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Foodgrain Market Integration Under Market Reforms in Egypt

by

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ABSTRACT

Using urban price data for the period 1976 to 1992 and rural price data for the period 1982 to 1992, the study assesses the degree of market integration for wheat, maize and rice. The study finds that i) reforms have not destabilized foodgrain prices; ii) there is some indication that the degree of segmentation among food grain markets has decreased during the reform period, especially for rural wheat and maize markets; iii) urban markets exhibit a much higher degree of market segmentation, particularly for wheat; and iv) the extent of market integration in terms of the magnitude of market interdependence and speed of price transmission was until 1992 very limited. Urban markets seemed to have a lower magnitude of integration than those of rural areas and the speed of adjustment was higher among these markets, reflecting the better communication and infrastructure network in urban areas.

1. INTRODUCTION

Egypt has over the years developed an extensive system of intervention in the foodgrain economy, characterized by a quasi monopoly of state agencies in distribution, processing, and foreign trade operations in the sector. Even though the policy and regulatory environment may have varied slightly across crops and over time, the basic model of intervention has been the following: 1) procurement through local institutions; 2) delivery to public storage and distribution companies; 3) processing through public processing mills; 4) distribution through public marketing and trading agencies.

Realizing the implications of the intervention system for the budget and for sustained growth in the agricultural sector, the Government of Egypt (GOE) initiated a series of reforms since the mid-eighties, in order to eliminate weaknesses in the system and bring the agricultural sector back onto a path of growth. The reform process initiated in 1986 with the lifting of acreage controls in major grains has been later extended to marketing and trade, by removing restrictions to private sector involvement in the distribution of foodgrains and agricultural inputs. Both agricultural input and output markets have witnessed a growth of private sector activity. After a long period characterized by massive government intervention in agricultural markets, a private sector-based distribution system is in the process of emerging.

One of the main objectives of reforming domestic markets is to create an environment within which domestic markets can function efficiently in terms of increased responsiveness of the pricing mechanism and the reduction of costs of operation on local markets. Consequently, the success of market liberalization can be judged by its contribution to cutting domestic costs of distribution and strengthening the mechanism of transmission of price signals among local foodgrain markets. Although only to a limited extent, due to data availability, the cost side of the analysis has been touched upon in the section of the study on the operation of local markets. The present section focuses on the price transmission mechanism across local markets, that is their degree of integration. Improvement in the degree of integration among local foodgrain markets is critical to ensuring a broad-based ramification of the changes in incentives that are expected to come about with the reform process.

The rationale behind the analysis of integration among local foodgrain markets is the need to acquire information about the level of interaction among prices in individual, spatially separated, markets and how that impacts upon the adjustment by local market participants to the adopted reform measures. It is through changes in market signals, such as prices, that adjustment by the multitude of market operators is coordinated. In the context of efficiently operating markets, the level of interaction is maximized to allow adequate adjustments. In the opposite case of segmented markets, prices for the same foodgrain in individual markets would behave independently of each other. Consumers and producers in individual markets are not induced to adjust to changes in the remaining markets.

The preceding remarks indicate the importance of information about market integration in at least two areas of concern with respect to policy reforms in the foodgrain sector. First, improved integration of domestic markets is itself one of the objectives of agricultural policy reforms. Furthermore, the actual level of integration among local markets has implications for the choice of approach to reforming markets and affects the progress and success of the reform process. Information about the level of integration can serve as an indicator of underlying structural and institutional deficiencies, implying the need for complementing and facilitating measures to accompany the implementation of reform measures.

Second, knowledge about the mechanism of price transmission across local markets acquires more importance in the context of liberalized and private-sector-based marketing systems. The withdrawal of the government from the direct operation of markets means that it has to pursue its policy objectives in the food sector through indirect measures, for which the price mechanism is usually a key vehicle. For instance, the objectives of price stabilization and food availability in vulnerable areas implies the need to monitor changes in local markets. Knowledge of the process of cross-market price transmission is a critical input into the design of market monitoring and information systems. It can help identify sets of central markets on which such systems can concentrate and thereby reduce the cost involved and improve their manageability.

Probably due to the long history of public intervention in the distribution system, there are relatively very few studies on foodgrain marketing in Egypt. The most important source of information related to grain marketing in the post 1990 period are the Tranche Reports on the performance of the agricultural policy reform program, sponsored by USAID in collaboration with the Ministry of Agriculture and Land Reclamation (MALR). However, it is useful to complement the analysis of the current private sector response to market reform with an analysis of the performance of markets over long periods of time, including those before the reform process. The general purpose of this part of the study is to analyze the integration of grain markets in Egypt. Its specific objectives are: i) to study the extent of market integration and segmentation, and work out the implication for the initiated reform process; ii) to identify sets of central markets in terms of their leading the process of price formation among local foodgrain markets; iii) to study the process (patterns, magnitude, and speed) of price transmission among local foodgrain markets.

The present part of the study is organized as follows. Section 2 briefly reviews the main features of the foodgrain economy under the process of market reforms. Section 3 analyses the structure of price conduct on major foodgrains before and during reforms. Section 4 applies different techniques to examine the various aspects of integration among foodgrain markets, followed by the summary of findings and conclusions in Section 5.

2. MAIN FEATURES OF EGYPT'S FOOD GRAIN ECONOMY UNDER MARKET REFORMS

Wheat, maize and rice are three important crops for Egypt's agricultural sector (Table 1). Wheat consumption in 1990 accounted for over 1/3 of calories in the average Egyptian diet (USDAa, Appendix table 35, p. 129). Maize is used as feed for livestock and poultry. In 1992 90% of consumption was devoted to feed use. Rice is a high valued product which brings Egypt substantial export revenues. In 1992 it was Egypt's largest export crop in volume and value, with exports accounting for 8% of total production volume (USDAc, p. 27 and USDAa, p. 95). In 1990 about 41% of total cultivated land was devoted to production of these three crops, with wheat and maize each occupying 16% and rice occupying 9% (See Table 1).

Wheat is the major winter crop; it is planted in November and harvested in May. Significant areas of wheat are planted for own-consumption. Wheat products form the basis of the Egyptian diet, particularly in the form of Baladi bread made out of 82% extraction flour. This bread is highly subsidized, although the government plans to lower the subsidies. Wheat is banned from commercial use as feed. The government has been heavily involved in the milling of wheat; many of these regulations have been lifted during the last few years. Farmers sell wheat soon after harvest due to lack of adequate storage facilities and relatively easy access to government payment stations. Demand for free market wheat comes from rural non-farm households for food and feed. In 1987 major reforms liberalizing the production and marketing of wheat were implemented.

Table 1--Supply and utilization of major grains in Egypt

Supply and Utilization in 1992 (tons)	Wheat	Maize	Rice
Production	4617	4500	2600
Imports	6000	1300	0
Exports	0	0	209
Consumption	10617	5800	2391
Feed	700	5220	0
Self-Sufficiency	44%	78%	109%
Percent of Cultivated Area in 1990	16%	16%	9%

Source: USDAa(pp. 81, 91, 95); World Bank (1993, Table 10, p. 116).

Maize is the major summer crop; it is planted in mid-June and harvested in October. A second crop is planted later and harvested in November, but with lower yields. The primary end use of maize is as feed. With local prices for meat, poultry and milk products

high and the presence of restrictions on imports of substitutes, feed demand is enhanced. 85% of livestock is held by small farmers, so that much of the domestic crop is used on farm. In 1991, USDA rough estimates indicate that of the 4.4 million tons produced locally, 1 ton was consumed by humans, 3.3 tons used for feed and seed or wasted, with the remaining 0.4 million tons or 10% marketed (USDAc, p.14). In 1986 marketing and production reforms were implemented for this crop, as well.

Rice is the second largest summer crop; seeds are prepared in May and seedlings transplanted in July, with harvesting occurring through October. While short-grain Japonica yields less than the long-grain Philippini, 85 % of crop is of the Japonica variety since consumers prefer it. Rice uses 18% of water resources. Until recently, more than 2/5 of paddy used to be procured by the government. The bulk of this procured rice is distributed through the Ministry of Supply ration system, although it is no longer subsidized. The remainder of the procurement quantity goes to government coops or private sector outlets and is sold at market prices or exported. The remainder of the crop not procured is retained by farmers for home consumption or sold in the free market. The farm paddy is milled in small, inefficient village stone mills. In 1991, production and marketing of rice was liberalized.

There is evidence of structural change in 1986 for production of each commodity in each governorate, except for the case of Dakhalia for wheat and Cairo for rice. There was a spurt of production around 1986 for all three commodities (see Figure 1). Population grew at a rate of 2.6% in each period (i.e. before and after 1986). Wheat production growth fell short of population growth by a wide margin before 1986, but far exceeded population growth by increasing at a rate of 14.3% during the reform period. Maize production growth fared better, slightly exceeding population growth prior to reforms and exceeding it by a wide margin at a 9.8% growth rate during the reform period. Rice production fell during the pre-reform period and fared almost as well as maize during the reform period, growing 9.4% (see Table 2).

Production inter-year variability, as measured by the standard deviation of percentage deviations of actual production from trend production, was greater during the reform period for both wheat and rice, but was greater during the pre-reform period for maize (see Table 2). The magnitude of variability differed more across commodities during the period of reforms, probably a reflection of government direct intervention through water area quotas.

In order to assess the possible consequences of reforms on the spatial distribution of production, it is useful to examine the pictorial representation of per capita production before 1986, during what might be termed a 'transitional period' between 1986 and 1989, during which reforms affecting only maize and wheat were implemented, and the period between 1990 and 1992 during which wheat, maize and rice reforms were concurrently in effect (See Figures 2.a-2.c).

Table 2--Growth and variability of production wheat, maize and rice.

	Wheat	Maize	Rice
Growth			
1976 to 1992	5.8	3.5	2.2
1976 to 1985	0.3	3.0	-0.02
1986 to 1992	144.3	9.8	9.4
Inter-year Variability			
1976 to 1992	6.1	3.0	44.5
1976 to 1985	5.2	3.9	3.5
1986 to 1992	7.7	1.4	6.0

Source: Computation based on production data from the Central Department of Agricultural Economics and Statistics.

For the case of wheat, all governorates produced 100 kg per capita or less during the pre-reform period. During the transitional phase, Kafr-el Sheikh production exceeded 100 kg per capita, while in the reform period per capita production in Kafr-el Sheikh, Behira, Dakhalia, Sharkia, Fayoum, Beni-Suef, Assyout and Sohag exceeded 100kg per capita.

In the case of maize, Behira, Gharbia, Menoufia, Sharkia, Fayoum, Beni-Suef and Menia produced more than 100 kg per capita during the pre-reform period. During the transitional period Gharbia produced less than 100 kg per capita. But, during the reform period Gharbia recovered to its pre-reform status of producing more than 100 kg per capita. In addition Ismailia and Sohag increased substantially their per capita production during the latter period.

Figure 1--Production of wheat, maize, and rice

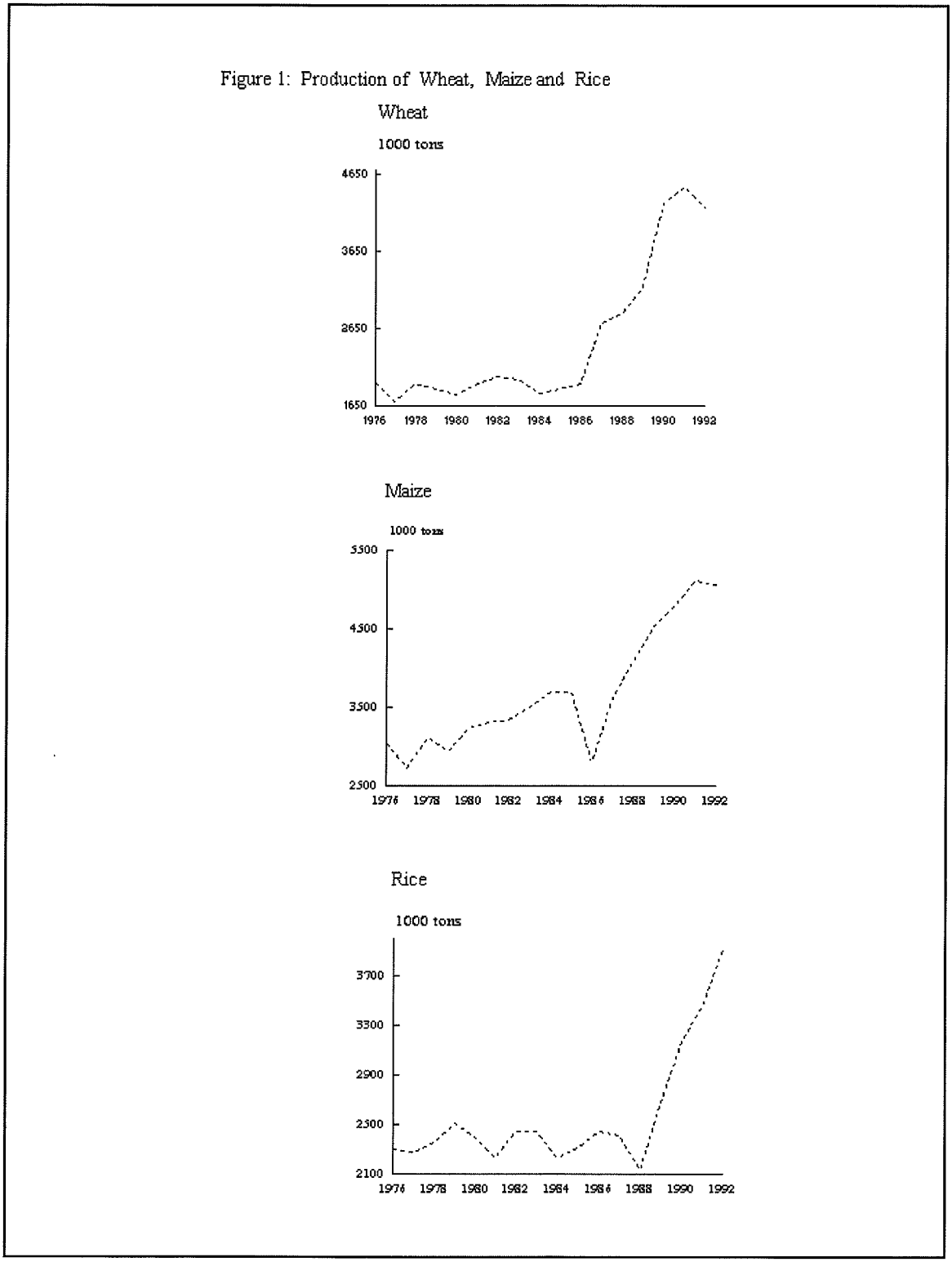
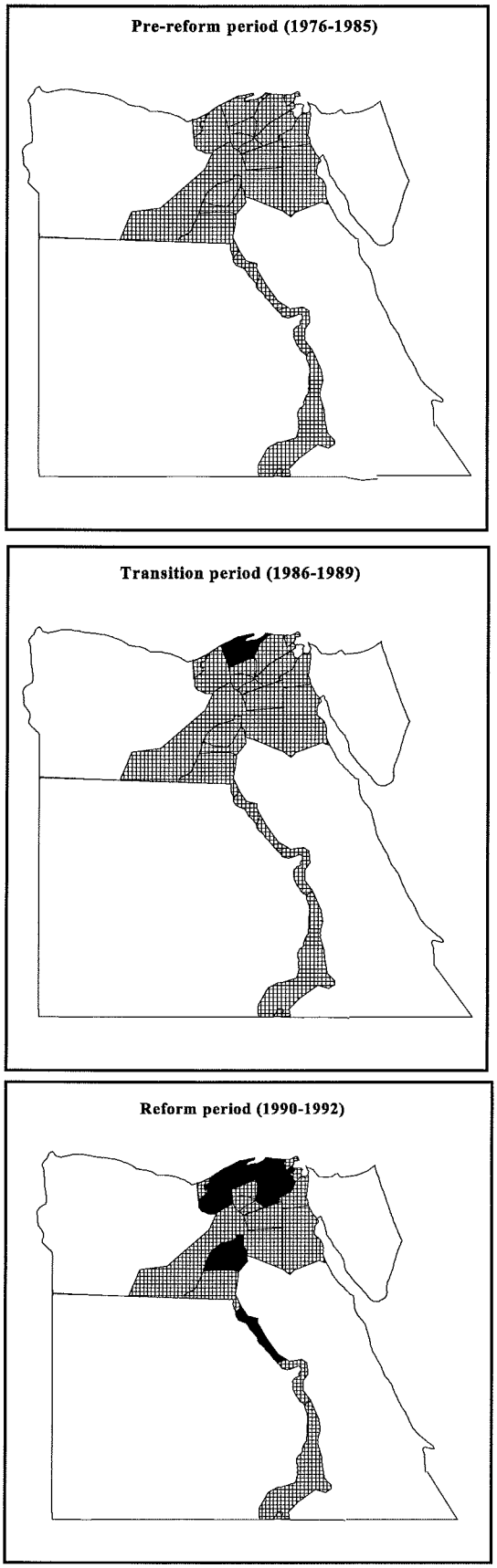
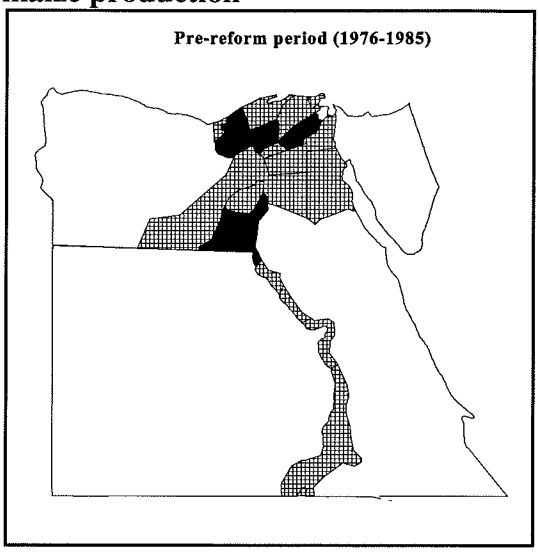


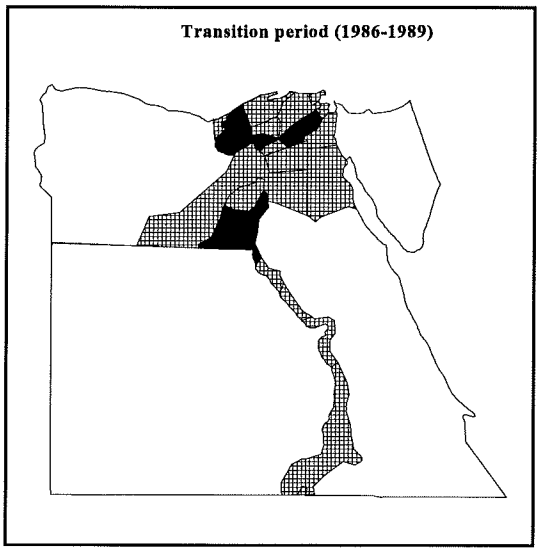
Figure 2.a--Per capita wheat production



Note: Dark regions indicate greater than 100 kg per capita of production

Figure 2.b--Per capita maize production





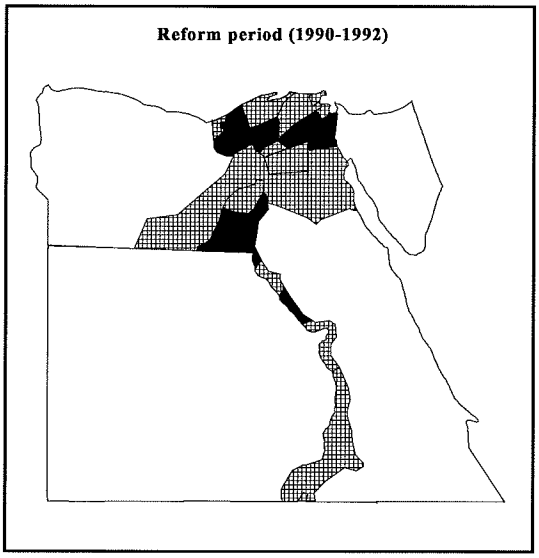
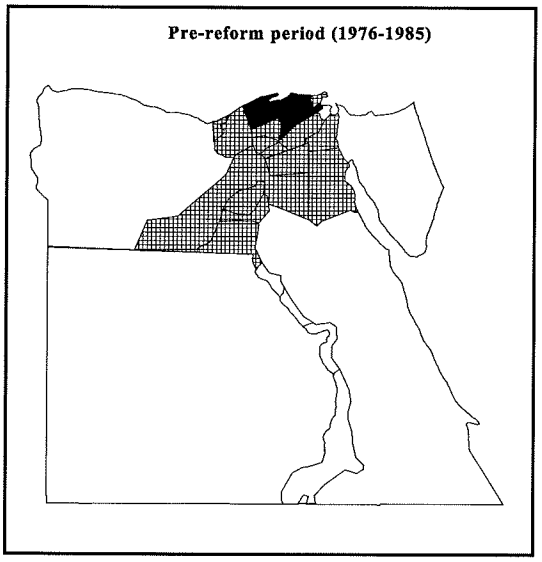
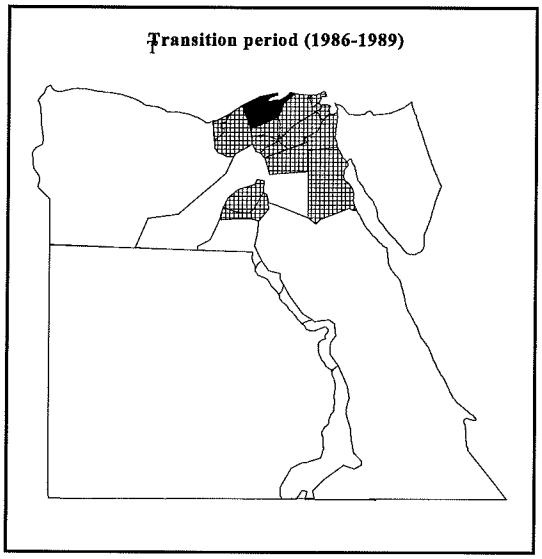
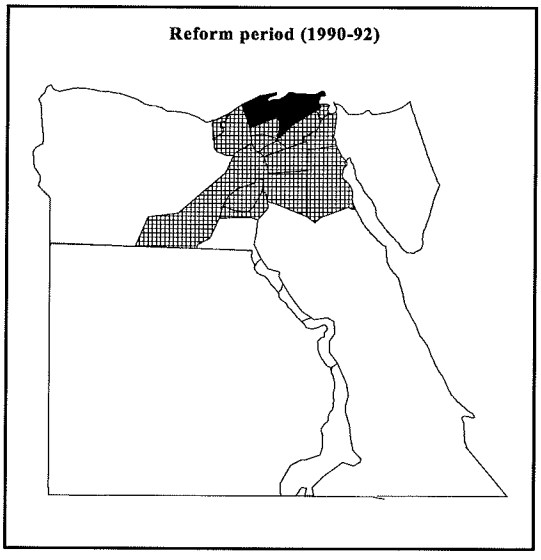


Figure 2.c--Per capita rice production







Note: Dark regions indicate greater than 150 kg per capita of production

Kafr-el Sheikh and Dakhalia out-performed other governorates in rice production during the pre-reform and reform periods. During the transitional phase Kafr-el Sheikh continued to produce more than 150 kg per capita. Assyout, Sohag, Quena and Aswan in Upper Egypt did not produce rice during the period of study; most of the rice production occurs in the Delta region. And, data were missing for some of the rice-producing governorates. Hence, an unshaded region might mean zero production levels of rice as it is for the four Upper Egypt governorates, or data might be missing. Marked improvement in terms or more spatially dispersed production is evident for the case of wheat only.

3. FOODGRAIN PRICE CONDUCT BEFORE AND AFTER REFORMS

The data used in the analysis of foodgrain price conduct are: monthly aggregate wholesale prices for January 1976 to December 1992; monthly governorate-level retail prices from 21 urban markets from January 1976 to December 1992; bi-monthly governorate-level retail prices from 16 rural markets for January 1982 to December 1992[1]. For urban (governorate capital) prices, data were obtained from one or more sources to reflect different socioeconomic levels within each governorate capital. For rural prices, data were collected from three to four villages within three districts for each governorate.

In order to asses the impact of various policy changes introduced after 1986, it is useful to examine the period before reform (before 1986) and the period during which reforms have been taking place (1986 to 1992). Reforms targeted at maize and wheat began in 1986 and 1987, respectively. And, reforms targeting rice began in 1991.

Wholesale Prices. Real growth for wholesale prices of wheat was 9.5% during the first period (see Table 3), and during the second period these prices rose 2.9% (nominal growth rate minus the relevant CPI growth rate). Similarly, for maize real wholesale price growth was 0.6 percent for the first period, and fell 4.2 during the second period. For rice, prices fell in real terms, by 0.1% during the first period and 4.5% during the second period (see Table 3).

Inter-year variability of wholesale prices, as measured by the standard deviation of percentage deviations of actual price from trend, was greater during the first period for all commodities. Intra-year variability of wholesale prices, as measured by the average within-year coefficient of variation, was also greater during period one for wheat and maize, but greater in period two for rice.

Retail Prices. Rural retail prices for all three commodities fell in real terms during period two. For wheat and maize real growth was positive during period one, while for rice inflation exceeded rural retail price growth. Both inter-year and intra-year variability were greater in period one over period two, except for the case of rice for which period 2 inter-year variability exceeded that of period one (see Table 3).

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[1] The data were obtained by MALR from the Central Agency for Public Mobilization and Statistics (CAPMAS).

Table 3--Growth and variability of prices for wheat, maize and rice

	Wheat	Maize	Rice
	Wholesale Price		
Growth			
overall	17.8	16.2	19.0
period 1	24.0	14.7	16.2
period 2	21.0	14.2	9.1
Inter-year Variability			
overall	21.2	15.9	162.5
period 1	23.9	18.4	171.2
period 2	14.1	11.4	244.2
Intra-year Variability			
overall	7.3	7.5	6.0
period 1	8.0	8.7	44.7
period 2	6.0	5.7	144.6
	Urban Retail Prices		
Growth			
overall	19.3	15.5	--
period 1	20.6	17.7	--
period 2	19.1	13.2	--
Inter-year Variability			
overall	70.0	51.0	--
period 1	80.0	54.5	--
period 2	55.1	59.5	--
Intra-year Variability			
overall	9.3	8.0	--
period 1	9.5	8.6	--
period 2	9.1	7.6	--
	Rural Retail Prices		
Growth			
overall	19.3	16.2	18.4
period 1	21.9	17.4	11.6
period 2	17.9	144.5	11.1
Inter-year Variability			
overall	69.2	42.7	59.0
period 1	82.7	48.5	35.7
period 2	50.0	45.0	45.2
Intra-year Variability			
overall	8.0	7.5	7.8
period 1	9.3	8.8	8.9
period 2	6.8	6.7	2.6
	CPI Growth Rates		
Overall	16.5	16.5	16.5
period 1	14.5	14.1	16.1
period 2	18.1	18.4	13.6

Note: Periods one and two refer to pre-reform and reform periods. These periods differ for each commodity. For wheat, reforms were first instituted in 1987, for maize reforms began in 1986 and for rice major reforms began in 1991. For wheat, period 1 is 1976-1986 and period 2 is 1987-1992. For maize, period 1 is 1976-1985 and period 2 is 1986-1992. For rice, period 1 is 1976-1990 and period 2 is 1991-1992.

Urban retail prices grew faster than the inflation rate (as measured by changes in the CPI) in period one. In period two wheat retail price growth exceeded the inflation rate, while that of maize fell short of the inflation rate. For both commodities intra-year variability was greater in period one. Inter-year variability was greater in period one for wheat and in period two for maize (see Table 3).

Hence, in the reform period price growth fell short of the rise in general prices as measured by the CPI. Within- and between-year variability, however, was less during the reform period, with a few exceptions, especially for rice. Within-year variability does not differ greatly between wholesale and retail prices. Except for rice wholesale prices, retail price between-year variability is greater than wholesale price between-year variability. Additionally, urban-rural retail price margins were roughly 13% in each period for wheat, and 13% in the first period for maize, falling to 3% during the second period.

Seasonality. Indicators of the seasonal patterns of wholesale and retail prices are reported in Table 4 and 5. Indicators are calculated using the X-11 method so that the computed ranges designate the average percentage point difference between the maximum and minimum values of the calculated seasonal component of prices. The figures for wholesale prices show some seasonal pattern for all three commodities. The low in prices occurs in September for wheat (for which harvest occurs in May), and in November for maize (for which harvest occurs in October), and in September during the post-reform period only for rice (for which harvest occurs in October). For rice, the range (difference between maximum and minimum values) of the seasonal indices triples from period one to period two.

The indicators for urban and rural retail prices computed for four governorates are chosen. Karf-el Sheikh, Behira, Beni-Suef and Sohag (the first two being in lower Egypt, while the latter two are in upper Egypt). Kafr-el Sheikh and Behira are important rice producing governorates, while Beni-Suef and Behira are prominent for maize.

Table 4--Seasonality patterns for aggregate wholesale prices

	Wheat		Maize		Rice	
	Period I	Period II	Period I	Period II	Period I	Period II
Max	Mar	Apr	Jul	Apr	Dec	Mar
Min	Sep	Sep	Nov	Nov	Jun	Sep
Range	8.6	8.6	9.2	8.3	6.0	18.0

Note: For each governorate the min month, the max month, and the range of the seasonality index is given for period one (before 1986) in the first column and period two (1986 to 1992) in the second column.

Table 5--Seasonality patterns for retail prices

	WHEAT								MAIZE								RICE							
	Kafr-el Sheikh		Behira		Beni-Suef		Sohag		Kafr-el Sheikh		Behira		Beni-Suef		Sohag		Kafr-el Sheikh		Behira		Beni-Suef		Sohag	
Period:	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
									RURAL PRICES															
Max	Mar	May	May	Apr	Mar	Jul	Mar	Apr	Jul	Jul	May	Apr	Jul	Jul	Sep	Apr								
Min	Sep	Jan	Aug	Aug	Oct	Feb	Nov	Feb	Nov	Mar	Oct	Dec	Sep	Jan	Dec	Dec								
Range	9.7	21.8	14.4	18.2	9.0	13.1	9.5	10.6	10.6	9.5	11.7	11.9	I.5	8.6	5.1	7.8								
									URBAN PRICES															
Max	Mar	Apr	May	Apr	Apr	Apr	Mar	Mar	May	May	May	May	Sep	Aug	May	May	Jan	Jun	Dec	Apr	Jan	Jul	Apr	Mar
Min	Oct	Dec	Jul	Jan	Aug	Sep	Jan	Nov	Sep	Jan	Nov	Dec	Feb	Dec	Jan	Jan	Mar	Nov	Jul	Jan	Sep	Jan	Nov	Sep
Range	13.3	8.3	39.0	8.0	18.3	7.9	8.5	9.1	16.1	9.2	14.4	8.4	20.0	6.9	14.2	11.2	I.1	6.5	9.1	9.1	6.2	5.3	15.8	7.2

Note: For each governorate the min month, the max month, and the range of the seasonality index is given for period one (before 1986) in the first column and period two (1986 to 1992) in the second column.

Urban retail prices do not exhibit any clear seasonal patterns. The seasonal index range is consistently higher in period one than in period two for wheat and maize rural retail prices, consistent with the finding of higher intra-year variability in period one. Rural retail prices do exhibit clearer seasonal patterns, but prices do not drop to a minimum immediately after harvest, as expected for producer prices (Goetz and Weber, p. 71).

The index range for most wheat and maize urban retail prices are higher in period two than period one, while the index range for rural retail prices for these two commodities is higher in period one. Hence, seasonality (as measured by the range) increases for urban retail prices, but decreases for rural retail prices, for wheat and maize. The differing trends in seasonality may reflect the freeing of urban markets during the reform period, which allows adjustments to changes in supply conditions and makes them more volatile. In contrast, the elimination of restrictions on local trading raises foodgrain mobility and dampens volatility in rural foodgrain markets.

The absence of clear and expected seasonal patterns may be due to one or several factors. It may be that the lag observed in seasonal lows is due to the fact that prices higher up in the marketing chain are analyzed here. The data may be poor. Or, it may be that in fact prices are not reflecting true scarcity. In fact, informal reports indicate that very little maize is marketed, and wheat is sold soon after harvest. Data on the seasonal distribution of marketed quantities being unavailable, it is difficult to reconcile the observed seasonal price index patterns with the crop and marketing cycle.

Price Margins. A quick way to understand how governorate prices are related to each other is to study their margins and their behavior over time. Two measures are proposed here. The first is the percentage difference between maximum and minimum governorate price at each point in time. This difference is related to transportation and other intermediation costs, but may also be affected by price policy that keeps prices in some governorates artificially low. By taking averages over the two periods, before and after 1986, one can detect a declining trend both in urban and rural areas, implying that the extreme price deviations are reduced (see Table 6). It is difficult to find out the extent to which this is induced by an eventual increase in the degree of market integration after liberalization or by the removal of price controls by the government.

The second measure of the relationship between governorate prices relates to the degree of variability between these prices as indicated by the coefficient of variation reported in Table 6. The figures indicate that spatial variability among governorate prices is decreasing after liberalization; however, the evidence is not very strong, except in the case of rice. The fact that prices are closer to each other after liberalization is suggestive of more integration, but this is not yet conclusive of greater transmission of price signals among governorates. In order to explore this issue, the degree of market integration needs to be examined more systematically.

4. EXTENT OF MARKET INTEGRATION AMONG MAJOR FOODGRAIN MARKETS IN EGYPT

The traditional tests of market integration have focused on correlation coefficients of spatial prices (see Lele 1971 for India, Farruk 1970 for Bangladesh, Jones 1972 for Nigeria). However, correlation coefficients mask the presence of other synchronous factors, such as general price inflation, seasonality, population growth, procurement policy, etc. Early criticism of this approach has been advanced by Blyn 1973, Harriss 1979, and Timmer 1974. More recently, contributions by Boyd and Brorsen 1986, Delgado 1986, and Ravallion 1986 have introduced time series methods in the study of market integration. Issues such as seasonality, the degree of market

Table 6--Margins and variability among governorate prices

	Period 1		Period 2	
Commodity prices	Margin btwn. Max and Min Governorate prices	Coefficient of Variation of governorate prices	Margin btwn. Max and Min Governorate prices	Coefficient of Variation of Governorate
Wheat Urban	134.6	23.6	112.4	21.1
Maize Urban	74.6	14.9	68.8	14.5
Wheat Rural	54.0	13.0	43.4	10.2
Maize Rural	48.3	11.1	35.3	8.9
Rice Rural	160.8	26.4	81.2	15.5

Note: Period 1 refers to the period period 1986 and Period 2 to the period since 1986.

integration, and the short versus long run adjustment process of prices could be precisely formulated. Further extensions of the time series methods, using ARCH methods (see Engle 1982) have been studied by Mendoza and Rosegrant 1991; a parallel line of research has introduced cointegration techniques to study long term relations between non-stationary price series (see Engle and Granger 1987, Ardeni 1989, Palaskas and Harriss 1991, Wyeth 1992, Goodwin and Schroeder 1991, Goletti and Babu 1993). More recently, the analysis of market integration has moved from a purely time series approach to an attempt to understand the underlying structural factors responsible for market integration (see Goletti, Ahmed, Naser 1993).

In what follows, alternative techniques of analyzing market integration are applied to urban and rural foodgrain prices to study the quality of price transmission between local markets.

Correlation Analysis of Foodgrain Markets. One simple way to study market integration is to consider correlation of price series between different markets. This is intuitively related to the idea that integrated markets exhibit prices that move together, and inter-market price correlations are the easiest way to measure these co-movements. However, tests of market integration that are based on correlation coefficients of local prices mask the presence of other synchronous factors, such as general price inflation, seasonality, population growth, procurement policy, etc[2]. This problem can be overcome by computing correlation coefficients based on price first differences. This has the added benefit of expressing market integration in terms of the interdependence between price changes in individual foodgrain markets. Moreover, price first differences would largely eliminate the technical problems related to spurious correlation arising from the presence of common trends.

The above technique was applied to retail price series of individual foodgrains in different governorates to estimate the extent to which price movements in these markets are interrelated[3]. The obtained results are reported in Tables 7 and 8. The higher the estimated coefficient, the stronger the relationship between the prices in the considered markets tends to be. The estimated coefficients are in general higher for rural retail prices than for urban retail prices.

Moreover, the coefficients tend to be higher in the post-reform period. The majority of correlations rose in period two over period one for rural retail prices in particular (see Tables 7 and 8).

Table 7--Average correlation of price first differences (percent)

	Wheat	Maize	Rice
		Urban Retail Prices	
period 1	9	8	--
period 2	12	9	--
		Rural Retail Prices	
period 1	18	10	24
period 2	48	40	11

Note: Period 1 and Period 2 definitions are specific to each commodity. See note Table 3.

[2] See criticism of this approach in Blyn 1973, Harriss 1979, and Timmer 1974.

[3] Wholesale prices are not available at governorate levels, so that analysis had to be restricted to retail prices.

Table 8--Percentage of period two correlations higher than period 1 correlations

Wheat	Maize	Rice
	Urban Retail Prices	
57	54	--
	Rural Retail Prices	
79	79	40

Note: Period 1 and Period 2 definitions are specific to each commodity. See note Table 3.

Correlations for urban retail wheat prices are generally weak, meaning a lower level of integration between urban markets for that crop. The coefficients, however, increased somewhat during the second period. The unreported estimates of the coefficient of correlation for individual pairs of markets showed a certain degree of disconnection among urban markets. This was particularly the case among the major urban centers Cairo, Alexandria and Port Said, for which obtained coefficients were negative.

Generally, the estimates for the coefficient of correlation for rural retail prices were higher than those for urban retail prices. Furthermore, the number of negative correlations among rural prices is much larger in the first period than in the second period. All negative correlations during the latter period were, however, exhibited by markets in the Aswan region.

In the case of maize, correlations of urban retail prices were quite weak during the first and second periods. Correlations for rural prices were somewhat higher than their urban counterparts, and they increased during the second period. For rural prices, most negative correlations in the first period were exhibited by markets in Giza, Beni-Suef, Assyout, Sohag, Quena and Aswan. In the second period there were fewer negative correlations for rural prices, with most being exhibited by Giza and Aswan.

Finally, coefficients for rural retail prices for rice were generally higher for the Delta governorates. In the first period most negative correlations were observed among markets in Ismailia, Assyout, Sohag, Quena and Aswan. In the second period negative correlations were found around Giza, Assyout, Sohag, Quena and Aswan governorates.

In summary, there seems to be a much stronger degree of interdependence between prices in rural markets than between urban markets. In addition, the situation for rural markets seems to have improved during the reform period. The negative correlations evidenced mostly among Upper Egypt governorates for rural prices and among major cities for wheat suggest a certain degree of segmentation among these markets. There is, however, some indication that the degree of market interdependence is increasing during the reform period, even though the impact seems to be much greater in rural than urban areas.

The correlation analysis conducted above gives an intuitive idea of price co-movement among foodgrain markets. However, even if seasonal and trend effects are eliminated in the estimation procedure, there is still the possibility that the degree of interdependence evidenced using the coefficient of correlation does not have any systematic long term validity. But, it is that long term relationship between local market prices that is of greater interest in the analysis of market conduct. The dynamic dimension of the interdependence between prices in local foodgrain markets can be captured through the cointegration analysis carried out in the next section.

Cointegration Analysis of Foodgrain Markets. The long term co-movement of prices gives a better indication of the degree of market integration than the mere interdependence evidenced through the correlation of price series. The cointegration techniques adopted in this section allows a detailed study of these co-movements. The first issue to be investigated with this approach is related to the degree of *segmentation* of markets. This case would occur if price movements in individual markets are completely irrelevant for making forecasts of price movements in other markets. In reality, however, markets for the same commodity are rarely segmented. Of more importance is, therefore, the stability of the relationships among prices in different localities rather than its mere existence. Prices move from time to time, and their margins are subject to various shocks, that may drive them apart. If, over time, a constant linear relationship can be established between local prices, then they are said to be *cointegrated*, and the level of cointegration between the prices series gives the extent to which the considered markets are integrated with each other.

The main interest of studying price integration among local foodgrain markets is to be able to identify sets of markets that lead other markets in the price transmission process. If two markets, A and B, are cointegrated, then there must be some sort of "causality" running from one market to the other. The concept of causality here is to be interpreted with the limited meaning of past movements in the prices in one (set of) market(s) contributing to the predictability of prices in other markets. If the causation is unidirectional, then, technically, past prices in one market can be used to forecast the prices in the other market (the principle of Granger causality)[4]. If the analysis can identify a market, whose prices can be used to systematically predict prices in the remaining markets, then that specific market is considered a *central* market[5].

Examining the degree of market integration between any pair of markets i and j, is to test whether or not there is any systematic relationship between the price series of the two markets. This can be done by estimating a linear relation of the type[6]

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[4] See Granger (1969).

[5] See Ravallion (1987) for the implication of cases where there is only one central market affect prices in other markets, leading to a radial model of price transmission.

[6] See Palaskas and Harris 1991, Goodwin and Scroeder 1991, Ardeni 1989.

$$p_{i,t} = \alpha + \beta \cdot p_{j,t} + u_t \qquad [1]$$

where p_{it} denotes the price at time t and at location i of a given foodgrain crop.The coefficients α and β are parameters to be estimated, and u_t is an error term.

Since the price series are generally nonstationary, this relation has interest only if the error term u_t is stationary, implying a stable pattern in the relationship between changes in the price of market i and changes in the price of market j. When this occurs, the two series are said to be cointegrated.

The two-step estimation procedure proposed by Engle and Granger (1987) is applied to urban and rural foodgrain prices in individual governorates to evaluate the stability of the patterns of price relationships among local markets. In the first step, price series in individual urban and rural markets are tested separately for the order of econometric integration, that is for the number of times each series needs to be differenced before transforming it into a stationary series. The test for integration for that purpose is the Augmented Dickey Fuller test (Dickey and Fuller 1979). In the second step, the residual u_t of the OLS regression [1] between a given pair of local foodgrain price series is in turn tested for stationarity, using the same Augmented Dickey Fuller test method, but this time to establish the stability of the patterns of the relationship between the two series. The presence of cointegration between two price series is indicative of interdependence between their respective markets. In other words, the presence of cointegration is indicative of non-segmentation between a considered pair of foodgrain markets.

Once the presence of cointegration between two foodgrain price series is established, then the relationship between the two series can be represented as an Error Correction Mechanism (ECM), as follows:[7]

$$\Delta p_{i,t} = \gamma_0^i + \gamma_1^i p_{i,t-1} + \gamma_2^i p_{j,t-1} + \sum_{k=1}^{k=m_i} \delta_k^i \Delta p_{i,t-k} + \sum_{h=0}^{h=n_i} \phi_h^i \Delta p_{j,t-h} \qquad [2]$$

where Δ is the difference operator; m_i and n_i are the number of lags; and the γ's, δ's, and φ's are parameters to be estimated. Causality from market j to market i can then be tested as follows:

$$H_0: \quad \gamma_2^i \neq 0, \ \varphi_h^i = 0, \ h = 1,2,..., n_i$$

The above test can be used to establish the existence of a *central market*, defined as a market whose prices have a one-way influence on prices in other markets. A weaker version of centrality would involve causation within a certain region, so that a *regional*

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[7] See Engle and Granger (1987).

center can be defined, consisting of a market whose prices affect prices in all markets within that region without being affected by them.

The model described above has been applied to monthly governorate prices of grains (wheat, maize, and rice) in urban and retail markets and bimonthly prices in rural markets. The period covered by the analysis goes from January 1976 to December 1992 for urban prices and January 1982 to December 1992 for rural prices. The results of the integration test for all samples has shown that the series are non stationary, with their order of integration being equal to one. Cointegration tests highlight that most of these markets have a stable long term relationship over the period of analysis.

The link between two foodgrain markets is considered segmented, if price series between the two markets are not cointegrated in any direction (neither from i to j nor from j to i). Accordingly, cointegration analysis is used to analyze the number of segmented links among Egypt's foodgrain markets. As pointed out by Table 9, the number of segmented markets is negligible for maize, both urban and rural, and for wheat rural markets. They show that the number of segmented markets is negligible for both urban and rural maize markets and for rural wheat markets as well. Urban wheat markets, in contrast, show a 7 percent share of segmented market links. The detailed, governorate-level, results reveal that mainly Port Said and Suez are responsible for the observed segmentation of urban wheat markets. Rice rural markets, on the other hand, show a proportion of segmented market links of more than 12 percent. This reflects mainly the segmentation of foodgrain markets between Upper and Lower Egypt.

Table 9--Segmented market links

	All Periods		Period 1		Period 2	
Commodity	Number of Segmented Market Links	Percentage of Segmented Market Links	Number of Segmented Market Links	Percentage of Segmented Market Links	Number of Segmented Market Links	Percentage of Segmented Market Links
Wheat Urban	36	18	57	15	48	12.6
Maize Urban	12	5.7	103	27.1	21	5.5
Wheat Rural	1	0.4	19	7.9	2	0.8
Maize Rural	3	1.3	5	2.1	2	0.8
Rice Rural	29	12	26	10.8	58	24.2

Note: Period 1 refers to the period before 1986 and Period 2 to the period since 1986.

The analysis of segmentation can be used to find out the extent to which the ongoing program of market reforms has affected the level of integration among local foodgrain

markets. By carrying out the segmentation analysis over each subperiod, before and after 1986, evidence is found of a tendency towards increasing levels of integration for wheat and maize, as the number of segmented markets decreases in the second period (see Table 9). It is also interesting to note that for these two commodities urban markets look less integrated than rural markets. For rice, the data available are those for rural retail markets. Surprisingly, in the liberalization period the number of segmented markets has increased. This result may be due to the late liberalization of rice relative to wheat and maize. Whereas wheat and maize marketing were already liberalized in 1987, reforms have been extended to the rice sector only in 1991, so that the analysis covers only the first full year of the reform process in that sector.

For the purpose of identifying central foodgrain markets, the causality test discussed earlier has been computed for all pairs of intergovernorate markets. Given the unavailability of price data for urban rice markets, the computations are restricted to maize and wheat. It appears that Alexandria, Damietta, Kalioubia, and Giza are the most important regional centers, in terms of leading the mechanism of price formation in the case of wheat. In the case of maize, regional market centers are located around Alexandria, Damietta, Kalioubia, Kafr el Sheikh, Behira, Menia, and Aswan. It may seem surprising that Cairo is not a regional center for either wheat or maize. This may be explained by the proximity to Cairo of both urban Kalioubia and Giza markets. The centrality of the above markets indicates that future eventual market monitoring programs could focus on price developments in these markets to efficiently predict the conduct prices and market adjustment processes within the foodgrain economy.

Cointegration analysis is a powerful tool to give a clear answer about the existence or not of a systematic relationship between two economic time series. However, it has two major weaknesses that need to be compensated for, in order to make it useful for market integration analysis for policy making purposes. In other words, the cointegration analysis is not able to say anything about: i) the strength of the relationship between the price series of the considered pair of markets; ii) the length of time it takes for a shock to be transmitted from one market to another; and iii) the symmetry of transmission of upward and downward price changes.

Dynamic Adjustment among Foodgrain Markets. Besides the mere existence of long term market interpendence and knowledge of the poles of market influence, it may be important for food policy purposes to have an idea of the *magnitude* of the interdependence and the *speed* with which changes in the price system are transmitted across individual markets. This additional information allows a better interpretation of changes in central markets in terms of their implications for price behavior in distant markets. Having exact information on the nature of intermarket relationships also contributes to improving the design and implementation of future foodgrain market related programs, such as market stabilization policies, floor pricing, market information systems, planning of food security reserves, etc.

In the preceding section, market segmentation has been described by the absence of cointegration. *Perfect integration*, in contrast, would occur if the price in one market is an exact translation of the price in another market, implying that price changes are fully transmitted between the two markets. The transmission factor can, in fact, in this case be interpreted as an indicator of transfer costs between the two markets. In reality, however, perfect integration or segmentation are only extreme cases, with intermediate degrees of integration being the normal situation. The main issue becomes then the measurement of the *magnitude* of intermarket price transmission. This will be done by applying autoregressive techniques to local foodgrain price series to yield dynamic multipliers which are used to measure the transmission of price changes.

In the process of intermarket price transmission, the impact of immediate shocks should be distinguished from their cumulative impact, which builds up over time. This is because the process of price transmission usually takes time, involving complex dynamic adjustments among individual markets. The analysis of the price adjustment process over time using the convergence of dynamic multipliers allows a study of the *speed* of price transmission, that is the number of days, weeks, or months it takes, for changes in prices in one subset of domestic foodgrain markets to be transmitted fully or partially to another subset of markets. In addition to the magnitude of price transmission, this information is key to understanding the operation of local markets and can be useful in the design of stabilization programs or market monitoring and information systems.

Normally, the speed of cross-market price responses is determined by the efficiency of the distribution system and of the structural characteristics of local markets. Rapid adjustments would reflect sufficient flexibility and responsiveness of the domestic market mechanism. Furthermore, given the magnitude of price adjustment between two markets, then the better integrated a given pair of markets, the lower the amount of time it takes for the two markets to complete the adjustment to induced price shocks. Accordingly, an indicator of the actual extent of market integration will be used, which combines the magnitude and speed dimensions of the adjustment process. For that purpose the ratio between the estimated coefficients for the magnitude and speed of transmission is computed and normalized betweeen 0 and 1. The values 0 and 1 designate, respectively, the extreme cases of total segmentation and full market integration.

The actual estimation applies autoregressive processes to foodgrain prices across governorates to obtain indicators for the magnitude and speed of the price transmission process across these markets. First differences of logarithms of individual foodgrain prices are used in the estimation because they can be directly interpreted as price percentage changes. The estimated coefficients of the autoregressive process in this case measure how price changes in one set of markets are related to price changes in another subset. For every pair of market locations i and j, the following bivariate autoregressive process is estimated:

$$p_{i,t} = \sum_{k=1}^{k=m_i} \alpha_{i,k}\, p_{i,t-k} + \sum_{h=0}^{h=n_i} \beta_{i,h}\, p_{j,t-h} + X_{i,t}\, \gamma_i + \epsilon_{i,t} \qquad [3]$$

where $p_{i,t}$ is the percentage change of the price of a given foodgrain in market i at time t, and $p_{j,t}$ the percentage change of the price for the same foodgrain in market j at time t. X_{it} denotes exogenous variables such as seasonal dummies and time trend, and m_i and n_i are the number of lags in the estimation. The $\alpha_{i,k}$, $\beta_{i,h}$, and γ_i are the coefficients to be estimated, and $\varepsilon_{i,t}$ the usual error term.

Technically, problems of simultaneity may be encountered in the estimation, related to the use of contemporaneous prices in markets i and j. Since prices in any given pair of markets may be affected by the same type of shocks concomitantly, the error term $\varepsilon_{i,t}$ is expected to be correlated with the percentage price change variable $p_{j,t}$. To overcome this problem, an instrumental variables estimation of $p_{j,t}$ has been used, taking lagged values of the prices of all markets included in the study. The three lags, one for prices in market i, one for prices in market j, and one for the instrumental variables, are determined simultaneously by application of the Akaike information criterion (see Akaike 1969). Following Mendoza and Farris (1992), the error term of equation [3] is modelled as an autoregressive conditional heteroskedasticity (ARCH) process (see Engle 1982). The ARCH model specifies the contemporaneous conditional variance as a function of past squared residuals. This specification captures the volatility clustering characteristics of price time series, i.e. the tendency of large residuals to be followed by large residuals and small residuals by small ones. In this case, the error term $\varepsilon_{i,t}$ is shown to be normally distributed with zero mean and variance h_t, where h_t is given by

$$h_t = a_0 + \sum_{k=1}^{p} a_k \varepsilon_{i,t-k}^2, \quad a_k \geq 0, \quad k=0,1,\ldots,p \qquad [4]$$

As pointed out earlier, an indicator that combines both the magnitude and speed of price adjustment is used to measure the actual degree of integration among foodgrain markets. The *magnitude* of price adjustment is estimated using average dynamic multipliers based on [3]. The dynamics of the adjustment process involves a series of interim multipliers, as initial shocks fluctuate to converge and bring the system to a steady state. In the context of the model introduced in [3], the cumulative effect of a shock to the price of a given foodgrain in market j on the price of the same foodgrain in market i, after k periods can be computed as:

$$\mu_k^{i,j} = \sum_{h=0}^{k} \frac{\partial E[p_i(t+h)]}{\partial p_j(t)} \qquad [5]$$

The full adjustment of the dynamic process described by the model is given by the long run dynamic multiplier, which corresponds to

$$\mu^{i,j}_{\infty} = \lim_{k\to\infty} \mu^{i,j}_{k} \qquad [6]$$

Accordingly, the *speed* of price transmission can be calculated as explained in the footnote to Table 9, by computing the time that it takes for the intermediate multipliers to converge within a certain range of the long run multiplier given by [6].

The results of the estimations are presented in Table 10[8]. The first row contains the percentage of individual foodgrain markets with significant long term multipliers, that is which show some degree of price interdependence. The higher the coefficients, the higher the frequency of interconnected markets. The second and third rows give the average values and the standard deviations of multipliers for markets of individual foodgrains. The figures indicate the magnitude of integration within each given category of markets. The higher the numbers in the second row, the greater the intensity of interdependence among the corresponding markets. The fourth and fifth rows contain the indicators of the speed of transmission of price changes across individual foodgrain markets. The longer it takes for price changes to be transmitted, the higher will be the coefficient in the fourth row. Finally, the last row presents the combined indicator of market integration which is computed as the ratio between the figures in rows two and four. The higher the intensity of intermarket transmission and the faster the transmission takes place, the better integrated are the considered foodgrain markets and, therefore, the higher the coefficients in the last row.

An overview of the individual results reveals a few interesting things[9]. First, rural grain markets in Egypt appear to transmit prices to a higher degree than urban markets, as highlighted by the higher values of the average long run multipliers. For wheat, the contrast between urban and rural markets is very striking. Whereas on average rural market prices in the long run adjust to about 68 percent of initial shocks originating in other markets, the adjustment for urban markets is only 35 percent. However, prices in rural markets take more time to adjust than those in urban markets. Rural maize markets, for example, need two months more than urban markets. Rural grain markets seem to react more virulently than urban markets because they are more closely linked with production factors than urban markets. However, urban markets transmit information more rapidly, presumably because of better infrastructure and communication.

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[8] In carrying out the estimations, trend effects were not detected, however, seasonal effects were detectable for all pairs of markets and ARCH effects were present for several market links.

[9] The reforms have not been introduced long enough to allow for sufficient degrees of freedom in carrying the estimations for the post-reform periods. The estimations are, therefore, carried out for the entire period under investigation.

The overall assessment of market integration of rural versus urban markets is rather complex. The combined indicator that takes both the extent of price transmission and the speed of adjustment into consideration, suggest that, overall, rural foodgrain markets are better integrated than urban markets, despite better market and information infrastructure among the latter. The difference may be explained by the higher level of private sector participation in rural markets and the higher level of control of price movements and foodgrain distribution activities in urban markets. In any case, the results indicate two main problems in terms of slow flow of price information among rural foodgrain markets (low adjustment speed) and rigidity in urban price structures (low adjustment magnitude).

Second, the variability of both average long term multipliers and adjustment speed, as measured by the coefficients of variations, is higher in urban than rural markets. This indicates an overall higher frequency of disconnected links among urban foodgrain markets. This is reflected in the numbers in the first row of the table. For wheat, for instance, only 32 percent of urban market links have significant long term price relationships, implying that the majority of wheat urban markets are really not affected by what happens in the rest of the country. The detailed results of the correlation analysis carried out earlier showed that this is particularly the case for major cities like Cairo, Alexandria, and Port_Said, which seem to be almost entirely

Table 10--Comparative dynamic indicators of market integration

Indicator	Egypt Wheat Rural	Egypt Maize Rural	Egypt Rice Urban	Egypt Wheat Urban	Egypt Maize	Bangladesh Rice	Malawi Maize
Percentage of significant market links	75	60	63	32	62		
Average μ of Long term multipliers $\mu^{i,j}$	0.68	0.57	0.61	0.35	0.48	0.73	0.49
Standard deviation of $\mu^{i,j}$	0.25	0.26	0.26	0.36	0.29		
Average τ of times $\tau^{i,j}$ to adjust to long term (in months)	4.47	4.79	4.85	3.53	2.77	2.6	5.7
Standard deviation of $\tau^{i,j}$	1.56	1.99	1.95	1.64	1.18		
Ratio μ/τ of averages of long term multiplier to time to adjust	0.15	0.12	0.12	0.099	0.17	0.28	0.086

Note: The time τ to adjust to the long term value μ is given by the first time such that $|\mu_\tau/\mu - 1| < \varepsilon$, and $|\mu_k/\mu - 1| < \varepsilon$, for every $k > \tau$, where ε is pre-specified tolerance limit (in our estimation it was taken equal to 0.01), and μ_k is the interim multiplier after k period.

segmented from the rest of the country. The observed segmentation may reflect a dichotomy between the import-dependent urban wheat markets and rural markets that are more closely linked to domestic production. The numbers for maize do not vary much as that grain is hardly consumed in urban markets. For rice, comparison could not be made, due to unavailability of urban price data.

Finally, the comparison of the above results with that of other countries (Bangladesh and Malawi) shows a relatively modest level of integration of foodgrain markets in Egypt. The results from the two countries cover similar periods and focus on the main foodgrains in these countries, i.e., rice for Bangladesh and maize for Malawi. Whereas Bangladesh has adopted a piecemeal approach to liberalizing its foodmarkets over a long period of time, Malawi has initiated the reform of its domestic markets in 1984. The figures in the table indicate that foodgrain markets in Egypt are much less integrated than rice markets in Bangladesh and hardly better integrated that maize markets in Malawi. The two comparative countries are both at a lower level of economic development and have a much less developed infrastructure than Egypt. Accordingly, one would have expected a higher degree of integration among Egyptian food markets. That would also indicate real scope for ongoing market reforms to contribute to improving market integration in Egypt's foodgrain economy.

6. CONCLUSIONS AND POLICY IMPLICATIONS

This paper has examined several issues related to market integration for grains markets in Egypt. Its main objective was to document the extent of market integration for major grains based on time series of monthly prices at the governorate level. The analysis has covered a period that for urban prices extends from 1976 to 1992 and for rural prices from 1982 to 1992. Therefore, the analysis covers both the pre-reform period before 1986, and the post-reform period after 1986. However, it is important to realize that the reform package was not uniform among commodities. For example, reforms have affected marketing of rice mostly during the last year of the sample period. The conclusions on the post-reform period should therefore be taken with some caution. Despite these limitations, the study provides a first attempt at analyzing integration among foodgrain markets in Egypt. Its conclusions and findings that are summarized below constitute a useful benchmark for future studies in this area, as the reform process goes on.

First, in spite of the dramatic changes in production and marketing regulation since 1986, reforms have not destabilized foodgrain prices. The private sector has succeeded in gradually expanding its participation in the distribution process, which was previously mostly controlled by the government, without destabilizing local foodgrain prices.

Second, there is some indication that the degree of segmentation among foodgrain markets has decreased during the reform period. This is the case for rural wheat and maize markets, but not for rice markets. Markets for the first two crops have been liberalized much earlier, which has brought about the decrease in the number of segmented markets. The above conclusion may be affected by the very short period of liberalization that is contained in our sample. Furthermore, price comovements, as measured by correlations of first price differences, have also increased in the second period.

Third, urban markets, particularly wheat and to a lesser extent maize, exhibit a much higher degree of market segmentation. The most segmented markets are the major centres, Cairo, Alexandria, and Port Said, which exhibit price dynamics that are entirely disconnected from the rest of the country.

Fourth, the extent of market integration, both in terms of magnitude of market interdependence and speed of price transmission, was until 1992 very limited. This has been observed in spite of the relatively high development of infrastructure and communication networks in Egypt. Past market intervention has helped to generate uniform price structures. But, since these prices could not be controlled at the same time and everywhere in the country, the extent of dynamic adjustment was generally low and slow.

The present study suggests that the process of market reform until 1992 did not produce major structural change in terms of improved market integration. Even if prices seemed to be moving together and responding to signals originating in various parts of the country, in general the magnitude of the response was limited and its speed quite low.

Urban markets seemed to have a much lower magnitude of integration compared to rural areas. However, the speed of adjustment was higher among these markets, reflecting the better communication and infrastructure network in urban areas. The following part of the study turns to the adjustments in the domestic system of output distribution that have underlined the above changes.

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