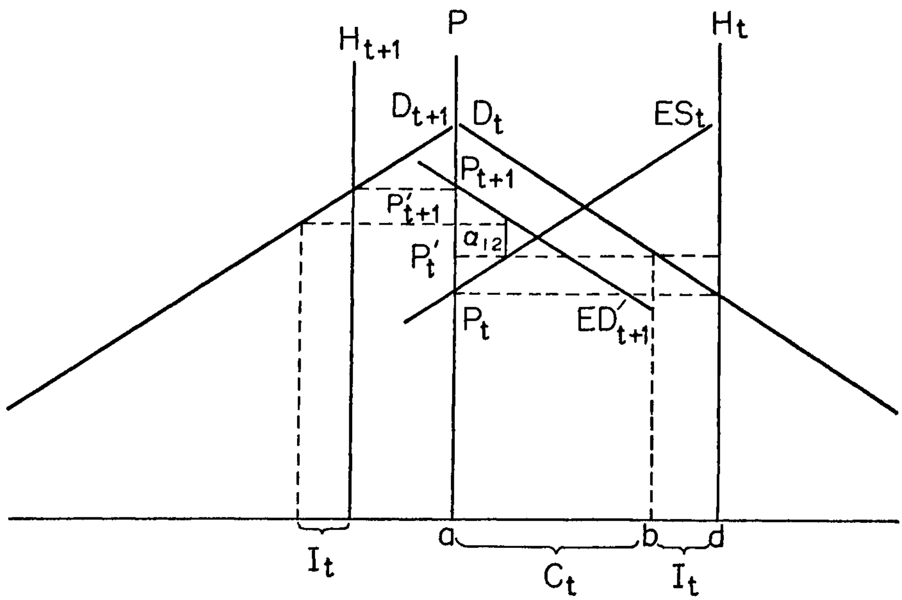
Production estimates are more of a problem. The *Monthly Statistical Bulletin* contains estimates of rice production aggregated on an annual basis only and at a total Indonesian level. Publications of more limited availability contain CBS estimates of annual provincial output (*16, 59*). The major difficulty surrounding Indonesian production data is the failure of the Central Bureau of Statistics to publish estimates of *seasonal* output at least on a provincial level basis. When two crops are grown annually rather than one, as is the case in Indonesia and many other tropical areas, the publication of only yearly totals renders the data almost useless for some types of agricultural economics research. While the CBS does not publish seasonal production figures, it does save the estimates of monthly planting and harvesting, garnered from an extensive sampling procedure (*37*), that are later aggregated for publication. Fortunately, I had access to much of this unpublished price and production data, which is virtually untouched by economists. Hopefully, a result of this investigation will be to identify the strengths and weaknesses of much of this material in order to facilitate and encourage its use in further research.

The first section of this paper reviews some main concepts of intertemporal price theory and suggests the appropriate framework for investigating seasonal price instability. Part 2 examines in detail the production data and contains the first published estimates of seasonal rice production during the period 1953–69 and an analysis of the distinctive characteristics of the wet and dry season rice crops on Java. Part 3 introduces the price series referred to above and deals with the problem of inflation. The question of market integration on Java and the implications of periods of market disruption for empirical research are also discussed. A moving-average technique is employed in Part 4 in order to isolate a normal seasonal price pattern in Javanese markets and gain a detailed look at seasonal price instability. Part 5 contains the major empirical contribution of the paper. Estimates of market expectations on seasonal production are developed. Errors in these expectations are measured and then employed in a model inspired by Holbrook Working's concept of "anticipatory price" (*63*) to measure their impact on seasonal price formation. The effect of other variables is also measured.

1. INTERTEMPORAL PRICE THEORY

The conceptual and theoretical framework behind most of this research is the literature on intertemporal price theory, particularly the work of P.A. Samuelson (*39*) and Working (*63*). The economic problem involved here is to explain the distribution of supplies for consumption over time and the coinciding price pattern. The problem of temporal distribution arises because production

CHART 2.—INTERTEMPORAL EQUILIBRIUM



and the appearance of supplies from foreign sources on domestic markets takes place at discrete points in time, yet there is an economic demand and often a biological need for continuous consumption.

Samuelson has shown that the intertemporal allocation of supplies by a free market and the determination of an intertemporal price equilibrium is analogous to the more familiar problem of finding a spatial equilibrium (*40*). Chart 2 is a back-to-back diagram illustrating production levels in two consecutive crop seasons. Only one crop is produced in each season and, for simplicity here, the harvest period for each is assumed to be very short. This exemplifies Indonesian conditions where every year two rice crops are produced, an abundant wet-season crop and a much smaller dry-season crop. D_t *and* D_{t+1} represent price elastic demand curves for the two seasons. H_t represents a wet-season harvest, followed by H_{t+1}, the smaller dry-season crop. Without storage of a portion of the wet-season crop for consumption in the dry season, the average price in period t, P_t, is considerably lower than P_{t+1}. In fact, grain dealers recognize that consumers in period $t+1$ will pay a higher price than those in period t for part of the period t crop. An excess demand curve, ED_{t+1}, is constructed showing as price varies the quantity of grain consumers in $t+1$ are willing to purchase in excess of what is supplied in $t+1$. This willingness to purchase additional quantities can be satisfied by carryovers from period t if there is incentive for traders to carry inventories into $t+1$. ES_t is the excess supply curve for period t. It shows that at prices above P_t some consumers in period t drop out of the market leaving supplies that can be carried into $t+1$. Since P_{t+1} is above P_t there is an incentive for merchants to hold part of H_t off the spot market and supply it at a future time to consumers in $t+1$. Storing the grain entails certain costs, however. As inventories are accumulated in period t, P_t increases in response to diminished marketed supplies. When the inventories are released in $t+1$ the additional quantities will cause P_{t+1} to fall. There is incentive to carry inventories over until $P_{t+1} - P_t = \alpha_{12}$, where α_{12} is the unit cost (marginal cost) of storage from period t to $t+1$. This equilibrium is shown in Chart 2 where the vertical distance between ED_{t+1} and ES_t equals α_{12}. The equilibrium prices after storage are P'_{t+1} and P_t', where $P'_{t+1} - P_t' = \alpha_{12}$. If H_t is supply in period t, C_t will be consumed in t and $bd = I_t$ will be carried into $t+1$.

These equilibrium conditions apply to the relationship between prices in any two time periods where a portion of the commodity is stored in the early period for consumption later on. In the case of the wet season portrayed in Chart 2, for instance, P_t is actually an average of the monthly prices for months comprising the wet season, each price differing from the one of the previous month by an amount necessary to cover the cost of storing grain for that period. Chart 3 shows the annual pattern of prices for two years, both similar to the one described in Chart 2. The solid lines show the pattern of prices with proper storage within seasons but no quantities stored from the abundant wet season for distribution in the dry season. In the post–wet-season harvest period, prices rise each month by the cost of storage. Just prior to the dry-season harvest the last portion of the wet crop is consumed. Demand conditions in the dry season are assumed similar to the wet season. The dry-season crop, being smaller than the wet-season crop and the only source of supply in the dry season, produces a dramatic jump in the price level as the market adjusts to the suddenly shortened supply conditions. Thereafter, prices rise monthly by the cost of storage until the cycle begins again with the wet-season harvest of the second year.

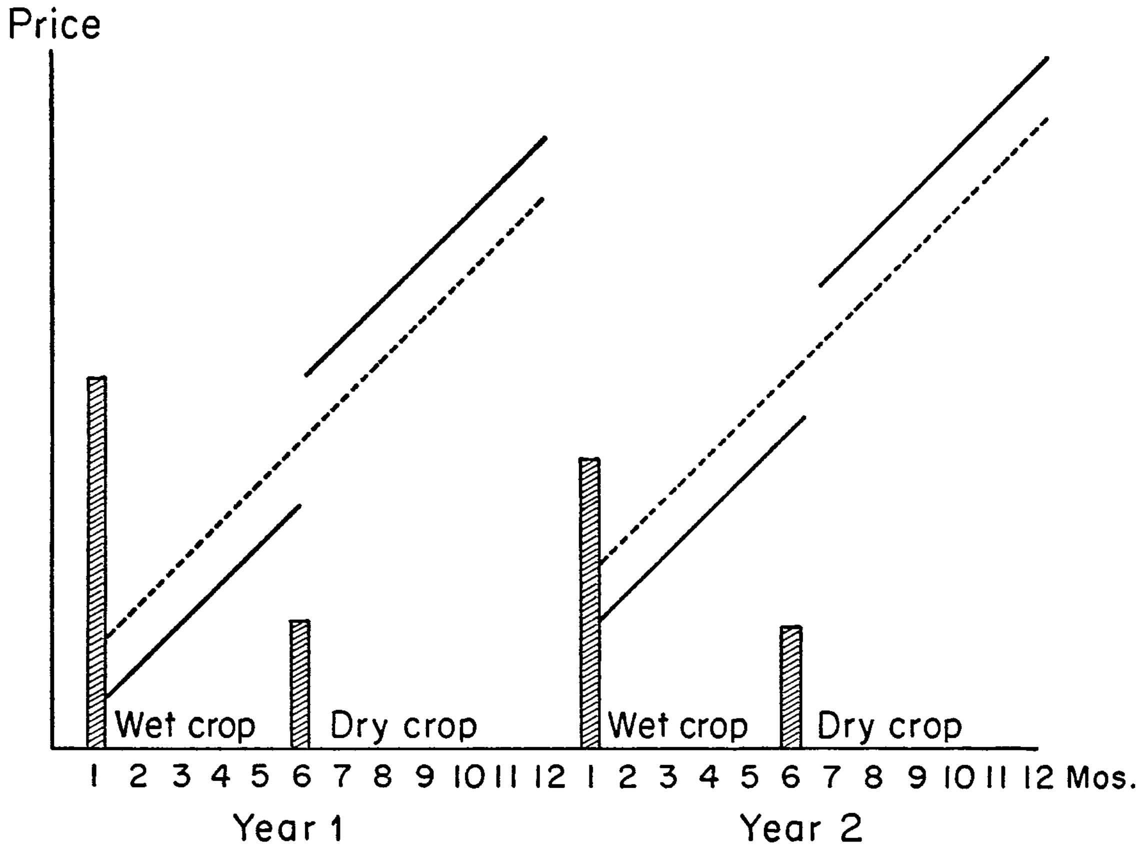
If anticipation of this substantial change in price level induces holders of the wet-season crop to store a portion of it for consumption in the dry season, as depicted in Chart 2, then the annual price pattern will differ from that described above and will follow the pattern traced by the dashed lines. As more of the wet-season crop is held off the market, the wet-season price level rises, and as more is placed on the market in the dry season, the dry-season price level falls. In equilibrium, the annual price pattern represents monthly price increases just sufficient to compensate the trade for the cost of storage.

It should be noted that even though the wet-season crop in year 2 is less than in the previous wet season, no portion of year 1 supplies is carried into year 2. This is because the smaller wet-season crop did not result in an increase in price to a level sufficient to cover the costs of storing grain from year 1 to year 2.[1] It is possible, however, that a very poor wet-season crop could justify the costs of storage of year 1 supplies for later consumption.

The model depicted in Charts 2 and 3 highlights the basic variables that influence prices over time, the relative amounts and periodicity of production, the costs of storage, and the conditions of demand. The model is too great an abstraction, however, to serve as a complete basis for an orderly empirical investigation of actual price movements. Two important aspects of the problem must be introduced: (1) sources of supply other than production and (2) uncertainty

[1] This simplified presentation ignores the important concept of "convenience yield" (*64*). The data are not adequate for examining its role in Indonesian rice markets.

CHART 3.—MARKET YEAR PRICE PATTERNS



concerning both the amount of production and other supplies and the timing of the appearance of these supplies on the market under investigation.

The following set of equations constitutes a more complete model, emphasizing the role of uncertainty and expectations as well as the simultaneous determination of prices and supply allocation over time (*13*; *60*):

$$C_t = F_c(P_t) \quad (1)$$
$$\hat{S}_t = \hat{H}_t + \hat{Q}_f \quad (2)$$
$$H_t = F_h(P_t^L) + y \quad (3)$$
$$I_t = S_t - C_t \quad (4)$$
$$P_t^* - P_t = F_p(I_t) \quad (5)$$
$$P_t = P_t^* - F_p(I_t) \quad (5a)$$
$$P_t^* = F_{p^*}(S_{t+1}^*) \quad (6)$$

where C_t = consumption in period t
P_t = price in period t
$\hat{S}_t$ = the market's estimate of current available supply
$\hat{H}_t$ = the market's estimate of harvest size in period t
$\hat{Q}_f$ = the market's estimate of supplies available from other sources, particularly:
(a) carry-in from previous period
(b) imports
(c) supplies of close substitutes
H_t = actual harvest size
P_t^L = lagged price
y = random factors affecting production
P_t^* = price expected in period t to prevail in period $t+1$
I = inventory.

Equation (1) relates consumption in period t to price in the same period. The second relationship is definitional, indicating the market's current estimate of available supplies. This entails an evaluation of the current harvest and other relevant supplies. Equation (3) assumes production in period t is a function of previous price conditions and random influences such as weather and pests. The market clearing identity which follows is self-evident. Equation (5) distinguishes the intertemporal price model, defining the expected difference in prices between two periods (crop seasons in this case) as a function of carryover from period t to $t+1$. This equation reflects the influence of storage costs. Equation (5a) is a restatement of (5); together with equations (1), (2), and (4), it shows that price serves to establish an equilibrium between the market's estimate of current supplies and two types of demand, one for current consumption, the other for storage into the next period. The final equation relates the price level expected to prevail in period $t+1$ to expectations regarding the initial supply in $t+1$.[2]

[2] Theoretically, the expected price level in $t+1$ is a partial function of expectations about $t+2$ which influence the amount of carryout from $t+1$. The infinite regression implied by this theoretically consistent model, however, results in the solution to the equation system being indeterminant. R. L. Gustafson suggests an operational method which, to some extent, obviates this difficulty (*13*). The model presented here, however, is solely for heuristic purposes.

This model places real factors, such as harvest size, in an environment of changing market knowledge and expectations about those factors and reflects Working's concept of "anticipatory price" (*63*). The smooth annual price patterns shown in Chart 3 reflect perfect arbitrage over time resulting directly from the assumption of complete market knowledge at all times about the size of current supplies and accurate expectations concerning the timing and magnitude of future supplies. With this omniscience, the price level adjusts immediately to the known supply and demand conditions. The smooth price rise which follows reflects only storage costs.

Real market prices, however, often exhibit patterns so apparently inscrutable that one is tempted to regard the simple price-determining model as a dubious abstraction at best. Working made a major conceptual contribution by emphasizing that price level adjustments are continually superimposed on the basic cost-of-storage-induced pattern. The price level adjustments occur as the market formulates new expectations and reacts to new information concerning current and future supply and demand conditions. This concept is discussed further and applied in Part 5. The framework reviewed above provides a valuable scheme for evaluating the factors that influence market price behavior. Particularly, it enables economists to distinguish empirically, for the purpose of separate analysis, price movements induced by storage costs from price level adjustments reflecting changing market knowledge and expectations about real supply and demand factors.

In a market such as the one for rice in Indonesia, the problem of anticipating and acquiring information about two crops every year is compounded by a poor transportation and communication network, government regulations, and uncertainty about imports and substitute commodities, as well as the timing of harvests and subsequent arrival of supplies in the market. A major goal of this research is to estimate the effects of some of these factors on price movements of rice in Indonesia.[8]

2. THE CHARACTERISTICS OF SEASONAL RICE PRODUCTION ON JAVA

Domestic production is the major component of Indonesia's annual rice supply. During the period recorded in Table 1, the relative level of imports fluctuates considerably, recently averaging about 5 percent of total rice supply. An understanding of seasonal production characteristics is an essential aspect of any investigation into rice price formation in Indonesia.

The Indonesian Central Bureau of Statistics publishes rice production statistics aggregated on an annual basis only (the reference to "wet" and "dry" paddy in the statistical bulletin distinguishes irrigated from non-irrigated rice). This practice belies the important fact that, particularly on Java, two rice crops a year are produced. The basis for this analysis, however, is unpublished CBS estimates of area planted and harvested and quantity harvested *monthly* which

[8] The integration of domestic and world commodity markets fits easily into the theoretical context described here. Although Indonesia was an important rice importer during the period under investigation here, world prices had no consistent influence on domestic markets for rice, due primarily to institutional barriers. For confirmation of this market isolation, see the empirical analysis in *12* and in Part 5 below.

TABLE 1.—TOTAL DOMESTIC PRODUCTION AND IMPORTS OF RICE, INDONESIA, 1950–70*
(Million tons, milled rice equivalent)

Year	Domestic production	Imports	Year	Domestic production	Imports
1950	6.02	0.33	1960	8.76	0.89
1951	6.22	0.53	1961	8.27	1.06
1952	6.64	0.77	1962	8.89	1.02
1953	7.31	0.29	1963	7.93	1.04
1954	7.84	0.26	1964	8.42	1.01
1955	7.51	0.13	1965	8.84	0.20
1956	7.60	0.83	1966	9.14	0.31
1957	7.63	0.55	1967	9.05	0.35
1958	7.98	0.92	1968	10.17	0.63
1959	8.29	0.89	1969	10.64	0.60
			1970	11.42	0.95

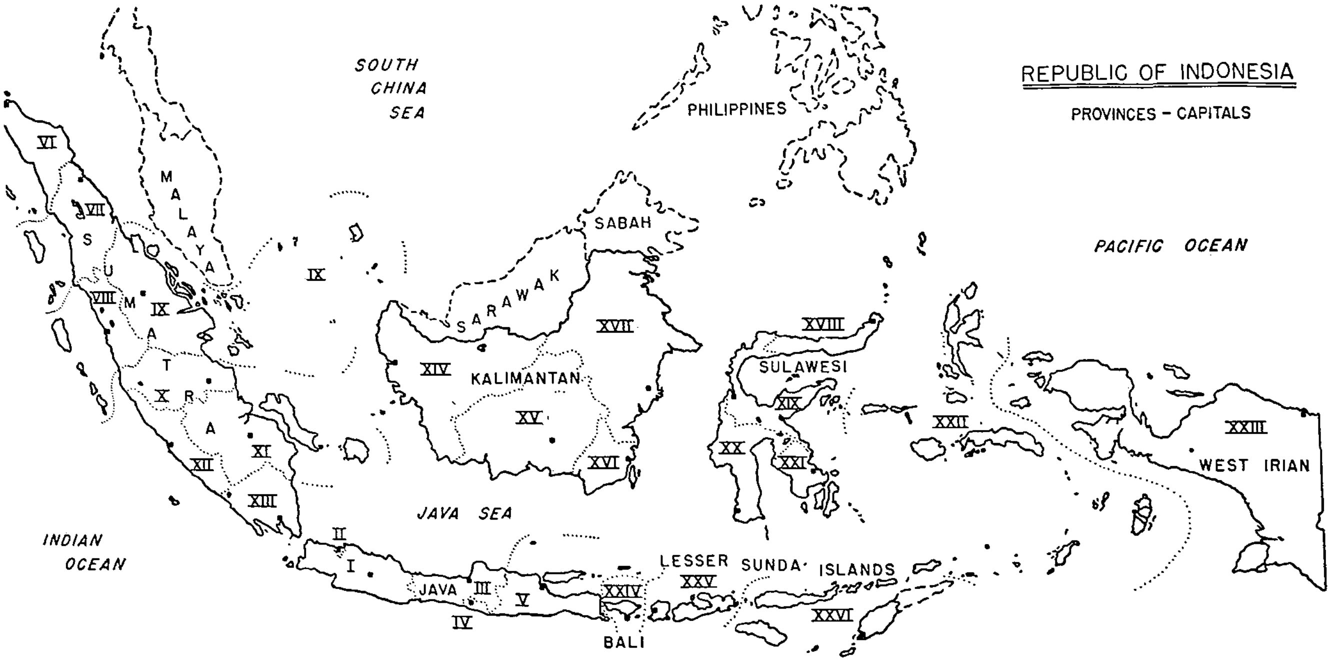
* Production data from Indonesia, Central Bureau of Statistics, various sources.

are available from CBS worksheets in Jakarta. Access to the entire data set was not possible, however, which inhibits, to some extent, the investigation here. Although the sample data are collected throughout Indonesia by the Department of Agriculture, Land Tax Organization, and CBS and aggregated at the subdistrict (*kecamatan*) level, only the monthly estimates aggregated on a Java-Madura basis were available. (Madura is a small island adjacent to Java; the area will hereinafter be referred to as Java.) The areas of Indonesia outside Java (see map) are excluded from the detailed analysis here because of the lack of monthly data upon which to base seasonal production estimates. Nevertheless, the area included represents about 65 percent of the Indonesian population and 55 percent of rice production (see Tables 2 and 3). The nature of rice production and

TABLE 2.—TOTAL POPULATION, INDONESIA AND JAVA-MADURA, 1950–70*
(Million persons)

Year-end	Indonesia	Java-Madura	Year-end	Indonesia	Java-Madura
1950	77.21	50.46	1960	95.30	61.90
1951	78.74	51.43	1961	97.45	63.29
1952	80.33	52.44	1962	99.74	64.81
1953	81.97	53.48	1963	101.93	66.24
1954	83.68	54.56	1964	103.97	67.57
1955	85.44	55.68	1965	105.89	68.82
1956	87.27	56.84	1966	107.64	69.95
1957	89.16	58.04	1967	109.42	71.07
1958	91.12	59.28	1968	111.33	72.31
1959	93.15	60.57	1969	113.39	73.63
			1970	115.59	75.08

* Data for 1950–61 from Indonesia, Central Bureau of Statistics; for 1961–70, from Indonesia, Central Bureau of Statistics Series, adjusted by the author for consistency with 1970 and 1971 census estimates.



	PROVINCE	CAPITAL
I	West Java	Bandung
II	Djakarta	Djakarta
III	Central Java	Semarang
IV	Jogjakarta	Jogjakarta
V	East Java	Surabaja
VI	Atjeh	Banda Atjeh
VII	North Sumatra	Medan
VIII	West Sumatra	Padang
IX	Riau	Pakanbaru

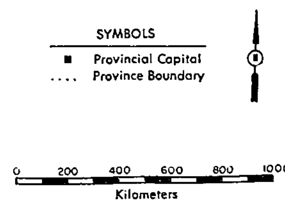
	PROVINCE	CAPITAL
X	Djambi	Djambi
XI	South Sumatra	Palembang
XII	Bengkulu	Bengkulu
XIII	Lampung	Tandjungkarang-Telukbetung
XIV	West Kalimantan	Pontianak
XV	Central Kalimantan	Palangkaraja
XVI	South Kalimantan	Bandjarmasin
XVII	East Kalimantan	Samarinda

	PROVINCE	CAPITAL
XVIII	North Sulawesi	Manado
XIX	Central Sulawesi	Palu
XX	South Sulawesi	Makasar
XXI	Southeast Sulawesi	Kendari
XXII	Maluku	Ambon
XXIII	West Irian	Djajapura
XXIV	Bali	Denpasar
XXV	West Nusa Tenggara	Mataram
XXVI	East Nusa Tenggara	Kupang

SYMBOLS

■ Provincial Capital

.... Province Boundary



Reproduced from Weitz-Hettelsater Engineers, *Rice Storage, Handling and Marketing Study: The Republic of Indonesia* (Kansas City, Mo., 1971).

TABLE 3.—TOTAL MILLED RICE PRODUCTION, INDONESIA AND JAVA-MADURA, 1953–70*
(Million metric tons)

Calendar year	Indonesia	Java-Madura	Calendar year	Indonesia	Java-Madura
1953	7.31	4.43	1962	8.89	5.14
1954	7.84	4.82	1963	7.93	4.44
1955	7.51	4.59	1964	8.42	4.37
1956	7.60	4.76	1965	8.84	4.87
1957	7.63	4.74	1966	9.14	4.66
1958	7.98	4.95	1967	9.05	4.98
1959	8.29	5.05	1968	10.17	5.54
1960	8.76	5.06	1969	10.64	5.87
1961	8.27	4.80	1970	11.42	6.31

* Source: Indonesia Central Bureau of Statistics, Jakarta.

price formation on Java is at least indicative of rice market characteristics and problems in the rest of Indonesia.[4]

Climatic conditions on Java are conducive to cultivation of two rice crops a year. The larger crop is produced during the wet season in both rainfed and irrigated fields. The smaller dry-season crop is grown only on land where the irrigation capability is sufficient to sustain a rice crop in the face of relatively sparse rainfall.

The monthly distribution of rainfall, recorded in Table 4, is the main factor determining the seasonal distribution of production on Java. Heavy rains commence in October or November with the West Monsoon arriving in December. The high level of rainfall prevails until April or May when a rather dramatic change in weather typically occurs. The dry conditions prevail until the cycle begins again in October or November. The influence of the weather pattern on rice production is evident in Chart 4. The estimates of monthly planting and harvesting were taken three years at a time for purposes of comparison in calculating the distribution of these activities throughout the year. In comparing Chart 4 with Table 4, the coincident periodicity of rainfall and production is clear. Although rice is planted and harvested throughout the year on Java, the seasonal pattern is distinct. Planting increases in October and November in response to the early rains and reaches a peak in January. The corresponding peak harvest period occurs four months later, in May.[5] Planting increases once again in May and June as seedlings are transplanted in the double-cropped fields. The dry-season harvest is much smaller and less concentrated than that of the wet season, commencing in September and reaching a moderate peak in September or October. Published data for 1955 (*26*, pp. 231–33), aggregated at the

[4] See below for a discussion of the problems surrounding the use of aggregated Java production variables to explain the formation of prices in provincial markets on Java.

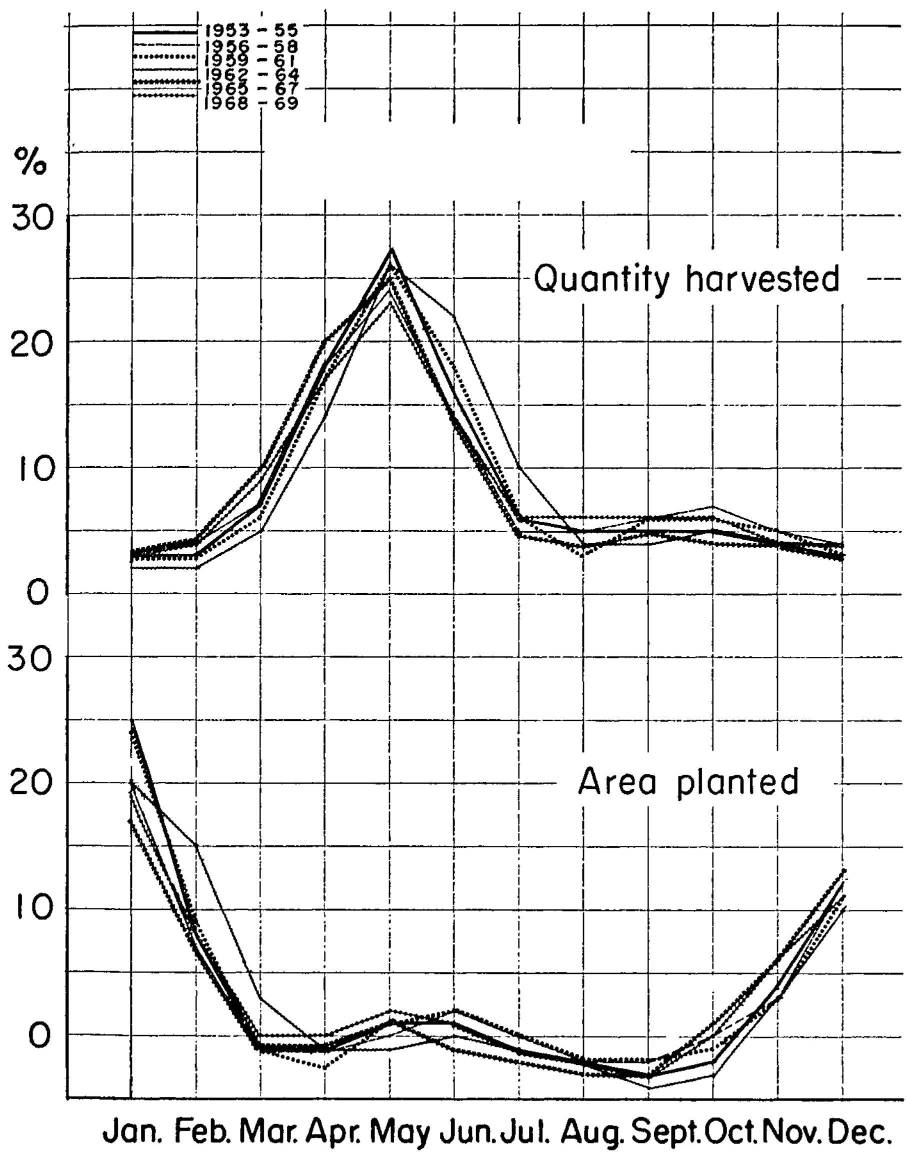
[5] The four-month gap between planting and harvesting was puzzling at first glance, since traditional Javanese varieties of wet rice mature in 150 to 160 days. The explanation for the "missing" month appears to lie in the fact that wet rice, unlike other grains, is initially grown in small seed beds for a month or so before being transplanted out into fields.

TABLE 4.—MONTHLY RAINFALL, JAKARTA AND SURABAYA, 1951–60*
(*Millimeters*)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
						Jakarta							
1951	201	361	205	69	83	181	87	112	51	149	13	166	1,678
1952	435	150	313	60	82	111	61	96	90	147	120	173	1,838
1953	156	107	338	60	152	127	21	27	0	8	157	70	1,223
1954	258	160	53	141	39	98	67	55	94	154	269	135	1,523
1955	411	343	181	84	92	158	132	94	74	143	255	183	2,150
1956	389	106	214	89	150	106	98	119	227	164	146	182	1,990
1957	267	235	225	42	50	47	73	51	39	1	75	125	1,230
1958	354	202	194	68	128	36	161	130	146	61	66	295	1,841
1959	382	94	243	255	154	66	106	1	13	92	124	304	1,834
1960	460	562	168	305	85	12	26	49	63	57	129	109	2,025
Average	331.3	232.0	213.4	117.3	101.5	94.2	83.2	73.4	79.7	97.6	135.4	174.2	1,733.2
						Surabaya							
1951	224	272	158	80	76	117	12	0	0	0	3	243	1,185
1952	203	106	215	47	7	9	0	28	0	80	183	293	1,171
1953	325	161	122	269	161	50	46	0	0	0	113	309	1,556
1954	282	249	150	156	126	82	61	43	21	16	198	171	1,555
1955	256	334	296	99	195	50	78	41	11	46	172	155	1,733
1956	209	226	193	34	39	156	49	94	9	51	95	249	1,404
1957	394	397	319	76	31	55	102	67	0	24	63	149	1,657
1958	341	259	221	98	130	14	39	39	2	52	210	219	1,624
1959	343	155	228	185	171	61	43	0	0	37	161	410	1,794
1960	173	292	227	68	209	15	52	11	21	0	103	241	1,410
Average	275.0	245.1	212.9	111.2	114.5	58.7	48.2	32.3	6.4	30.6	130.1	243.9	1,508.9

* Data from U.S. Department of Commerce, Environmental Science Services Administration, *World Weather Records 1951–1960*, VI, 1968.

CHART 4.—AREA PLANTED AND QUANTITY HARVESTED AS PERCENTAGE OF ANNUAL TOTAL: JAVA AND MADURA*



* Three-year averages derived from original worksheets, Indonesia, Central Bureau of Statistics (Jakarta).

provincial level, show East Java with a greater proportion of the wet-season crop harvested in May and a less concentrated dry-season harvest than either Central or West Java. The dominant impression, however, is a rather homogeneous seasonal pattern throughout Java, confirming the representative nature of the all-Java pattern developed here. It should be noted that the "Outer Islands" of Indonesia have production patterns different from Java and from one another.

TABLE 5.—DRY STALK PADDY PRODUCTION, JAVA AND MADURA, BY SEASON, 1953/54–1969/70*

(*Thousand metric tons*)

Season	Feb.	Mar.	Apr.	May	June	July	Aug.	Wet season total	Sep.	Oct.	Nov.	Dec.	Jan.	Dry season total	Annual total	Dry season ÷ annual total
1953/54	350	759	1,801	2,244	1,065	573	424	7,216	387	307	270	210	186	1,360	8,576	.16
1954/55	201	490	1,295	2,439	1,741	613	410	7,189	489	464	384	253	249	1,839	9,028	.20
1955/56	223	556	1,585	2,373	1,327	435	417	6,916	485	411	336	273	270	1,775	8,691	.20
1956/57	331	768	1,828	2,118	1,114	429	469	7,058	483	473	416	374	369	2,115	9,173	.23
1957/58	450	724	1,659	2,063	1,030	428	416	6,770	515	564	444	324	281	2,128	8,898	.24
1958/59	271	492	1,309	2,470	1,553	490	359	6,944	590	722	495	326	239	2,372	9,316	.26
1959/60	308	674	1,697	2,440	1,290	456	359	7,224	598	628	482	327	236	2,271	9,495	.24
1960/61	246	505	1,462	2,404	1,692	563	293	7,165	580	617	498	358	257	2,310	9,475	.24
1961/62	262	597	1,456	2,430	1,930	590	286	7,551	382	366	296	245	198	1,487	9,038	.17
1962/63	160	315	1,104	2,275	2,247	841	449	7,391	479	535	407	345	245	2,011	9,402	.21
1963/64	228	528	1,257	2,105	1,641	641	291	6,691	243	223	211	244	127	1,048	7,739	.14
1964/65	133	336	1,091	1,874	1,802	917	332	6,485	351	449	379	413	303	1,895	8,380	.23
1965/66	450	1,010	1,951	2,393	1,085	523	403	7,815	410	332	366	292	217	1,617	9,432	.17
1966/67	280	802	1,834	2,437	1,683	644	361	8,041	544	487	406	272	267	1,976	10,017	.20
1967/68	414	1,035	1,862	2,257	1,140	409	460	7,577	527	359	280	248	204	1,618	9,195	.18
1968/69	179	750	1,852	2,337	1,647	555	527	7,847	703	589	506	488	488	2,774	10,621	.26
1969/70	567	1,177	1,802	2,599	1,394	635	718	8,842	633	620	431	385	334[a]	2,403[a]	11,245[a]	.21

* Data from Central Bureau of Statistics, Jakarta.
Wet-season planting: Oct.–April. Wet-season harvest: Feb.–Aug.
Dry-season planting: May–Sept. Dry-season harvest: Sept.–Jan.
[a] Jan. 1970 estimated on the basis of 1965–69 seasonal harvest index; at 3 percent of total.

Table 5 shows the monthly production data organized on a seasonal basis. Separate analysis of wet and dry seasons is essential to an understanding of Indonesian market and price behavior. The dominance in size of the wet-season crop is striking. In an average year, dry-season production accounts for only one-fifth of the total output.

The emphasis heretofore has been on the seasonal regularity of the production pattern on Java. As this analysis proceeds, however, variability in output from the seasonal norms emerges as the salient characteristic. Instability in both wet and dry seasons and in the annual total output is evident in Chart 4. Three causes of year-to-year variability are discussed briefly here: (1) fluctuations in output due to weather, pest, and disease conditions; (2) fluctuation in planted area due to irrigation and rainfall conditions; and (3) farmer response to economic factors, particularly prices.

Chart 5 compares variation in planted and harvested area on a seasonal basis. The quality of these data is difficult to assess. On three occasions, the estimate of harvested area exceeds planted area in the wet season. The discrepancies are not large, but are cause for concern and an indication that, perhaps, the data should not be called upon to show more than general patterns and relationships.

Weather, pest, and disease conditions are reflected in differences between planted and harvested areas as well as in yield measurements. The Indonesian Agriculture Extension Service in 1960 reported its analysis of sources of rice crop damage (see *30*, pp. 47–53):

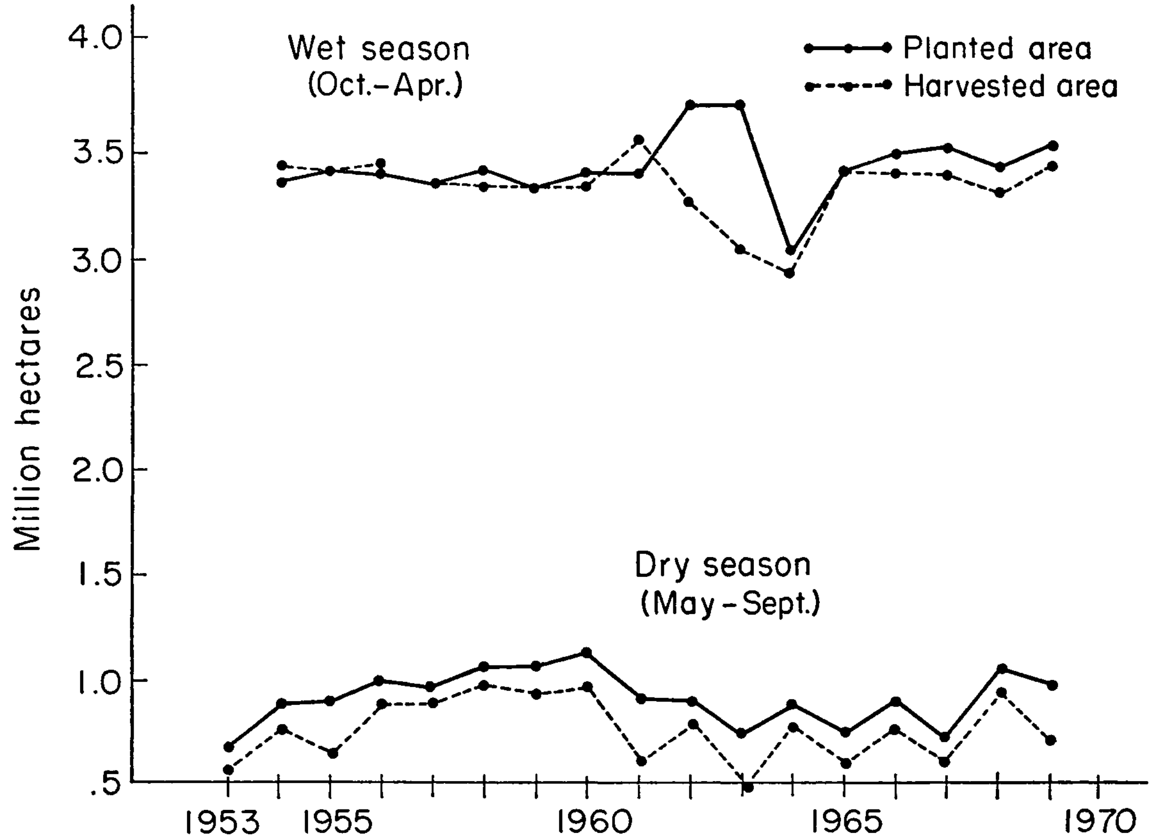
> Drought constituted 20 percent of the total damage to wet rice fields [both seasons] in 1958, 32 percent in 1959 and 17 percent in 1960, while floods in the same years resulted in damage of 28 percent, 34 percent, and 40 percent, respectively.... Rat damage alone of the wet rice crop counts for the third largest [cause of damage], surpassed only by flood and drought. It amounted to 19 percent annually during the 1958–60 period. Together with diseases it amounted to almost 40 percent of the total damages reported for those years.

Weather constitutes the principal factor influencing rice output, particularly in the dry season. With irrigation water scarce, the dry-season crop appears to respond dramatically to above average amounts of rainfall. Combined with greater sunlight available during the relatively cloudless dry season, adequate rainfall can result in a substantial increase in rice yields (*3*).

The results of simple rainfall response functions for the wet- and dry-season crops are shown here. Specifying the effect of rainfall on the wet-season crop can be highly complex, involving questions of timing and moisture sensitivity thresholds that go beyond the scope of this study.[6] Since the wet-season crop reacts positively to adequate early rain and negatively to preharvest flooding, the use of total seasonal rainfall in a linear model is inappropriate. The actual equation estimated here for the wet-season crop is as follows:

[6] For a sophisticated model for measuring the influence of weather and other climatic variables on grain output see Bernard Oury's "Time Series Analysis of West Punjab District Wheat Production Data" (*33*).

CHART 5.—PLANTED AND HARVESTED AREA OF RICE: JAVA AND MADURA*
(*Million hectares*)



* Data from original worksheets, Indonesia, Central Bureau of Statistics (Jakarta).

$$Q_r^w = 7000.2 - 1.03R_w' + 55.9T$$
$$(28.8)^*(-1.19) \quad (2.65)^{**}$$

years 1953–60, 1964–68

$R^2 = 0.42$ # obs. 13

Significance levels: * = 0.5%
** = 2.5%

t statistics in parentheses

where Q_{rt}^w = wet-season output of dry stalk paddy (thousands of metric tons) in year t,

R_{wt}' = $|R_{wt} - R_w|$ where R_{wt} is the actual mean value of rainfall measured in Jakarta and Surabaya in year t during the October–May interval, and R_w is the mean value of total rainfall measured in Jakarta and Surabaya during the October–May interval over the years 1953–60, 1964–68 (wet-season rainfall figures are not published for 1961–63). This deviation is expressed as an absolute value, and

T = annual trend.

Specifying the rainfall variable as an absolute-valued deviation from the norm implies the highly simplified assumption that amounts of rainfall less than or greater than the seasonal average, regardless of timing, are equally detrimental to the wet-season crop. Although the proper sign is obtained in the estimated equation, the variable is not significant at the 10 percent level and its explanatory power is weak.

The dry-season rainfall response is somewhat easier to specify. There is little chance of flooding during the peak dry-season harvest months on Java. The principal rainfall constraint facing the dry-season crop is inadequate rainfall throughout the growing season. A dry-season rainfall variable defined in terms of actual amounts of rainfall makes sense in a linear model, although the question of timing remains as a major source of error. The actual dry-season equation estimated is:

$$Q_r^d = 1050.5 + 2.12R_d + 25.5T$$
$$(3.43)^* \ (3.26)^* \quad (1.32)^{***}$$

years 1953–60, 1963–68

$R^2 = 0.50$ # obs. 14

Significance levels: * = 0.5%
*** = 10%

t statistics in parentheses

where Q_{rt}^d = dry-season output of dry stalk paddy (thousands of metric tons) in year t,

R_{dt} = actual mean value of rainfall in year t measured in Jakarta and Surabaya during the May–September interval, and

T = annual trend.

The results from this simple specification show the very strong impact of rainfall on the dry-season crop.

An additional impact on output is from the farm price of rice. Little evidence exists on this aspect of rice output in Indonesia.[7] Contrary to assumptions gen-

[7] Mubyarto presents some tentative evidence on price-supply response on Java (*30*).

TABLE 6.—SEASONAL AND ANNUAL CHANGES IN PRODUCTION OF DRY STALK PADDY, JAVA AND MADURA, 1954/55 TO 1969/70*

February–January year	Wet season[a] Thousand tons	Wet season[a] Percent	Dry season[b] Thousand tons	Dry season[b] Percent	Annual total[c] Thousand tons	Annual total[c] Percent	Percent of annual change[d] Wet season	Percent of annual change[d] Dry season
1954/55	− 27	− 0.4	+ 479	+35.2	+ 452	+ 5.3	(6.0)	106.0
1955/56	− 273	− 3.8	− 64	− 3.5	− 337	− 3.7	81.0	19.0
1956/57	+ 142	+ 2.1	+ 340	+19.2	+ 482	+ 5.6	29.5	70.5
1957/58	− 288	− 4.1	+ 13	+ 0.6	− 275	− 3.0	104.7	(4.7)
1958/59	+ 174	+ 2.6	+ 244	+11.5	+ 418	+ 4.7	41.6	58.4
1959/60	+ 280	+ 4.0	− 101	− 4.3	+ 179	+ 1.9	156.4	(56.4)
1960/61	− 59	− 0.8	+ 39	+ 1.7	− 20	− 0.2	295.0	(195.0)
1961/62	+ 386	+ 5.4	− 823	−35.6	− 437	− 4.6	(88.3)	188.3
1962/63	− 160	− 2.1	+ 524	+35.2	+ 364	+ 4.0	(44.0)	144.0
1963/64	− 700	− 9.5	− 963	−47.9	−1,663	−17.7	42.1	57.9
1964/65	− 206	− 3.1	+ 847	+80.8	+ 641	+ 8.3	(32.1)	132.1
1965/66	+1,330	+20.5	− 278	−14.7	+1,052	+12.6	126.4	(26.4)
1966/67	+ 226	+ 2.9	+ 359	+22.2	+ 585	+ 6.2	38.6	61.4
1967/68	− 464	− 5.8	− 358	−18.1	− 822	− 8.2	56.5	43.5
1968/69	+ 270	+ 3.6	+1,156	+71.4	+1,426	+15.5	18.9	81.1
1969/70	+ 995	+12.7	− 371	−13.4	+ 624	+ 5.9	159.5	(59.5)

* Based on Table 5. The ratio of dry stalk paddy to milled rice is roughly 100 to 52.
[a] Change from previous wet season.
[b] Change from previous dry season.
[c] Change from previous annual total.
[d] Figures in parentheses indicate change in the opposite direction from the annual change.

erally made in studies of price-supply response, the area planted to rice reflects—probably to a greater degree than most grain crops—current and expected weather conditions. This makes it difficult to sort out the farmer's planting decision with respect to price expectations.[8] The fact that rice on Java is transplanted in the fields about one month after germinating in seedbeds gives farmers an additional opportunity to assess weather conditions before committing labor to the arduous transplanting activity. Dry-season planting is particularly sensitive to current weather conditions. If irrigation water is insufficient at the time of transplanting, the area will not be planted out because seedlings will not survive the arid environment. A substitute crop such as maize or soybeans may be planted. This problem and the difficulty in obtaining farm-gate prices inhibits research into the question of own and cross price-supply response.

The cumulative impact of weather, disease, pests, prices, and other factors[9] on seasonal rice production is summarized in Table 6. The data recorded in Table 6 show both seasonal and annual changes in output expressed as percentages of the previous year. The extreme variability of the dry-season crop is evident. As mentioned previously, the dry-season crop is relatively small, generally about 20 percent of the annual total. Year-to-year fluctuations in this crop may not appear so dramatic when placed in the context of annual change in total Indonesian production.

[8] Jere Behrman documents this problem in measuring response for rice in Thailand (see *4*).
[9] An important, though undocumented "other factor" is deterioration of irrigation facilities, particularly during the early 1960s.

Also shown in Table 6 are variations in the seasonal crops placed in their annual context. The large influence of the small dry-season crop on both the magnitude and direction of year-to-year change in total annual output is striking. In all years (excepting 1965, 1967, and 1969) when the annual crop varied by 4 percent or more from the previous year, the change in the dry-season crop constituted the major component of the total change. In nine of the sixteen years analyzed, the dry-season crop outweighed the wet-season crop in the annual change. In four years, the magnitude of change in the dry-season crop was sufficient to offset even the direction of change of the wet-season crop.

These startling facts suggest the importance of the dry-season rice crop. The relative size of the dry crop is deceiving and draws attention away from its astonishing instability and strategic position in the Indonesian economy. The logic of intertemporal price theory and the concept of "anticipatory prices" developed in Part 1 lead to the hypothesis that dry-season production variability results in that crop exercising great influence over seasonal price movements in Indonesia. This proposition is examined in detail below.

3. PRICE DATA, INFLATION, AND MARKET DISRUPTION

Since 1948, the Bureau of Logistics (BULOG) and its antecedents have collected average monthly retail rice prices in various urban centers. Over the years, a number of markets throughout Indonesia have been added to the collection. The length, quality, and completeness of the time series varies from market to market. The longest and most complete records, chosen for analysis in the following sections are for monthly prices of "medium quality"[10] rice in four provincial capital cities on Java—Jakarta (Jakarta Special District), Bandung (West Java), Semarang (Central Java), and Surabaya (East Java). Jakarta, politically the most important retail market, is the major rice deficit province on Java. The three other urban markets are located in the major rice production areas on Java.

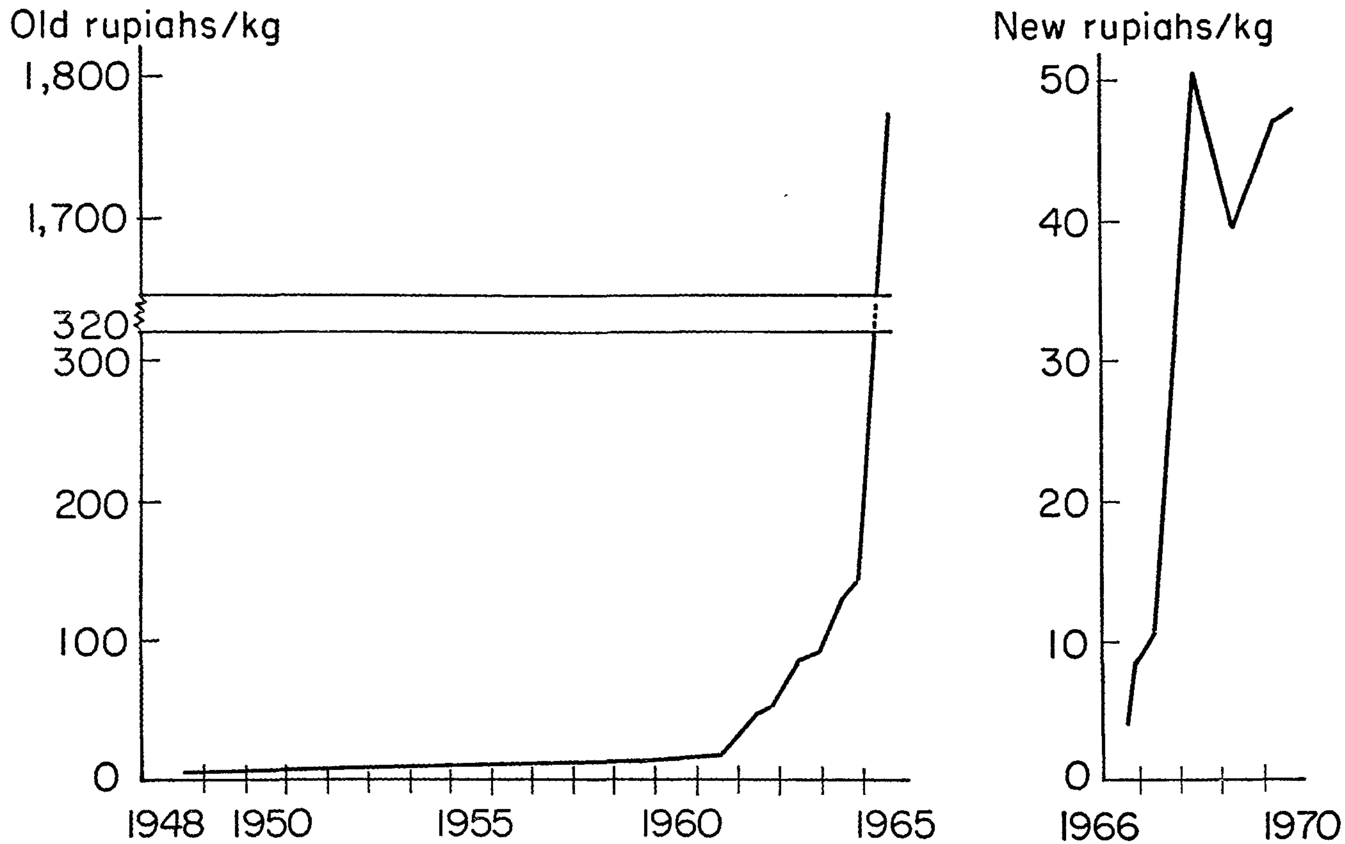
The magnitude of inflation in Indonesia should evoke scepticism regarding the possibility of measuring the impact of real supply and demand factors on market prices. During the past quarter century, Indonesia's economy has been among the least stable in the world. Chart 6 indicates the overwhelming impact of Indonesian monetary and fiscal policies on the Jakarta rice market. Prices began to rise moderately, by Indonesian standards, in 1956. The now almost legendary inflation commenced in 1961, reaching its crescendo in 1965 and 1966. Since that time, the stabilization program has gradually taken effect.

In order to distinguish real from monetary effects, the prices recorded in the four markets were deflated by the Jakarta Food Price Index adjusted for the exclusion of rice prices.[11] The result of this operation is shown in Chart 7. Bandung, the closest market to Jakarta, is excluded from the graph for the purpose of visual clarity. The results are encouraging and, given the magnitude of Indonesian inflation, surprising. These deflated prices should reflect nonmonetary influences and, indeed, seasonal patterns and price level fluctuations appear to

[10] "Medium quality" is not precisely defined. The error resulting from the influence of quality differences on the medium quality price series is small and unimportant for this study.

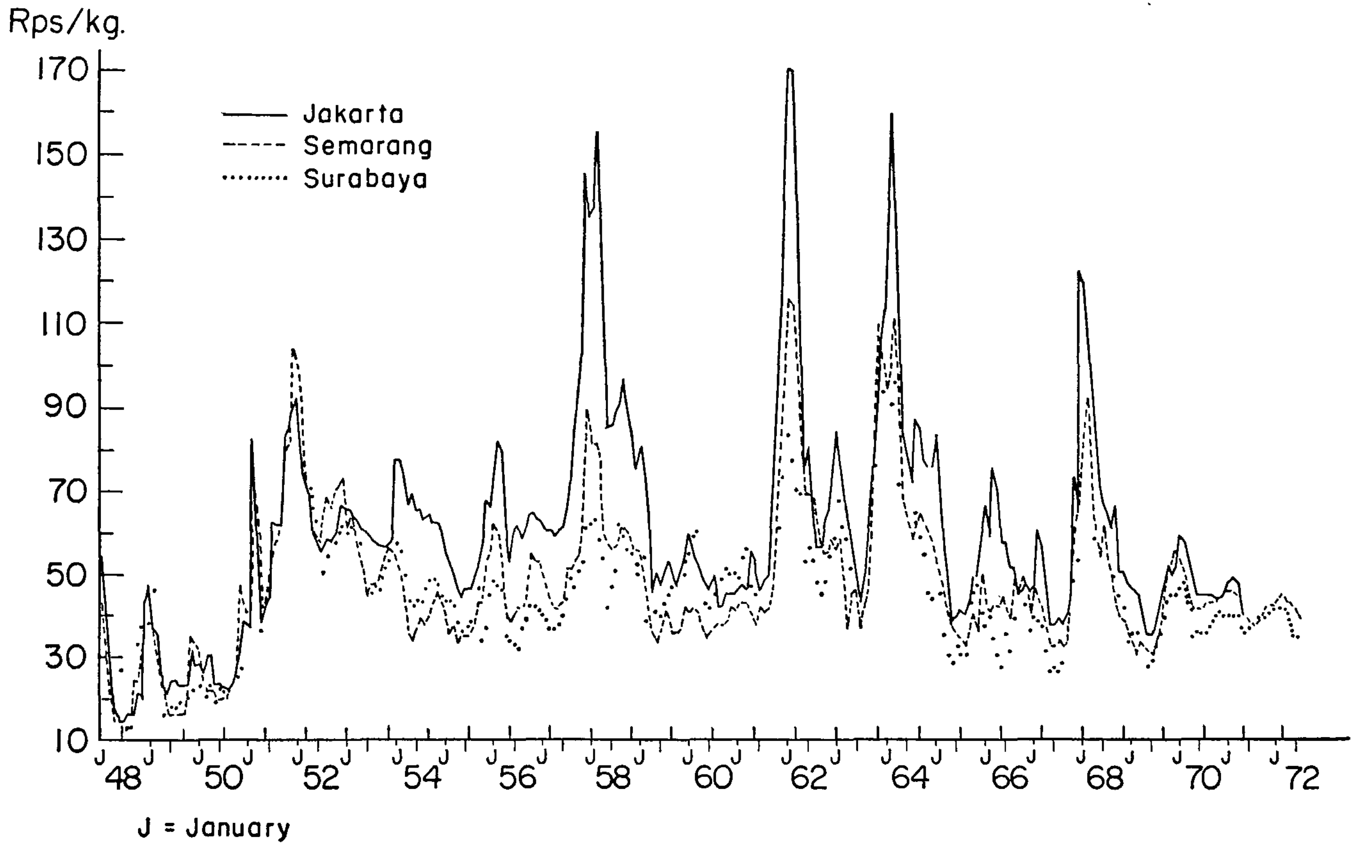
[11] This deflator series was calculated and its use suggested to me by C. Peter Timmer (see *49*).

CHART 6.—MONTHLY RETAIL PRICE, UNDEFLATED: JAKARTA MEDIUM QUALITY RICE, 1948–70*



* Data from Indonesia, Bureau of Logistics (Jakarta), n.d., mimeo.
New rupiahs = 1/1,000 old rupiahs.

CHART 7.—MONTHLY RETAIL PRICE, MEDIUM QUALITY RICE, DEFLATED BY FOOD PRICE INDEX (RICE EXCLUDED): JAKARTA, SEMARANG, SURABAYA, 1948–72*



* Data from Indonesia, Bureau of Logistics (Jakarta), n.d. mimeo.

emerge. Econometric procedures, however, enable a more discriminating analysis than visual inspection.

The seasonal price formation model estimated below derives from the general concept that prices in any particular market are a result of interaction between supply and demand in that market. This postulate, the cornerstone of most economic analysis, explains the potential research value attached to the production time series and the record of market prices presented here. There is, however, an important inconsistency in the data employed throughout most of this study. The production estimates, as explained above, are aggregated at the total Java level, while the price series were recorded in various urban areas throughout Java. A supply variable aggregated at the Java level is valid in the following analysis only if it is a reasonable reflection of supplies in each of the four provincial markets for which we have prices, i.e., only if provincial markets on Java are well integrated.

In this regard, it is useful to distinguish between the two concepts of "region" and "market." A region is a geographical description of an area surrounded by specified spatial boundaries, for example, Java. A market, on the other hand, has both spatial and temporal dimensions and is always associated with a particular commodity or commodities. The geographical extent of a market comprises the region within which a single price reigns for the associated commodity. More correctly, a market for commodity x is a region within which the price of x at any two points, a and b, differs by only the marginal cost of the marketing services required to move the commodity from a to b. The concept is analogous to that of a temporal market developed above. The existence of a market implies the free movement of the commodity within the market region so that an equilibrium price or constellation of prices is established throughout (*6*, Chaps. 4, 5). Whether or not Java should be considered a market is a question requiring attention.

A substantial trade in rice, controlled by both private and government channels (*26*; *59*, Chap. 7), exists among the provinces of Java, particularly between Jakarta and the major rice-producing provinces of West, Central, and East Java. The actual magnitude of these flows is not recorded, however. Though interprovincial trade is important it must surmount important man-made and natural barriers. Trading rice across provincial boundaries requires government authorization. In addition, the topography of Java, particularly the mountain ranges separating Central Java from the other provinces, is an obstacle to trade. Rice flows overland by rail and road between West Java and Jakarta and over the mountains from Central Java to Jakarta. Rice moving from East Java, the largest producer, to Jakarta is carried by ship. This transportation system is generally in poor repair. During periods of economic and political turmoil, the further deterioration of this network is an additional inhibition to interprovince trade.

Since prices at any time in a market should differ by only the marginal cost of transportation and associated marketing services, prices throughout a perfect market move in unison in response to any change in supply or demand within the market region. In order to test the degree of integration among the four major urban rice markets on Java, the deflated monthly retail prices in Jakarta were correlated year-by-year with prices in Bandung, Semarang, and Surabaya.[12] The results for 1951–71 are shown in Table 7.

[12] An April-March market year is used.

TABLE 7.—INTERMARKET CORRELATION COEFFICIENTS FOR MONTHLY RETAIL PRICE (DEFLATED) OF MEDIUM QUALITY RICE: ANNUAL BASIS

April-March year	Jakarta and: Bandung	Semarang	Surabaya	April-March year	Jakarta and: Bandung	Semarang	Surabaya
1951	.98	.96	.92	1961	.99	.96	.93
1952	.73	.30	.82	1962	.92	.64	.84
1953	.80	−.11	.44	1963	.99	.89	.84
1954	.87	−.04	.20	1964	.95	.86	.84
1955	.98	.95	.49	1965	.91	.71	.29
1956	.39	.87	.63	1966	.64	−.23	−.70
1957	.98	.97	.94	1967	.97	.97	.99
1958	−.53	.82	.37	1968	.96	.92	.92
1959	.02	.64	.54	1969	.92	.87	.95
1960	.28	−.15	.01	1970	.16	.22	.48
				1971	.90	.82	.67

The evidence in Table 7 indicates that the 21-year interval experienced periods of relatively high market integration throughout Java, interspersed with periods of extreme disintegration. The reasons for this unstable record are not difficult to discover. With the exception of 1970,[13] the periods of general market disruption, as evidenced by low correlation coefficients, correspond with dramatic deterioration in political conditions and internal security throughout Java.

The establishment of Indonesian political independence at the end of 1949 was not followed by a period of national cohesion.[14] On the contrary, profound controversy surrounded the entire concept of an Indonesian nation-state. The bitter debate over the founding of a secular rather than a Muslim state was made more complex by the division between those who looked upon sovereignty as signaling the start of a period of capitalist-oriented nation-building and those who viewed independence as a means toward achieving the socialist goals of a still unfinished revolution. In addition there was tension concerning the role of the Army in Indonesian social and political affairs.

Civil war broke out at the end of 1957. While fighting was most extensive in Sumatra and Sulawesi, Java experienced severe social and economic disruption as well. The resulting breakdown in trade throughout Java is revealed in the price correlations in Table 7. In October 1965, a decaying economy coincided once again with dramatic political events. This period of chaos ended in 1967 with Sukarno's removal from power.

The results in Table 7 and the analysis in the following sections suggest strongly that Java generally can be considered an integrated market, albeit an imperfect one. During some years, however, the general Javanese market concept is rendered questionable by the severe disruption of commodity trade. When the flow of rice within and, especially, between provinces is substantially impaired,

[13] There was little price variability in 1970; however, in some months, prices in the four markets moved one or two rupiahs in opposite directions. In November 1970, BULOG changed the indicator variety for which prices are collected to a slightly cheaper quality. These factors combined to produce a low 1970 correlation coefficient which is not comparable to those of the pre-1967 period as evidence on market integration.

[14] This capsule history relies heavily on Bernard Dahm's *History of Indonesia in the Twentieth Century* (*8*, Chaps. 5–8) and D. J. Steinberg's *In Search of Southeast Asia* (*44*, pp. 281–300).

prices in local urban markets cannot be expected to reflect fully the influence of total Indonesian or even total Java supplies. The use of these supply variables in the following investigations introduces an "error-in-variables"-type distortion.

In addition to disrupting the flow of commodities, social and economic instability directly influences the economic behavior of consumers and others in the market place. When civil strife erupts, confidence is shaken in the future availability of food in local markets. The resulting rush by consumers and merchants to acquire additional stocks drives prices up in a dramatic fashion. The high correlation among prices on Java in 1957, for instance, when rice prices in Jakarta rose 75 percent (deflated) between July and March probably reflects the common anticipation of food shortages throughout Java rather than any improvement in market integration. This behavior is difficult to isolate in econometric analysis except, in some cases, by the use of dummy variables.

Inflation also confounds the econometric analysis of consumer and price behavior. Deflating prices removes most of the purely monetary component of price changes. The inflation phenomenon, however, has a real impact on economic behavior, particularly the demand for stocks. Farmers, for instance, anticipating future price increases, may hold more stocks longer than usual, and then release these enlarged inventories late in the season, thus influencing the seasonal price pattern.

The influence of these and other factors, induced by socioeconomic instability, if not specified properly, may distort econometric estimates and mask the more stable relationships predicted by economy theory. They are undoubtedly a source of some of the error in the estimates presented below.

4. THE SEASONAL PATTERN OF RETAIL RICE PRICES

The simple intertemporal price-formation model summarized earlier in Charts 2 and 3 predicts that prices for seasonally produced commodities will follow a basic recurring annual pattern reflecting the periodicity of production and the costs of storage, with monthly prices strung out above and below the annual average price and differing from one another by the costs of storage. Since this smooth pattern would occur only in years when the size and magnitude of supply and demand is judged accurately early in the market year, the concept of "anticipatory price" explains why this simple seasonal formation may not be apparent in actual market prices such as those shown in Chart 7. Nevertheless, if a strong normal seasonal pattern underlies a long series of monthly prices, it is possible to isolate this from price fluctuations induced by new information in the market.

In any particular year, the deviation of a monthly price from the annual average is composed of both seasonal forces and price-level adjustments resulting from new market information about supply and demand forces. If for each year in a time series, one observes the deviation of one particular monthly price from the respective annual average and then averages these deviations, the price-level adjustments will probably cancel out one another and only the relatively consistent seasonal influence remains. This is the basic idea behind the moving average method of isolating the general seasonal pattern in a time series of prices (*11*, Chap. 5). The seasonal production pattern on Java described in Part 2 proved

TABLE 8.—SEASONAL PRICE RISE EXPRESSED AS A PERCENTAGE OF THE INDEX VALUE OF THE LOW MONTH

Area	Seasonal price increase (*percent*)	Number of months between low and high price	Average monthly price rise (*percent*)
Jakarta	40.0	7 or 8	5.7 or 5.0
Bandung	42.5	8	5.3
Semarang	37.4	6 or 7	6.2 or 5.3
Surabaya	40.3	8	5.0

to be quite consistent over time. Therefore, a recurring 12-month pattern should underlie the time series of monthly spot prices, reflecting the periodicity of the wet- and dry-season crops.

In order to find this pattern, a 12-month moving average of the full time series (1948 through June 1971) of deflated monthly spot prices is calculated. The moving average technique is designed to isolate any trend in the series. Ratios of the original monthly prices to the corresponding moving average values are formed. These ratios measure the monthly deviations from the average. The average of these ratios is calculated for each month (e.g., all January ratios are averaged) in order to arrive at the seasonal value for each month. The average of the ratios forms a "seasonal price index" which shows the underlying seasonal pattern of retail rice prices on Java.

The seasonal rice price indices for the four Javanese provincial capitals derived by this technique are shown in Chart 8. The results when compared to the production pattern in Chart 4 are as expected. In each market, the seasonal low month is May or June, reflecting the arrival of the wet season crop on the urban markets. From the low month, prices rise until January or February. Prices reach their seasonal peak in Semarang and Surabaya, major production areas, one month earlier than in Jakarta, reflecting the arrival of early new crop supplies. The dry-season crop is not generally large enough to cause prices to fall in September or October. The July dip in the Surabaya index deviates somewhat from the "ideal" pattern and probably indicates an earlier and more abundant dry-season crop than in the other provinces.

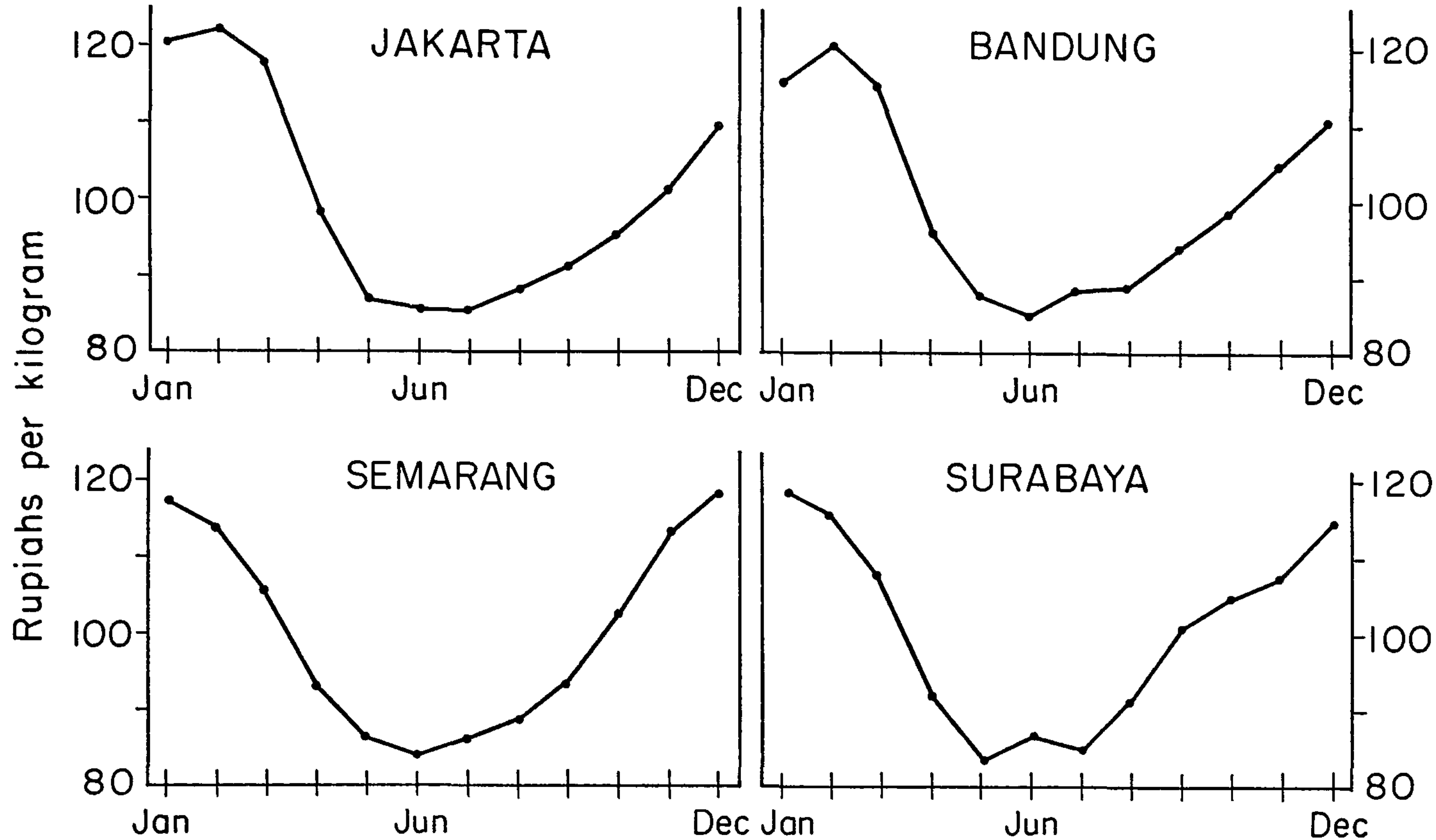
As indicated in Part 1, the seasonal price rise should, in a competitive market, reflect the costs of storage. In order to test the performance of each market in this regard, the seasonal price rise shown in Chart 8 is measured from low month to high month. The results of this procedure are shown in Table 8.

Though little evidence is available on actual storage costs in Indonesia, the major component in storage costs is believed to be interest charges. The only independent estimate of storage costs I have found is 3.5 percent to 6.5 percent per month (*1*, p. 143). This range is consistent with the storage costs implied here by the seasonal price indices. This is evidence that, on the average, supplies are allocated efficiently over time in Javanese rice markets.

Tables 9 through 12 provide a more detailed look at seasonal price movements in the four markets. For each market year, Sections A and B show the month of lowest and highest price, respectively. The prices in these months are expressed as ratios to the moving average and are called "price relatives." The two columns

CHART 8.—SEASONAL PRICE INDICES FOR FOUR JAVANESE PROVINCIAL CAPITALS*

(Ratio to 12-month moving average)



* Data from Indonesia, Bureau of Logistics (Jakarta), n.d., mimeo.

Table 9.—Jakarta: Seasonal Price Movements, 1949/50 to 1970/71*

April-March years	A: Low price relative														B: High price relative														C: Number of months between high and low	Seasonal increase[a] D	E
	Month of lowest												Value of[b]		Month of highest												Value of[c]				
	A	M	J	J	A	S	O	N	D	J	F	M	Lowest	June	A	M	J	J	A	S	O	N	D	J	F	M	Highest	Jan.[d]		Full	Standardized
1949/50		x											.71	.82								x					1.23	1.08	6	73	32
1950/51						x							.68	.86											x		1.85	.91	5	72	6
1951/52			x										.73	.73										x			1.28	1.28	7	75	75
1952/53			x										.85	.85									x				1.09	1.07	6	28	26
1953/54								x					.89	.98										x			1.19	1.19	2	34	21
1954/55			x										.98	.98									x				1.07	1.00	6	9	2
1955/56		x											.85	.87											x		1.27	1.17	9	49	35
1956/57		x											.82	.93							x						1.06	1.02	5	29	10
1957/58				x									.81	.83												x	1.42	1.27	8	75	53
1958/59		x											.78	.81										x			1.11	1.11	8	42	37
1959/60	x												.74	.83										x			1.16	1.16	9	57	40
1960/61					x								.90	.95											x		1.00	.99	6	11	4
1961/62					x								.64	.77											x		1.64	1.52	6	156	97
1962/63					x								.66	.82										x			1.32	1.32	5	100	61
1963/64				x									.63	.70												x	1.61	1.19	8	156	70
1964/65				x									.76	.81										x			1.27	1.27	6	67	57
1965/66		x											.72	.76												x	1.30	1.20	10	81	58
1966/67						x							.84	1.02											x		1.29	1.01	5	54	−1
1967/68					x								.64	.76										x			1.64	1.64	5	156	116
1968/69			x										.88	.88						x							1.08	.97	3	23	10
1969/70		x											.81	.83										x			1.21	1.21	8	49	46
1970/71			x										.92	.92											x		1.11	1.08	8	21	17
Frequency	1	6	5	3	4	2		1												1	1	1	2	8	6	3					
Average																													6.4	64.4	39.6
Mode																													6		
Range																													2 to 10	9 to 156	−1 to 116

* Prices are expressed as ratios to the moving average and are called "price relatives."

[a] The "full" seasonal increase is the increase from the lowest to the highest price relative expressed as a percent of the lowest; the "standardized" seasonal increase is the corresponding percent for the price relatives in the low and high months of the price index.

[b] Lowest price relative for the year and for the low month in the seasonal index which is described for Chart 9.

[c] Highest price relative for the year and for the high month in the seasonal index.

[d] The index is at its high in February as well, and at its low in June as well.

TABLE 10.—BANDUNG: SEASONAL PRICE MOVEMENTS, 1949/50 TO 1970/71*

April-March years	A: Low price relative														B: High price relative														C: Number of months between high and low	Seasonal increase[a]	
	Month of lowest												Value of[b]		Month of highest												Value of[c]			D	E
	A	M	J	J	A	S	O	N	D	J	F	M	Lowest	June	A	M	J	J	A	S	O	N	D	J	F	M	Highest	Feb.		Full	Standardized
1949/50			x										.71	.71											x		1.32	1.32	8	86	86
1950/51			x										.76	.76												x	1.45	1.41	9	91	86
1951/52			x										.76	.76									x				1.38	1.08	6	82	42
1952/53			x										.84	.84									x				1.12	1.08	6	33	29
1953/54		x											.89	.93											x		1.11	1.11	9	25	19
1954/55			x										.92	.92									x				1.07	.94	6	16	2
1955/56				x									.85	.89												x	1.27	1.19	8	49	34
1956/57		x											.83	.85								x					1.11	.96	6	34	13
1957/58			x										.84	.84									x				1.37	1.23	6	63	46
1958/59		x											.76	.77										x			1.27	1.21	8	67	57
1959/60		x											.82	.86											x		1.09	1.09	9	33	27
1960/61									x				.90	.92											x		1.19	1.19	2	32	29
1961/62				x									.73	.86												x	1.57	1.45	8	115	69
1962/63		x											.79	.81										x			1.23	1.16	8	56	43
1963/64				x									.64	.71												x	1.47	1.42	8	130	100
1964/65				x									.80	.82										x			1.19	1.05	6	49	28
1965/66		x											.71	.77												x	1.27	1.05	10	79	36
1966/67							x						.89	.96											x		1.24	1.24	4	39	29
1967/68					x								.76	.83											x		1.64	1.64	6	116	98
1968/69			x										.93	.93								x					.98	.95	5	5	2
1969/70		x											.82	.85							x						1.20	1.11	5	46	31
1970/71			x										.90	.90											x		1.09	1.09	8	21	21
Frequency	0	7	8	4	1	0	1	0	1												1	2	4	3	7	5					
Average																													6.9	57.6	42.1
Mode																													8 & 6		
Range																													2 to 10	5 to 130	2 to 100

* Prices are expressed as ratios to the moving average and are called "price relatives."

[a] The "full" seasonal increase is the increase from the lowest to the highest price relative expressed as a percent of the lowest; the "standardized" seasonal increase is the corresponding percent for the price relatives in the low and high months of the price index.

[b] Lowest price relative for the year and for the low month in the seasonal index which is described for Chart 9.

[c] Highest price relative for the year and for the high month in the seasonal index.

TABLE 11.—SEMARANG: SEASONAL PRICE MOVEMENTS, 1949/50 TO 1970/71*

April-March years	A: Low price relative — Month of lowest: A	M	J	J	A	S	O	N	D	J	F	M	Value of[b]: Lowest	May	B: High price relative — Month of highest: A	M	J	J	A	S	O	N	D	J	F	M	Value of[c]: Highest	Dec.	C: Number of months between high and low	Seasonal increase[a] D: Full	E: Standardized
1949/50			x										.64	.65								x					1.48	1.40	5	131	115
1950/51					x								.68	.80											x		1.49	1.02	6	119	28
1951/52		x											.79	.79									x				1.41	1.41	7	79	79
1952/53			x										.78	.80									x				1.16	1.16	6	49	45
1953/54			x										.83	.93								x					1.17	1.16	5	41	25
1954/55		x											.78	.78								x					1.15	1.11	6	47	42
1955/56					x								.85	.89										x			1.31	1.19	5	54	34
1956/57		x											.77	.77							x						1.20	1.15	5	56	49
1957/58			x										.85	.86									x				1.38	1.38	6	62	61
1958/59		x											.85	.85									x				1.11	1.11	7	31	31
1959/60		x											.80	.80											x		1.10	1.08	9	36	35
1960/61		x											.91	.91											x		1.06	1.03	9	17	13
1961/62					x								.68	.84										x			1.48	1.30	5	118	55
1962/63		x											.87	.86										x			1.14	1.06	8	31	23
1963/64			x										.63	.85								x					1.40	1.27	5	122	49
1964/65				x									.81	.86								x					1.08	1.08	4	33	26
1965/66				x									.84	.90									x				1.23	1.23	5	46	37
1966/67				x									.90	1.02										x			1.13	.93	6	26	−9
1967/68					x								.68	.83											x		1.50	1.14	6	121	37
1968/69		x											.91	.91			x										1.04	.92	1	14	1
1969/70			x										.80	.85								x					1.25	1.23	5	56	45
1970/71	x												.89	.91										x			1.06	1.06	9	19	17
Frequency	1	8	6	3	4												1				1	6	5	5	4						
Average																													5.9	59.5	38.1
Mode																													5		
Range																													1 to 9	14 to 131	−9 to 115

* Prices are expressed as ratios to the moving average and are called "price relatives."

[a] The "full" seasonal increase is the increase from the lowest to the highest price relative expressed as a percent of the lowest; the "standardized" seasonal increase is the corresponding percent for the price relatives in the low and high months of the price index.

[b] Lowest price relative for the year and for the low month in the seasonal index which is described for Chart 9.

[c] Highest price relative for the year and for the high month in the seasonal index.

TABLE 12.—SURABAYA: SEASONAL PRICE MOVEMENTS, 1949/50 TO 1970/71*

April-March years	A: Low price relative — Month of lowest												Value of[b]	
	A	M	J	J	A	S	O	N	D	J	F	M	Lowest	May
1949/50	x												.54	.66
1950/51					x								.77	.81
1951/52	x												.71	.76
1952/53				x									.79	.91
1953/54			x										.84	.96
1954/55		x											.87	.87
1955/56		x											.88	.88
1956/57				x									.81	.86
1957/58	x												.88	.89
1958/59		x											.76	.76
1959/60			x										.84	.87
1960/61			x										.85	.87
1961/62					x								.74	.91
1962/63						x							.80	.87
1963/64				x									.65	.78
1964/65		x											.89	.89
1965/66		x											.73	.73
1966/67		x											.73	.73
1967/68					x								.69	.76
1968/69		x											.92	.92
1969/70		x											.77	.77
1970/71	x												.86	.89
Frequency	4	8	3	3	3	1								

April-March years	B: High price relative — Month of highest												Value of[c]		C: Number of months between high and low	Seasonal increase[a] D	Seasonal increase[a] E
	A	M	J	J	A	S	O	N	D	J	F	M	Highest	Jan.		Full	Standardized
1949/50									x				1.39	1.05	8	157	59
1950/51											x		1.37	1.18	6	78	46
1951/52									x				1.27	1.20	8	79	58
1952/53											x		1.10	1.09	7	39	20
1953/54										x			1.16	1.16	7	38	21
1954/55							x						1.08	1.01	5	24	16
1955/56					x								1.24	1.18	3	41	34
1956/57								x					1.10	1.03	4	36	20
1957/58											x		1.18	1.17	10	34	32
1958/59					x								1.15	1.04	3	51	37
1959/60												x	1.21	1.12	9	44	29
1960/61												x	1.18	1.02	9	39	17
1961/62										x			1.35	1.35	5	82	48
1962/63										x			1.28	1.28	4	60	47
1963/64										x			1.49	1.49	6	129	91
1964/65										x			1.20	1.20	8	35	35
1965/66								x					1.29	1.01	6	77	38
1966/67						x							1.25	1.06	4	71	45
1967/68										x			1.48	1.48	5	115	95
1968/69						x							1.04	.93	4	13	1
1969/70											x		1.18	1.15	9	53	49
1970/71								x					1.06	1.04	7	23	17
Frequency					2	2	1	3	2	6	4	2					
Average															6.2	60	38.9
Mode															4		
Range															3 to 10	13 to 129	1 to 95

* Prices are expressed as ratios to the moving average and are called "price relatives."

[a] The "full" seasonal increase is the increase from the lowest to the highest price relative expressed as a percent of the lowest; the "standardized" seasonal increase is the corresponding percent for the price relatives in the low and high months of the price index.

[b] Lowest price relative for the year and for the low month in the seasonal index which is described for Chart 9.

[c] Highest price relative for the year and for the high month in the seasonal index.

at the right of Section A show the value of the lowest price relative of the year and the value of the price relative corresponding to the lowest month in the seasonal price index (see Chart 8). The two columns at the right of Section B show similar values for the actual yearly high and the highest month in the price index. The frequency of annual low and high prices occurring in specific months is shown at the bottom of Sections A and B. With the exception of Jakarta, the frequency of the annual low price is more concentrated than that of the annual high. This probably reflects the consistency of peak harvest periods from year to year, compared to the uncertainty surrounding the factors which influence the seasonal price rise.

Sections D and E are basically similar and provide a more realistic look at the seasonal price pattern than the price indices shown in Chart 8. Section D shows the seasonal price rise for each year measured from the actual low to the actual high month in that year and expressed as a percentage of the low month. Section E shows the seasonal price rise for each year measured from the low month in the seasonal price index to the highest month in the seasonal price index and expressed as a percentage of the low month value. Section C shows the number of months between the actual low and the actual high for each year. All of these measures are utilized below in the investigation into the causes of seasonal price formation.

Sections D and E provide evidence that the seasonal price index (Chart 8), due to its quality as an average, masks a great deal of year-to-year variability in seasonal price movements. Although, on the average, seasonal rice prices on Java increase approximately enough to offset storage costs, seasonal increases of over 70 percent and less than 30 percent (as measured in Section D) are not uncommon. During the period analyzed here, the largest seasonal price rise in Jakarta was 156 percent in five months (1967/68) and the smallest was 9 percent over a six-month period (1954/55). This is the kind of instability referred to briefly in the introduction and normally associated with grain markets in developing countries (see, for instance, *1*, *22*, *25*, and *27*). Part 5 attempts to explain the factors influencing the seasonal price variability shown above.

5. SEASONAL RICE PRICE FLUCTUATIONS ON JAVA: A MODEL OF ANTICIPATORY PRICES

Holbrook Working developed the concept of "anticipatory prices" (*63*) in response to the commonly held view that frequent and sometimes dramatic price changes observed in commodity markets constitute evidence that most commodity price fluctuations cannot be explained by supply and demand forces. The basic idea underlying a valid model of commodity price formation, according to Working, is that "it must make adequate place for expectations in the formation of demand."

The review of intertemporal price theory in Part 1 explained the idea of a commodity market as a mechanism for allocating the existing stock of a commodity between two types of demand—one for present consumption and the other for future consumption. The market responds to price signals, and the price consumers are willing to pay for a commodity at a future date depends upon the market conditions at that time. Of course, future market conditions, particularly supplies, are not known with certainty, hence the role of expectations or anticipations in price formation, as market participants decide whether to build up inventories for future sale or release a portion of stocks for current consumption.

The change in commodity prices over any time interval is attributed, by theory, to two factors: (1) the level of storage costs and (2) changes in expectations concerning supply and demand conditions. In equilibrium, prices between two dates will differ by storage costs only. This equilibrium reflects perfect arbitrage over time, resulting from accurate expectations concerning market conditions. This pattern, however, is ideal. Normally, expectations formed at the beginning of the time interval require revision before the end is reached. Between two dates, say the immediate post–wet-season harvest and the dry-season harvest, prices may rise by more than the cost of storage because, during the interval, new information enters the market. There may be news toward the middle of the interval that the wet harvest is, in fact, smaller than previously estimated. Inventory holders, anticipating shorter supplies and higher than expected end-of-season prices, now refrain from releasing the full amount of supplies originally intended for the early season market. Current prices rise, and the market generally adjusts toward a new higher equilibrium price level. Soon after receiving news of a short current harvest, however, the market may receive reports of favorable weather affecting the next crop. This fosters the anticipation of larger supplies and lower prices at the end of the time interval. A portion of inventories reserved for future sale is now released for current consumption because prices at the end of the interval are now predicted to be less than storage costs. If the dry-season crop is, in fact, larger than expected at the time of the wet-season harvest, the price difference during the time interval, after rising beyond storage costs, may indeed end up being less than storage costs.

The reason commodity prices appear to fluctuate randomly is not because they are formed by factors having nothing to do with supply and demand; on the contrary, it is precisely because they are formed by conditions of supply and demand which themselves depend essentially on random phenomena, such as weather. Working states that (*63*, p. 195):

> From our model, we can also deduce something about the nature of the price fluctuations that it will generate. The able and well-informed traders whom we have been considering make their profits by getting information that permits them to predict price changes. The information on which these predictions are made, however, so far as it is new and useful for price prediction, is itself unpredictable, or substantially so. Consequently we may say, subject to slight qualification, that the price changes generated by the model are unpredictable price changes. That is, no change is predictable except on the basis of the information that gives rise to the change.

Uma Lele (*25*, pp. 167–73), in an investigation of seasonal price variability in India, states that "a very rudimentary analysis of the off-season price rise should involve examination of the interrelationships between cereal prices and the cereal's arrivals and production."[15] She then proceeds by measuring percentage seasonal

[15] To my knowledge, Lele's is the only published attempt to estimate, with econometric techniques, the causes of seasonal price fluctuations in commodity markets of a developing country.

price increases and regressing them against *total* crop year production and *total* market year arrivals. In neither case did the results show a significant relationship. She concludes that (p. 172):

> Arrivals and crop size thus generally serve as poor explanations of the year-to-year variability in the pattern or extent of seasonality in the prices of the three major cereals. Rather, seasonal price movements seem to have been influenced by a complex set of factors, such as zonal restrictions, procurement, imports, public distribution of cereals, credit control, and ceiling prices, all of which not only varied from one cereal to another but, even in the case of the same cereal, from one state to another. In addition to all of these factors which influenced prices of individual cereals in a set of trading markets, the prices and supplies of other cereals influenced price levels of particular cereals whenever there was a substitution of one cereal for another in consumption. All of these factors are too complex and too varied, statistical information too inadequate, and the time series too short to be explained by a rather simple set of statistical equations.

It is important to note that intertemporal price theory does *not* predict a relationship between seasonal price increases and the level of annual output or market arrivals. The fact that Lele did not find the relationship for which she was looking is, therefore, not surprising.[16] In fact, the theory predicts, in the case where supplies are accurately anticipated, a zero relationship between seasonal price changes and annual output. That is, if the level of annual output is correctly estimated early in the market year then the level of the seasonal low price, occurring in the immediate post-harvest period, will fully reflect the influence of total output from the previous crop year. The seasonal price rise that follows should reflect only the cost of storage.

If seasonal price increases are greater or less than storage costs, as is frequently the case in India and Indonesia, then, in addition to storage costs, they reflect the magnitude by which quantities supplied and demanded *differ* from expectations formed early in the market year. Empirical investigation of seasonal prices, therefore, requires either good monthly inventory data (unavailable for Indonesia) or an index of market expectations on the relevant supply and demand conditions as well as information which enables one to judge the degree of error in those expectations. Ultimately, it is this error, not the level of annual output or arrivals, that results in seasonal price fluctuations.

According to the price indices presented in the preceding section, prices generally are at their seasonal low on Java in either May or June, immediately following the peak wet-season harvest period. What are the important expectations that determine this price and what are the factors most likely to require a revision of these expectations before the seasonal high price is reached later in the market year? The early season price reflects the market's estimate of the size of the wet-

[16] Lele's failure to test a model consistent with conventional intertemporal price theory may be due to her conclusion, based on stock-book records, that "traders and millers avoid building up heavy stocks of grain in the immediate postharvest period and depend largely on a quick turnover of stocks for profits" (*25*, p. 190). She attributes the lack of speculation largely to an imperfect financial market, extreme uncertainty and government anti-hoarding policies. Although Lele's evidence is not sufficient to discard completely the anticipatory price concept (in fact, she employs it in her study of jowar markets [*24*]), an operational model would be difficult to specify in the Indian case due to the large number of substitute commodities involved.

season crop as well as the level of stocks carried in from the previous market year. Since part of this large early season supply is carried out into the dry-season part of the market year, some expectation about the dry-season crop also enters decisions affecting the early season price level. Other factors influence this price as well, such as expectations about substitute food crops, government intervention, imports, political stability, and even the timing and magnitude of the next wet-season harvest.

Table 6 documented the striking variability of the dry-season rice crop compared to the relatively stable wet-season harvest. Application of intertemporal theory suggests the hypothesis that the small but volatile dry-season harvest contributes more to seasonal price instability in Indonesia than the larger wet-season crop. Although new information and actual circumstances will force the market to revise its expectations on each of the variables mentioned above as the year wears on, the dry-season rice crop stands out as the factor most likely to induce large seasonal price changes. This is so because of its great instability and its importance as a source of grain in the last half of the market year. Dry-season maize production, for example, the closest food substitute for which reasonable data are available, runs between 30 percent and 50 percent by weight of the dry-season rice harvest.[17]

Casual comparison of Table 6 with Tables 9 through 12, showing seasonal price changes, reveals evidence of the dry season's influence on prices. In 1954/55, for instance, the wet-season harvest was .4 percent less than in the previous year. During the market year, however, prices rose by only 9 percent in Jakarta in six months. The normal seasonal price increase, induced by storage costs, was truncated later in the market year by the arrival of unusually large supplies from the dry-season crop, a 35 percent increase from the previous year. In 1961/62, the wet season experienced a 5.4 percent increase in output over the previous year's harvest. However, the dry-season crop was 35.6 percent less than in the previous year, driving prices in Jakarta up 156 percent in six months and in Semarang 118 percent in five months.

The reasons behind the influence of the dry-season crop are straightforward. When prices reach their seasonal low in Indonesia, most of the wet-season harvest is completed and the crop is arriving in markets. The crop is relatively stable from year to year, and even in exceptional years the market has considerable early information upon which to develop the expectations that help form the early season low price. The other major expectation influencing this early season low price concerns the dry-season rice crop. Frequently, at the time of the season low price, much of the dry-season rice has not even been transplanted out into fields. Therefore, most information about the dry crop enters the market *after* the date of the seasonal low price. This is the type of "unpredictable" information referred to by Working as dominating seasonal price movements. The following is a more rigorous model and empirical test of the anticipatory price concept and

[17] Actual dry-season maize figures are not available; however, a general estimate can be obtained by applying the monthly maize harvest index averaged over the years 1953–62 (*32*, p. 242) to the annual maize production figures. This shows 45 percent of Java's maize is harvested between September and January.

the influence of the dry season crop and other variables on seasonal prices in Indonesia from 1954–69.[18]

The general form of the model is:

$$P' = A + bD_w + cD_d + dY_m + eG$$

where P_{ij}' = seasonal price rise in market year i (April–March), market j, from month x to month y expressed as a percentage of month x. Specifically,

$P_{ij}'^a$ = percentage seasonal price rise in year i from the low month in the seasonal price index to the high month in the seasonal price index (see column E of Tables 9 through 12 for data).

$P_{ij}'^b$ = percentage seasonal price rise in year i from the actual low price to the actual high price for year i (see column D of Tables 9 through 12) divided by the number of months between the low and high month (see column C of Tables 9 through 12). The division is to hold storage costs constant.[19]

D_{wi} = deviation of the wet crop from expectations, expressed as a percentage of the expected *total* annual crop. That is:

$$\left((Q_{wi} - Q_{wi}^*)/Q^*_{ti}\right) \times 100,$$

where Q_{wi} = actual value of the wet-season harvest in crop year i (see Table 5).

Q_{wi}^* = the expected value of the wet-season crop in year i at the time of the seasonal low price. This value is the average of the linear trend value of Q_w in year i and the actual value of the wet crop in the previous year, $Q_{w(i-1)}$.

$Q_{wi} - Q_{wi}^*$, the deviation of the wet-season crop from expectations, is expressed as a percentage of Q_t^*.

Q_{ti}^* = the expected value of the total annual crop. This value is $Q_{wi}^* + Q_{di}^*$.

D_{di} = deviation of the dry crop from expectations, expressed as a percentage of the expected *total* annual crop. That is

$$\left((Q_{di} - Q_{di}^*)/Q_{ti}^*\right) \times 100,$$

[18] Although seasonal prices are measured from 1949–70 in Tables 9 through 12, seasonal production data were available to me for only 1953 through 1969. Since the specification of expectations here involves averaging the linear trend value and a one-year lag, one year of the production series is lost.

[19] In the case of P'^a, there is no need to deflate by the monthly interval, since the index low and high month, hence the time interval, are the same regardless of year.

where Q_{di} = actual value of the dry-season harvest in crop year i (see Table 5).

Q_{di}^* = the expected value of the dry-season crop in year i at the time of the seasonal low price. This value is the average of the linear trend value of Q_d in year i and the actual value of the dry crop in the previous year, $Q_{d(i-1)}$.

$Q_{di} - Q_{di}^*$, the deviation of the dry crop from expectations is expressed as a percentage of Q_{ti}^*.

Y_{mi} = Indonesian maize yield in calendar year i.

G_i = amount of rice injected by government during calendar year i for the purpose of price stabilization, expressed as a percentage of Q_{ti}^*.

In order to segregate the influence of storage costs from that of other variables in the analysis, the price variables are defined as percentage rather than absolute changes. Interest charges are the major component of storage costs in Indonesia. During a given interval, therefore, the actual value of price changes due to storage costs is a function of the purchase price of rice, which changes from year to year. The percentage change in price attributed to storage costs during a given interval is, however, largely a function of real interest rates, which are assumed here to be constant during the period. In the case of P'^b, which, unlike P'^a, is measured over a different monthly interval from year to year, the percentage seasonal price increase is divided by the number of months in the interval, in order to hold the influence of storage costs constant.[20]

The rationale for carrying out the analysis on two different monthly intervals, represented by P'^a and P'^b, concerns the problem of choosing a time interval during which the major variables influencing price changes are the ones specified in the analysis. The idea behind P'^a is that price changes during the time interval comprising the low and high months in the seasonal price index result from the variables that most consistently determine the seasonal price rise. On the other hand, reference to Tables 9 through 12 above shows that the month in which the actual high price occurs is distributed widely around the high month identified by the seasonal index. The distribution is more concentrated around the index month in the case of the seasonal low, except in Jakarta. In other words, in most years, the actual annual high is reached before or after the index month. If the actual high comes before the index month, then P'^a reflects the influence of factors that caused the price rise, such as the dry crop, and also factors that caused prices to decline from their peak, such as government injections, the arrival of substitute food supplies, and the new crop harvest. If the actual high price is achieved after the index month, then P'^a may not reflect the full influence of D_d. On the other hand, the price increase following the index month may reflect the late arrival of new crop supplies rather than the influence of the dry-season crop. The latter, hopefully, is the case, for then P'^a reflects the full influence

[20] The model assumes a perfectly elastic supply of storage, i.e., constant unit costs of storage.

of D_d but not the impact of timing of the new crop, a variable that remains unspecified in this analysis. Similarly, in cases where government injections and the arrival of substitute foods, such as maize, cause the price peak to occur prior to the index month, then P'^b might better reflect the influence of the wet- and dry-season crops. Comparisons of the results for P'^a and P'^b should provide additional insight into the formation of seasonal prices.

The reasons for defining D_w and D_d as deviations from expectations requires no further explanation. The procedure for determining expectations calls for some discussion, however. Q_w* and Q_d* reflect the hypothesis that early season market expectations about the wet- and dry-season crops are developed from a simple distributed lag-type mechanism. In other words, last year's experience (represented by the one-year lag) is an important influence on expectations concerning this year. This influence, however, is conditioned by the experience of earlier, but recent, years (represented by the linear trend value).[21] This assumption is probably more valid for the dry-season crop, which, in most cases, is not even in the ground at the time the early season low price is achieved, than for the wet-season crop, which is already arriving in markets at this time.

The linear model estimated here assumes that prices change along a constant elasticity demand function, where percentage changes in prices and quantities bear a constant relationship to one another. The model relates a percentage change in price to the change in supplies measured as a *percentage* of the quantity which determined the early price in the time interval. The quantity influencing the early season price is assumed, in this analysis, to be the combined market expectations on both the wet- and dry-season crops, Q_t*. The price rise is determined by quantities which were unexpected in the early season. These quantities, since they are related in the model to percentage price changes, are defined as percentages of the expected total crop.

The maize yield variable, Y_m, is a proxy for changes in expectations regarding the dry-season maize crop. The seasonal change in rice prices is a partial function of unexpected changes in the supply of maize, a major dietary substitute. Early season expectations regarding maize production are difficult to measure without either data on seasonal maize production or planted area. Annual maize yield data are available. Yield fluctuations are employed here as an indication of unexpected changes in the dry-season maize crop.

The Indonesian government carried out some price stabilization measures throughout the entire period under investigation here. The actual influence of these injections on rice prices is an interesting question. Unfortunately, data presently available record only the annual level of injections on a total Indonesia basis. The actual timing of injections and their magnitude in particular markets are important in an analysis of this type. Nevertheless, some insight may be gained from including the G variable in the analysis.

Table 13 presents the results obtained from estimating this seasonal price model. The equations (1) and (1′) series establish beyond question the influence of the dry-season crop on seasonal price formation. In each of the four

[21] Preliminary estimates were made using only the linear trend value as an index of expectations. The results were similar to those presented here, but the R^2 values, particularly, were considerably weaker in many cases.

TABLE 13.—SEASONAL PRICE MODEL RESULTS*

Equation	Dependent variable†	Regression coefficients for independent variables (t values in parentheses): Constant	D_w	D_d	Y_m	G	R^2	Durbin-Watson statistic
				A: Jakarta				
1a	P'^a	46.40 [a]	−1.28	−4.53 [a]			.46	2.38
	Jkt	(6.85)	(−.86)	(3.13)				
1′a	P'^b	11.72 [a]	−0.47 [b]	−0.99 [a]			.39	1.43
	Jkt	(6.41)	(−1.18)	(−2.54)				
2a	P'^a	99.15	−1.87	−4.37 [a]	−3.93	−2.28	.50	2.64
	Jkt	(0.66)	(−1.12)	(−2.64)	(−0.26)	(−0.95)		
2′a	P'^b	22.43	−0.70 [c]	−0.97 [b]	−0.48	−0.92 [c]	.50	1.76
	Jkt	(0.59)	(−1.65)	(−2.30)	(−0.12)	(−1.49)		
				B: Bandung				
1b	P'^a	43.50 [a]	−2.16 [b]	−4.51 [a]			.73	1.37
	Bnd	(10.64)	(−2.41)	(−5.61)				
1′b	P'^b	9.62 [a]	−0.29 [c]	−0.72 [a]			.54	1.95
	Bnd	(10.17)	(−1.42)	(−3.53)				
2b	P'^a	128.3 [c]	−2.61 [a]	−4.18 [a]	−7.73	−1.64	.76	1.95
	Bnd	(1.47)	(−2.68)	(−4.34)	(−0.88)	(−1.17)		
2′b	P'^b	33.52 [c]	−0.39 [b]	−0.62 [a]	−2.26	−0.35	.61	2.62
	Bnd	(1.68)	(−1.76)	(−2.79)	(−1.11)	(−1.07)		
				C: Semarang				
1c	P'^a	34.24 [a]	−0.06	−2.07 [a]			.28	1.45
	Sem	(7.84)	(−0.07)	(−2.22)				
1′c	P'^b	11.20 [a]	−0.24	−0.94 [a]			.46	1.79
	Sem	(8.11)	(−0.79)	(−3.17)				
2c	P'^a	54.40	0.66	−1.88 [b]	−4.24	3.05 [b]	.56	2.30
	Sem	(0.70)	(0.75)	(−2.18)	(−0.54)	(2.42)		
2′c	P'^b	32.32	−0.37	−0.85 [a]	−1.87	−0.47	.51	1.71
	Sem	(1.07)	(−1.10)	(−2.56)	(−0.61)	(−0.99)		
				D: Surabaya				
1d	P'^a	42.24 [a]	−1.32 [c]	−3.89 [a]			.66	1.47
	Sur	(10.87)	(−1.56)	(−4.68)				
1′d	P'^b	11.63*[a]	−0.18	−0.90 [a]			.42	2.10
	Sur	(8.25)	(−0.60)	(−2.98)				
2d	P'^a	51.71	−1.86 [b]	−3.91 [a]	0.54	−2.19 [b]	.74	2.21
	Sur	(0.66)	(−2.12)	(−4.51)	(0.07)	(−1.73)		
2′d	P'^b	2.29	−0.26	−0.95 [a]	1.22	−0.35	.46	2.23
	Sur	(0.07)	(−0.75)	(−2.76)	(0.39)	(−0.70)		

* See text for description of the model and definitions of the variables. Data used are from Tables 9 through 12 for the years 1953–69, yielding 16 observations for each equation (see fn. 18). Levels of significance are indicated as follows: [a] .01; [b] .05; [c] .10.

† Seasonal price rise.

markets, D_d is very significant and bears a much larger coefficient than D_w, as predicted. In Jakarta, for example, a 1 percent decrease in the dry-season rice crop from early season expectations (relative to Q_t^*) augments the normal seasonal price rise by 4.53 percentage points. The R^2 values are higher for P'^a than for P'^b, except in Semarang, indicating the more exclusive influence of D_w and D_d on P'^a than on P'^b.

In Bandung and Surabaya, D_w is more significant when related to P'^a than to P'^b. This may indicate that the actual annual low price, included in P'^b, results from fairly complete information about the wet-season crop. Any rise from this low price, therefore, will not be explained by changes in information regarding the wet crop. In Jakarta, a nonproducing area, D_w has a significant influence on P'^b. This may reflect relatively poor information at the time of the seasonal low price concerning the ultimate availability of wet-season supplies in the Jakarta market. Adjustments resulting from new information result in D_w being more significant on P'^b than on P'^a. This is consistent with the relatively broad distribution of the actual low price month around the index low month in the Jakarta market shown in Table 9.

Equations (2) and (2′) series show, in addition to the rice crops, the influence of dry-season maize production and government stabilization operations, on seasonal price changes. Annual maize yields are a relatively poor proxy for changes in expectations regarding the dry-season maize crop and this may account for some of the weakness in the results. Nevertheless, some information is derived from inclusion of Y_m in the analysis. The expected negative sign is obtained in all markets except Surabaya, which is located in the largest maize producing and consuming province. The positive although insignificant sign obtained in the Surabaya market highlights an important relationship between dry-season maize and rice.

The dry-season price rise and maize yields are simultaneously determined, but in an indirect fashion. The same unusually dry conditions that diminish the dry-season rice crop and cause prices to rise have a favorable effect on maize output and yield. If dry conditions are evident early in the season, some farm land, normally planted to rice, is sown with maize. The larger area under maize as well as the fact that the additional land is more fertile than the hill soils normally reserved for maize influences dry-season output. The dry weather also has a favorable effect on maize yields, unlike its effect on rice. This simultaneity confuses the estimate of maize's influence on seasonal rice prices. The inverse relationship between unexpected maize supplies and rice prices is probably much stronger than indicated here.

Government stabilization operations appear to have some effect on seasonal price movements. The lack of information concerning the timing and magnitude of injections in specific markets and, again, the simultaneous relationship between price changes and injections, impairs the results. Nonetheless, the expected negative sign is obtained in all markets except Semarang. In Jakarta, G is more significant in explaining P'^b than P'^a. Inspection of Table 9 shows that in many years the index high price month comes *before* the actual annual high price in Jakarta. This is consistent with the results here, which show that government stabilization operations have a significant influence on the level of the season peak price, but little influence on price changes occurring prior to the earlier index high month. In the other markets, where the actual annual peak price often occurs prior to the high month in the price index, G is more significant in equations with P'^a than P'^b, suggesting that the price decline from the actual peak price to the price in the index month is influenced by government injections. The actual level of the peak price in these markets, however, is probably less influenced by government operations than is the case in Jakarta. The positive sign on G in Semarang suggests a positive influence of price changes on the decision to release government stocks. The absence of G to help explain P'^a in equation (1) in Semarang probably contributes to the low R^2.

The influence of inflation and world rice prices on P'^a and P'^b was estimated, but the results are not shown in Table 13. In neither case were significant coefficients obtained. (The influence of world prices on domestic rice price formation in Indonesia is discussed more fully in *12*, pp. 56–59.) Although during the period Indonesia was one of the largest importers in the world, she remained isolated from normal world market forces. A large amount of the rice imported by the government agency (currently BULOG) was obtained through intergovernment concessional arrangements and distributed internally via the wage ration. Government regulation forbids the importing of rice through private channels. Though smuggling is, of course, significant, this activity was inhibited throughout much of the period by rampant inflation and uncertainty concerning exchange rates. The results indicate a much greater degree of market isolation than that created by shipping charges.

The estimates presented here are hindered by specification error involving the definition and coverage of variables, the omission of some important factors, and some simultaneity problems. The results, however, clearly document the role of the dry-season crop in seasonal price formation. Interpretations of the estimates of the influence of maize and government injections involve conjecture and are imprecise; nevertheless, they are indicative and provide important insights into the character of seasonal price formation.

6. CONCLUSIONS

The comparison of average seasonal price increases and storage costs is a conventional test of efficiency in the commodity food markets of developing countries. The technique applied here to Indonesian rice markets shows a typical (although not universal) result—over a number of years, *on the average*, seasonal price changes are just sufficient to offset storage costs. While this evidence tends to refute the common charge of exploitation by monopolistic middlemen, it sheds little light on—in fact it camouflages—the chronically unstable seasonal price movements which often characterize these same markets. The charge of exploitation, not borne out by evidence, represents a frustration on the part of producer and consumer fostered by extreme uncertainty about the terms of trade in staple foodstuffs.

Seasonal price movements during a given interval result from a complex of influences. The specific factors that dominate these prices vary between countries and markets. Regardless of environment, intertemporal price theory, particularly the concept of "anticipatory prices," serves as a valuable conceptual framework for generating specific hypotheses and organizing data in the investigation of seasonal price changes.

It is not my intention here to suggest that rice prices in Indonesia are formed on perfectly operating speculative or "anticipatory price" markets. Insufficient credit, unwillingness to assume risk, farmer storage practices, local market corners and other imperfections are all important in Indonesia. I am contending, however, that the formation of and attempt to fulfill expectations through inventory behavior consistent with conventional theory plays a role in Indonesian rice price formation important enough to justify application of an anticipatory price model in an analysis of seasonal price instability. This contention is supported by the seasonal price indices and the estimates of the anticipatory price model presented above.

In the case of Indonesia, the price model focuses attention on the small but volatile dry-season rice crop as a salient factor in the formation of seasonal rice prices. The role of the dry-season maize crop and government stabilization operations was also explored. Although the analysis here concerns only Indonesia, seasonal production instability is, perhaps, the most likely inhibition to efficient speculation in commodity markets in many tropical areas.

The problem of allocating inventories efficiently over one year with two seasonal crops is similar, in theory, to that of allocating supplies over two years with two annual crops.[22] In reality, however, inventory decisions in the face of two seasonal crops are often more difficult than when only one harvest occurs annually. With a given food crop the probability of an important growth variable, such as moisture, falling short of or exceeding a critical threshold level is often greater in one season than the other. Stated formally, the probability distribution of yields associated with a particular crop varies according to season. This is clearly the case with rice in Indonesia.

Understanding the fundamental causes of seasonal price instability does not necessarily imply knowing the remedy. If the presumption prior to this research was that the wet-season crop or total annual rice supplies determined seasonal price movements, then the results here, highlighting the dry-season crop, shed important new light on the source of the problem. Though the difficulty appears to emanate primarily from the dry-season harvest, the investment in water and pest control required to stabilize even this relatively small crop may possibly outweigh the benefits to such a project. Alternatively, a government firmly committed to stabilization may find such investments highly desirable.

Though certainly not a complete solution, an improvement in speculative performance may result from additional, early information in the market concerning prospects for the dry-season crop. Planting of the crop is not complete by the end of July, yet the area planted to rice from May to July is an indication of the size of the forthcoming harvest, particularly in years of early drought when farmers decide to plant a substitute crop rather than rice. The following equation shows the relationship between May-July planted rice area estimates (CBS, unpublished) and the ultimate size of the dry-season harvest, 1953–69. The semilogarithmic function gave the best fit to the data.

$$Q_d = -9581.2 + 1771.6 \log A_d$$
$$(-3.01) \quad (3.62)$$
$$R^2 = .47 \qquad \# \text{ obs. } 17$$

t statistics in parentheses

Allocation of additional resources to the collection and early dissemination of dry-season planted area information may improve both the quality of the estimates and the performance of the market.

[22] For optimal inventory models applied to grain see *13*, *35*, and *36*.

Throughout the period analyzed here, the Indonesian government attempted, with rather limited success, to defend floor and ceiling prices by accumulating stocks in the post-harvest period and injecting rice during the off season (*paceklik*). The dominant position of rice in the Indonesian diet and its role as a wage good suggests there are social benefits to be derived from a viable stabilization program. Whether or not the benefits are sufficient to justify such a program depends on institutional considerations as well as on the opportunity cost of resources employed. The measurement of these benefits and costs is complex and beyond the scope of this research. However, a realistic stabilization policy should reflect the nature of the problem. The results of the study may, therefore, contribute toward defining the proper role of a public storage program in Indonesia.[23]

Some insight into the question is gained by distinguishing two types of storage programs. The operation of a seasonal type buffer stock entails the acquisition of inventory in the early season and injection of grain in the preharvest period in such a way that seasonal prices rise only by the cost of storage and no unplanned stocks are carried into the following market year. Since a competitive, private market with perfect knowledge of supplies during the relevant time interval would, theoretically, achieve the same result, a seasonal buffer stock may be justified by the presence of market inefficiency. The research presented here indicates that volatile rice markets in Indonesia are largely a result of production instability rather than market-place inefficiency. This fact argues against the policy of a seasonal buffer stock. In addition, there is no evidence to suggest that a public storage agency is more competent than the private trade in either predicting the size of the dry-season crop or managing inventories in the face of such a prediction.

The public agency, however, is probably in a better position to undertake the risk and cost of maintaining a contingency type buffer stock. This policy requires the maintenance of a grain stockpile which is injected into the market in defense of a ceiling price. The stock is replenished from foreign sources. Domestic procurement occurs only in the process of supporting a floor price. The size of the stockpile and complexity of the marketing operation depend on the spread between the floor and ceiling intervention prices. One approach, similar to the policy followed by Indonesia, is to project an average price level around which free market prices are expected to fluctuate. The floor and ceiling prices are set around this average such that the spread is equivalent to the seasonal cost of storage. Defending this narrow spread in the face of the seasonal production instability revealed here requires frequent intervention and a large contingency stock. The Indonesian experience with this policy is not encouraging. An alternative to this policy is to stipulate a wider band between floor and ceiling prices. The approach requires a smaller stockpile and less frequent market intervention and, therefore, may result in fewer instances of policy failure and more success in preventing dramatic price instability.

The results of this research are in many respects indicative and preliminary,

[23] This is particularly so now that the era of rampant inflation has, hopefully, passed, and rice stabilization strategy can aim more directly at results of production instability rather than the problems caused by fiscal and monetary excesses. For a history and analysis of Indonesian rice policy see *47*.

and will, hopefully, serve as a guide to further in-depth investigation. A study is required that emphasizes the institutional characteristics of each market, yet that is informed throughout by intertemporal and spatial price theory, similar to recent work in other developing areas (*22, 25, 43*). Information is needed concerning farm inventory decisions with respect to large and small crops; the acquisition of information and formulation of expectations and inventory decisions by the merchant community; the relationship between government stabilization operations and private speculative behavior; and the effect of credit availability on inventory accumulation.

The research presented in this paper confirms the underlying regularities in the Indonesian rice production and price data. The investigation also highlights the need for more published data aggregated at the provincial level and on a seasonal basis. Since the Central Bureau of Statistics already collects the data on this basis, additional effort is required only in preparing it for publication.

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